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HACKING OF WEATHER USING ARTIFICIAL TECHNIQUE BY CLOUD SEEDING

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Abstract:

In 200,000 years old human history of existence on planet earth humans have evolved and have been striving to get better every day. In this process humans have altered every natural method to match there purposes and satisfy their needs. Humans therefore have reworked every irrigation process, cultivation process, river systems ETC; and have moved towards much more productivity methods in every field of life but humans couldn't alter the weather according to their desire. Weather has been an important factor for any process to occur on this magnificent and beautiful planet. The word weather roughly means "the state of the atmosphere at a particular place and time as regards heat, cloudiness, dryness, sunshine, wind, rain ETC". Of late humans have tried to alter the weather according to their desire to fulfil their needs since late 1990. In our project we are trying to perceive the relation between "weather, irrigation and rainfall". This topic is a part of climate engineering, rainfall engineering and Irrigation engineering which are new streams of civil engineering domain. This civil engineering project gives an overview of the modern methods which have been recently adopted by various developed countries to make weather or precipitation act as they desire for. Hence, it means they have hacked the natural process of precipitation and made it artificial. Our project also tries to know the plight of farmers facing drought and floods due to irregularities in rainfall and steps taken by various central and state government organisations to rescue them from this crisis .But to our fate our government is least bothered about the farmers and hence leading to huge loss of population of this beautiful nation and its honest citizens by disasters which leave them helpless and hence in many cases farmers take extreme steps such as suicide and moving towards urbanisation. Our project also consists of photographic references and various other data collected from meteorological department, forest department, irrigation department, land records department, Agriculture department and RTI.

Key Words: climate engineering, rainfall engineering, environmental engineering, rainfall pattern droughts and floods.

Introduction:

In present day world due to pollution and various manmade faults such as storing more water than required from rivers which disturbs the natural course of rivers, Deforestation, Global Warming ETC and various other reasons there has been a huge difference in rainfall patterns .As per new studies and research at MIT scientist have said that rainfall has patterns and this can be further classified in to major groups EL-NINO and LA-NINO effect which Is basically an oceanic cycles of warm water and cold water which maintain the temperature of earth. Usually these cycles have a time period of 10 years but this may change according to place and geography of land. Further these cycles are main reasons behind occurrence of monsoon in any part of world. In our project we try to understand the effects of irrigation on rainfall patterns and how we can tackle drought by modern methods of artificial precipitation. Artificial precipitation is new technique followed by various developing and developed countries such as China, Singapore, America, Russia Etc to satisfy there need of rains for farming so that the farmers don't run in to losses and farmers are satisfied.

INDIA is land of farmers and hence rainfall is an important factor for agriculture here. But due to drastic changes since last two decade there has been huge difference in monsoon patterns which has disturbed farmers life eventually. Due to huge industrial revolution going on in our country many farmers are leaving there farming lands and getting employed at industries for better employment and wages as they couldn't afford the cost of agriculture and mainly bore wells as there is no proper rainfall to irrigate the huge agricultural fields .These problems are global issues now as every country has been affected by this crisis. Many countries such as America, china, Japan, Russia, Chile, Singapore ETC have moved towards a new method Artificial Rain.

Technology:

These Artificial Rain are new way of making precipitation possible further it enhances the chances of precipitation too, it also helps in satisfying the need of water for irrigation, and would further increase the ground water levels too. Artificial Rain can be made possible by Ice Breaking Boom, Rain Rocker, The Atmosphere Zapper, Seeding the Sky, Riding the Lighting and various geographical changes to land mass to be

irrigated or the place where precipitation is needed. Our states Andhra Pradesh and Telangana have been 2nd in statics of 2012 suicide estimations .In recent two years 2015 and 2016 the number has gone very high and we are next to only Maharashtra which also shares our fate of unseasonal rains and drought .This problems can be solved by these methods. And further restore the faith of farmers in irrigation and our government also. We as civil engineers must feel responsible and try to implement these path braking and out of the box methods so that these we can be out of this crisis by some extent till an permanent solution of green future is made possible.

Cloud Type	LWC(g/m^3)
Cirrus	0.03
Fog	0.05
Status	0.25-0.30
Cumulus	0.25-0.30
Stratocumulus	0.45
Cumulonimbus	1.0-3.0

Artificial Methods of Precipitation:

- ✓ Cloud Seeding
- ✓ Ice Breaking Boom
- ✓ Rain Rockets
- ✓ The Atmosphere Zapper
- ✓ Riding The Lighting

Objectives of the Study:

- ✓ The objective of our project is to better understand how irrigation can effect rainfall and also how we can plan an agriculture to feed our growing population .It will also allow us to "Model, Predict and ADAPT" to changing climate. It also focuses on how artificial and natural methods of precipitation can make agriculture possible in drought hit zones.
- ✓ Precipitation: The objective of our project is mainly based on studying rainfall (or) in technical terminology it can be described as "Precipitation". The history of precipitation goes back to 4.5 billion years ago when our planet broke from sun to form a land mass which was very hot back then but gradually cooled down which resulted in formation of gaseous clouds which ultimately lead to rains.
- ✓ Clouds: In meteorology, a cloud is an aerosol comprising a visible mass of minute liquid droplets or frozen crystals, both of which are made of water or various chemicals. The droplets or pa1rticles are suspended in the atmosphere above the surface of a planetary body. On Earth, clouds are formed by the saturation of air in the hemispheres (which includes the troposphere, stratosphere, and mesosphere). The air may be cooled to its dew point by a variety of atmospheric processes or it may gain moisture (usually in the form of water vapour) from an adjacent source. Nephology is the science of clouds which is undertaken in the cloud physics branch of meteorology.
- ✓ How do we calculate the Amount of Water Present in Cloud: The liquid water content (LWC) is the measure of the mass of the water in a cloud in a specified amount of dry air. It is typically measured per volume of air (g/m3) or mass of air (g/kg). (Bohren, 1998). This variable is important in figuring out which types of clouds are likely to form and is strongly linked to three other cloud microphysical variables: the cloud drop effective radius, the cloud drop number concentration, and the cloud drop size distribution. (Wallace, 2006). Being able to determine the cloud formations that are likely to occur is extremely useful for weather forecasting as cumulonimbus clouds are related to thunderstorms and heavy rain whereas cirrus clouds are not directly associated with precipitation
- ✓ Problems with Present Day Precipitation Patterns: As temperatures rise and the air becomes warmer, more moisture evaporates from land and water into the atmosphere. More moisture in the air generally means we can expect more rain and snow (called precipitation) and more heavy downpours. But this extra precipitation is not spread evenly around the globe, and some places might actually get less precipitation than they used to get. That's because climate change and global warming.
- ✓ On average, the world is already getting more precipitation now than it did 100 years ago: 6 per cent more in the United States and nearly 2 per cent more worldwide.
- ✓ This has a huge effect on farmers as many of agricultural schemes in our country and south Asia depend on monsoons and seasonal rains but due to global warming there has been huge change in patterns of rains since last 10 to 20 years.

Scope of the Study:

- ✓ Some Basic Changes on Various Aspects of Environments
- ✓ How Irrigation Has Effected Rainfall Patterns
- ✓ How Rainfall Can Be Made Possible By Various Artificial And Natural Methods
- ✓ Impact on Effectiveness
- ✓ Environment and Health

Research Methodology:

The most common chemicals used for cloud seeding include 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. When Cloud seeding increases snowfall takes place when temperatures within the clouds are between 19 and −4 °F (−7 and −20 °C).Introduction of a substance such as silver iodide, which has a crystalline structure similar to that of ice, will induce freezing nucleation. In mid-latitude clouds, the usual seeding strategy has been based on the fact that the equilibrium vapour pressure is lower over ice than over water. The formation of ice particles in super cooled clouds allows those particles to grow at the expense of liquid droplets. If sufficient growth takes place, the particles become heavy enough to fall as precipitation from clouds that otherwise would produce no precipitation. This process is known as "static" seeding. Seeding of warm-season or tropical cumulonimbus (convective) clouds seeks to exploit the latent heat released by freezing. This strategy of "dynamic" seeding assumes that the additional latent heat adds buoyancy, strengthens updrafts, ensures more low-level convergence, and ultimately causes rapid growth of properly selected clouds. Cloud seeding chemicals may be dispersed by aircraft or by dispersion devices located on the ground (generators or canisters fired from anti-aircraft guns or rockets). For release by aircraft, silver iodide flares are ignited and dispersed as an aircraft flies through the inflow of a cloud. When released by devices on the ground, the fine particles are carried downwind and upward by air currents after release. An electronic mechanism was tested in 2010, when infrared laser pulses were directed to the air above Berlin by researchers from the University of Geneva. The experimenters posited that the pulses would encourage atmospheric sulphur dioxide and nitrogen dioxide to form particles that would then act as seeds.

Effectiveness:

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 2003 the US National Research Council (NRC) released a report stating, "...science is unable to say with assurance which, if any, seeding techniques produce positive effects. In the 55 years following the first cloud-seeding demonstrations, substantial progress has been made in understanding the natural processes that account for our daily weather. Yet scientifically acceptable proof for significant seeding effects has not been achieved.

Referring to the years 1903, 1915, 1919, 1944, and 1947 weather modification experiments, the Australian Federation of Meteorology discounted "rain making". By the 1950s, the CSIRO Division of Radio physics switched to investigating the physics of clouds and had hoped by 1957 to better understand these processes. By the 1960s, the dreams of weather making had faded only to be re-ignited post-corporatisation of the Snowy Mountains Scheme in order to achieve "above target" water. This would provide enhanced energy generation and profits to the public agencies that are the principal owners. Cloud seeding has been shown to be effective in altering cloud structure and size and in converting super cooled liquid water to ice particles. The amount of precipitation due to seeding is difficult to quantify. There is statistical evidence for seasonal precipitation increases of about 10 per cent with winter seeding.

Clouds were seeded during the 2008 Summer Olympics in Beijing using rockets, to coax rain showers out of clouds before they reached the Olympic city so that there would be no rain during the opening and closing ceremonies, although others dispute their claims of success. A 2010 Tel Aviv University study claimed that the common practice of cloud seeding to improve or induce rainfall, with materials such as silver iodide and frozen carbon dioxide, seems to have little if any impact on the amount of precipitation. A 2011 study suggested that airplanes may produce ice particles by freezing cloud droplets that cool as they flow around the tips of propellers, over wings or over jet aircraft, and thereby unintentionally seed clouds. This could have potentially serious consequences for particular hail stone formation.

Impact on Environment and Health:

With an NFPA 704 health hazard rating of 2, silver iodide can cause temporary incapacitation or possible residual injury to humans and mammals with intense or continued but not chronic exposure. However, there have been several detailed ecological studies that showed negligible environmental and health impacts. The toxicity of silver and silver compounds (from silver iodide) was shown to be of low order in some studies. These findings likely result from the minute amounts of silver generated by cloud seeding, which are about one percent of industry emissions into the atmosphere in many parts of the world, or individual exposure from tooth fillings.

Accumulations in the soil, vegetation, and surface runoff have not been large enough to measure above natural background .A 1995 environmental assessment in the Sierra Nevada of California and a 2004 independent panel of experts in Australia confirmed these earlier findings. "In 1978, an estimated 2,740 tonnes of silver were released into the US environment. This led the US Health Services and EPA to conduct studies regarding the potential for environmental and human health hazards related to silver. These agencies and other state agencies applied the Clean Water Act of 1977 and 1987 to establish regulations on this type of pollution."

Cloud seeding over Kosciuszko National Park a biosphere reserve is problematic in that several rapid changes of environmental legislation were made to enable the trial. Environmentalists are concerned about the uptake of elemental silver in a highly sensitive environment affecting the pygmy possum among other species as well as recent high level algal blooms in once pristine glacial lakes. Research 50 years ago and analysis by the former Snowy Mountains Authority led to the cessation of the cloud seeding program in the 1950s with non-definitive results. Formerly, cloud seeding was rejected in Australia on environmental grounds because of concerns about the protected species, the pygmy possum. Since silver iodide and not elemental silver is the cloud seeding material, the claims of negative environmental impact are disputed by peer-reviewed research as summarized by the international Weather Modification Association.

Ice Breaking Boom:

In many cold countries there is scarcity of fresh water and in many cases due to hail storms and snow, crops get destroyed hence farmers incur huge losses so these kind of methods help in converting hail storms into rain which leads to fresh water for irrigation in places like these. In this process and cannon is placed at a high altitude so that it is audible at every place another reason why it is kept at higher altitude is that it can be nearer to clouds as its main effect is on clouds and rains. In many places clouds carry hail storms which eventually effects cultivation of fruits which are main crops to be sown in these places. An cannon is placed at high altitude which is been filled with gun powder at lower part of cannon .This gun powder is burnt which leads to an huge boom sound all over the place this shock wave disturbs the snow present in cloud and hence initiates rainfall .

Effectiveness:

This is very effective in places where hails storms are common as these boom sounds can disintegrate huge masses of snow very effectively Hence they can cause rains immediately but these cannot be used in dry and warm places as this equipment is not effective there.

Uses Worldwide:

At present France is the only main user of this particular technique but in some parts of United States of America this technique has been gaining popularity as this doesn't have any side effects on nature.

Rain Rockets:

This method is similar to that of cloud seeding by aircraft but in this instead of aircrafts rockets are used as these doesn't require much of economical invest and is easily affordable. Many countries have been using this method as these rockets have wide reach with minimal effect and these also can be transported easily without any hassle.

Floods and Drought:

Today, droughts and floods are a common feature and their co-existence poses a potent threat, which cannot be eradicated but has to be managed. Transfer of the surplus monsoon water to areas of water deficit is a potential possibility. This would also help create additional irrigational potential, the generation of hydropower, as well as overcoming regional imbalances. The recurrence of drought and famines during the second half of the 19th century necessitated the development of irrigation to give protection against the failure of crops and to reduce large-scale expenditure on famine relief.

Floods in India:

Floods are recurrent phenomena in India. Due to different climatic and rainfall patterns in different regions, it has been the experience that, while some parts are suffering devastating floods, another part is suffering drought at the same time. With the increase in population and development activity, there has been a tendency to occupy the floodplains, which has resulted in damage of a more serious nature over the years. Often,

because of the varying rainfall distribution, areas which are not traditionally prone to floods also experience severe inundation. Thus, floods are the single most frequent disaster faced by the country.

Flooding is caused by the inadequate capacity within the banks of the rivers to contain the high flows brought down from the upper catchments due to heavy rainfall. Flooding is accentuated by erosion and silting of the river beds, resulting in a reduction of the carrying capacity of river channels; earthquakes and landslides leading to changes in river courses and obstructions to flow; synchronization of floods in the main and tributary rivers; retardation due to tidal effects; encroachment of floodplains; and haphazard and unplanned growth of urban areas. Some parts of the country, mainly coastal areas of Andhra Pradesh, Orissa, Tamil Nadu and West Bengal, experience cyclones, which are often accompanied by heavy rainfall leading to flooding.

Area Prone to Flood:

In 1980, Rashtriya Barh Ayog (National Commission on Floods) assessed the total area liable to flooding in the country as 40 million hectares (ha), which constitutes one-eighth of the country's total geographical area. The Working Group on Flood Control Programme set up by the Planning Commission for the Tenth Five Year Plan put this figure at 45.64 million ha. About 80 per cent of this area, i.e. 32 million ha, could be provided with a reasonable degree of protection.

Damage from Floods:

More significant than the loss of life and damage to property is the sense of insecurity and fear in the minds of people living in the floodplains. The after-effects of flood, such as the suffering of survivors, spread of disease, non-availability of essential commodities and medicines and loss of dwellings, make floods the most feared of the natural disasters faced by humankind.

Flood Damage:

	Maximum	Average
Area affected	17.5 million ha (1978)	7.63 million ha
Crop area affected	10.15 million ha (1988)	3.56 million ha
Population affected	70.45 million (1978)	32.92 Million
Houses damaged	3 507 542 (1978)	1 234 616
Heads of cattle lost	618 248 (1979)	91 242
Human lives lost	1 1316 (1977)	1 560
Damage to public utilities	US$ 705 million (1998)	US$ 126 million
Total damage	US$ 1 255 million (1998)	US$ 307 million

Heavy flood damage was inflicted during the monsoon of 1955, 1971, 1973, 1977, 1978, 1980, 1984, 1988, 1989, 1998, 2001 and 2004. Highlights of the damage are given below:
Flood-prone areas are shown in the map.

Institutional Arrangements:

At the central level, the Union Ministry of Water Resources is responsible for development, conservation and management of water as a national resource, i.e. for general policy on water resources development and for technical assistance to the states on irrigation, multipurpose projects, groundwater exploration and exploitation, command area development, drainage, flood control, water-logging, sea-erosion problems, dam safety and hydraulic structures for navigation and hydropower. It also oversees the regulation and development of inter-state rivers. These functions are carried out through various central organizations. Urban water supply and sewage disposal is handled by the Ministry of Urban Development, while rural water supply comes under the purview of the Department of Drinking Water under the Ministry of Rural Development. The subject of hydro-electric and thermal power is the responsibility of the Ministry of Power. Pollution and environment control comes under the purview of the Ministry of Environment and Forests. Water being a state subject, the state government has primary responsibility for use and control of this resource. The administrative control and responsibility for development of water rest with the various state departments and corporations.

National Water Policy:

The National Water Policy adopted by the National Water Resources Council in April 2002 highlights the provisions for project planning, surface- and groundwater development, irrigation and flood control.
Irrigation plays a major role in increasing the production of food grains. The policy provides following directives for irrigation management:

- ✓ Irrigation planning either in an individual project or in a basin as a whole should take into account the irrigability of land, cost-effective irrigation options possible from all available sources of water and appropriate irrigation techniques for optimizing water- use efficiency. Irrigation intensity should be such as to extend the benefits of irrigation to as large a number of farming families as possible, keeping in view the need to maximize production;
- ✓ There should be close integration of water- and land-use policies.
- ✓ Water allocation in an irrigation system should be done with due regard to social equity and justice. Disparities in the availability of water between head-reach and tail-end farms and between large and

small farms should be obviated by adoption of a rotational water distribution system and supply of water on a volumetric basis subject to certain ceilings and rational pricing;

- ✓ Concerted efforts should be made to ensure that the irrigation potential created is fully utilized. For this purpose, the command area development approach should be adopted in all irrigation projects.

Approach to Drought Management:

The behaviour of the monsoon is usually erratic and uncertain in India. Kharif (summer crop) production depends on the quantum and distribution of rainfall. The behaviour of monsoon is broadly classified as:

- ✓ Normal season with normal onset, cessation and distribution of the monsoon;
- ✓ Delayed onset of the monsoon;
- ✓ Normal onset but early withdrawal of the monsoon;
- ✓ Normal onset and cessation but prolonged drought period in between (inter-spell dry period;
- ✓ Flood/excess rains;
- ✓ Uneven distribution of rain.

The preparations for dealing with such situation, which is necessary to maintain from year to year, are:

- ✓ Early warning;
- ✓ Early response;
- ✓ An efficient intelligence system;
- ✓ Timely maintenance of the irrigation system and adoption of a crop stabilization strategy;
- ✓ An effective programme of relief works by advance shelf of projects of the works by different departments
- ✓ Pre-positioning of adequate foodstuff and their delivery;
- ✓ Alternate arrangements for drinking-water supply;
- ✓ Construction of deep wells and bore wells and repair of those which are defunct and continuous repair of hand pumps.

Initiative Taken for Drought Management:

From 1900 to 2002, droughts in India resulted in 2 750 430 deaths and affected some 900 million people, apart from huge financial losses. It is the creeping effect of drought over long periods and its severity that sensitized the Government of India to treat the problem from several angles—scientific, technological, economic, social and environmental. Some of the initiatives taken for drought management by the Government are:

- ✓ Enhancement of the capabilities of long-range forecasts to climate modelling and weather forecasting;
- ✓ In 1989, the National Centre for Medium Range Weather Forecasting started to forecast weather on a medium-term basis (3-10 days in advance);
- ✓ Monitoring of storage position of reservoirs: 76 important reservoirs of the country having a total live storage capacity of 131.22 billion m3 are being monitored. A further 49 have also been identified for inclusion in the monitoring system, which will increase storage capacity of the monitored reservoirs to 156.69 billion m3, i.e. about 74 per cent of the total capacity of 213 billion m3 created so far;
- ✓ Efforts are under way to improve the efficiency of the irrigation system;
- ✓ The National Agricultural Drought Assessment and Monitoring System became operational in 1989;
- ✓ The National Centre for Disaster Management was set up in 1995 to undertake human-resource development, research, building a database and providing information services and documentation on disaster management;
- ✓ Many programmes to prevent/ mitigate drought in the long term;
- ✓ Supporting research to provide solutions to drought-related problems;
- ✓ Setting-up of a National Data Bank under the All India Co-ordinated Project on Agrometeorology at the Crop Research Institute for Dry Land Agriculture, Hyderabad;
- ✓ Setting-up of a National Disaster Management Authority.

The new Drought Risk Management Programme under formulation aims to build on the previous Programme's experience to reduce the vulnerabilities of communities to drought through community-based approaches and appropriate risk management and better decision-support systems at state and district levels.

Approach to Flood Management:

Approaches to dealing with floods may be any one or a combination of the following available options:

- ✓ Attempts to modify the flood
- ✓ Attempts to modify the susceptibility to flood damage
- ✓ Attempts to modify the loss burden
- ✓ Bearing the loss.

The main thrust of the flood protection programme undertaken in India so far has been an attempt to modify the flood in the form of physical (structural) measures to prevent the floodwaters from reaching potential damage centres and modify susceptibility to flood damage through early warning systems.

Structural Measures:

The following structural measures are generally adopted for flood protection:

- ✓ Embankments, flood walls, sea walls
- ✓ Dams and reservoirs
- ✓ Natural detention basins
- ✓ Channel improvement
- ✓ Drainage improvement
- ✓ Diversion of flood waters.

Of these measures, embankments are the most commonly undertaken in order to provide quick protection with locally available material and labour. The major embankment projects taken up after independence are on the rivers Kosi and Gandak (Bihar), Brahmaputra (Assam), Godavari and Krishna (Andhra Pradesh), Mahanadi, Brahmani, Baitarni and Subarnarekha (Orissa) and Tapi (Gujarat). These embankments play an important role in providing reasonable protection to vulnerable areas. Realizing the great potential of the reservoirs in impounding floods and regulating the flows downstream for flood moderation, flood control has been sought to be achieved as one of the objectives in multipurpose dams. Reservoirs with a specifically allocated flood cushion have been constructed on the Damodar system in Jharkhand and the Hirakud and Rengali dam in Orissa. However, many other large storage dams, e.g. Bhakra dam, without any earmarked flood storage, have also helped in flood moderation.

During the post-independence period, multi-purpose projects such as the Damodar Valley Corporation (DVC) reservoirs, the Bhakra-Nangal project, Hirakud dam, Nagarjuna Sagar project etc., have been constructed to increase food production, energy generation, drinking-water supply, fisheries development, employment generation, flood moderation, etc. These large dams have played a significant role in reducing damage by way of flood moderation. One of the important flood moderation examples achieved by dams is that of Damodar Valley, where four reservoirs were constructed with flood management as one of the objectives. During the 2000 monsoon, DVC reservoirs saved the life and property of people from a possible disaster through flood moderation. Up to 2005, 34 398 km of new embankments and 51 318 km of drainage channels were constructed. In addition, 2400 town protection works were completed and 4 721 villages were raised above flood levels. Barring occasional breaches in embankments, these works gave reasonable protection to an area of some 16.5 million ha.

Non-Structural Measures:

Non-structural measures include:

- Flood forecasting and warning
- Floodplain zoning
- Flood fighting
- Flood proofing
- Flood insurance.

A brief description of the most important measure, i.e. flood forecasting, and the progress made so far is given below.

Flood Forecasting and Warning Network in India:

Of all the non-structural measures for flood management which rely on the modification of susceptibility to flood damage, the one which is gaining increased/ sustained attention of planners and acceptance by the public is flood forecasting and warning, which enable forewarning as to when the river is going to use its floodplain, to what extent and for how long. As for the strategy of laying more emphasis on non-structural measures, a nationwide flood forecasting and warning system has been established by the Central Water Commission.

Flood forecasting and flood warning in India commenced in a small way in the year 1958 with the establishment of a unit in the Central Water Commission, New Delhi, for flood forecasting for the river Yamuna at Delhi. This has now grown to cover most of the flood-prone interstate river basins. The Central Water Commission is currently responsible for issuing flood forecasts at 173 stations, of which 145 are for river stage forecast and 28 for inflow forecast. On average, about 6 000 flood forecasts are issued every year with a maximum of 7 943 forecasts in 1998. The forecasts issued by the Central Water Commission have been consistent with about 96 per cent accuracy as per the present norms of the Central Water Commission. A forecast is considered to be reasonably accurate if the difference between forecast and corresponding observed level of the river lies within ±15 cm. In the case of inflow forecasts, variations within ±20 per cent are considered acceptable, as a result of which the flood-forecasting and warning services have rendered immense benefit to those in flood-prone areas.

Modernization of Flood Forecasting Services:

The Central Water Commission is making a constant endeavour to update and modernize forecasting services on a continuous basis to make flood forecasts more accurate, effective and timely. Initiatives being taken for modernizing flood forecasting services are:

- ✓ The establishment and modernization of the flood forecasting network, including inflow forecast through automated data collection and transmission; use of satellite-based communication systems through very small aperture terminals; and improvement of forecast formulation techniques using computer-based catchment models;
- ✓ Development of a decision-support system for flood forecasting and inundation forecast model for the Mahanadi basin and flash flood forecasting for Sutlej basin;
- ✓ Development of a real-time flood-forecasting system for the Brahmaputra and Barak basin, envisaging data collection through automatic sensors and transmission through satellite and forecast formulation using a computer-based mathematical model.

Suggestions:

- ✓ The largest cloud seeding system is in the People's Republic of China. They believe that it increases the amount of rain over several increasingly arid regions, including its capital city, Beijing, by firing silver iodide rockets into the sky where rain is desired. There is even political strife caused by neighbouring regions that accuse each other of "stealing rain" using cloud seeding. About 24 countries currently practice weather modification operationally. China used cloud seeding in Beijing just before the 2008 Olympic Games in order to clear the air of pollution. In February 2009, China also blasted iodide sticks over Beijing to artificially induce snowfall after four months of drought, and blasted iodide sticks over other areas of northern China to increase snowfall. The snowfall in Beijing lasted for approximately three days and 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.
- ✓ In India, cloud seeding operations were conducted during the years 1983, 1984–87, 1993-94 by Tamil Nadu Govt. due to severe drought in the years 2003 and 2004 Karnataka government initiated cloud seeding. Cloud seeding operations were also conducted in the same year through US-based Weather Modification Inc. in the state of Maharashtra. In 2008, there were plans for 12 districts of state of Andhra Pradesh.
- ✓ In Jakarta, cloud seeding was used to minimize flood risk in anticipation of heavy floods in 2013, according to the Agency for the Assessment and Application of Technology.
- ✓ In Southeast Asia, open burning haze that pollutes the regional environment. Cloud-seeding has been used to improve the air quality by encouraging rainfall.
- ✓ 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 neighbouring countries. On 25 June 2013, hailstones were reported to have fallen over some parts of Singapore. Despite denials, some believe that the hailstones are the result of cloud seeding in Indonesia.
- ✓ In 2015 cloud seeding was done daily in Malaysia since the haze began in early-August. Thailand started a rain-making project in the late-1950s. Its first efforts scattered sea salt in the air to catch the humidity and dry ice to condense the humidity to form clouds. The project took about ten years of experiments and refinement. The first field operations began in 1969 above Khao Yai National Park. Since then rainmaking has been successfully applied throughout Thailand and neighbouring countries. On 12 October 2005 the European Patent Office granted to King Bhumibol Adulyadej the patent Weather modification by royal rainmaking technology.

Conclusion:

As the world is speeding ahead in the field of artificial rains we INDIA an agricultural country which is mainly dependent on rains for water need to implement these modern techniques so that drought and floods could be avoided. As these methods are economical and non-hazardous they can be easily implemented and would help in serving the purpose of rains all over country and also drought affected areas. The potential technology of precipitation enhancement is very closely linked to water resources management. It is important that the users of this potential technology are integrated into programs at a very early stage in order to establish the requirements and economic viability of any program Future investigations thus should concentrate on establishing a physical hypothesis that incorporates all the major components of the precipitation formation processes in order to provide as sound a scientific basis as possible for estimating the magnitude of the expected effect. To attain this objective we will have to increase our understanding of the individual components of the precipitation formation process. Progress in understanding a single component of this process is intrinsically limited if an understanding of all the major components is not developed to comparable levels. It is very important not to make the same mistake with the new hygroscopic seeding method. Although very exciting and promising results have been obtained to date, some fundamental questions remain that need to be answered in order to provide a sound scientific basis for this technique. As mentioned in the introduction, water is becoming an ever more scarce and precious commodity around the world. The potential societal benefits of precipitation enhancement are therefore too important for us to ignore, and a coordinated strategy should be developed to provide a sound scientific basis for precipitation enhancement programs. With the new tools and techniques, the

scientific community has an excellent opportunity to provide new insights, and to contribute substantially, to the benefit of water re-sources management around the globe

References:

1. ASCE, 2003: Standard practice for the design and operation of hail suppression projects. American Society of Civil Engineers, EWRI/ASCE 39-03, 79p. Balasch, S., R. Romero and A. Ferrer, 2004: A logistic regression model applied to evaluate the influence of operating time of AgI ground acetonic generators onthe size and hardness of hail. Natural Hazards 32, 345-355.
2. Dessens, J., 1986: Hail in Southwestern France. II:Results of a 30-year hail prevention project with silver iodide seeding from the ground. J. Clim. Appl. Meteor., 25, 48-58.
3. Dessens, J., C. Berthet and J.L. Sanchez, 2006: A sensitivity test for hail prevention assessment with hailpad measurements. J. Wea. Modif., 38, 44-50.
4. Dessens J., C. Berthet and J.L. Sanchez, 2009: Seeding optimization for hail prevention with ground generators. J. Wea. Modif., 41, 104-111.
5. Farley, R.D., Hui Chen, H.D. Orville and M.R. Hjelmfelt, 1996: The numerical simulation of the effects of cloud seeding on hailstorms. 13thConf. on Weather Modification, Atlanta, Georgia, 23-30