Cloud Seeding Technology

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Why is in news? If raindrops fall in Delhi on November 20 and 21, they could be ‘artificial’. The Delhi government said there is a possibility for a cloud seeding pilot in the city on these two dates to reduce pollution levels, if things go to plan.

Cloud seeding:

Cloud seeding is a **weather modification technique** that improves a cloud’s ability to produce rain or snow by introducing tiny ice nuclei into certain types of subfreezing clouds.

It is the **process of artificially generating rain by implanting clouds** with particles such as **silver iodide crystals**.

The primary goal of it is to **enhance precipitation in areas** facing water shortages, droughts, or where water resources are critical for agriculture, hydroelectric power generation, or other purposes.

Modern cloud seeding **dates back to the late 1940's**, springing from a discovery at the General Electric (GE) labs in Schenectady, New York in 1946.

Types of Cloud Seeding Methods:

Static Cloud Seeding:

This method involves introducing ice nuclei, such as silver iodide or dry ice, into **cold clouds that have super-cooled liquid water droplets.**

The ice nuclei can trigger the formation of ice crystals or snowflakes, which can grow at the expense of the liquid droplets and fall as precipitation.

Dynamic Cloud Seeding:

Dynamic cloud seeding is a method of inducing rain by **boosting vertical air currents**.

The process is considered more complex than static cloud seeding because it depends on a sequence of events working properly.

Hygroscopic Cloud Seeding:

This method involves **spraying fine particles of hygroscopic materials**, such as salts through flares or explosives into the **base of warm clouds**.

The particles can act as cloud condensation nuclei and increase the number and size of the cloud droplets, which can enhance the reflectivity and stability of the clouds.

Working of cloud seeding:

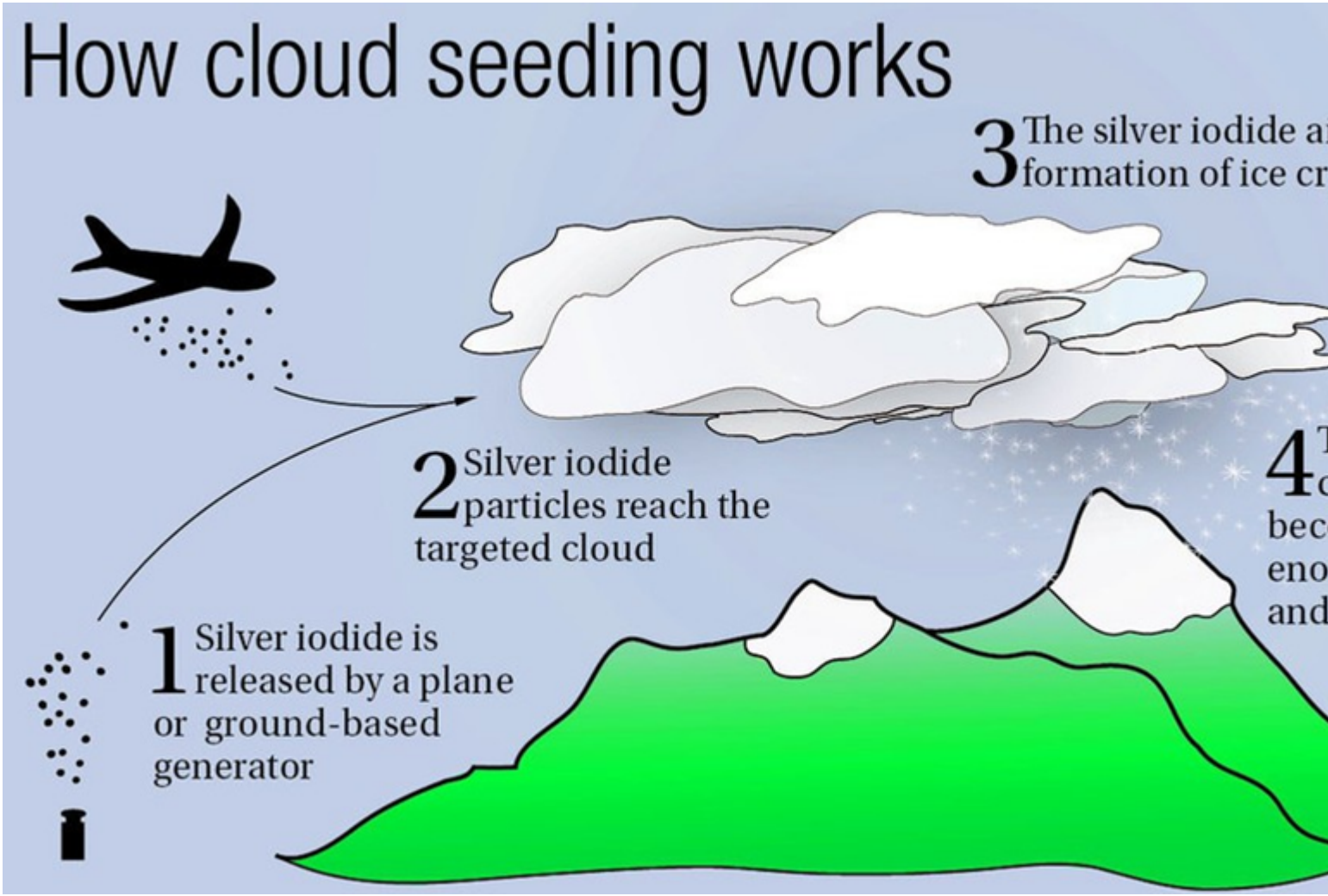
Cloud seeding **does not create new clouds**.

It **increases the amount of rainfall by 10-15%** from existing clouds by adding tiny particles called ice nuclei to the clouds.

Inside the seeded clouds, water vapour freezes onto the particles. These heavier frozen particles fall towards the ground as rain.

Cloud seeding materials are released via **ground-based and/or airborne systems**.

The **most common** cloud seeding materials are **silver iodide and dry ice**.



Cloud seeding so attractive – why?

Cloud seeding is a **highly portable and flexible technology**.

It does not require construction of large, permanent and costly structures, such as dams or water conveyance systems

Projects can be **mobilized quickly and operations** can be regulated.

Studies have indicated **no significant environmental impacts**.

Further, the benefit/cost ratios associated with most cloud seeding projects are typically very favourable.

Existing Practices in World:

Cloud seeding is **not new to India** and it has earlier been attempted in **Karnataka, Andhra Pradesh and Maharashtra** to address drought.

Similar experiments of cloud seeding had earlier been tried in **Australia, America, Spain and France**.

In **United Arab Emirates**, the cloud seeding technique led to creation of 52 storms in Abu Dhabi.

Till last year, IMD had around 30 successful incidents of seeding.

Also, such seeding is routine in Russia and other cold countries where the technique is used to disperse fog at the airports.

Applications:

It is used to **combat drought conditions** by increasing precipitation. It is particularly valuable in arid and semi-arid regions.

It is used to **augment water resources** for agricultural and municipal use. It can help refill reservoirs and aquifers.

In regions that **rely on snowmelt for water supply**, this method can be used to increase snowfall in mountains, contributing to higher snowpack levels.

In some cases, cloud seeding can be employed to **reduce air pollution** by encouraging precipitation that washes pollutants from the atmosphere.

Cloud seeding is primarily done to **create certain conditions in specific areas**, also termed as **microclimates**. Places like airports, for instance, often use cloud seeding to create a stable condition for their runway. This is to ensure that planes are not restricted from taking off or landing.

Concerns:

Some chemicals are potentially **harmful to the natural environment**. Mostly, this applies to the plants which depend on the contaminated rain to produce food.

Cloud seeding is a **very expensive process**. Planes are used to get the chemicals into the air and this is a big obstacle as some of the areas in need of this technology do not have enough financial backing to facilitate the process.

Cloud seeding could have **many dire consequences to the environment** if not well regulated. Dry areas are not usually well-positioned to handle certain weather conditions, and thus, may become easily flooded and cause more harm to the already struggling environment.

There are concerns about the **health and safety of people exposed to the substances** used as seeding agents. While they are typically released at high altitudes, some of these particles may eventually reach the ground.

While some studies suggest that cloud seeding can be effective in enhancing precipitation, there is **not a universal consensus on its efficacy**. The scientific community continues to study and debate its effectiveness.

Dependence on atmospheric conditions: For cloud seeding to be successful, **certain uncontrollable conditions** have to be met.

For example: Clouds have to be present, not just any cloud but clouds capable of producing rain. The atmospheric conditions must also suit the process as certain conditions could lead to an unwarranted result like the rain falling in

a different location or not falling at all.

Weather systems do not adhere to political borders. Cloud seeding in one region **can affect weather patterns in neighbouring countries**, leading to potential diplomatic and international concerns.

The **long-term impact of cloud seeding on ecosystems**, including water resources, air quality, and climate, remains a topic of research and concern.

Conclusion:

Cloud seeding is a valuable tool for increasing precipitation in regions where water resources are limited, but it is not a standalone solution to address long-term water scarcity.

It is typically used in conjunction with other water resource management strategies. Additionally, cloud seeding programs often require careful monitoring and regulation to ensure they are conducted safely and responsibly.

In light of these concerns, proponents of cloud seeding argue that it can be a valuable tool in managing water resources, particularly in regions facing water scarcity.

Critics, however, emphasize the need for rigorous scientific assessments, responsible regulation, and transparent communication with the public to address these concerns and challenges associated with cloud seeding.