

Western Connecticut State University

Operation Popeye
...and Weather Modification As a Weapon of War

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Dedicated To:

To all people that helped through this process. Your help I will never fully be able to be thank you for.

Abstract

This essay is about weather modification. The essay covers time period from end World War Two until sign of treaty Convention on the Prohibition of Military or Any Other Hostile Use of Environmental modification Techniques. The change would occur in the society over such time in the United States. The use of weather modification during the Second Indochina War would cause a series of events to unfold to cause change in world thinking about environmental change. Therefore this paper traces the change that occurred over this time period.

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Introduction

Weather and the environment have a profound impact on human beings. There several different consequences when a major environmental event makes an impact on human history. These events have a type of impact so rare and so major as to alter everyday life and cause humans to change their behavior. Some of these types of events are drought, flood, tropical cyclones, and snowstorms. The impacts of these types of event are dependent on different factors, such as how humans prepare for such events.

Just after the Second World War a new technique was developed that would promise to enhance such preparation. This technique would become known as weather modification, and it changed how weather would be conceived. Weather modification could have constructive applications, and showed much promise. It could be applied for preventing crop failures and stopping floods and other negative weather effects. Yet despite these positive effects, these new techniques also caused debate over whether changing the weather was a form of playing God and altering unnaturally the human population. Therefore, although experiments in weather modification in the United States between 1946 and 1974 showed that it could be a useful element of military strategy, development assistance, and private corporate profit, weather modification was ultimately abandoned because the legal and ethical issues raised by modification practices outweighed the potential benefits.

Weather modification, like any other attempt by human to change their environment, is an attempt to bring a level of control and stability to the world and protect it from extreme change. These extreme changes could be simple as drought or flooding for a region that normally does not experience such weather conditions. Weather modification seeks to alleviate extreme weather events to limit human suffering. Two useful examples of the need to alleviate natural but unusual weather events can be seen through examining the “dust bowl” event in the American Midwest in the 1930s and rare New England hurricanes.

The events of the Dust Bowl of the late 1920s and 1930s would be an example of how the weather produced profound geographical and geological changes, with considerable human implications. In that case, the attenuation of native vegetation in the form of grasses in the face of unusual weather destroyed the ability of native soil to remain in place. Despite the significance of the weather on these events, however, historians tend to focus only on the aftermath of these weather events, not on the weather itself.¹

In the case of the Dust Bowl, like many other cases, the implications of weather events are only realized at a much later date. Given that the Dust Bowl devastated multiple states, congressional action was clearly required. Yet Congress only acted after the dust cloud had reached the capital in Washington DC.² Clouds of dust needed to traverse over 2000 miles for political action to be taken.

¹ Donald Worster, *Dust Bowl: The Southern Plains in The 1930s*. (New York: Oxford University Press, 2004) 7-8

² *Ibid* 184-185

Tropical Storm Irene in 2011 and Hurricane Sandy in 2012 provide more evidence of how weather events tend to be ignored until their profound impact is felt by a critical mass of the population. Although major tropical storms are rare in the New England area of North America, minor tropical weather events occur with some frequency, even if there is sometimes a long period of time between events. If the storm had hit the United States lower latitudes, it would not have been as bad because of the soil make-up in the Mid-Atlantic States or southern east coast of North America. Since the New England states have glacier till soil, a smaller hurricane causes a great deal of flooding and destruction in New England. These aforementioned examples show how the weather events can have a major impact on human life.³

When the truly devastating impact of weather events is actually felt, humans have a natural tendency to want both to prepare for the next event, and if possible, to prevent it. Therefore human nature dictated that if given the means to control the weather and the environment, most would jump at the opportunity. Controlling the weather would be appealing because it would eliminate the uncertainty involved in the obvious inability to precisely predict weather events. Having such control over the environment would be very tempting.

The ability to control weather events is not merely a matter of science fiction. Human ability to control the weather and to predict outcomes of weather events were among the advances in the field of meteorology during and immediately after World War Two. One of the advancements in the field of

³Nicholas, K Coch. October 13, 2012. "Hurricane Irene - A Catastrophic Hydrological Disaster for the Northeastern U.S." Lecture, Science Building, Western Connecticut State University, Danbury, CT.

meteorology that made weather modification more feasible was radar technology. Radar's well-known military application was to detect aircrafts in flight; however, in a meteorology application it could also be used to detect water condensation in different forms and density. These advancements in the field of meteorology will be a main discussion point in this thesis, with particular attention paid to weather modification and its effect on regional weather patterns.

For the purposes of this thesis, weather modification will be defined as an intentional act to modify the weather. The paper will not discuss nonintentional acts of weather modification. An example of a nonintentional act to modify the weather would be what in common parlance is called "global warming"; that is, the human-caused increase in atmospheric levels of carbon dioxide, which has contributed to a shift in global temperatures. Our focus will be, in particular, on such techniques of willful weather modification such as cloud seeding, in which the weather modification has significant effects, and can even be used as a weapon of war. We will spend less time considering other methods of weather modification such fog dispersion, the effort to use techniques to control visibility for airplanes through clearing low clouds and fog. The limited space and time for this thesis will require us to focus on those aspects of weather modification with the greatest potential impact on human lives.

Another important consideration of this thesis is that understanding weather modification requires at least an elementary background in meteorology. Therefore, a brief digression into meteorology, the modern-day study of weather, becomes necessary. Meteorology is a multidisciplinary field of science containing aspects of physics, chemistry, mathematics, and computer science; without

combining these fields of study, the weather would be more difficult to study and understand. The vocabulary is also unique to the field, but every effort will be used to explain key terms when necessary, or technical terms will be replaced with other common-use terms that are more accessible to the public.

The first step necessary to understanding weather modification is the physics which occurs on the molecular level in clouds. Water is a dipole molecule, which means water functions like a magnet. However, the magnetic-like properties of water are not necessarily enough to cause water vapor atoms to be attracted to each other and coalesce into droplets to fall from the sky as rain. The production of rain also requires collision, which occurs in part at random and by chance.⁴

Other processes can cause water molecules to coalesce, but this depends on where the cloud is located in the atmosphere. There are two basic types of clouds. The first cloud, a warm cloud, is located in the atmosphere where the temperature is not below zero degrees Celsius. The second type of cloud is located in an area of the atmosphere where the temperature is below zero degrees Celsius. The physics of how raindrops grow is key for understanding how weather modification programs work. There are several different theories and models about water droplet and ice crystal growth in clouds. The programs to be discussed in this thesis will involve both warm clouds and cold clouds. Any processes caused by humans that affect this process of cloud growth will be

⁴ John Walles and Peter Hobbs, *Atmospheric Science: An Introductory Survey*, 2nd ed. (Burlington, MA: Academic Press, 2006), 209.

considered intentional and defined as weather modification for the purposes of this thesis.

Consider the location of the bulk of the United States land mass. In this land mass there could be a wide range of possible weather conditions and events, from tropical events to arctic events. An example of these variable weather conditions can be seen by the fact that the state of Arizona experiences a monsoon season, a tropical event involving warm clouds. Yet this very same state also experiences snowstorms from very cold clouds.

In other words, the United States encompasses a vast area that has wide-ranging weather events. The United States government, through various federal agencies, collects data about these weather events. The government has been doing this continually since 1890 with the help of citizens under the Organic Act, which created the Cooperative Observer Program. This program does not require citizens to participate in program, but rather supplies data freely to field meteorologists who can use this data as they see fit.⁵ The government had accumulated over fifty years of data on weather by 1946, when the first experiment in weather modification occurred in the United States.

The government and military have always had an interest in weather, because of the impact weather has on society and humans. Therefore, weather control through weather modification became a very tempting tool to develop. If the government could control the weather, it would be more powerful than any military force because weather control meant the ability to create famine through

⁵ National Weather Service, "NWS Cooperative Observer Program," accessed May 19, 2013, <http://www.nws.noaa.gov/om/coop/what-is-coop.html>

crop failures, devastation through drought and floods, and the ability to destroy infrastructure, among other effects.

Ultimately the unpredictable negative impacts of altering weather patterns would be the undoing of research into weather modification in the United States. Ultimately, people could not accept the changes that would cause by weather modification, especially in the volatile political climate of the late 1960s and early 1970s.

This study will employ a chronological approach to the development and research of weather modification systems in the United States from the first experiments into modification in 1946 to the signing of the Weather Modification Convention in 1976. Rather than studying every instance of the application of weather modification, this thesis will examine key turning points in both military and civilian weather modification operations. It will utilize sources from government publications about weather modification, as well as key pieces of investigative journalism from the 1960s and 1970s, as the press exposed to public previously secret military programs using weather modification technology. The significance of the order of events in these cases necessitates a chronological approach.

Weather is a global event. No matter how small a weather event may seem, it will in some way affect every place on planet Earth. Therefore, while this thesis focuses on United States weather modification operations, to give a more complete account of history of weather modification during this time period, a global approach becomes necessary. This thesis will thus examine weather modification at different places as building blocks to be used in piecing together

how each piece of information forms a picture and a coherent story of weather modification.

The Postwar Period and the Determination of the Viability of Weather Modification

This section will examine the postwar years from 1946 to 1950, which can be classified as the early years of weather modification. During this time, scientists experimented with methods of cloud seeding. Both in the private and public sectors, such experiments with weather modification began shortly after the conclusion of World War Two. The weather modification experiments at the time required both military and civilian operations, and each had different aspects. The motives for these weather modifications in each operation were different, for the intended outcomes were dependent on the group of people who was carrying out the operation to modify the weather. Understanding the motives of these respective groups by an examination of their goals for those operations is crucial.

One of the first groups of people in the United States to begin experimentation with weather modification was those working for public works-related entities in the Western United States. They became involved because the water supply had been a known issue in this area. In the nineteenth century, the increase of population during the western migrations of the US population to these areas had taxed the natural water supplies. An example of this concern about water shortage were the reservoirs built to supply water for arid regions of

California and Western areas of the U.S. as the population grew in those regions.⁶ The O'Shaughnessy Dam was built to supply the city of San Francisco, California with a stable water supply after that city's devastating earthquake in 1906. There were other projects that took place under the New Deal programs, such as the Hoover Dam for the city of Las Vegas, Nevada.

However, at the beginning of the postwar era, a new method for water management was under development in the western states. On November 13, 1946, the first large scale experiment was carried out by Vincent Schaefer. Schaefer worked for the General Electric Corporation under Irving Langmuir, who won a Nobel Prize in 1932 for his work in surface chemistry. Schaefer himself became known for copying a snowflake in 1940 using a thin plastic coating called Formvar.⁷ Then, in the early 1940s, he began work with precipitation static, ice nuclei, and cloud physics.⁸ By 1946, he was able to use dry ice as an agent to modify clouds by causing ice crystals to form in super cool clouds,⁹ which in turn caused a cloud to precipitate.¹⁰ Modification of clouds could be carried out to force clouds to precipitate prematurely, by the use of dry ice. Schaefer's experiment was sponsored by the General Electric Corporation.¹¹

⁶ Kendrick A. Clements, "Engineers and Conservationists in the Progressive Era" *California History*, 58:4 (Winter, 1979/1980): 285

⁷ M.E. Grenander Department of Special Collection and Archives, "VINCENT J. SCHAEFER PAPERS, (UA-902.010), 1891-1993," <http://library.albany.edu/speccoll/findaids/eresources/findingaids/ua902-01.html> accessed Dec. 6, 2013

⁸ Ibid.

⁹ Supercooled clouds are clouds formed by water droplets which are below the freezing point of water, but the water remains in a liquid form instead of a solid form of ice crystals. Further definition and explanation can be found in: Wallace and Hobbs

¹⁰ "Wartune" Magazine, Weather Under Control Forecast: High Legal Winds Followed by Better Climate, February 1948, Record Group 331, Box 7416, Folder 1, National Archive Records Administration, Archive II, College Park, Maryland. (hereafter cited as NARA II, RG331, Box 7416, Folder 1.) 1

¹¹ Ibid., 1.

After this successful experiment, and the other similar experiments which replicated these results, private corporations began to consider the legal ramifications of this technology. In one particularly notable test, researchers with General Electric managed, on December 19, 1946, to cause precipitation of eight inches of experiment-made snow to fall over large parts of Vermont and New York, when the forecast only called for a “fair and warmer” day.¹² This result gave pause to General Electric about continuing these experiments, because of the very real the legal implications: General Electric lawyers imagined the possibility that the company would be sued for damages for modifying the weather to the detriment of some.¹³

Therefore, before General Electric could conduct any further experiment in weather modification, a solution was needed to continue their experiments while simultaneously reducing the liability they would incur from such experiments. The solution was found by General Electric through a contract with the Army Signal Corps that they obtained in March 1947.¹⁴ The Army agreed to this joint venture in part because of their close connections to General Electric researchers at the time. The civilian meteorologists in the Signal Corps engineering laboratories were themselves former General Electric employees.¹⁵

Originally, however, General Electric had attempted to negotiate such a contract with the US Navy. The Navy later became a part of the contract as a cosponsor.¹⁶ Both the Navy and Army had an interest in weather modification

¹² Ibid, 7.

¹³ Ibid, 7.

¹⁴ Ibid, 7.

¹⁵ Ibid, 7.

¹⁶ Ibid, 7-8.

research. This combination of Army and Navy engineers, working together with private companies initially led by General Electric, became known as Project Cirrus.¹⁷ Project Cirrus also involved the US Weather Bureau and eventually expanded its scope of operations from New Mexico and the Atlantic Ocean basin off the coast of Florida. In part, this geographic range reflected one of Project Cirrus's main goals: attempting to modify hurricanes.¹⁸ The first priority was to modify the course or track of a hurricane as it made landfall. Yet this would merely result in hurricanes devastating a different area. Therefore, even the government was forced to stop such hurricane experimentation because the unintended consequences and potential liability were simply too great.¹⁹

By 1950, the Air Force was being used as a source of supply for the cloud seeding operation. The Air Force supplied, for a test flight: "two (2) B-17 aircraft, one (1) L-5 aircraft and appropriate aircraft crews; four (4) pilots, one (1) Navigator and four (4) enlisted flight personnel."²⁰ The Air Force, by the commitment of the aforementioned supplies, became inextricably involved in Project Cirrus as well. However, the Air Force's involvement in the project is somewhat limited because of the small size of the force in 1950. The Air Force chose to not fully dedicate the supply above to the project, but rather to station them near central operations and make them available on short notice.²¹ The cautious position taken by the Air Force in limiting their participation is

¹⁷ F.O. Carroll to Headquarter USAF, July 12, 1949, Sarah Clark: Correspondence File, Record Group 342, Box 3717 National Archive Records Administration, Archive II, College Park, Maryland (hereafter cited as NARAII), RG342, Box 3717.

¹⁸ Congressional Research Service, *Weather Modification Programs, Problems, Policy, and Potential*, (1978; repr., Honolulu: University Press of the Pacific, 2004), 39.

¹⁹ *Ibid.*, 39 - 40.

²⁰ F.O. Carroll to Headquarter USAF, July 12, 1949, NARAII, RG342, Box 3717.

²¹ *Ibid.*

somewhat perplexing, considering that the Air Force was a pioneer in weather modification. It had begun the process of cloud seeding in April 1948. The area targeted for cloud seeding by the Air Force at that time was a region of Japan that was then experiencing a drought.²² The issues that arose from the lack of water were so acute that water had to be flown in from Tokyo. The water in this region was rationed, so that for several weeks, people could only access water for two hours per day.²³ The outcome of the Air Force attempts to cloud seed in this case are unclear. What was reported back was only a recommendation that cloud seeding be further researched.²⁴ However, an internal memo shows that Air Force planes could be used for the cloud seeding operation, and that therefore means had to be found for cloud seeding, such as artillery.²⁵ This process would use artillery shells to spread the chemical agents to generate the cloud.

One possible reason that this Japan experience caused the Air Force to be reticent about cloud seeding was a concern that this seeding might cause unintended weather effects on the Korean Peninsula. These lessons were brought to bear during Army experiments in Japanese cloud seeding in 1950 that followed the Air Force operations in Japan. The Army was aware of the legal liability it may incur during such operation, example of this legal liability consideration effect of such operation on neighboring countries such as Korea. This was particularly important to the United States Military at the time, since 1950 was the year that commenced the Korean War. The army reached the conclusion of cloud seeding operation in Japan in 1948 would have no policy

²² M. H, Halef to Marquat April 3, 1948, NARAII, RG331, Box 7416, Folder 1.

²³ Levy and Marquat to Department of Army, April, 1948, NARAII, RG331, Box 7416, Folder 1. I

²⁴ Ibid, I

²⁵ Ibid, I.

impact on Korea.²⁶ This was important, as the United States did not want to add atmospheric uncertainty to the already volatile situation on the Korean peninsula. In any case, for whatever reason, by 1950 the Air Force seems to have been backing away from taking the lead on seeding operations to modify the weather. This position may be related to other events at the time.

Another agent of the government that was involved in modification was the Weather Bureau.²⁷ This civilian agency of the federal government took a different approach to weather modification. Weather Bureau scientists believed that silver iodine would be a better agent for a large-scale operation.²⁸ The Weather Bureau was also more focused on the modification of the energy of storms.²⁹ Their position resulted from the way storms are thought about in community of atmospheric scientists, as agents for the transfer of energy. This concept is similar to that of heat mechanics, in which heat is understood as a mechanism to transfer areas of energy from high amounts to an area of low amounts of energy.

On the West Coast, the California Electric Corporation was also conducting weather modification experiments in the late 1940s. These experiments were cloud seeding experiments to determine if clouds could be generated in a localized area to produce rainfall over a targeted reservoir in order to fill the reservoir during a period where natural low amounts of rain occurred.

²⁶ Memo for the Record, April 9, 1948, NARAII, RG331, Box 7416, Folder 1.

²⁷ The Weather Bureau would be transformed in the 1960s as the National Weather Service under the National Ocean Atmospheric Administration.

²⁸ Charles C. Bates and John F. Fuller, *America's Weather Warriors* (College Station, TX: Texas A&M University Press, 1986), 143.

²⁹ Horace R. Byers. "History of Weather Modification" in *Weather and Climate Modification*, ed. W. N. Hess (New York: John Wiley & Sons, 1974), 25-26.

The army also kept records on the California Electric Corporation.³⁰ In a paper by Stuart A. Cundiff dated April 17, 1950 explained the results of the experiments carried out by the California Electric Corporation in 1947 and 1946. In particular one of the results was a 14% increase in precipitation. This paper was placed into a military file about cloud seeding operations.³¹ These experiments were covered in newspapers in the area and the US Army Signal Corps did compile a file on the experiments conducted there.³² With these experiments and others, the military knew by early 1948 that cloud seeding could be successful and had major implications.³³

Thus, in conclusion, by the postwar era, parts of the United States military were teaming with the private sector to use newly invented cloud seeding techniques to increase the water supply in drought-ridden regions. This was true not just in arid areas in the United States, but around the world as well. After World War II, the Army, along with the Air Force, had operations in Japan to increase the water supply by inducing rainfall. The introduction of ideas of how to induce rain occurred near the same time of Project Cirrus was being conducted. By late 1940s the military was intensely interested in weather modification by the method of cloud seeding, and this interest seems to be tied to the potential profitability of the technique for private sector corporations such as General Electric, which brought the idea of weather modification to the military as a

³⁰ Ernest to Kennedy Record Group 331, Box 7416, Folder 2, National Archive Records Administration, Archive II, College Park, Maryland. (hereafter cited as NARAII, RG331, Box 7416, Folder 2.)

³¹ Stuart A. Cundiff, April 17, 1950. "An Industrial Operation to Produce Precipitation" NARAII, RG331, Box 7416, Folder 2.

³² Ernest to Kennedy NARAII, RG331, Box 7416, Folder 2

³³ Stuart A. Cundiff, April 17, 1950. "An Industrial Operation to Produce Precipitation" NARAII, RG331, Box 7416, Folder 2.

means to reduce their legal liability. The Army conducted experiments in weather modification with other armed services beginning in October 1948 under Project Cirrus.³⁴

The implications and outcomes of Project Cirrus can be evaluated in a few different ways. One feature of note from these files is that the Army and Air Force engineers seemed different points of view on weather modification, with the Air Force being much more concerned about the potential unintended consequences of using these techniques. As established above, the army had a pressing motivation for this research: the lack of drinkable water in Japan right after the war.³⁵ The Army was basically administering Japan after the war. If the population did not have water to drink, it might have led resistance among the civilian population of Japan to the postwar occupation. The evidence of this concern is seen in correspondence written back and forth between officers stationed in Japan and the mainland about different ways to try to induce rain over Japan.³⁶ The Army went as far as to consider the implications of this action for the volatile Korean conflict if they were able to successfully cause rain to occur.

However, the Air Force was taking a much more limited role in cloud seeding operations. The Air Force was unwilling to dedicate equipment and men to a solo project of their own, and was only willing provided resources to the Army on a limited, on-call basis.³⁷ Despite Air Force caution, the interest in expanding both the civilian and military uses of weather modification in the

³⁴ Ewin R. Petzing to Chief of Staff May 12, 1949 NARAI, RG342, Box 3717.

³⁵ Levy and Marquat to Department of Army, April, 1948, NARAI, RG331, Box 7416, Folder 1.

³⁶ Putt to Commanding General, May 19, 1949, NARAI, RG342, Box 3717

³⁷ Ibid.

1950s led to its widespread use both in development assistance and as a weapon of war for more than two decades.

The 1950s and early 1960s

The 1950s and early 1960s was an era of growth in the field of meteorology. As mentioned above, there were advances in radar, but that was not the only advancement to come out of the postwar era that would impact the field of meteorology. The most important advancement was in computer technology. The computer would allow for faster computation equations and the processing of larger amounts of data and would grow to be crucial in the field of meteorology.

The 1950s saw another government agency to begin experimenting with the use of weather modification to cause rainfall in different countries. The State Department entered in the weather modification field in 1951.³⁸ The State Department had a clear motivation to move into the field. The military's use of cloud seeding to address a water shortage in Japan showed that weather modification could be used as a form of development assistance throughout the world. The State Department could create situation where it would have godlike power over counties by offering promise of rain.

The first operation to emanate from the State Department operation were conducted in Israel in the Jordan Valley. There was an idea to start such an operation in the region as early as 1951, as evidenced by State Department talks

³⁸ Project agreement no.070403, December 17, 1953, Records Group 469, File 71-12-050 National Archive Records Administration, Archive II, College Park, Maryland. (hereafter cited as NARAII, RG469, File 71-12-050.) : 1

with Israel.³⁹ One of the goals of these operations was to increase the amount of water in the region for the people and the farms.⁴⁰

Water in the Middle East is a very precious commodity. Water in general has always commanded a great deal of attention from governments in the region. The United States considered entering into an agreement with the Israelis to induce artificial rain, since this would provide a strategic advantage to the Israeli government if they could control where it rained. As part of that agreement, the United States was to train citizens of Israel in the techniques of weather modification.⁴¹ If the Israelis were able to master weather modification, they would be able to deprive other populations of water by redirecting the rain.

The Israelis were serious about the type of program they wanted to carry out, as evidenced by the type of training they wanted to receive from the United States. Some of the aspects of the training were “fuel research and production, training in techniques, cloud and rain physics, mechanisms, and practical field problems.”⁴² The knowledge that was being gained by Israel could be also applied to other fields, especially fuel research.

Weather modification was not simply a process indicated by a contract signed between the Israeli and United States governments, nor was it a necessarily proven operation even when considering early results of weather modification project in the United States. In 1953, when the contract was signed, experiments had only been carried out in the US for about seven years. Although the U.S. Army thought weather modification was viable and could be used, not all

³⁹ Ibid, 1.

⁴⁰ Ibid, 2.

⁴¹ Ibid, 2.

⁴² Ibid, 2.

agencies or other government believed that weather modification could be carried out consistently or successfully. The operation in Israel did have some issues when it came to funds to run the project, and because of this, by December 1, 1954, about a year after the agreement between the two governments was signed, the project fell into trouble over a lack of updates on progress.⁴³

However, this project was not only one being carried out by the State Department during the 1950s in the Middle East. After the project was cancelled in Israel, a plan was formed to apply these techniques to Lebanon. The project in Lebanon was conceived around March 11, 1955.⁴⁴ The goal in this project was increase the amount of precipitation over Lebanon in stop a potential drought.⁴⁵

The location of Lebanon was favorable to establishing a cloud seeding operation over the area. Lebanon was blessed with normal weather patterns for moisture flow, increasing the predictability of the effects the operation would have on the region. Nevertheless, some the countries could be impacted by this operation, and were therefore considered early on in the planning for it, were Syria and Iraq.⁴⁶

The Lebanon project was a significant project for the State Department. They drew on approximately seven years of information from weather modification experiments that had been conducted. In State Department correspondence, officials calculated the estimated cost-benefit ratios went as high

⁴³ Dwight Rugh to Ralph Goldman 12/1/1954 NARAII, RG469, File 71-12-050.

⁴⁴ Memorandum, "Cloud Seeding Operations for Lebanon", April 1, 1955, Records Group 469, National Archive Records Administration, Folder Cloud Seeding Operation, Archive II, College Park, Maryland. (hereafter cited as NARAII, RG469, Folder CSO) .

⁴⁵Ibid

⁴⁶Ibid

as 300 to 1 for the use of silver iodine to generate clouds.⁴⁷ The reasoning behind such estimates is that water is very important part of life on Earth. Water is so important to life on Earth that it could not exist in any way without it. So cloud seeding to increase water in dry areas would have a huge impact for the region.

Experts were concerned about the project's being experimental and the unpredictable effects on climates in the region.⁴⁸ However, even a small increase of rain during a drought in the region would have a significant impact on the economic situation in Lebanon.⁴⁹ The State Department was also concerned about which type of clouds were over Lebanon. Depending on whether the clouds were warm clouds or super cool clouds, they would cause silver iodine to be ineffective; the iodine technique was only effective if super cool clouds were present.⁵⁰

The Lebanese government wanted to explore the option of weather modification in more official way. Therefore, with order number 72, the President of the Lebanese Council of Ministers established a commission to examine a proposal for more permanent cloud seeding that was submitted by the Water Resource Development Corporation (WRDC).⁵¹ This corporation was mentioned before in the State Department letter discussing possible corporations that would have expertise in weather modification overseas.⁵² These connections continue to suggest private/public partnerships in weather modification.

⁴⁷Enholmgreen, May 25, 1955, NARAII, RG469, Folder CSO, 2.

⁴⁸ Ibid, 2.

⁴⁹ Ibid, 2.

⁵⁰ Ibid. 3.

⁵¹ Order # 72, December 20, 1956 NARAII, RG469, Folder CSO,

⁵² Enholmgreen May 25, 1955 NARAII, RG469, Folder CSO, 3.

The proposal by the WRDC is quite extensive. The company boasts of expertise in various weather modifications in various seasons throughout the world in the foreword of the report.⁵³ They suggest the possibility of increased precipitation in target area from 10 to 50 percent.⁵⁴ These figures seem to be a bit high compared to some of the early examples mention in this report, in which it was estimated that increase were only as great as .01 inches of rain increase. However, there are examples where weather modification events led to massive amounts of precipitation being released, as in the case of General Electric's causing of massive accidental snowfall in upstate New York with their early experiment in 1947.

The WRDC report offers some historical proof for its claims. Although it includes some events prior to end of World War II, the historical proof the report uses relates to General Electric experiments from 1947 and later, and how weather modification was applied in the USA to increase the precipitation with in large-scale atmosphere disturbances.⁵⁵

Now, this suggests the formation of a partnership between the government and private corporations. This relationship in this field grew after the late 1940's. The legal implications of weather modification forced this cooperation between the public and private sectors. The military assistance in this relationship was used to provide the legal cover that was needed for weather modification, and the WRDC Company took full advantage of this relationship. The State Department

⁵³ Water Resources Development Corporation, "A Report on a Proposed Weather Modification Project for Lebanon" Forward, NARAII, RG469, Folder CSO, I-III

⁵⁴ Ibid, III

⁵⁵ Ibid, V- IV.

was also assisting in the relationship by providing a place outside the United States to conduct these operations.

Therefore, by the middle of the 1960's the relationships between these companies and government were strong. The moral implications of weather modifications were considered both by the government and by corporate entities, but not always fully. This lack of consideration would lead to a decision to use weather modification not only as a diplomatic means to assist people, but as a military means to destroy them.

Weather Modification and the Second Indochina War

Weather modification activity in Vietnam undertaken by the United States was purely under the auspices of a military operation. The operation's code name was Operation Popeye. It was primarily aimed at increasing the amount of rainfall over Vietnam from monsoons and other tropical weather systems, such as tropical storms. The United States' military forces would gain tactical advantages from such operations. One of these advantages would be control over where rainfall came from, at what time it came, and how much rainfall ensued. I will not argue the merits of such weather modification activities. Rather, I will contend that during the timeframe of escalating United States intervention in Southeast Asia (1965-1973), the United States military came to the conclusion that while weather modification can be effective in certain circumstances, its impact was hard to quantify.⁵⁶

The United States began operations of weather modification in Indochina in March 1966. These operations thus coincided with the Johnson administration's escalation of direct American involvement in Vietnam, which had begun in earnest in 1965. Operation Popeye was conceived in secrecy due to the politically sensitive status of weather modification at the time. The operation was therefore to be carried out under the guise of reconnaissance.⁵⁷

The controversy that caused the military to carry out weather modification clandestinely stemmed from findings about the human cost of these programs.

⁵⁶ For another essay, I would suggest new method that now becoming wide used meteorology field for determining model accuracy with method known as heincasting. [Need this note? I'd delete it.]

⁵⁷ Seventh Air Force, "7AF Plan 463-67 (R) Popeye, November 7, 1966 page 1, National Archive Records Administration, Records Group 472, Box 29, Folder 206-02, Archive II, College Park, Maryland (hereafter cited as NARAII).

The impact of weather modification extended well beyond the scope of its military uses. By this time, weather modification was also known to affect the mood of people subjected to it, increasing the incidence of suicide, depression, and other psychiatric conditions. Also, weather plays a role in increasing crop diseases. By the mid-1960s, it was also known to have a negative (and unpredictable) effect on civilians' food and water supplies.⁵⁸

Another reason for controversy was the unpredictable economic impact of weather modification. Although a change in weather could have a positive economic impact, the impact could also be negative, as explained in the unintentional snowfall in upstate New York mentioned earlier in this essay. The economic impacts could also be positive in one area but negative in another. Whether the economic, cultural, or climactic impacts of weather modification were seen as positive or negative depended on the point of view of the observer. This statement should be taken in its most literal sense, because depending on where an observer was located, increased cloud cover or precipitation could be good or bad. Drought over the Ho Chi Minh trail, for example, might fit the military objectives of the United States, but an ensuing drought in South Vietnam might not. This is the reason this operation need to carried out in secrecy, because the political fallout from robbing other people (such as Cambodians and Laos) of rain to increase rain over Vietnam for military reasons would be immense.

⁵⁸ W. R. Derrick Sewell, [correct?] "Weather modification: When Should We Do It and How Far Should We Go" in *Weather Modification Science and Public Policy.*, ed. Robert G. Fleagle (Seattle: University of Washington Press, 1970), 94-95.

The further reason for this operation was that there had been a successful test carried out over Laos. That test succeeded in extending the rainy season and was deemed a success by the U.S. Air Force, which supervised the operation. Therefore, based on these positive results, Operation Popeye went ahead as planned.

The operation had three major objectives. The first major objective was to target areas for increased rainfall. There was different level of priority targets first primary target was to deny in many operations of logistical support. The second priority was to degrade the traffic ability or the movement of information along the lines of communications for the enemy. The last priority for increase rainfall was to annoy and harass the enemy troops. The second major objective was to dissipate or suppress clouds or rain fall in areas example of the targets were clouds that prevented because suspicions, air support, attacks where visual notification was necessary, mobile air defense missiles and other transient targets.⁵⁹

The scope of the operation is on a synoptic scale—to use a meteorology term--because over the geographical region of Southeast Asia, where Vietnam was located, would synoptic scale weather events could be found on weather map of Vietnam. A key aspect of weather modification efforts is that they were done usually on a mesoscale, or as part of weather system, such within groups of clouds that would create a single mesoscale weather event. However, what the Air Force was doing in Operation Popeye was something much larger in scale than

⁵⁹ Seventh Air Force, "7AF Oplan 463-67 (R) Popeye", November 7, 1966 page A-I-1, NARAII, RG472, Box 29, Folder 206-02.

just a single mesoscale weather event. It tied many mesoscale modifications of weather into larger weather events that could be mesoscale weather events. The Air Force targeted two different monsoons over Vietnam: the Northeast Monsoon and the Southwest Monsoon. These two Monsoons would be considered synoptic scale weather events. Also these monsoons also run year-round functionally, and therefore, cloud seeding operations could be conducted all year round. The northeast monsoon runs from October through mid-April and the southwest monsoon runs from mid-May to mid-October.⁶⁰

The Air Force was not only planning on cloud seeding the two monsoons in Vietnam. They took advantage of typhoons and tropical storms that came over Vietnam or near it in order to seed more clouds after the storms passed because this created ideal conditions for cloud seeding after their passage.⁶¹

However, back in the United States, another story was unfolding. In 1966, the National Science Foundation (NSF) pointed out that no one knew how many people used weather forecasts to influence the social and economic decision-making process. The NSF urged scientists to study the extent to which people relied on forecasts. This question was significant; if no one relied on weather forecasting, then weather modification might be seen as more innocuous, since, first, it was less likely that enemies in war would rely on such data to make business decisions, and second, it was less likely that they would actually be aware that such modifications were taking place at all. In 1967, the National Center for Atmospheric Research also took on the task of examining the impact of

⁶⁰ Ibid, B-I-1.

⁶¹ Ibid, B-I-1.

human manipulation of the atmosphere. One of the findings of the report was that a solution on air pollution must be found before it became a cause of conflict.⁶²

However, the NSF report indicates that Johnson administration officials did not see reducing the potential damage caused by weather modification as a priority, since they had come to the conclusion by 1967 that weather forecasting was immaterial to a majority of Americans. This report then sidesteps the issue of whether using weather modification techniques as a tool to improve agriculture or for other purposes might have harmful unintended consequences. As mentioned in the earlier example in this thesis about the unintended increase of snowfall in New York State in 1948, private property landowners were already in fear of disaster if weather modification experiments continued. This example can be extended to apply to this later point, as people might be interested in keeping nonmodified weather systems for these reasons, and they would thus want to avoid intentional acts of modifying the weather.

While the unpredictable effects of weather modification continued to be a hindrance to using it for civilian purposes, that same unpredictability provided important advantages for the Air Force application of these techniques in Southeast Asia. If the Air Force could create a situation in which the enemy were forced to take some predictable action in response to unpredictable weather, this would operate as an aid to their military strategy. The importance of control over terrain and atmosphere on the battlefield was highlighted by US experiences

⁶² National Science Foundation, *Weather Modification Ninth Annual Report, 1967*, 70-71.

in Operations Steel Tiger and Tiger Hound in 1965, the year prior to the inception of Operation Popeye.

In 1965 and 1966, through Operations Steel Tiger and Tiger Hound, the Air Force conducted bombing operations in parts of southern Laos, and a combination of various naturally-occurring but unpredictable weather events, such as monsoonal rainfall which produced mudslides and made areas of the Ho Chi Minh Trail very difficult to navigate, created a problem for the North Vietnamese Army (NVA).⁶³ The Air Force documents that reported this observation saw the value the weather could play in conjunction with conventional military tactics such as bombings.

In Operation Popeye (1967-1972), what the Air Force created was a system of weather modification to enhance Other mission operations in Vietnam. For example, defoliation missions that relied on dropping napalm on forests would be more effective in conjunction with reducing the chance of rain from cloud cover. A reduction in rainfall would allow fire to spread and burn more of the land.⁶⁴ Such a reduction in rainfall would also force local populations, who were presumed to be sympathetic to NVA and NLF elements, into an agonizing choice about how to use their water supplies. Local villages could either choose to fight the fires or to keep sufficient water for other uses such as drinking.

In considering the effectiveness of Operation Popeye, one important factor was that the operation was secret, and therefore was not subject to popular pressure or bad press. This would change, however on July 2, 1972, when a New

⁶³ Seventh Air Force, "7AF Oplan 463-67 (R) Popeye", November 7, 1966 page A-I-1, NARAII, RG472, Box 29, Folder 206-02.

⁶⁴ Ibid, A-I-1.

York Times report by Seymour Hersh claimed that the first attempt at weather modification occurred in South Vietnam as early as 1963.⁶⁵ That the Air Force had considered this tactic as early as this time period fits in the timeline of implementing it by 1967, when Operation Popeye formally began.

As we have previously mentioned, in the early 1960s most weather modification was carried out under the auspices of the State Department, which had implemented weather modification programs in the Middle East for the purpose of providing water via artificial rainfall. Hersh's article now showed how key members of the State Department opposed weather modification being turned into a weapon of war.⁶⁶

Hersh was reporting this in July of 1972, around the same time as the Pentagon Papers were being made public by Daniel Ellsberg and the *New York Times*. In fact, the case reached the Supreme Court and the decision, which was announced on June 30, 1971 with a great deal of press coverage, ensured that the material in the Pentagon Papers would remain available on First Amendment grounds. In a sense, Operation Popeye was part of the case, as it appears in the Fourth Volume of the Gravel Edition of the Pentagon Papers, which was released in 1971.⁶⁷ Although Operation Popeye was classified, the materials in the Pentagon Papers were also classified; this was the major issue at stake in the case. The fact that the Pentagon Papers were made public clearly helped Hersh in his reporting. Hersh explains that the Central Intelligence Agency (CIA) first used weather modification when the Diem Regime was facing protests from the

⁶⁵ Seymour Hersh, "Rainmaking is Used as Weapon by US," *New York Times* July 3, 1972

⁶⁶ *Ibid*

⁶⁷ *The Pentagon Papers IV*, Senator Gravel ed. (Boston: Beacon Press 1971), 421

Buddhists in the summer of 1963; apparently the regime, with cooperation from the CIA, seeded clouds and created storms to disperse protesting monks. This tactic seemed to work, causing over seven inches of rain to fall on protests on two separate occasions.⁶⁸

Hersh's understanding of the operations reflects the same tactical goals mentioned by the military itself, with some difference in emphasis. Hersh cites the deterrence of troop movements of the North Vietnamese Army and the suppression of antiaircraft fire as the major operation objectives of weather modification. However, Hersh leaves out another objective, that of assisting the defoliation mission of the Air Force, out of his report entirely, which is curious, because it was just as important to the operation. This part of the operation, of course, had considerable moral implications.

Part of the sensitivity of these operations and perhaps why they were classified had to do with the nature of their approval process. The operation required Presidential authorization before the plan went into effect.⁶⁹ This meant that if these operations were to cause drought or flooding, or lead to environmental genocide, the blame for these human rights violations would lie squarely at the feet of the President (at the time of Hersh's writing, Richard Nixon).

Operation Popeye grew as time progressed. Hersh reports how, by 1967, the weather modification operations were being conducted over Laos during the war. At this time, an operation was in force to add chemicals to warm stratus

⁶⁸ Hersh, "Rainmaking is Used as Weapon by US," New York Times July 3, 1972

⁶⁹ *Ibid.*

clouds. This chemical had the benefit of causing acid rain. The effect of acid rain is well known in current times, but back during this time period, as was mentioned before, it was not seen as a significant problem. This acid rain had high pH content. It was thus highly acidic, and was meant to react with the metal in artillery and military equipment to cause it to fail.⁷⁰ By extension, if the pH was high enough to cause a chemical reaction with metal, then the rain would also be acidic enough to change the pH of the soil and water. This change would have had an extremely detrimental effect on plants, animals and humans. It must have led to the loss of crops, livestock and fish. The uncertainties with this sort of very volatile approach to weather modification are considerable, and it might have led, with prolonged use, to the collapse of the entire Indochinese ecosystem. Perhaps most resistance to weather modification might stem from opposition to these kinds of tactics.

Hersh supported a call for change as well based on the persistence of weather modification efforts. Weather Modification Operations were supposed to be stopped in 1967 by order of Secretary of Defense Robert McNamara. However, they continued anyway, and were in effect as late as 1972. Along with the environmental dangers and ecological consequences that can occur from weather modification, Hersh was also concerned with secrecy within the State Department concerning it.⁷¹ An incident prior to operation Popeye becoming active with State Department prior the Vietnam War was using weather modification as a means of giving aid to countries that need increase in water

⁷⁰ *Ibid.*

⁷¹ Seymour Hersh, "McNamara orders to end the rainmaking in 67 reported," *New York Times*, July 3, 1972. [correct?]

supply. The most recent one relevant to the region was India. President Johnson had also used his State Department to conduct weather modification over India in 1965, because the rainfall had been short that year as the monsoons did not provide the rain that it would normally provide the region.⁷²

Hersh's report makes it clear that the more weather modification became increasingly prevalent mechanism of war, the more that weather modification became unpredictable and problematic. Senator Claiborne Pell, reacting to the revelations about its use in Southeast Asia, commented that "this [weather modification] is Pandora's box." As a resident of Newport, Rhode Island, Senator Pell lived in an area which could be easily affected by weather modification, and he held hearings about such activities in the Senate's subcommittee on Oceans and International Environment.⁷³

⁷² Doel, Ronald, E., and Kristine C. Harper. "Prometheus Unleashed: Science as a Diplomatic Weapon in the Lyndon B. Johnson Administration." *Osiris* 21:1 (2006), 76

⁷³ Hersh, "Rainmaking is Used as Weapon by US," *New York Times* July 3, 1972.

Weather as a Weapon: The Aftermath

By 1972, with the advent of these reports on operations in Indochina, it was clear that the Pandora's Box of weather modification had indeed been opened. The public began to understand the prevalence of weather modification operations at the international level. The nation was in the midst of the Cold War. Not only that, but it was a time of great antiwar fervor, which was just cooling down as key members of the antiwar movement were getting elected to Congress. Now with the reports coming out in newspapers, Senator Pell called for an investigative hearing. Weather as weapon of war would change. This change would also have impact on the civilian use of the technology.

Therefore, on July 11, 1973, approximately a year after the first publication of the articles exposing Operation Popeye to the public, the Senate passed a resolution expressing an interest in the Nixon administration's pursuing a treaty to ban weather modification or any other geophysical or environmental modification as a weapon of war.⁷⁴ This resolution passed the Senate by a vote of 82 to 10.⁷⁵ After a year-long discussion, however, proponents could not pressure the executive branch to take a firm position on the issue.⁷⁶

⁷⁴ *Hearing before Subcommittee on Ocean and International Environment of the Committee on Foreign Relations, SR 71, 93rd Cong., January 25, 1974, 1.*

⁷⁵ Fleagle, Robert, James A. Crutchfield, Mohamed F. Abdo, and Ralph W. Johnson. *Weather Modification in the Public Interest*, (Seattle: University of Washington Press, 1974), 49.

⁷⁶ I still am waiting upon freedom of information act request I request on visit to National Archive 2 group of Henry Kissinger's State Department documents on weather modification policy points in College Park Maryland. Therefore I have little or no hope just like the Senators of getting information from Henry Kissinger and spirit of cooperation as to the policy points of weather modification for the State Department

However, Senator Pell would not relent in his fight against using geophysical and environmental devices as a weapon of war. Senate resolution 71 even expanded into areas other than weather modification. The resolution would go on to demand the banning of earthquake generating devices and devices that would modify the ocean.⁷⁷ The resolution also called for the treaty to be signed in Geneva, a neutral party place and be open for all nations in the world would be eligible to sign the treaty. The State Department took a noncommittal position on Senate Resolution 71. In the hearing conducted on January 25, 1974, Mr. Herman Pollock, the Director of the International Scientific and Technological Affairs Bureau, was forced to respond to questioning from Senator Pell, but his responses demonstrate this lack of commitment on the part of the administration is the excessive number of times that he reported that the administration was “studying” the issue.⁷⁸

Mr. Pollack continued his noncommittal answers when came to the operation over Indochina. When he was questioned by Senator Pell about whether the operation had any influence on the executive branch’s position on the ban, his answer was: “I can’t find way to respond to your query.”⁷⁹ Again, the State Department witness in this hearing was trying to evade the question.

As was explained earlier in the thesis, the State Department supported many divergent weather modification operations. The State Department has two points of view on this issue. The first one was that weather modification could be used as a tool to give water to countries that needed to increase their water

⁷⁷ Hearing before Subcommittee on Ocean and International Environment of the Committee on Foreign Relations, SR 71, 93rd Cong., January 25, 1974, 3-8.

⁷⁸ *Ibid*, 9.

⁷⁹ *Ibid*, 13.

supply. The second was that it might be diplomatically useful to deny water to states as a negotiating tactic. Also, part the reason for the State Department acting in this manner that is under the *realpolitik* leadership of Henry Kissinger the State Department was often willing to have a two-faced approach to these issues for strategic reasons. In the face Senate Resolution 71 and the hearing in 1973, the State Department was attempting to play down the importance of weather modification efforts, a tactic made clearer in 1974 by State Department unwillingness to make getting information to Senator Pell a priority.⁸⁰

Another consideration was the civilian use of weather modification in the treaty. Weather modification was being used for some time to fill reservoirs in the Western United States, as this thesis has previously mentioned. This civilian use of peaceful means of weather modification meant that people would not suffer as much due to drought. Since these water sources were used both for hydroelectric purposes and for drinking water sources, a shortage might mean power outages, a shortage of available drinking water, or both. One controversial aspect of a weather modification ban was whether such a ban might make such civilian purposes of weather modification either difficult or illegal to carry out.

Another potentially controversial item discussed in the formulation of such a treaty was the terms of any sanctions against a country for engaging in forbidden weather modification. Such sanctions were necessary because weather modification could also have unintended consequences that could cause drought, or countries even with primitive use of the technology could use it to deny

⁸⁰ United States Information Service, "Special Bulletin," September 11, 1973, Box 28, Folder 01, Douglas Pike Collection: Unit 01 - Assessment and Strategy, The Vietnam Center and Archive, Texas Tech University. Accessed November 17, 2013.
<http://www.vietnam.ttu.edu/virtualarchive/items.php?item=2122801021>, 20

another country water. Water is fundamental; it is needed for life on earth. Sanctions were necessary to alleviate the potential suffering of a country that had suffered the consequences of these modifications. Hence the moral arguments that countries should only use weather modification for good and help other countries but not harm them.

The next witness after Pollack was Mr. Forman from the Defense Department.⁸¹ The remarks given by Forman were equally vague and noncommittal on weather modification. Forman's repeat answer to nearly every question was that he did not "have enough knowledge" to determine the effects or consequences of such a treaty or of the effectiveness or consequences of weather modification.⁸² However, the 1967 section of the Pentagon Papers clearly indicates that by that time, the military knew of both the effective and destructive powers of weather modification.⁸³ The only question that might remain was the degree to which they knew about the long-term impact of these weapons.

The Defense Department was still trying come to a decision on the effectiveness of certain types of weather modification. One of example they pointed to was the use of fog dispersion during war. They used fog dispersion as an example of an acceptable and necessary practice that might be banned under the treaty. However, this argument is difficult to accept. There is a considerable and definable difference between fog dispersion and cloud seeding. To be able to clear a foggy area in order to see more clearly in a time before Global Positional System (GPS) technology would have been very important for civilian and

⁸¹ Hearing before Subcommittee on Ocean and International Environment of the Committee on Foreign Relations, SR 71, 93rd Cong., January 25, 1974, 15.

⁸² *Ibid*, 15-19.

⁸³ The Pentagon Papers IV, Senator Gravel ed. (Boston: Beacon Press 1971), 421.

military aircraft that were trying to land or take off; whereas the cloud seeding weather modification is aimed at changing the rainfall over an entire area.⁸⁴ The Defense Department tried to walk very fine line to keep every tool it can, which is understandable considering their function.

However, the Defense Department was also taking an overarching view of weather modification in offering cautious and measured opposition to such a treaty. Defense Department representatives pointed out that the treaty only dealt with the wartime operation of weather modification, and did not consider its use during periods of peaceful relations with other countries. In pressing this inconsistency, they invoked the idea that allowing unchecked civilian use of weather modification without military oversight might be a danger to the whole ecological system. The example he gave was that if a country such as Canada want to meddle with the polar ice caps to make for more viable farm land, this would massively increase sea levels--an unpleasant thing for Rhode Island, Senator Pell's home state.⁸⁵ This is obviously a kind of tactic of distraction; the Defense Department focusing on unlikely civilian scenarios to attempt to carve as many exceptions into what they saw as an nearly inevitable treaty as possible.

The military position on these issues is clearly one with logical flaws because it is not clear why a military ban cannot coexist with peaceful uses of weather modification. Clearly, for example, a ban on nuclear weapons production need not make it impossible to contemplate the safe use of nuclear power. A nuclear reaction can be used inside a weapon to create a massive

⁸⁴ Hearing before Subcommittee on Ocean and International Environment of the Committee on Foreign Relations, SR 71, 93rd Cong., January 25, 1974 pg 18.

⁸⁵ Ibid, 22.

explosion, or can be done under controlled conditions to generate heat and create electric power for everyday use. Weather modification should be regarded as analogous to nuclear power.

However, now that the U.S. government's full use of weather modification had been exposed, these arguments could be effectively countered. Among those arguing in support of a treaty to ban the weaponization of weather was James Leonard, Vice President for Policy Studies at the United Nations Association. He was a strong supporter of Senate Resolution 71.⁸⁶ He glad to see that the Defense Department, bowing to practicality, was limiting its opposition to the treaty.

Support for the treaty was also growing internationally. An indication that such support was widespread and that most countries generally welcomed such a treaty was that it was quite similar to the internationally supported Comprehensive Test Ban Treaty in that it allowed input and suggestions from many counties.⁸⁷ Leonard also saw great potential for such a treaty for the United States in following way:

There is not, I believe, any valid military argument for our retaining the option to use environmental warfare; there already is and will continue be a substantial cost to us in scientific terms if we continue to protect this option; and we are paying a substantial political price for our failure to take the leadership in ... closing off the possibility of environmental warfare.⁸⁸

Thus, the treaty would allow for the United States to exercise soft power in being perceived as a global environmental leader. As an indication of the importance of that step, Mr. Leonard also suggested that Congress could cut off the funding for

⁸⁶ Ibid, 26.

⁸⁷ Ibid, 28.

⁸⁸ Ibid, 30.

weather modification warfare until the executive branch made steps towards such a treaty.⁸⁹

However, the military would get a second chance to respond to these ideas in the hearing after Congress called forward Pierre St. Amand from the Earth and Planetary Sciences Division of the Naval Weapons Center, even though St. Amand came to the hearing as private citizen and not on behalf of the Navy.⁹⁰ St. Amand explained the degree to which important military weather work was inextricably tied to Project Stormfury, which was a civil project that focused on the reduction of the destructive effect of hurricanes. Similarly, military research into weather modification—which would presumably not continue after the treaty—brought about drought relief and saved money that would have been allocated for disaster relief. He cites one example from the Philippines in which a US-based cloud seeding operation saved crops, preventing an expenditure of more than \$25 million in food aid.⁹¹ The picture he is describing shows how weather modification can be used for good, and that some of that benefit is inextricably tied to military uses.

However, St. Amand was still a man of the Navy, which affected his views on a treaty that would have banned weather modification as a weapon of war. Although he understands all the terrible things that could happen with weather modification and geophysical war, he finds a reason to say why such a treaty is not needed. The main reason he gives for not having a treaty is that “the use of any weapon or device whatsoever to protect a fighting force does in itself

⁸⁹ Ibid, 32.

⁹⁰ Ibid, 32.

⁹¹ Ibid, 36.

constitute an act of war."⁹² This means that to have any weapon would cause act a war including even the peaceful uses of weather modification. His argument does have merit in that weather modification cannot be employed without affecting other weather patterns. This means that it is unclear where civilian weather modification ends and a military use begins.

St. Amand augments his arguments with the rather novel assertion that a ban on weather modification might lead to a dependence on even more brutal tactics. He makes a rather interesting argument about how weather modification is patently less cruel than burning the enemy out with napalm and killing the enemy by just stabbing or shooting them, rather than with rainfall.⁹³ The problem with too much rainfall is that it can cause flooding and landslides, which can be just as effective and devastating as burning somebody out with napalm and killing them because they could be killed easily enough in those natural disasters. Ultimately, no matter what, killing people can be brutal, and all of these tactics are trying to kill people.

Therefore St. Amand's position is that if there must be a treaty, then there should be certain exceptions for geophysical modification of the battlefield that ought to be acceptable. The three recommendations that he made are:

1. Tactical use of or geophysical weapons be permitted for the benefit and protection of our fighting forces.
2. Strategic use be limited, when and if it becomes a reality, it is too peaceful application by mutual agreement of the countries concerned and the concurrence of such neighbors also may be affected.
3. That the military forces be used in such constructive efforts if it is to their advantage to do so.⁹⁴

⁹² Ibid, 38.

⁹³ Ibid, 39.

⁹⁴ Ibid, 41.

What we see here is the Navy, through this private citizen, suggesting a limited treaty which would ban some aspects of geophysical warfare but not all of them, and which would allow for fog dispersion and other such operations which are necessary for safety of the troops.

The next witness came from Dartmouth College: Professor of Environmental Policy J. F. MacDonald. MacDonald emphasized the importance of having the USSR on board with the treaty.⁹⁵ Having the USSR and the United States both as signatories of the treaty would provide the treaty with great importance and would also allow other countries to sign the treaty. MacDonald did not believe that the reason to enter such a treaty stemmed from any prior abuses. The reason according to him to seek a universal ban on these types was two-fold. The first reason was that not all effect of weather modification could be predictable. The second was that there was little to no ability to target weather modification. It was impossible to restrict a weather modification operation in order to just affect a military target. Civilians would also inevitably be affected by these operations too.⁹⁶ Moreover, because the effects of weather modification did not simply stop at national boundaries, the United States use of these techniques could negatively affect their relations with other countries.

Professor MacDonald was also concerned about the free exchange of information. He said that it would cast suspicion on the legitimate development of weather modification for peaceful purposes and also disrupt agreements for the free exchange of atmospheric data.⁹⁷ This would create chaos and disruption

⁹⁵ Ibid, 50.

⁹⁶ Ibid, 51.

⁹⁷ Ibid, 52.

for forecasts because no computer models would be able to be initialized for forecasting purposes.

Therefore, MacDonald believed that their revolution would preserve such an arrangement. He also believed the Senate resolution also would generate some controversy over the fog dispersion question for war airplanes. But he simply dismissed this by saying that violations would always caught when they were major violations, such as the seeding clouds with silver iodine and not little one such fog dispersion.⁹⁸

MacDonald also brought up some of the other weapons that ought to be also banned. One weapon not necessarily banned by draft treaties of weather modification involved drilling into the ground and using fluid to create earthquakes. Once again this type of weapon would affect not only military targets, but the civilian population as well.⁹⁹ MacDonald also pointed out that chemicals could be put in the atmosphere to alter the nature of ultraviolet light. Again this weapon would not only potentially kill humans but also the environment, because it would be harmful to plants and animals.¹⁰⁰ Each of MacDonald's examples became progressively more deadly with each example he brought up in the hearing.

The next step in the hearing was to hear from Thomas F. Malone from Butler University, who held the position of Director of the Holcomb Research Institute. His background includes weather modification on the President's National Advisory Committee on Ocean and Atmosphere. One of the main points

⁹⁸ Ibid, 53.

⁹⁹ Ibid, 54-55.

¹⁰⁰ Ibid, 55.

of his testimony was that there was a vision within the executive branch of what atmospheric or weather modification could do, and that these were being juxtaposed with the more abstracted negative consequences that were being highlighted in this particular Senate hearing that was being conducted.¹⁰¹ The nightmare had been shown throughout this hearing. Senator Pell, it seemed to Malone, was interested painting a very negative picture of weather modification that would overwhelm the potential benefits that weather modification could have for the country, such as reducing droughts and creating a stable water supply.

Malone went on to raise another point about weather modification in the executive branch, and that is that the secrecy surrounding weather modification was a means to exaggerate the claims about how effective weather modification had been. He believed that the secrecy surrounding the Southeast Asia operation was a symptom of trying to keep the claims about the effects of the program being exaggerated.¹⁰² The shroud of secrecy surrounding Southeast Asian cloud seeding increased because it became tangled with national security issues, which supercharged the necessity to exaggerate successes.¹⁰³ Mr. Malone would be the last witness during this particular Senate hearing.

The other Senate hearing was held on March 20, 1974. The military presented a detailed report to Senator Pell's committee on the operation of rain making in Southeast Asia. The witness for the Defense Department was Dennis J. Doolin, a Deputy Assistant Secretary of Defense for East Asian and Pacific

¹⁰¹ Ibid, 67.

¹⁰² Ibid, 67.

¹⁰³ Ibid, 69.

Affairs. Doolin was not alone in his giving the testimony. He was also accompanied by the representative of the Air Force, Major General Ray Furlong, and a Deputy Secretary of Defense as well as William Chaplin from the State Department Bureau of International Scientific and Technological Affairs, along with several other witnesses.¹⁰⁴

These witnesses would describe the operations of rain making his Southeast Asia that was conducted from 1967 to 1972, which employed silver iodine and lead iodine.¹⁰⁵ This is the first time in the sources that I have consulted that lead iodine has been mentioned. The use of lead iodine is another indication that the United States military had no regard for the environment, and that its single-minded priority was to take actions that would serve its purposes in winning a battle. They would be willing to destroy the environment as long as it corresponded with military objectives, such as making roads impossible to traverse during the rainy season and extending the rainy season to continue that scenario. Another aspect to the goals of the mission was to wash out river crossings for the enemy.¹⁰⁶ What these operation goals show is the willingness of the military to carry out such an operation.

In conclusion, the available evidence about the use of weather modification as a weapon in the Second Indochina War, both from military sources and from Senator Pell's hearings, indicates that United States strategy regarding weather modification was subject to consistent evaluation based on cost-benefit analysis. Causing a situation to see the damage being inflicted is

¹⁰⁴ Ibid, 87.

¹⁰⁵ Ibid, 88.

¹⁰⁶ Ibid, 89.

worth the cost of an operation better spent on another operation. The annual cost for program was 3.6 million dollars, not so great when compared to other costs of the wartime operation.¹⁰⁷ The area of operation was expanded from the aforementioned Operation Popeye and were not limited to those over the skies of Vietnam. By early 1967, cloud seeding operations were being conducted over Laos. The war has spilled over in Laos before with operations such as Operation Barrel Roll and Operations Steel Tiger and Tiger Hound. To see the weather modification be expanded in to Laos and Cambodia is not surprising, but from the perspective of most of these witnesses, it supported the need for an international treaty on weather modification, for which the hearing was being held.

Moreover, the geophysical aspect of land was taken into consideration as well. In Indochina, the clouds were being seeded over draining basins or watersheds.¹⁰⁸ Since those clouds were being filled with lead or silver, those elements fall to ground along with water, producing water pollution. The pernicious effects of lead were just becoming known at that time, leading to a debate domestically about the common practice of using lead as an additive to gasoline in America. However, certainly if anyone would be aware of the harmful effects of lead, it would be environmental engineers working for the United States military. Furthermore, the combined affects cloud modification with the concentration of pollution from other sources on land during the Indochina wars has to be taken into consideration. An example of this land effect on rainfall is

¹⁰⁷ Ibid, 93-101.

¹⁰⁸ Ibid, 102-103.

that the difference between the Red River at flood stage and at a normal stage is only nine meters.¹⁰⁹ This means such operation would affect the operation of flood controls or the dam system in Southeast Asia. Another aspect to consider is that military would bomb dams and bridges from the air, just like in any other war, so that the effect of cloud seeding had to be considered in conjunction with these techniques of conventional warfare.

Both domestically and internationally, revelations about the extent of the United States' use of weather modification in the Second Indochina War were a key aspect in building momentum behind the establishment of an international convention to ban the practice. The other impetus for such a ban was the realization that weather modification could affect multiple nations. This idea was first grasped to the extent that weather modification operations originally restricted to Vietnam expanded into Cambodia and Laos and undoubtedly affected neighboring nations such as Thailand, China, and Burma as well. The need for regulation of such dangerous multinational environmental concerns was not beyond the comprehension of leaders within the United States. The establishment of the Environmental Protection Agency in 1970 was in part recognition that the actions of one state could affect another, and that the environmental decision-making in the United States would not only affect neighboring countries but also the world. In a 1978 report on Weather Modification Programs, entitled *Weather Modification Programs: Problems, Policy, and Potential*, the Congressional Research Service indicated that by the

¹⁰⁹ John Gliedman, "Terror From The Sky North viet-Nam's Dikes and the U.S. Bombing" August 1972, Box 04, Folder 12, Douglas Pike Collection: Unit 11 - Monographs, The Vietnam Center and Archive, Texas Tech University. Accessed November 17, 2013. <http://www.vietnam.ttu.edu/virtualarchive/items.php?item=2390412006>, 75.

end of 1975 there were twenty-nine states with some sort weather modification law, including many Western states that had suffered from water shortages.¹¹⁰ The piecemeal lawmaking of the states provided a reason for the federal government to intervene on this matter. In fact, the federal government was taking steps to intervene to stop potential issues occurring. Senator Pell was from the State of Rhode Island and was concerned about what weather modification might do to sea levels.

Hence on July 3, 1974, the United States and the Soviet Union would come to an agreement that officially stated that weather modification did pose a problem and that weather modification should not be used in warfare.¹¹¹ This joint diplomatic agreement was the breakthrough that would lead in fairly short order to an international convention banning most forms of weather modification.

¹¹⁰ Congressional Research Service, 332-333.

¹¹¹ Ibid, 429.

Treaty to End the Hostile Use of Weather Modification

In the years just prior to the signing of the weather modification convention, weather modification was hardly President Richard Nixon's top foreign policy goal, though he was committed to environmental reform. Indeed, despite Nixon's relative disinterest in an international convention to eliminate weather modification, this was an unprecedented era of international cooperation on the weather. During this time, the World Weather Watch and the Global Atmospheric Research Program were operating with new and refined technology and promoted cooperation in 135 countries. These were major advances in the weather field which would help to lay the for treaty on weather modification.¹¹²

The treaty would be called the Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques (ENMOD). It was signed by the United States on May 18, 1977.¹¹³ The treaty banned not only weather modification as weapon of warfare, but as a hostile diplomatic tool. The State Department was using weather modification as means to aid countries that need of water, and that practice of using weather modification as a form of positive development assistance was apparently not covered by the treaty. However, this new treaty would prevent a negotiation in which denying a country of water from the sky was employed as a threat.

¹¹² Edith Brown, "West International Response to Weather Modification," *International Organization* 29, no. 3 (1975): 811-812

¹¹³ Congressional Research Service, 429.

The international response to the treaty was some similar to the outcome Senator Pell had predicted . The treaty was greeted enthusiastically and garnered many signatories. Currently there are seventy-six states that are parties to the Treaty. However, this treaty is not without controversy, in that it is somewhat vague in certain sections. An example of this vagueness is “long-lasting or severe impacts the means of destruction damage or injury to other state party”.

¹¹⁴ The question is: what constitutes long-lasting? The treaty never defines what a long lasting effect is. This “long-lasting” phrase can be interpreted as a matter of geologic time, which is to say on the order of millions of years, or something much shorter-term such as a year or two. Depending on the context, either could be considered a long-lasting effect of environmental change. Another aspect of this vagueness is that international considerations are pitted against nations’ desire to share information about meteorological data.

Weather in general effects every human being on the planet. This statement is an absolute statement. It is very rare to find absolutely true statements, but this one can be made with little or no debate. However how much a human is affected by the weather may vary on the location at which the human is located. Another aspect to consider with this is the reason why meteorological data are shared in the first place. The reason why that shares the data is to get better forecasts for humans in order to prevent economic damage since most of the world lives in a capitalist system or bartering system.

¹¹⁴ Convention on the Prohibition of Military or Any Other Hostile Use of Environmental modification Techniques, May 18, 1977, Article, 1.

If environmental weapons were to be developed that would shatter this underlying trust and the sharing of data between countries. One of the first worldwide organizations was a meteorological organization that is currently known as the WMO, or the World Meteorology Organization.¹¹⁵ After World War II this sharing became more important because new discoveries were being made about oceanic currents and their effect on weather and discovering those oceanic currents at the same time.¹¹⁶

The reason for most of the difficulties in the treaty can be partly attributed to why the treaty came to the United Nations. The Soviet Union was the party that brought the idea of the treaty to floor United Nation and not the United States even though United State Senate had told the Executive Branch of government to seek a treaty. As indicate by the Senate's hearing, the executive branch under the Richard Nixon was not ready to negotiate such a treaty during the summer of 1974. ¹¹⁷ The United States was in a weakened state to negotiate this treaty by the mid-1970s, though in a few years President James Carter expressed greater interest. The United States was also in a weak moral position to take the lead on negotiating this treaty, given that it had just been utilizing controversial weather modification techniques during the Second Indochina War.

In the Cold War context, the USSR's rhetoric should be expected from the because it put the United States in a very weakened position, and the USSR could take advantage of the weather modification issue for public relations purposes.

¹¹⁵ Edith Brown, 810.

¹¹⁶ Ibid.

¹¹⁷ Lawrence Juda, "Negotiating a Treaty on Environmental Modification Warfare: The convention on Environmental Warfare and its Impact Upon Arms Control Negotiations," *International Organization* 32, no. 4 (1978): 977, accessed November, 24, 2013, [Http://www.jstor.org/stable/2706184](http://www.jstor.org/stable/2706184).

In many ways, the USSR was able to assert the moral high ground by not wanting to engage in environmental warfare.¹¹⁸ They continued the spirit of cooperation that has always been a necessity for meteorologists in order to accurately predict the weather across the globe and in local regions.¹¹⁹

Weather is basic to the human condition and humans must interact with the environment on a day-to-day basis. In some respect that ENMOD treaty was signal of change in environmental ethics. It was ratified just at the point during which a paradigm shift was taking place in regard to human control over the environment. Part of this change stemmed from the realization that weather and environment do much more than simply affect just one's local area. The way that the treaty emphasized coordination and cooperation in enforcement of the ban on weather modification, and the subsequent cooperation of both the communist bloc and non-communist nations, was a harbinger of future environmental cooperation.¹²⁰

The fact that the actions of private corporations were not mentioned in the treaty is instructive. It suggests that the framers of the convention supposed that the laws of each individual signatory nation would keep corporations from violating the treaty. Indeed, perhaps the public/private partnerships on weather modification that proved necessary in the U.S. context bear this theory out. General Electric discovered in the late 1940s that for its own legal protection from tort liability, it could only team with government entities to conduct weather modification activities. Also, in the United States at least, the creation of the EPA

¹¹⁸ Ibid, 977 – 978.

¹¹⁹ Edith Brown, 807.

¹²⁰ Convention on the Prohibition of Military or Any Other Hostile Use of Environmental modification Techniques, May 18, 1977, Article, 3.

would also cause companies to reconsider these types of activities to modify or impact the environment.

The overall impact of the ENMOD treaty was considerable. It is not so much that the treaty brought about a massive change in the world environment as much as it was that it made it possible to keep the *status quo* for international environmental policy. The free exchange of meteorological data would keep flowing. The attempt to control the environment would be confined to local areas, but even then a neighbor could object safely under this treaty if weather modification was having negative impact on them.

Conclusion

Weather Modification as weapon of war and other policies came halt due to the profound legal, political and social pressure brought to bear on the military and Congress to stop it. The pressure to stop the potentially dangerous and unpredictable effects of weather modification grew as time progressed from the beginnings of the U.S. weather modification experience in 1947 to the signing of ENMOD. The social effects of environmental modification ultimately are inextricable from their political and legal effects. Close observers could have noted this inextricability from considering the results of the General Electric experiments of the late 1940s, during which engineers caused over a foot of snow to fall over a wide area simply by mistake.

This event was important because it marked the beginning of government involvement in weather modification activities. The federal government realized that weather modification experiments by private corporations needed to be curtailed because of the legal impacts of the environment modification that might occur. Thus, weather modification activities were largely conducted under the auspices of the U.S. State Department during the 1950s, during which time the Department of State was using weather modification in several different countries to provide rain in order to prevent or curtail drought that was naturally occurring in these countries.

What is important about drought is that it is a natural process, which produces some benefits to other than just the negatives of creating crop shortages

and famine. Droughts allow for landscapes to be renewed, much as natural wildfires are sometimes allowed to occur in order to thin out forests. In order to allow the ecosystem to restart a new and allow for other species of plants and animals to thrive again in order to rebuild a mature forest, sometimes fire is needed. Similarly, some of these cloud seeding operations were also occurring in the Middle East, an area that is notorious for having water shortages. In some respects, modifying the weather in order to create more artificial rain is not only an unnatural thing for the environment but modifying the environment in order to support more human life over the natural environment that would naturally occur there and only support a certain number of humans. But modifying the environment of which humans live in is nevertheless an understandable thing for humans to do, and of course other means of reducing the impact of the weather and the environment—from dykes to dams to canals—have existed for millennia.

Weather modification is an extension of the technologies that humans can use to modify their own environment, technologies that go beyond mere farming, building shelter, and a variety of other activities. The reason why humans engage in these supplementary activities is to modify the both the social and environmental structure around them for their own benefit. The mere ability to modify their environment allows for other activities of humans to occur in regions which otherwise might not support human habitation.

With the necessity to alter the environment comes the need to restrict these alterations so that they do not negatively affect others. Hence, with new technology, new legal structures began to develop to decide which activities are acceptable versus which are not acceptable. In particular, with better technology

developing for the weaponization of the environment in the postwar era, it became increasingly clear that these tools were especially dangerous and unpredictable, and therefore required special regulations. These weapons are especially dangerous because they threatened to destroy the natural environmental balance that is necessary for humans to survive on the planet. When the United States chose to cloud seed over Vietnam during the Second Indochina War, it began to pass over the boundary between modifying the environment for the benefit of all and creating a destructive non-livable situation for humans in the affected area.

What Operation Popeye represented was the worst kind of environmental modification. The United States cloud seeding over Indochina made the situation for Vietnamese, Lao, and Cambodia people miserable and caused an environmental disaster—a disaster that only augmented the damage done by other damaging chemicals such as napalm and dioxin, and damage made only worse by seeding clouds with large amounts of lead. Thus, the United States not only cloud seeded but also combined it with its defoliation operation which led to the destruction of the land which would take years if not decades to renew itself.

Weather modification was used as a regular weapon of war during wartime by United States after World War II. The U.S. use of environmental weapons would eventually cause an international response to the growing ability of humans to modify their environment and the world around them in ways that could be destructive if not applied properly. The secrecy surrounding the United States' use of these weapons also caused the response it received from the international community and domestic community to be compounded and more

negative about environmental modification as becoming a weapon of war than it otherwise might have been.

Senator Pell of Rhode Island was correct in calling weaponizing of weather a "Pandora's box"; once open, it caused immense environmental damage. Furthermore, the unpredictable effects of long-term environmental warfare, combined with ever-better technology, raised the specter that the weaponization of weather may have eventually wreaked chaos to the human race. Hence, Senate resolution 71, which demanded the executive branch to seek a treaty to ban such activities of weather modification, was a useful corrective in stopping environmental modification from becoming a significant weapon of war. Once the Soviet Union took an active interest in this idea, it provided the catalyst to negotiate a treaty at the United Nations. While the United States did become a signatory to the treaty, the inaction of the United States' executive branch during the Nixon Administration was ultimately a public relations coup for the USSR, and the executive branch was made to look like it failed to act in the best interest of United States foreign policy. The recalcitrance of the executive branch was also against the interests of the Senate, which had directed the executive branch to seek the treaty.

Therefore the treaty, which banned environmental modification for hostile or military purposes, was an important but only initial first step in managing the environment in a correct and responsible way on the international level. The example of weather cooperation on meteorological data should be a model for how environmental modification should be constrained in the future.

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