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Al-Bayan Center for Planning and Studies

Cloud Seeding - A Review

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Al-Bayan Center Studies Series

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Abstract

Water is a necessity on Earth, and global water consumption is increasing significantly. There should be ways to keep the demand for water while also providing resources.

This study presents a potentially promising technology that creates precipitation from clouds. This technique is known as cloud seeding. Cloud seeding is a type of weather modification that involves changing the amount or type of precipitation that falls from clouds. This is accomplished by dispersing substances into the air that serve as cloud condensation or ice nuclei, which in turn alters the microphysical processes that occur within the cloud. Cloud seeding can be done in several different ways. Dry ice, silver iodide, and potassium iodide are the three chemicals that are utilized the most frequently in the process of cloud seeding. Cloud seeding is done to enhance the amount of precipitation that falls in a region, disperse fog and clouds so that a place can remain dry by precipitating out, minimize the sum of cloud cover, purify the air of pollution, and assist in extinguishing wildfires by causing it to rain.

Introduction

Water, which is essential for the survival of all life on earth, is the most significant naturally occurring renewable resource. In many regions of the world, rivers, reservoirs, and groundwater are the primary traditional sources and supplies of water. Lakes and rivers also play an

* Researche.

important role. These resources are in danger because of ever-increasing demands, which are brought about by shifting patterns of land use and expanding populations. The strain that is placed on water supplies as a result of prolonged droughts and increased consumption is what drives up the price of potable water and causes shortages. Water availability has been steadily deteriorating across a large portion of the globe in recent years. Numerous nations, many of which are in semiarid parts of the world, are currently engaged in climate engineering projects in the hope of expanding their access to freshwater resources [1].

Since water makes up 70 percent of our planet, it is natural to believe that there will always be an abundant supply of it. On the other hand, the freshwater that we drink, bathe in and use to irrigate our agricultural fields is extremely scarce. Only three percent of the water on Earth is freshwater, and of that three percent, two-thirds of it is locked away in glaciers or is otherwise inaccessible to humans. Because of this, there are approximately 1.1 billion people around the world who do not have access to water, and a total of 2.7 billion people experience water scarcity for at least one month out of the year. Inadequate sanitation is another issue that affects 2.4 billion people; as a result, these individuals are at risk of contracting water-borne diseases such as cholera and typhoid fever amongst other illnesses. Each year, diarrheal diseases alone claim the lives of two million people, the majority of whom are children [2].

Cloud Creation

Clouds form as a result of water vapor produced by temperature increases on the ground. The vapor is lifted by temperature variations on different highest points, and as it moves up, it cools. Particles of various

types exist and are carried by air, where they collide with vapor. The vapor condenses around the air particles in a chemical process known as nuclei condensation. This process produces larger particles of water droplets; however, because the water droplets are light in weight, they continue to fly and form the clouds we know. This process necessitates certain atmospheric conditions, the most important of which is relative humidity. Cloud formation necessitates a high relative humidity of 60 to 100 percent. To understand why this is important, consider partial pressure as the number of water molecules in a medium and total pressure as the capacity of that medium. As a result, if the medium has a high number of molecules, the relative density is high; however, if the medium has a higher capacity than the number of molecules, the relative density is low. To put it simply, if the number of droplets is high, clouds are likely [3,4].

The Cloud Seeding Methodology:

A rainstorm happens when moisture collects around naturally existing airborne particles such as dust and sand, leading the air to reach a saturation point where it can no longer hold in the moisture and droplets fall as rain. Cloud seeding fundamentally speeds up the process by adding more "nuclei" around which water droplets can condense. Salts, dry ice, or silver iodide can all be used as nuclei. Silver iodide, potassium iodide, and dry ice are the most frequent compounds used to seed clouds (solid carbon dioxide).

At higher temperatures than silver iodide, this can generate ice crystals. The usage of hygroscopic materials, such as table salt, is becoming more widespread as a result of positive research. When temperatures within the clouds are between 19 and 4 °F (7 and 20

°C), more snowfall occurs during cloud seeding. The introduction of a chemical with a crystalline structure comparable to that of ice, such as silver iodide, will cause freezing nucleation, Fig.1.

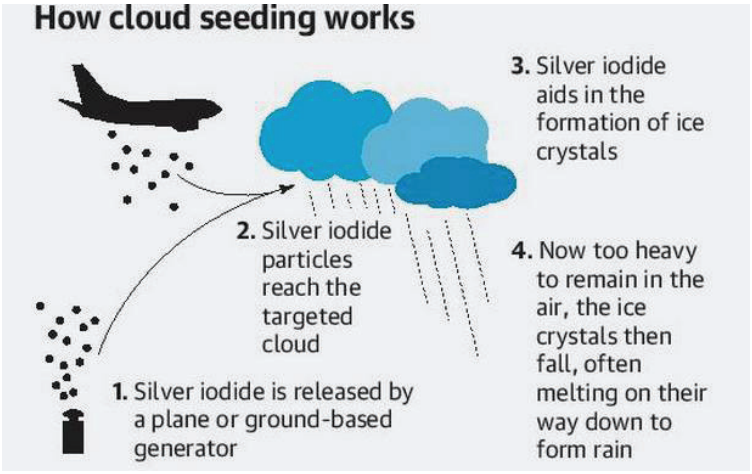

Fig.1 Cloud seeding diagram

Cloud seeding is achieved through three distinct methods. Each technique is used depending on the atmospheric conditions of clouds as well as the type of clouds being targeted. Seeding of hygroscopic cloud, seeding of static cloud, and dynamic cloud seeding are the three techniques.

Seeding of Hygroscopic Clouds

The term hygroscopic refers to a substance's ability to absorb water moisture from the air, and in this case, having this property is critical for cloud seeding for condensation purposes. Hygroscopic cloud seeding is used on warm-based clouds, which are prevalent in the UAE. Because the clouds are convective cumulus, the UAE is using hygroscopic cloud seeding. This methodology employs salt minerals such as sodium, potassium, and magnesium. These salt minerals are

thought to be the embryos from which raindrops form. They increase the size of the droplets, which accelerates chemical condensation and increases the likelihood of precipitation [6]

Seeding of Static Clouds

Spreading silver iodide, also known as dry ice, into clouds is the static cloud seeding method. Unlike hygroscopic cloud seeding, static cloud seeding is applied to cold-based clouds with temperatures ranging from -10 to -25. Thus, glaciogenic materials must be used in this methodology because they increase the concentration of ice crystals in clouds by either forming new crystals or freezing cold droplets. Furthermore, as the name implies, static cloud seeding does not involve air motion because all conditions are stable during the process. There are restrictions on the atmospheric conditions that must exist for static cloud seeding to be performed. As a result, this methodology cannot be applied everywhere, and obtaining successful results in one area does not guarantee that the same will occur in another unless the atmospheric conditions are replicated [6].

Dynamic Cloud Seeding

The main difference between static and dynamic cloud seeding that affects the process greatly is air motion. The goal of dynamic cloud seeding is to increase vertical air currents, which allows a significant amount of water droplets to pass through the clouds, increasing the chances of precipitation. Dynamic cloud seeding, like static cloud seeding, is done on cold-based clouds. The materials used are also glaciogenic; however, dynamic cloud seeding requires significantly more materials than static cloud seeding in order to increase the

likelihood of precipitation. Dynamic cloud seeding is a sophisticated methodology that includes a long list of steps, each of which must be performed correctly, or the entire process must be repeated [6,7].

ADVANTAGES of CLOUD SEEDING:

1. Produces Rain: In areas where rain is desperately needed, cloud seeding may be the only way to produce rain. In areas where there is little precipitation, silver iodide is used to induce rain production. Rain is necessary to keep the area hydrated and fertile for the growth of crops and other plants.

2. Increases Economic Activity: Wherever there is rain, there is farm produce. Farms that produce more can benefit the local economy and feed the people (and even animals). Cloud seeding can significantly improve living conditions in arid areas.

3. Regulates Weather: Cloud seeding, in some ways, allows us to control the weather in a specific area. It does more than just produce rain; it also regulates water vapor, preventing damage caused by destructive hail and storms.

4. Makes Dry Places Liveable: Locals have an impressive ability to adapt to their natural environment. However, inhospitable places that are rarely visited by rain can be hostile to tourists and foreigners. Such places can be made habitable through cloud seeding [8].

DISADVANTAGES

1. Requires Potentially Harmful Chemicals: The chemicals used in cloud seeding have the potential to harm the environment, particularly the plants that cloud seeding is meant to protect. There has been no significant research into the environmental effects of silver iodine. Iodism is a type of iodine poisoning in which the patient experiences a running nose, headache, skin rash, anemia, and diarrhea, among other symptoms. It has been discovered that it is extremely toxic to fish, livestock, and humans.

2. Is Not Infallible: Cloud seeding necessitates the presence of rainclouds. It will not work on any other cloud formation. Furthermore, seeded clouds may travel to another location and cause precipitation in the intended location. As a result, whether cloud seeding is truly effective in producing rain can be debated.

3. Expensive: It is very expensive to create artificial rain. The chemicals must be delivered to the air via planes, which are difficult to come by in low-income areas. Cloud seeding may be required in poverty-stricken areas suffering from drought or famine.

4. Causes Weather Issues: If not properly regulated or controlled, cloud seeding can result in undesirable, if not entirely destructive, weather conditions such as flooding, storms, hail risks, and so on. Places that don't get much rain or none usually don't have the infrastructure to handle so much rain. These areas may become flooded quickly as a result of cloud seeding, causing more harm than good [9].

Advantage	Disadvantage
Contributes substantially to vegetation, notably for agricultural production, as most farmers in third-world regions rely solely on rain.	There is the potential of mild to moderate depression because cloudy and gloomy weather might dampen thoughts and feelings.
Provides access to clean drinking water.	If it's excessively acidic, it can seriously damage plants and trees, and rocks.
Water is recycled from all around the world and redistributed to the ground.	Prolonged heavy rains lead to serious floods, placing a great deal in jeopardy.
Rain has an important function in removing dust and debris from the air and detoxifying it.	Rain also triggers erosion, which strips away the soil's rich layer.

Fig.2 Advantages and Disadvantages of Rain Seeding

Conclusion:

Even though it will affect agricultural soil, cloud seeding is cost-effective. Before using cloud seeding, governments and people should adopt and implement various water-source management strategies, such as rainwater harvesting, artificial recharge of aquifers, and concurrent use of surface and groundwater. Another reason is that cloud seeding has been discovered to be ineffective now because it primarily affects clouds that are already showing signs of rain. As a result, it is unknown whether it is the cause of the rain. In general, trying to cure drought is an ongoing battle, and cloud seeding is the most recent technology used for this. Determining whether a technique is good or bad may be more difficult than you think. The opportunities for achieving high rates of progress in agriculture and industrial growth are directly related to a nation's availability of water resources, so cloud seeding becomes a necessity to address this critical situation.

Bibliography:

[1] R. Ariketi, "Cloud Seeding," Research Gate, 2019.

[2] Christner, B. C., Morris, C. E., Foreman, C. M., Cai, R. and Sands, D. C., Ubiquity of biological ice nucleators in snowfall. Science. 319(5867): 1214 (2008).

[3] Klein, D. A., Environmental impacts of artificial ice nucleating agents, Dowden, Hutchinson and Ross, Inc., Stroudsburg, pp 256 (1978).

[4] J. Fan, L. R. Leung, D. Rosenfeld, Q. Chen, Z. Li, J. Zhang, and H. Yan, "Microphysical effects determine microphysical response for aerosol," PNAS, vol. 110, no. 48, pp. E4581-E4590, 2013.

[5] S. Malik, H. Bano, R. A. Rather and S. Ahmad, "Cloud Seeding; Its Prospects and Concerns in the Modern World," Int. J. Pure App, vol. 6 (5), no. 2320 – 7051, pp. 791-796, 2018.

[6] Cooper, W. A., and Lawson. R. P., Physical interpretation of results from the HIPLEX-1 experiment. Journal of Climate and Applied Meteorology 23(4): 523-540 (1984).

[7] Cooper, W. A., Bruintjes, R. T. and Mather, G. K., Calculations pertaining to hygroscopic seeding with flares. Journal of Applied Meteorology 36(11): 1449-1469 (1997).

[8] S. Malik, H. Bano, and R. A. R. S. Ahmad, "Cloud Seeding; Its Prospects and Concerns in the Modern World," nt. J. Pure App, vol. 6 (5), no. 2320 – 7051, pp. 791-796, 2018.

[9] N. Regoli, "12 Important Pros and Cons of Cloud Seeding," Connect Us, 23 August 2015. https://connectusfund.org/12-important-pros-and-cons-of-cloudseeding.