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Making Rain in India is a Necessity/Cloud Seeding

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Abstract
Water is the base of human life. Day by day water resources are decreasing and its uses are increasing. Rain is the main source of water and plays key role in agriculture. This paper concentrates on the scenario of rain in India and emphasizes the need of cloud seeding in India. As per the report of World Bank, India is going to be the water stressed country by 2025. Annual average precipitation of India is 1 170 mm and around 80 percent of the total area of the country experiences annual rainfall of 750 mm. Due to the large spatial and variability in the rainfall, water resources distribution in the country is highly skewed in time and space and water deficit country by 2050 and its 16 percent of total area is drought prone and farmers are committing suicide so there is a great need of proper water management. Through cloud seeding India can tackle this situation. Cloud Seeding is a technique to create condensation by increasing precipitation in air. In India there is huge need of this type of technology which can increase humidity in drought prone area, like Vidarbha region that is the worst region for agriculture. More than 20,000 farmers committed suicide in this region. Cloud seeding is the only hope of the people who are living in drought prone areas.
Key Words: *Condensation, Precipitation, Silver iodide, hygroscopic nucleus, calcium chloride.*

Introduction

Water is most important commodity on earth for sustaining human life. In many countries of the world, resources of ground water and reservoirs, are either insufficient or under threat from ever-increasing demands of water from changes in land use, growing populations and decreasing rain. India is one of the water-challenged countries in the world. Groundwater levels are declining what water is available is often severely impure. And critical situation arose when national supply predicted to fall 50 percent below demand by 2030. In India rain is the major source of water. India depends upon the monsoons for rains. South West Monsoon is the main source for India as a whole, coastal area of Tamil Nadu and South Andhra Pradesh get the benefit of the North East Monsoon. Average annual rainfall in India is about 11770 mm varying from 100mm to 10,000 mm. Total precipitation is about 4000 bcm. A delay in the arrival of monsoon has left India's paddy fields burnt and caused water-shortages throughout the main cities. Experts are increasingly thinking of ways to coax passing clouds to precipitate, as irrigation sources run dry. In order to tackle this situation Indian Government is thinking to attempt cloud seeding in India.

Cloud seeding

Cloud seeding, a type of weather alteration, is the attempt to change the amount of precipitation by dropping substances into the air that serve as cloud condensation which cause them to dissipate and modify the microphysical processes within the cloud.

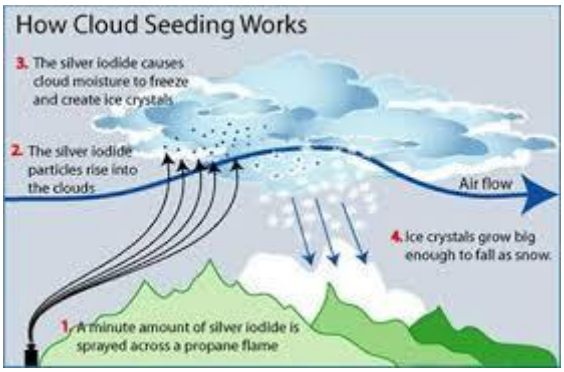

Figure 1- Working of Cloud Seeding

Natural rainfall occurs when super cooled cold water get in touch with particles of dust and sand forming ice crystals. The ice crystals provide a nucleus around which more water droplets can reside, increasing the size of the droplet, or in colder air snowflakes. When the droplet becomes enough large, it falls as snow or rain.

History of cloud seeding

The concept of cloud seeding started in 1946 when Dr. Vincent Schaefer, working at the GE Laboratory New York. He conducted a research to create artificial clouds in a chilled chamber. During his first experiment, Vincent thought the chamber was too warm and positioned dry ice to lower the temperature of his chamber. Water vapor in the experimental chamber formed a cloud around the dry ice and ice crystals in the dry ice had provided a nucleus around which droplets of water could form inside the chamber.

Methodology of Cloud seeding

In low humidity areas, there is least water in the sky. A rainstorm occurs after moisture collects around naturally occurring particles in the air like dust sand, causing the air to reach a level of saturation point at which it can no longer hold in that moisture and droplets fall in the form of rain. Cloud seeding essentially helps that process along, providing additional "nuclei" around which water droplet can reside and condensation occurs. These nuclei can be salts, calcium chloride, dry ice or silver iodide. Silver iodide is effective because its form is similar to ice crystals and Calcium chloride is often used in warm or tropical areas.

Types of cloud seeding

Cloud seeding works in two type of cloud, cold cloud and warm cloud. Clouds with temperatures above 0° Celsius (32° F) are warm clouds. Cold cloud seeding increases the number of nuclei available to take greater advantage of the moisture in the cloud and form raindrops that otherwise would not have formed. They are seeded by sodium chloride that is hydroscopic because it absorbs water and thus starts a coalescence process as larger droplets collate smaller ones. Cold clouds can be seeded at temperatures lower than -40° C. Seeding of cold clouds causes some of this vapor to freeze becoming ice crystals. Then these ice crystals turn into ice nuclei necessary for raindrops to form. Two seeding agents are used on cold clouds, dry ice (CO_2) and silver iodide (AgI). Silver iodide will also induce super cooler water vapor to freeze on it since it has a crystalline structure (hexagonal) which is similar to an ice crystal. Cloud seeding actually works best to make snow rather than rain.

Another is, warm cloud seeding. It involves clouds in tropical regions that never reach the freezing point. In these clouds, raindrops form around hygroscopic nuclei. Water droplets that are small in size collide and coalesce until they form a large and heavy drop enough to fall.

To persuade the warm rain practice, calcium chloride is used to provide the nucleus for rain formation. There are following three types of cloud seeding methods.

- **Static cloud seeding** involves diffusion of a chemical like silver iodide into clouds that provides a crystal around which moisture can condense. The moisture is already there in the air, but silver iodide essentially makes rain clouds more effective at revealing their water.
- **Dynamic cloud seeding** involves the boost of vertical air currents, which encourages more water vapor to pass through the clouds; this will cause the cloud to grow larger and yield additional precipitation. More than 100 times ice crystals are used in dynamic cloud seeding than in the static method.
- **Hygroscopic cloud seeding** is associated with warm cloud seeding which dispels salts through flares or explosives in the lower portions of clouds. The objective is to enhance rainfall by promoting the coalescence process using hygroscopic salt nuclei generated by pyrotechnic flares or a fine spray of a highly concentrated salt.

The salts grow in size as water contracts with them.

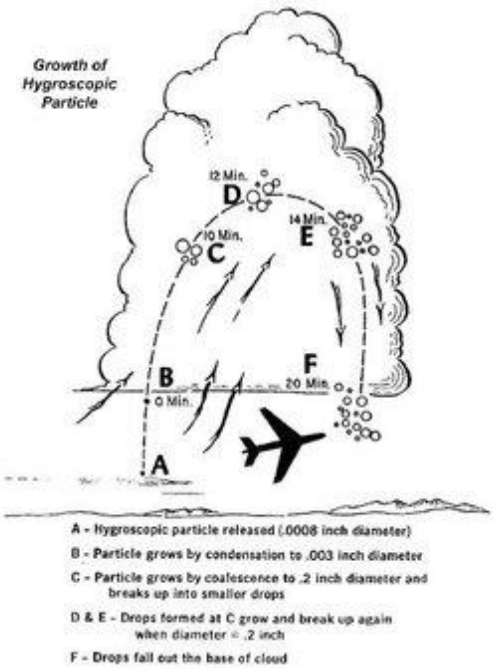

Figure 2- Hydroscopic Cloud seeding

Cloud Dissipation

Cloud seeding is not just used to enhance precipitation. It can also use to evaporate clouds and fog. In winters when the fog is very cold at airports, adding large quantity of dry ice leads to the fog to dispel because it turns all the liquid to ice and the ice crystals settles to the ground and leaving clear air. The dry ice cools the liquid, super cooled water even further and the droplets turn into ice crystals. This works only with fog that is very cold, but ice.

Worldwide use of Cloud Seeding

In 2009, during the Beijing Olympics, particles of Silver Iodide were dissolved into clouds. It formed rain in places around Beijing to ensure the opening ceremony of Olympics itself would not be affected by rainfall. Silver Iodide helped to increase the number of hails, while reducing their size at the same time. It means the probability of rain fall is very low. Sometimes this technique is used to reduce fog at airports. In US, Cloud seeding is occasionally used by major resorts to induce snowfall. Cloud seeding is used to enhance the precipitation in drought prone areas, to reduce the size of hails that form in thunderstorms and to reduce the amount of fog around airports. In January 2006, an $8.8 million cloud seeding project began in Wyoming to examine the effects of cloud seeding on snowfall over Sierra Madre. Eleven western states and one Canadian province (Alberta) are having weather modification operational programs.

Needs of cloud seeding in India

In India, drought affects around 16 per cent of the total area and the total average drought prone area is 10 lakh sq km or about one third of the total land area of the country. Around 12 per cent of the population is affected by drought. A drought prone area can be defined as one in which the probability of a drought year is more than 20 per cent. A drought year occurs when less than 75 per cent of the normal rainfall is received. A chronic drought prone area is one in which the probability of a drought year is greater than 40 per cent.

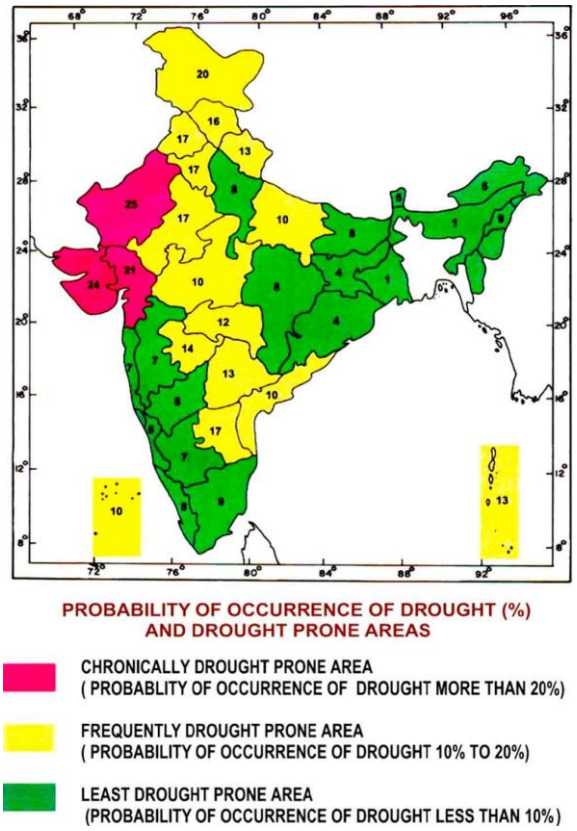

Figure 3- Map of Drought Prone Areas in India

The areas regularly obsessed by droughts are those receiving low (generally below 75 cm annually) and very unreliable (variability over 40 per cent) rainfall. In all 77 districts receiving less than 75 cm of rainfall per annum are droughts prone. In addition, there are 22 districts in Maharashtra, Madhya Pradesh, Gujarat, Karnataka, Uttar Pradesh and Rajasthan accounting for 9 per cent of the cultivated area of the country which receives 75 to 85 cm rainfall per annum.

There are so many water deficit regions in India but situation is very crucial in Vidarabha region of Maharashtra. Vidarbha is Maharashtra's most droughts prone region. Vidarbha lies on the northern part of Deccan Plateau. There are no major hilly areas and large basaltic rock formations exist throughout Vidarbha. Due to the low intensity of the troughs and the unsuitable movement of low pressure belts in Bay of Bengal , which forms in the Arabian Sea, poor rainfall occurs in the Central Maharashtra and Marathwada regions.

Figure 4-Map of Vidarbha Region

Situation is worst in this Vidarabha region. More than 200,000 farmers committed suicide in Maharashtra in the last decade, out of which more than 70% farmers belong to the 11 districts of Vidarbha region.

Current scenario of Monsoon

India in May 2015 had forecast India gets 88 per cent of normal rainfall this monsoon season down from the 93 per cent forecast it had in april. Rainfall of less than 90 percent is considered to be a drought year. In second long-range forecast, the India Meteorological Department (IMD) released the likely monthly and regional distribution of rainfall during June to September. Northwest India, including Delhi, likely to gets only 85 per cent of the normal rainfall. How monsoon behaves, is most crucial for the agriculture sector. If there is reasonably good rainfall and it is evenly distributed both in area and in time, then there would not be much to worry about on the agriculture, but according to the latest monsoon forecast, there is likely to be 92 per cent rainfall in July and 90 per cent in August.

Conclusion

Good water supply works as an engine in economic development. More the water resource of a nation the higher will be the opportunities for achieving high rates of progress in agriculture sector and industrial growth that help in promoting employment opportunities, higher standards of living and economic wealth. But India is not very rich in water wealth. As Indian water resources are declining and India is going to be water stressed country till 2025. On another side its 16 percent of total area is drought prone and farmers are committing suicide cloud seeding became the necessity to tackle this critical situation. The cloud seeding technology is very closely associated with water resources management that is the major requirement of India.

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