Cloud Seeding

...science fact, not science fiction...

- Snowy Hydro has been conducting a scientific trial of cloud seeding in the Snowy Mountains since 2004.
- An independent evaluation of this trial has shown an average 14% increase in precipitation when cloud seeding was undertaken during suitable conditions
- Comprehensive monitoring and assessment shows no evidence of any significant adverse environmental impacts or downwind effects.

About Cloud Seeding

Cloud seeding involves the introduction of a seeding agent into suitable clouds to encourage the formation and growth of ice crystals or raindrops, which in turn enhance the precipitation from the cloud.

The technique has been in use globally for more than 50 years and in Australia for more than 40 years. Today there are over 150 cloud seeding projects around the world.

Snowy Hydro designed this research project to determine if cloud seeding can be used to increase snow falls, at reasonable cost, and without any significant adverse effects on the environment or rainfall downwind of the target area.

The cloud seeding project used a formal experimental design and evaluation plan with criteria for success which was clearly defined and published in advance. This was done to ensure the results would be credible, the process transparent and that the results could be relied on. Most importantly, the final evaluation and peer reviews of project outcomes were undertaken independently of Snowy Hydro Limited.

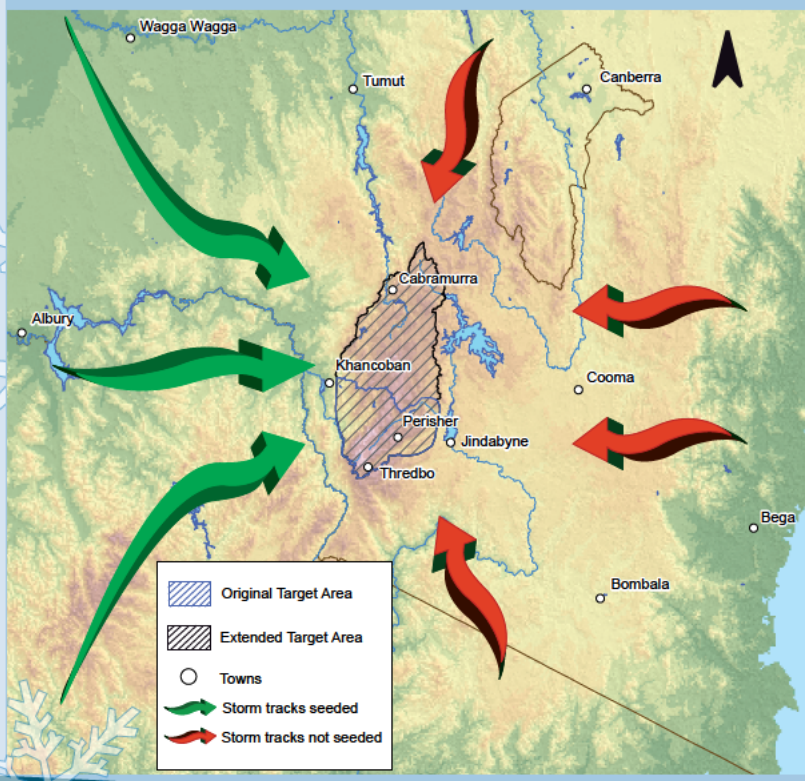
The trial was run using methods typically used for medical research, where some patients receive the active treatment and others a placebo. These treatments are allocated according to a random design to avoid inadvertent bias. In the case of this project, some cloud seeding experiments were seeded, and others not. The present randomisation of seeding means that less than 50% of the suitable weather systems are actually seeded.

The Target Area

The original target area comprised approximately 1000 km^2 mostly within the Kosciuszko National Park. In 2008, the NSW Government approved an expansion of the cloud seeding area and an extension to the program. The expansion has increased the size of the target area to around 2150 km^2, and now includes northern catchments of the Snowy Mountains Scheme.

Westerly systems only for seeding

The cloud seeding project targets storm systems coming from the west. Weather systems approaching the ranges directly from the north, east or south are never seeded, and there are no cloud seeding generators in place which could operate under these wind directions.



The History of Cloud Seeding in the Snowy Mountains

The potential for cloud seeding in the Snowy Mountains was recognised in the early 1950s. A joint experiment between the CSIRO and the Snowy Mountains Hydro-electric Authority (1955–1959) reported a 19% increase in precipitation of seeded storms.

However, the results from that project were challenged due to claims that proper scientific procedure had not been followed.

Further preliminary studies were undertaken in the late 1970s, and again during the winters of 1988 and 1989, and a second cloud seeding project was proposed in 1993.

This did not proceed at the time, mostly because of concerns held by some stakeholders that precipitation would fall as rain rather than snow.

An independent expert panel was commissioned in 2003 to undertake a comprehensive assessment of the potential environmental effects of a cloud seeding experiment over the Snowy Mountains.

The panel reported to the NSW government that 'any significant adverse environmental impacts would be very unlikely'. This resulted in the passing of enabling legislation, the *Snowy Mountains Cloud Seeding Trial Act 2004 (NSW)*, authorising Snowy Hydro to undertake the Snowy Precipitation Enhancement Research Project (cloud seeding) over a target area in the Snowy Mountains region of NSW.

THE ENVIRONMENTAL INVESTIGATIONS CONDUCTED OVER THE LAST SIX YEARS SUPPORT THE CONCLUSION OF THE EXPERT PANEL, PROVIDING COMPELLING EVIDENCE THAT CLOUD SEEDING HAS NOT HAD, AND IS UNLIKELY TO HAVE, A SIGNIFICANT ADVERSE ENVIRONMENTAL IMPACT.

How Does it Work?

Winter precipitation over the Snowy Mountains is largely associated with moist westerly weather systems. As these systems approach the mountains, the air mass is lifted and condenses further to form orographically enhanced clouds. These clouds are composed of tiny water droplets.

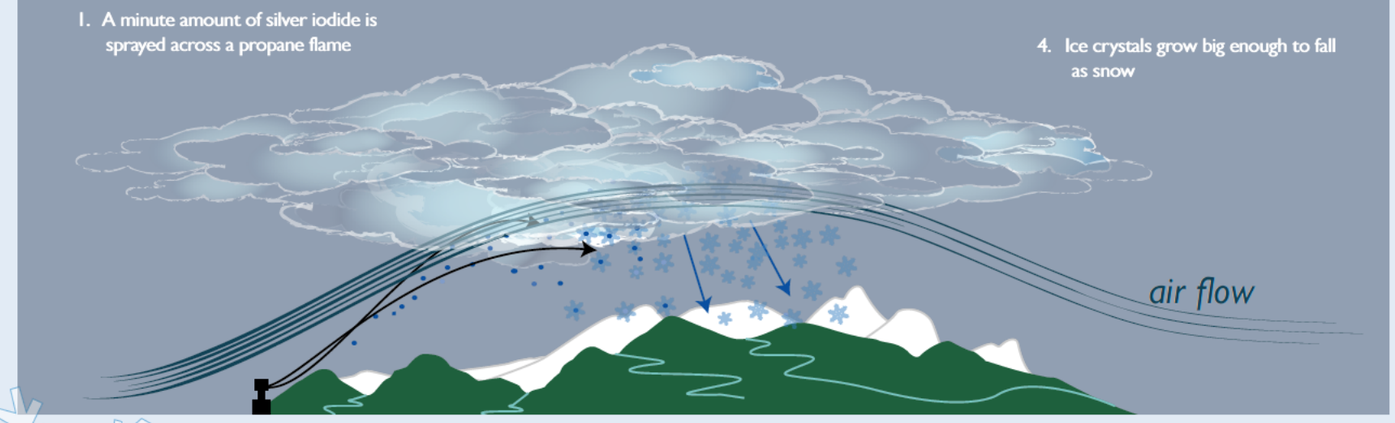
Under certain conditions the water droplets in the cloud remain in liquid form, even at temperatures well below zero degrees Celsius. Water in this form is known as super cooled liquid water.

To fall out of the clouds as snow, the super cooled liquid water droplets need to form ice crystals. This naturally occurs through interaction with tiny airborne particles (like dust or other ice crystals), or when cloud temperatures are very cold; for example, at least minus 30°C. If there are not enough of these particles, or the temperatures are not cold enough, then not all the super cooled liquid water droplets are converted into ice crystals to form snow flakes.

These systems can be described as naturally inefficient, and under normal circumstances (that is, if left unseeded) these clouds pass across the mountain range and the moisture in them evaporates as the clouds descend on the leeward side of the mountain. The result is the well understood, naturally occurring phenomena known as a rain shadow.

To enhance the precipitation of these inefficient clouds, additional particles can be introduced for the excess super cooled liquid water droplets to freeze onto.

The introduction of these particles allows ice crystals to form and grow, and fall to the ground as snow. This process is known as glaciogenic cloud seeding.



Impact of Seeding Agent

In addition to the seeding agent (silver iodide), an inert tracer agent (indium (III) oxide) is also released from each generator site. Snow samples are collected from the target area after cloud seeding experiments, and these are analysed to provide scientists with information on targeting and cloud seeding effectiveness.

A large number of soil, lake and stream sediments, moss, peat and water samples were collected prior to the commencement of the cloud seeding trial in 2004. Analysis of these samples confirmed silver and indium to be present in measurable and wide-ranging concentrations well before any cloud seeding operations took place.

More than 2000 environmental samples are collected each year to determine if concentrations of the seeder and tracer compounds are increasing above background levels, or approaching the relevant environmental guideline trigger values for investigation. Expert analysis of all of the monitoring data collected (2004–2009) shows average concentrations of silver and indium remain unchanged or very low compared to the relevant environmental guidelines.

All potable (drinking) water supplies within the cloud seeding target area are regularly tested, and show an average concentration of silver around one part per trillion (that is, one part in one million, million parts). Every sample collected has been almost 100,000 times lower than the level specified in the National Health and Medical Research Centre Australian Drinking Water Guidelines (2004). In comparison, commercial distilled water supplied from a local supermarket was found to have a concentration of around 40 parts per trillion of silver.

What we use to cloud seed

Silver iodide is used as the seeding material because it has very similar physical properties to natural ice crystals.

Ground based generators arranged along the western side of the mountains dispense very small quantities of minute silver iodide particles into winter storm clouds as they pass over the mountain range.

These particles are so small that more than 300 million particles would fit on the head of a pin. On average the amount of seeding material used each year across more than 2150 km^2 could be contained within an average domestic water bucket.

The Equipment

The infrastructure for the cloud seeding trial includes:

- an extensive network of high resolution meteorological instruments (for monitoring weather conditions and recording meteorological data)
- a weather balloon launching facility near Khancoban
- two remote sensing facilities, with special instrumentation designed for measuring super cooled liquid water. These instruments identify and target inefficient systems for cloud seeding, ensuring that efficient systems are left to snow naturally, and
- a total of 23 ground generator sites along the western side of the mountains.

What does it cost?

More than $20 million was spent over the first six years of the project. Just over $16 million of these funds were provided by Snowy Hydro. Early promising results were sufficient for the Federal Government to also provide $4 million in research funding support.

Environmental Management and Care

Snowy Hydro implemented a comprehensive Environmental Management Plan for the cloud seeding project.

The plan was developed in collaboration with experts from the NSW Department of Environment, Climate Change and Water and in consultation with the NSW Natural Resources Commission (NRC).

More or Less Rain Downwind?

From time to time, questions are raised by some stakeholders to the east of the Snowy Mountains as to whether the seeding is adversely impacting on rainfall downwind of the project.

Their concerns are based on the idea that increasing precipitation in one area can only be done at the expense of a decrease in precipitation in another area.

While the Expert Panel determined there would be no adverse impact, the evaluation plan for the project included a scientific assessment of potential downwind effects to validate this conclusion.

Individual case studies were also undertaken for a number of sites, including Cooma, Bombala, Bega and Braidwood. The assessment found no evidence of any impacts – positive or negative – downwind of the target area.

Results

An independent evaluation of the trial reported that, under suitable conditions, cloud seeding increased snowfalls on average by 14%. Moreover, an assessment of the data collected for the trial found no evidence of any adverse downwind effects or environmental impacts. The NSW government instructed the NRC to undertake a further independent expert review of the trial outcomes and the key findings of that investigation included:

"Overall, the NRC confirms that the trial is being conducted in compliance with the Act, is of a high scientific standard and the evaluation plan is statistically sound";

"There is no evidence that cloud seeding operations have had adverse environmental impacts over the first phase of the trial";

"The monitoring results have detected no adverse impacts on rainfall in downwind areas during the first phase of the trial";

"…evidence that cloud seeding has increased snowfall in the target area under defined weather and operating conditions".

The Future

The Snowy Hydro cloud seeding project set out to answer the question: 'Can cloud seeding be used to increase snow falls, at reasonable cost and without any significant adverse effects on the environment or downwind of the target area?'

The independent analysis shows under suitable conditions cloud seeding increased precipitation by 14%, with no evidence of any downwind effects. Importantly, the environmental monitoring over the six years of the program has shown no evidence of any significant adverse environmental impacts.

Given these outcomes, the transition from a scientific trial to an ongoing operation is now an urgent priority.

This would mean that all suitable cold fronts would be seeded, delivering further benefit to stakeholders. Snowy Hydro has now formally requested that the NSW Government make the necessary arrangements for a continuing cloud seeding operation.

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Snowy Hydro welcomes your comments and feedback. Contact us for more information:
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