A Study of Artificial Rainfall

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Introduction:

Need of Water: Plants and animals need water for their life. There is no life without water. Water is the most essential for the continuation of life process. Water is strong influence in regulating climate. Waterfalls, tides, dam water and river currents are use to move machines and generate power. Water is essential for drinking, agriculture, industry, plant life, animal life and domestic use. It also provides surface for navigation.

Vincent Schaefer discovered the principle of cloud seeding (1946) • The Dutch physicist A. Feraart done the first field experiment by using co2 • In India first artificial rain fall operation conducted 1983 in Tamil nadu due to severe drought • U.S. based modification takes place by Maharashtra which helps to operate the operation in 12 districts of AP in 2008

The Water Resources:

a) The sea and oceans: The water is the basic and important resource. The Earth is called as hydrosphere because there is 71% water and 29% land on the surface of the Earth. The water gets evaporated from solar energy it is converted into water vapors. According to wind flow it is carried out and transmitted into clouds.

b) Dams and River Water: There are more than 500 big dams were constructed in the country and rivers in north India having perennial water supply. The evaporated water from dams and river are also useful for rainfall.

There are problems of drinking, industrial and agriculture water in the Maharashtra state so there is need of artificial rainfall in the state. In Maharashtra the experiment of artificial rain began in 2006. According to Indian Metrological Department (IMD). In 2015 the rainfall is less than average rainfall it may be true in India there is drought in the many states of India. In 2016. This year in Maharashtra there is very less rainfall so the sowing of various crops were not completed.

Objectives:

1) To study the concept of artificial rainfall
2) To provide water for drought prone area and study the need of artificial rainfall.
3) To study which methodology used for the artificial rainfall.
4) To help the requirement of water demands of world.
5) It enhances the yield of agriculture.

Methodology of Study: The present research work is based on only secondary sources of data. The data is collected from various sources are as follows: Census of India-2011, Socio-economic...

Why there is no rainfall?

To find the answer of this question first we try to understand how the rainfall begins. The rain comes from clouds that we know how the clouds formation is? When we go upward direction from the surface of the earth the temperature of atmosphere decreases, when vaporized air goes upward it becomes cold and there is formation of micro water drops. It is called as“Megh Bindu”. These infinite Megh Bindu are called as clouds. The air is also cooled when surface of the earth is cool. In winter the surface of the Earth is cool at night. Because of this water vapors are converted into micro particles of water, it is called as fog, means the clouds on land. For the formation of fog the bottom air becomes cool or it become cool when it go in upward direction. This process is necessary for the formation of clouds. It is natural process at various places in the atmosphere.

Types of Clouds: There are various types of clouds observed in the atmosphere on different latitudes and longitudes. The air pressure is not same in the atmosphere of various places. It is low or high at various places. So wind flows from high pressure to low pressure areas.

Cumulus Cloud: In low pressure areas agglomerated air goes upward and the micro water particle in this process the heat is given out from the water particles so the air become light and it gets the force to carry out the cloud the upward direction in this way the height and size of the cloud increases. These clouds are called cumulus clouds. Cumulus clouds are dense, dome-shaped with horizontal base.

Orographic Clouds: When there is a barrier of mountains the wind flows with upward direction with clouds. This is due to the temperature from the sun there is formation of rays, water vapors, it is observed and finally it is converted into clouds is called as orographic clouds. It gives orographic rainfall.

Stratus Clouds: The air is agglomerated in atmosphere this clouds scatter in nature. The color of the clouds is grey and are usually arranged in groups.

Low level Clouds: The classification of clouds is done according to height also. The clouds which are observed on 1 to 3 km from surface of the Earth are called as low level clouds.

Medium level clouds: The clouds height of about 3 to 6 km from the ground are known as medium level clouds.

High level clouds

The clouds above 6 kms height from the ground are called as high level clouds, the high level Cold clouds: These clouds are again classified into two types they are hot clouds and cold clouds. Generally the temperature of atmosphere decreases when we go upward direction from surface of earth. The temperature of atmosphere at 5 km from land is about 0°C. This is the frozen point of water so at this height the water vapors converted into ice clouds. The clouds which are above this frozen atmosphere point is called as cold clouds.
Types of artificial rain

Warm cloud seeding by using NaCl:
1. Dry ice cloud seeding
2. Silver iodide cloud seeding

Cold cloud seeding by using AgCl:
1. Water drop cloud seeding
2. Common salt cloud seeding

Worm cloud seeding:
It is also known as hygroscopic seeding, It is done by using salt NaCl, CaCl2. This process is
done at temperature higher than 0°C, and This process produce rain

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Cold cloud seeding:
• It is also known as glaciogenic seeding
• It is done by using AgCl
• This process is done at temperature lowered than 0°C
• This process produce larger snow crystal

Methodology:
Principles: Clouds are classified into worm and cold cloud based on cloud top
temperature. If the cloud temperature is positive then this cloud is called as worm cloud and if it
is negative then this cloud is called as cold cloud. Nucleus needed for precipitation differs with
types of cloud. Hygroscopic materials are necessary as nucleus for worm cloud.

Why no Rain?
There are two major causes of no rainfall:
1) There is lack of proper formation of clouds
2) The clouds are available in some regions but lack of process of condensation in first stage for
   process of formation of clouds air cannot move to vertical direction. It requires low pressure
   belts. Some times the air flows from upward to downward direction. It is called opposite
direction flow of air in this period the high pressure area is created; because of this the
process of formation of clouds is stopped.
In second stage, there are clouds; but no rainfall when there are many dust particles available in the atmosphere at a certain height, there is competition in between the dust particles to attract the moisture which is limited in the atmosphere, so because of this not a single (Megh Bindu) cloud radius of particle reach up to 14 micron in size. So that there is not formation of water drops (jal bindu) or the water formation process is stopped. Such types of clouds can not gives the rains. After some times such clouds disappear in the atmospheric environment. If there is lack of ice-formation, dust particles in the clouds then there will be not formation of megh bindu to ice particles so that the process of formation of rains is decreased because of this there is no any possibility of rainfall.

This is the condition of south west monsoon rainfall in some climatic regions in India. India is a sub continental country having about 125 cores of population, agriculture, industry and other economic activities are depend on rainfall. The water is a major resource of economic development. The Indian metrological department (IMD) gives weather broad cast which is useful to our activities. The year 2015 to 2016 IMD use the weather broad cast about rainfall it will be less rain fall than average rainfall in 2015 and it is true taking into consideration our government has to go for artificial rainfall.

What is artificial rainfall?
Making seeding is a weather modification system that aims to boost precipitation or rain by introducing condensation nuclei such as salt or dry ice.

1. Aircraft drop flares or artillery/rockets are shot from the ground to introduce artificial nuclei into cloud systems that have the right conditions. The artificial nuclei then attracts water vapor within the cloud.

2. System to become larger droplets fall as rain. Once it becomes heavy, the droplets fall as rain. Hygroscopic seeding, which involves using salts such as sodium chloride or potassium chloride, are larger nuclei resulting in very big cloud droplets.

3. Once seeded, it cloud take less than an hour to rain. In case of warm cloud systems, where in the temperature is not colder than 0C, salt is preferred for seeding. Silver iodide or dry ice generally used for clouds colder than 0C.

Cloud Seeding: Cloud seeding, A from of weather modification, is the attempt to change the amount or type of precipitation that falls from clouds, by dispersing substances into the air that serve as cloud condensation or ice nuclei, which alter the microphysical processes within the cloud.

Methodology of rainfall: The most common chemicals used for cloud seeding are silver iodide, potassium iodide and dry ice (solid carbon dioxide). Liquid propane, which expands into a gas, has also been used. This can produce ice crystals at higher temperatures than silver iodide. After promising research, the use of hygroscopic materials, such as table salt, is becoming more popular. Cloud seeding to increase snowfall takes place when temperatures within the clouds are between 19 and -4f (-7and -20). Introduction of a substance such as
Silver iodide, which has a crystalline structure similar to that of ice, will induce freezing nucleation.

1. How it works?
   - Cloud seeding involves the use of water-absorbent materials to encourage the formation of clouds and rain. The effectiveness of cloud seeding cannot be proven and some worry that it may actually cause harm. This process is implemented in some areas like Texas and Utah.

2. Cloud seeding
   - Cloud seeding is one of the tools to mitigate the effects of drought. The process in which the precipitation is encouraged by injecting artificial condensation nuclei through aircrafts or suitable mechanism to induce rain from rain bearing cloud. The raindrops are several times heavier than cloud droplets. These mechanisms are different for cold and warm clouds.

3. Cold cloud seeding:
   - Cold cloud seeding consist of two type: 1. Dry ice seeding. 2. Silver iodide seeding.

4. Dry ice seeding:
   - It remains as it is at –80°C and evaporates, but does not melt.
   - Aircrafts are commonly used for cloud seeding with dry ice. Aircraft flies across the top of a cloud and 0.5 – 1.0 cm dry ice pellets are released in a steady stream. While falling through the cloud a sheet of ice crystals is formed. From these ice crystals rain occurs.
   - This method is not economical as 250 kg of dry ice is required for seeding one cloud.

5. Silver iodide seeding:
   - Minute crystals of silver iodide produced in the form of smoke acts as efficient ice-farming nuclei at temperatures below –5°C. Silver iodide atomic arrangement is similar to that of ice therefore it is most effective substance.
   - The release silver iodide smoke into super cooled cloud from an aircraft. It is more effective than that of dry ice seeding because it required less amount of silver iodide as compare to co2.

6. Worm cloud seeding:
   - 1. Water drop seeding.

7. Water drop seeding:
   - Coalescence process is mainly responsible for growth of rain drops in warm cloud.
   - Water drops of 25 mm are sprayed from aircraft at the rate of 30 gallons per seeding on warm clouds.
   - Water droplets or large hygroscopic nuclei are introduced in to the cloud.

8. Common salt seeding:
   - Common salt is a suitable seeding material for seeding warm clouds.
   - It is used either in the form of 10 per cent solution or solid.
   - The spraying is done by power sprayers and air compressors.
   - The balloon burst technique is also beneficial.

9. Impact on environment and health:
   - AgCl2 cause the residual injury to humans and mammals.
   - Silver and its compound are toxic in nature. Still its impact on environment is negligible.
   - Its toxicity is only 1% of toxicity generated by industry.
   - It is not good for ecology balance

Effectiveness:
Cloud seeding is no loner considered a fringe science, and is considered a mainstream tool to improve rain precipitation and snow. New technology and research has
produced reliable results that make cloud seeding a dependable and affordable water-supply practice for many regions. While practiced widely around the world, the effectiveness of cloud seeding is still a matter of academic debate. In 2004 the United States National Research Council released a report stating that to date, there is still no convincing scientific proof of the efficacy of intentional weather modification as it only has 30% or less chance of success.

**Uses worldwide:**

**China:** The largest cloud seeding system in the of the People's Republic of China, which believes that it increases the amount of rain over several increasingly arid regions, including its capital city, firing silver iodide rockets into the sky where rain is desired. China also blasted iodide sticks over Beijing to artificially induce snowfall after four months of droughts, and blasted iodide sticks over other areas of northern China to increase snowfall. The snowfall in Beijing lasted for approximately three days led to the closure of 12 main roads around Beijing. At the end of October 2009 Beijing claimed it had its earliest snowfall since 1987 due to cloud seeding.

**India:** In India, cloud seeding operations were conducted during the year's 1983, 1984-87, 1993-94 by Tamil Nadu Govt. due to severe droughts. In the years 2003 and 2004 Karnataka government initiated cloud seeding, cloud seeding operations were also conducted in the same year through U.S. based Weather Modification Inc. in the state of Maharashtra. In 2008, there are plans for 12 districts of state of Andhra Pradesh.

**Indonesia:** In Jakarta, due to frequent occurrence of flood in wet season, cloud seeding also used as an anticipation, according to Agency for the Assessment and application of Technology. On 20 June 2013, Indonesia said it will begin cloud seeding operations following reports from Singapore and Malaysia that smog caused by forest and bush fires in Sumatra have disrupted daily activities in the neighboring country. On 25 June 2013, hailstones were reported to have fallen over some parts of Singapore. Despite NEA denials, some believe that the hailstones are the result of cloud seeding in Indonesia.

In 2015 cloud seeding is done daily in Malaysia since the haze began in early August.

**United Arab Emirates:** In the United Arab Emirates, cloud seeding is being conducted by the weather authorities to create artificial rain. The project, which began in July 2010 and cost $11 million, has been successful in creating rain storms in the Dubai and Abu Dhabi desert.

**North America:** Cloud seeding is occasionally used by major ski resorts to induce snowfall. Eleven western states and one Canadian province (Alberta) have ongoing weather modification operational programs. In January 2006, an $8.8 million cloud seeding project began in Wyoming to examine the effects of cloud seeding on snowfall over Wyoming’s Medicine Bow, Sierra Madre, and Wind River mountain ranges.

Artificial rainfall means to help the natural process of formation of water drops from the clouds (rainfall). The sowing of sodium chloride (NaCl) powder having 4-10 micron diameter the sodium chloride powder is spared at the base of the clouds which having into position of vertical movement. There is attraction of water towards sodium chloride particle. This particles observe
the moisture from the clouds and get a slice of water drops more than 14 micron this is the cause of rainfall then the condition is ceases.

In cold clouds when there is a lack of *jal Bindu* then there is spreading of silver iodide powder. The shape of silver iodine is like a ice crystal. Therefore the size of snow crystal is increasing in size, When the size of snow particles are sufficient then it comes towards land in the form of rain so the chemicals are spread from the peaks of the mountains.

For artificial rainfall it is necessary to place a generator on the peak of the mountains and sprays sodium chloride (NaCl) and silver iodide (SiI) by the machines in the clouds in this process if the clouds are on very high in height from the land then the spray material cannot reaches in particular position of clouds. So this method is not so effective.

In second method of artificial rainfall the rockets are used to spray the sodium chloride or silver iodide in clouds. This method is used in China.

This method is not so scientific because there is no control to spray the chemicals because there is no control to spray in a particular parts of clouds. The third method with the help of aeroplane directly the NaCl particles are spread in hot clouds It can be also burst the cylinders of silver iodide ( SiI) on cold above the frozen point for such types of practice the climates and clouds observation can be done by the radar size and shape and types of clouds, available *megh bindu* in the clouds and height of the clouds, from these observation design is taking that which type of material will spray. According to all these study pilot can spray the material in the clouds so that the process of rainfall which was naturally stopped will be helpful by this method.

**History of Artificial rainfall:** The process of artificial rainfall was practiced in various states of India in Karnataka in 2003, Maharashtra in 2004 to 2015 and in Andhra Pradesh from 2003 to 2007 the artificial rainfall was practiced.

This experiment is practiced by Geological Ministry Government of India. It includes all the metrological school and related research institutes in the country. This experiment was practiced between Zoog to Zoll under the control of Indian Institute of Tropical Metrology ( IITM ).

In September 2009 the observation of monsoon clouds were drove by the experts by aeroplanes and it was recorded.

These observations were noted by aeroplanes from *Pathankot* to north, *Gohati* to east, *Banglou* to south and Pune to west.

In this period about 220 hours aeroplanes were got taken up in the atmosphere for artificial rainfall,

The temperature in clouds, vertical velocity of clouds, size and shape of particles of water, their nature, all these mater were recorded on rader. It is observed that which clouds are useful for artificial rainfall.
The clouds in the rain shadow area are useful for artificial rainfall. Because process of artificial rainfall was broken by the dust particles in this atmosphere, if Sodium Nitrate (NaN), Sodium Chloride (NaCl) or Sodium Idoide (NaI) will spray in these clouds it may be helpful to artificial rainfall.

In 2010 and 2011 in month of September-October the experiments were carried out from Hyderabad for artificial rains in Telangana in Karnataka and draught prone areas of Maharashtra. The experiments were also carried out in August to September 2015 in Jalgaon District and at Baramati of Pune District.

Conclusion: The artificial rainfall to help for natural process of condensation with the help of chemicals spraying through the clouds. The clouds are particular type which gives the rainfall. It is necessary to spray the chemicals like Sodium Chloride, Sodium Iodide, Sodium Nitrate to spray through the clouds.

Southwest Monsoon is a irregular rainfall in India. When we see the requirement of water resource of India for various activities and population it requires large amount of water. So it is mandatory to have a artificial rainfall.

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