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# Cloudseeding

As early as 1948, Santa Barbara County has participated in weather modification activities in order to augment local water supplies. Weather conditions are "modified" by seeding clouds - cloud seeding - with condensation nuclei to increase the amount of rain that falls. There are a number of benefits from doing this, which are supported by statistical analysis. The most significant benefit is that in some years up to 20% more rain falls in areas where clouds have been seeded than in control (unseeded) areas. There are three distinct benefits of cloud seeding: infiltration of significant amounts of water into ground water basins; runoff into reservoirs; and irrigation effects on grasslands and crops.

To understand how cloud seeding works, it is important to understand clouds. Clouds are composed of droplets of water vapor of varying size and temperature. These cloud droplets form on microscopic particles of atmospheric dust, called condensation nuclei. Toward the top of the cloud formations, "supercooled" water vapor may exist. This means that the water vapor is suspended in the cloud at temperatures that are below freezing.

Precipitation forms when this vapor contacts a particle or "nuclei". The vapor freezes to the particle and forms an ice crystal. The crystal grows larger as more vapor contacts it. When it becomes large enough to overcome the forces of "uplift" in the cloud, it falls out as precipitation. This precipitation may reach the ground as hail or snow, or during its descent it may melt and reach the ground as rain. It may evaporate entirely on the way down and rejoin the cloud as vapor. The existence of supercooled water vapor constitutes the most opportune conditions to seed clouds for rainfall augmentation purposes. It is possible, though, to seed clouds without supercooled water vapor, under certain meteorological conditions.

In storms typical to Santa Barbara County, there is much more moisture available than there are condensation nuclei to act as ‘bus’ mechanisms to bring the cloud droplet from a high elevation in the atmosphere down to earth’s surface. For this reason, Santa Barbara County’s weather modification program focuses on adding more condensation nuclei to clouds to increase rainfall.

A number of substances have been shown to work for cloud seeding, including dry ice, but the most commonly used substance is silver iodide (AgI). There are two ways to inject silver iodide into clouds: aerial and land-based methods. In aerial seeding, silver iodide generators are mounted on the wing tips of an airplane which flies directly into the most productive part of the cloud. Land-based generators are placed at the top of mountains where updrafts carry the silver iodide into passing clouds. The generators burn a solution of silver iodide and acetone which releases the seeding agent in a smoke form.

Local aircraft generators are flown on planes leaving the Santa Barbara or Santa Maria Airports. This is a more precise method of seeding because the pilot can fly directly into precipitation bands, the most productive portions of the storm. These bands can be detected by radar and pilots can be directed to them by radio. Ground generators are located at the Refugio Pass and La Cumbre Peak in the Santa Ynez Mountains, and are independently activated by a meteorologist from the control center. A computer model is used to pre-determine the effects of seeding. The County cloud seeding program is only conducted north of the Santa Ynez Mountains, partly to avoid inundating populated areas with rain, and partly because run-off south of the mountains goes into the ocean.

The effectiveness of cloud seeding has been evaluated to demonstrate its benefits. Recent statistical studies suggest that seeding results in a maximum increase in precipitation of about 20% over one rain season. This translates to thousands of acre feet of additional water captured for storage in local reservoirs. For example, in a wet year such as 1992-93, approximately 20,000 acre feet of water was generated through cloud seeding, and this figure does not include infiltration into groundwater basins.



The local cloud seeding program is operated between November 1 and April 30 of most years. Seeding

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is only possible during those months if there are clouds present that might produce rain. During drought periods, cloud seeding is not effective. Conversely, in large storms, seeding operations are suspended in order to avoid contributing to flooding problems. The most effective seeding occurs during moderately wet years such as occurred in 1992 and 1993. Some level of cloud seeding is conducted most years.

The current cloud seeding program in Santa Barbara County uses state-of-the-art technology to reduce the associated risks of excessive rainfall or rainfall occurring in areas not intended. County hydrologists use a network of rain and stream flow gages together with predictive computer models to prevent potential problems. A set of suspension criteria is established every year which specifies conditions under which seeding may be conducted. For example, all seeding is suspended in the areas recently burned by wildfires (such as the Marre Fire in Santa Ynez Valley) because those areas are sensitive to excessive soil erosion which can lead to landslides. Seeding can resume when biologists and others have determined that there is no longer any danger of landslides or other adverse erosion impacts. The program is under the constant supervision of a certified meteorologist who uses real-time radar and satellite imagery to monitor storm progression and rainfall.

The cost of the annual cloud seeding program is shared among the County and the water districts which receive a benefit from it. The cost is well justified when compared to its benefits. The average cost of water produced by cloud seeding is less than $100 per acre foot. By comparison, the cost of State Water on the South Coast is roughly $1200 per acre foot. Desalinated seawater costs approximately $1950 per acre foot. Groundwater and water from Lake Cachuma average between $75 and $250 per acre foot. Cloud seeding is one of the least expensive sources of water available to us.

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