

Tempestas Futuras

Geoengineering as a «Luxury of Being Afraid»

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Humanity has always been exposed to nature and the climate. From heavy rains and hurricanes to heat waves and droughts, we've had to endure climatic events, which often lead to catastrophic consequences. These disasters—causing hunger, homelessness, and destruction—have always been a part of our existence, something we had no choice but to face. Geoengineering has emerged as a potential solution—a way to intervene and lighten these crises through technology.

When researching about geoengineering it is important to mention it as a term that “encompasses all techniques designed to modify the climate and alleviate the effects of global warming” according to the IPCC glossary, and together with it the Anthropocene.

We have been warned about the greenhouse effect ever since 1896 by Swedish scientist Svante Arrhenius, however it is now that we have an increased access to information and are sensing the climate change that we feel a greater threat and the urgency to act against a climate dystopia. Opinions here vary, some say in order to guide society during this epoch it may involve internationally accepted large-scale geo-engineering projects, those are called the “techno-utopians” by meteorologist Paul J. Crutzen and there are also the “eco-soterians” who believe geoengineering will only worsen the climate catastrophes in the long term bringing us to a worse scenario.

Nonetheless geoengineering has also been used to manipulate the earth's natural system promising short term solutions based on a State's necessities and interests. For instance the usage of methods such as cloud seeding, to ensure water reservoirs are filled during the drought season, or enhancing snowpack levels in the Sierra Nevadas Mountains. It goes on to extremes, as the planned blue skies ahead for an important olympic day back in 2008 in Beijing, China.

I analyse these happenings and developments in the Geoengineering as an impactful societal phenomena—it is a luxury to be able to manipulate nature and the climate to a country's benefit, not only in the monetary aspect but also to be able to contemplate it as a solution. What if “The Luxury of Being Afraid” slowly turns what once was an effort to address collective climate crises into an evolving luxury.

“THE DELIBERATE INTERVENTION IN THE EARTH'S NATURAL SYSTEMS.”
Quote from book “Against the Anthropocene” by T.J Demos

1
NASA Evidence on Climate Change
<https://science.nasa.gov/climate-change/evidence/>

2
Book: Against the Anthropocene: Visual Culture and Environment Today by T.J Demos

3
Geoengineering Insights
<https://academic.elsevier.com/levels/collegiate/article/geoengineering/474306>

4
IPCC Glossary
https://www.ipcc.ch/site/assets/uploads/sites/2/2019/10/SR15_Glossary_spanish.pdf

Geoengineering Monitor Map

2000–2024



1
www.geoengineeringmonitor.org/all-technologies

OCEAN FERTILISATION
 CLOUD SEEDING
 DIRECT AIR CAPTURE
 BIOCHAR
 ARTIFICIAL UPWELLING
 ENHANCED WEATHERING
 SEAWEED FARMING
 AND BIOMASS SINKING
 STRATOSPHERIC
 AEROSOL INJECTION

www.geoengineeringmonitor.org/all-technologies

www.dri.edu/cloud-seeding-program/what-is-cloud-seeding/#:~:text=Cloud seeding is a weather,base for snowflakes to form.

Geoengineering technologies generally and broadly fall into two main categories, the Solar Radiation Modification (SRM) and Carbon Dioxide Removal (CDR).

Many are hypothetical proposals found only in research papers and modeling studies, while others are already undergoing testing and commercialization.

1

Refers to dumping iron (as powdered iron sulphate) or other nutrients (e.g. urea) into the ocean in areas with low biological productivity in order to stimulate phytoplankton growth. In theory, this would draw carbon dioxide out of the atmosphere as the phytoplankton grows, and then when it dies and falls to the ocean floor the carbon would be sequestered there for long periods of time.

5

Transporting nutrient-rich deep ocean water to the sea surface by pumping it or through other artificial methods. The idea is that this will result in increased phytoplankton growth which will absorb more atmospheric carbon dioxide. The absorbed carbon will then be stored long-term when the dead phytoplankton biomass sinks to the ocean floor.

2

A weather modification technique that aims to manipulate a cloud's ability to produce rain or snow by spraying silver iodide or salt particles into clouds. This technique has been used for decades in some regions to enhance rainfall during droughts or to increase water supplies as well as increased snow pack levels during winter. Cloud seeding can be done from ground-based generators or aircraft.

6

Crushing millions of tonnes of rocks and spreading them onto farmland or beaches, or dumping them into the sea, in order to react with and fix atmospheric carbon dioxide into the oceans and soils.

3

Aim to extract carbon dioxide and other greenhouse gases from the atmosphere by chemical and mechanical means, generally using a chemical sorbent and large fans to move air through a filter. The carbon dioxide can then be compressed and injected into geological formations deep underground or used for other purposes, such as Enhanced Oil Recovery (EOR) or the production of e-fuels.

7

These schemes involve the industrial cultivation of seaweed to remove carbon dioxide from seawater. The seaweed is then sunk in the deep ocean where it is claimed that the captured carbon will remain locked on the sea floor for hundreds of years, or it is used to create products such as biofuels, fertilisers and animal feed.

4

Biochar is produced through pyrolysis, a process where biomass combustion occurs in a low oxygen environment at very high temperatures. It results in a solid carbon-rich charcoal-like substance, which can be mixed into soil where it is theoretically stored.

8

Spraying sulfur dioxide and other aerosols into the stratosphere to block the sun/ act as a reflective barrier against incoming sunlight. Proposals range from shooting particles from artillery guns, using large hoses or releasing particles from the back of aircraft. Self-levitating particles, as well as using other reflective minerals (like titanium and aluminum), are also being considered.

CLOUD SEEDING

Cloud Seeding

Cloud seeding is a form of weather modification that aims to increase precipitation by altering the physical properties of clouds. Technically, the process begins by dispersing chemical agents such as silver iodide, potassium iodide, or, in some cases, sodium chloride or even liquid propane. These agents are chosen because their molecular structures mimic ice crystals, providing surfaces onto which water vapor can condense. When introduced into a cloud system, these substances attract surrounding water droplets or ice crystals, facilitating their growth and eventually forming droplets heavy enough to fall as precipitation.

There are three primary methods of dispersing cloud-seeding agents: aerial, ground-based, and rocket-based seeding. In aerial seeding, planes equipped with flares or burners release the particles directly into clouds at specific altitudes. Ground-based seeding stations, on the other hand, use specialized equipment to launch particles into the lower atmosphere, which are then carried up into cloud systems by natural air currents.

Initially explored in the 1940s, cloud seeding has become an attractive technology for countries facing water shortages, drought, or irregular rainfall. Notably, privileged countries with substantial resources, such as China, the United Arab Emirates, and the United States, have heavily invested in cloud seeding to supplement water reserves and protect agricultural regions. The UAE, for instance, has one of the most extensive cloud-seeding programs, deploying it regularly to mitigate water scarcity in arid regions.



1

Desert Research Institute
www.dri.edu/cloud-seeding-program/what-is-cloud-seeding/#:~:text=Cloud seeding is a weather,base for snowflakes to form.

2

Figure, Morocco's cloud seeding sparks debate.
Marocco World News
www.marocworldnews.com/2024/08/364756/moroccos-cloud-seeding-plans-raise-concerns-in-spain

Traditional method of artificial rainmaking in use since the 1940's

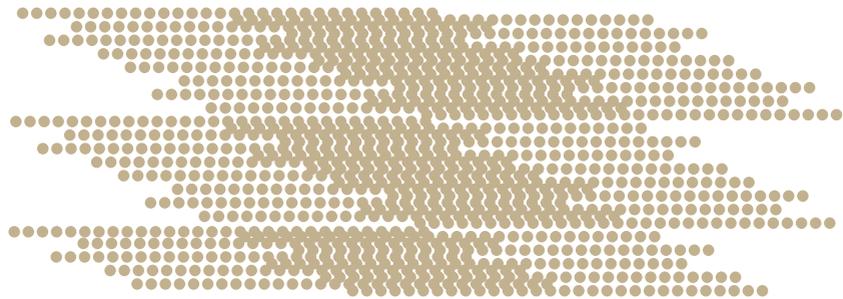
1

Silver iodide is released by a plane or ground-based generator



2

Silver iodide particles reach the targeted cloud



3

Silver iodide aids in the formation of ice crystals



4

Now too heavy to remain in the air, the ice crystals then fall, often melting on their way down to form rain



STRATOSPHERE

TROPOSPHERE

Silver iodide



"Silver iodide is an inorganic compound with the formula AgI. The compound is a bright yellow solid, but samples almost always contain impurities of metallic silver that give a grey colouration. The silver contamination arises because some samples of AgI can be highly photosensitive. Silver iodide is also used as an antiseptic as well as in cloud seeding." NIH (National Library of Medicine)

1 The golden-yellow crystals on this mineral sample are iodargyrite, a naturally occurring form of β -AgI. Wikimedia

2 Silver iodide is prepared by reaction of an iodide solution (e.g., potassium iodide) with a solution of silver ions (e.g., silver nitrate). A yellowish solid quickly precipitates. Wikimedia



Cloud seeding in the UAE



Aerial-based seeding

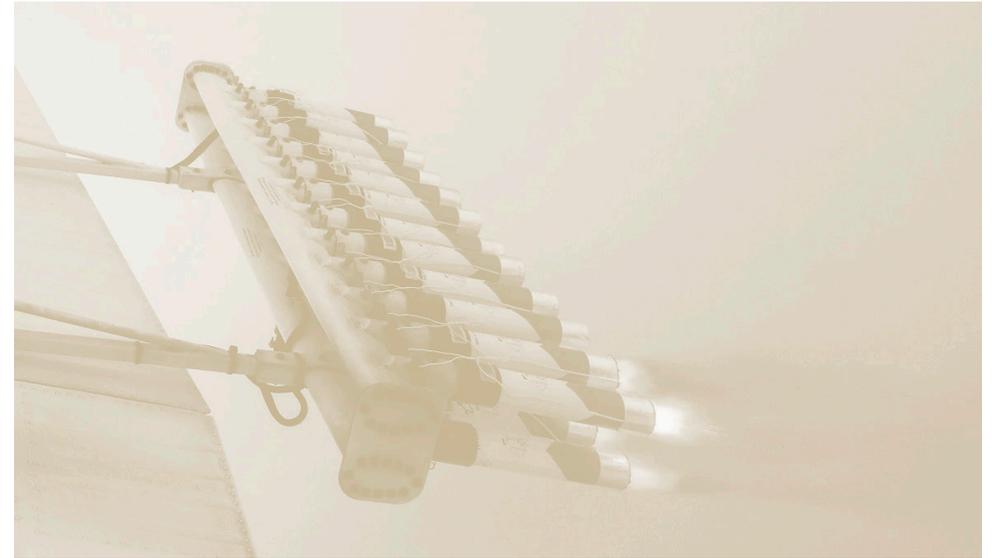


Figure 1

Cloud-seeding: Making it rain in the UAE, 1. September 2023

<https://www.edgemiddleeast.com/innovation/emergentech/rain-in-the-desert-uae-announces-cloud-seeding-tests>

Figure 2

Making it rain: The Case for Cloud Seeding in the UAE, 1. November 2015

<https://www.waterworld.com/drinking-water-treatment/potable-water-quality/article/16201703/making-it-rain-the-case-for-cloud-seeding-in-the-uae>

“BUKIT MERAH DAM WATER LEVEL RISES TO 33% AFTER INDUCED RAINFALL.”

“BEFORE CLOUD SEEDING, THE WATER LEVEL WAS AT 12%. AFTER THE OPERATION, IT HAS INCREASED TO 33% IN LESS THAN A WEEK.”

says Infrastructure, Energy and Water Committee chairman, Datuk Seri Mohammad Nizar Jamaluddin.

“MY GRATITUDE TO THE NATIONAL DISASTER MANAGEMENT AGENCY.”

When researching about cloud seeding the term “water reservoirs” came up the most – the use of cloud seeding in order to fill water reservoirs for the drought season. To illustrate this “necessity” I have put together this study case about the Bukit Merah dam, Malaysia where cloud seeding is frequently used and approved by Infrastructure, Energy and Water Committee chairman, Datuk Seri Mohammad Nizar Jamaluddin.



Figure 1

Bukit Merah dam, Malaysia viewd from the airplane while “cloud seeding” is happening
The Star
www.thestar.com.my/news/nation/2024/08/12/bukit-merah-dam-water-level-rises-to-33-after-induced-rainfall

Figure 2

Inside of an airplane performing cloud seeding in the Bukit Merah dam, Malaysia.

Figure 3

Drone shot from the Bukit Merah dam, Malaysia

**Study case: Snow Enhancement Programm,
Sierra Nevada Mountains, California**

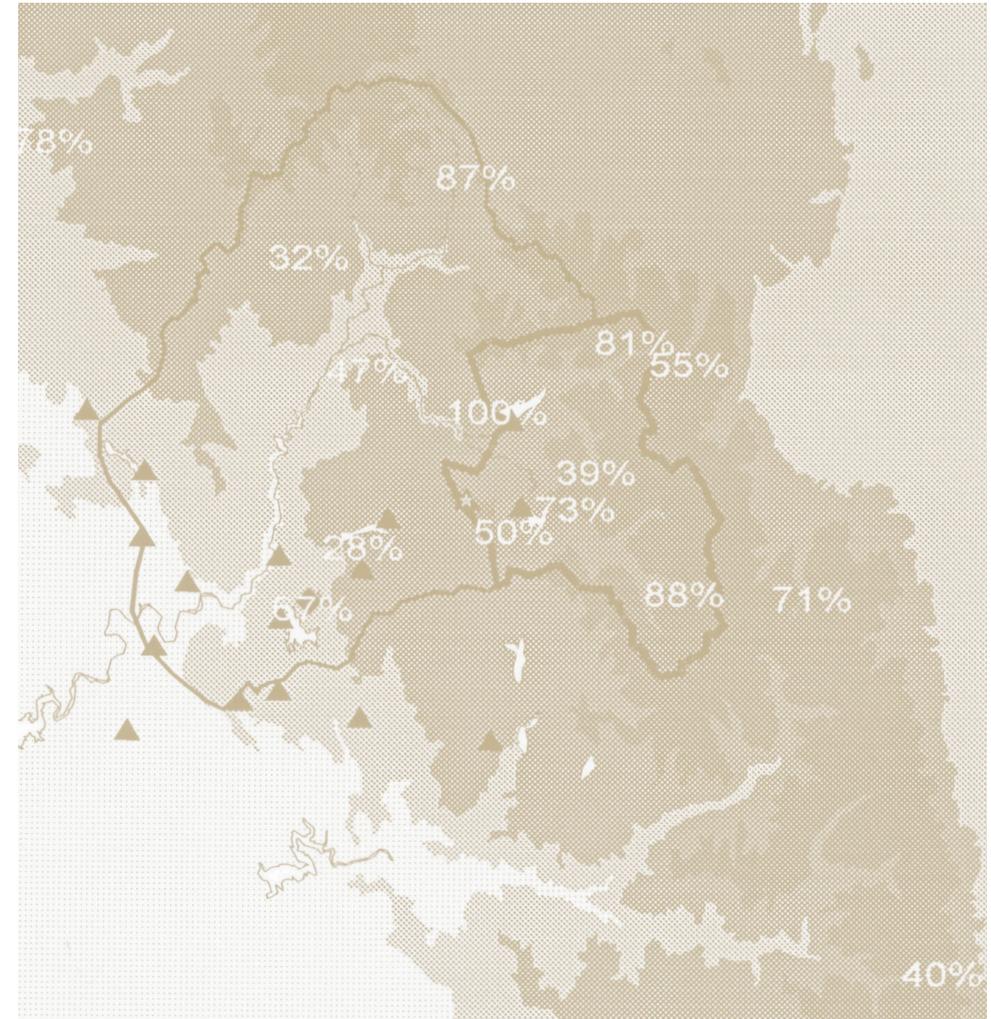
Winter orographic cloud seeding (cloud seeding where wind blows over a mountain range causing clouds and rain or snow by lifting the air) has been practiced in California since the early 1950s. Most of the projects are along the central and southern Sierra Nevada, with some in the Coast Ranges.

The snow enhancement program in California is part of the state's proactive approach to managing water resources in the face of persistent droughts and changing climate patterns.

The goal is to increase the winter snowpack in California's mountainous regions, which serves as tourism during ski season, a vital natural reservoir, slowly releasing water during the spring melt and supporting water supplies throughout the dry summer months.

Managed by both state agencies and utilities, the program aims to boost snowfall by up to 10%, a significant contribution considering California's reliance on snowpack for approximately one-third of its water needs.

**Targeting Effectiveness in southern
Sierra Nevada Mountains**



Map shows percentages of snow samples with Ag above background during the 1994 season
Triangles are ground generator sites



Precipitation enhancement operational programs in California during 2022



1

Sierra Nevada Aerial,
Wikimedia

2

Document: Draft Precipitation
Enhancement RMS, California
Water Plan 2023.

Climate catastrophe

The rise of cloud seeding highlights a growing disparity in climate resilience between wealthier and less privileged countries. Wealthier nations can leverage this technology to secure their water resources. For example while the United States is using cloud seeding to increase their snowpack levels there are countries like Brazil specifically in the state of Rio Grande do Sul that has faced a big flooding catastrophe in 2024 where 2.398.255 people were affected by the flooding and are now having to rebuild their lives after losing everything.

Looking forward, cloud seeding raises ethical and environmental concerns. The potential for unintended consequences, such as altered weather patterns or ecological impacts, is a major debate topic. Additionally, cloud seeding's long-term environmental impacts remain uncertain, as repeated use of chemical agents like silver iodide may have consequences for ecosystems. Dubai a city known for the intense usage of cloud seeding has lately been suffering strong flooding, it is not scientifically proven the reasons for it, however it is speculated to be a side effect of the weather manipulations.

Figure 1

Atypically heavy rains in the United Arab Emirates in April 2024 caused flooding, flight cancellations and school closures. Vehicles were abandoned on highways like this one in Dubai. npr.org

Figure 2

A flooded parking lot in Dubai in April 2024. Getty Images

Flooding in Dubai, UAE, 2024

“UAE SEES ITS HEAVIEST RAINS IN 75 YEARS”

National Public Radio, Washington, D.C., United States



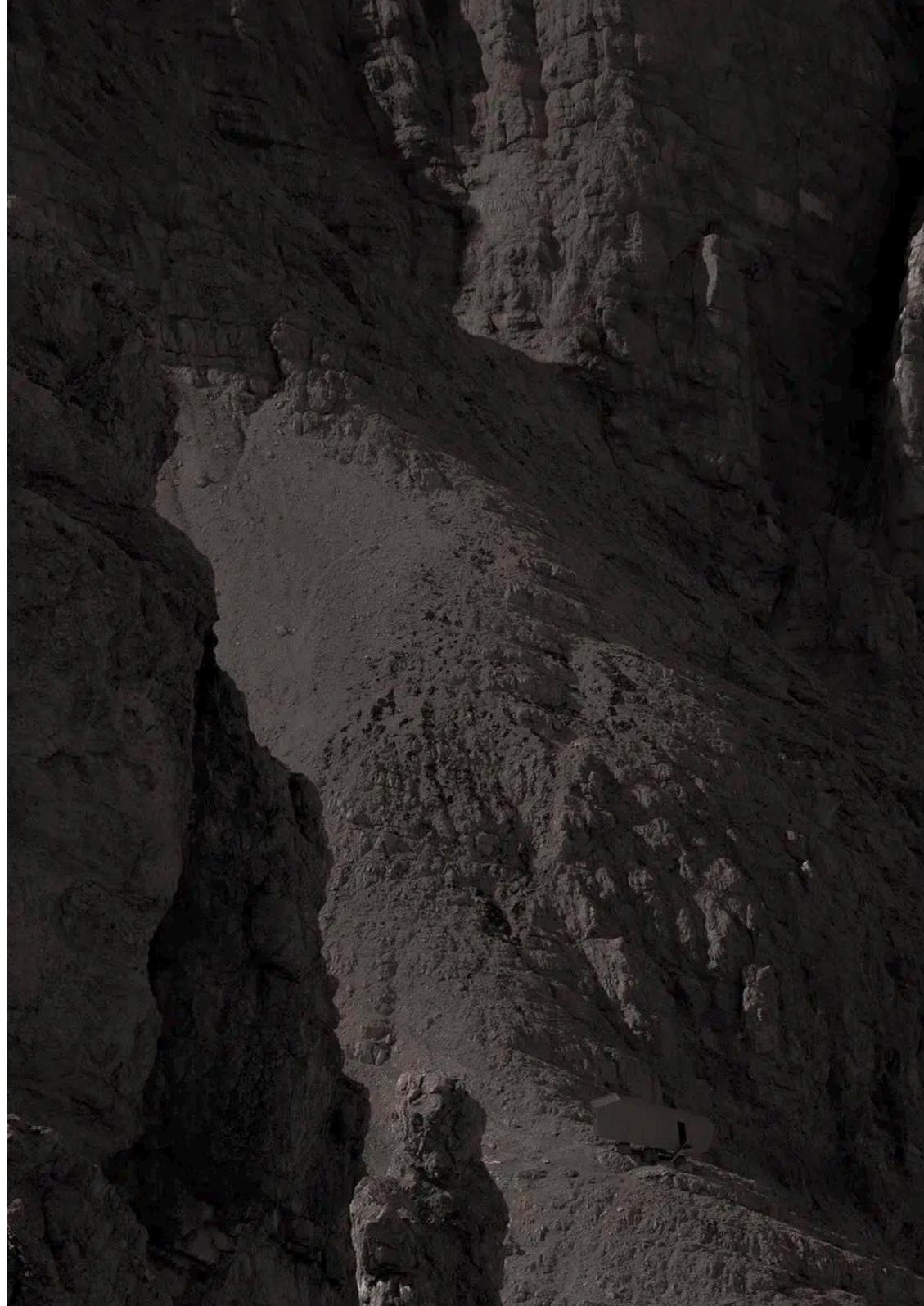
Initially indicated as a solution, humanity invested resources into geoengineering projects meant to combat climate change, these interventions quickly became tools of exploitation, prioritizing profit for powerful corporations and wealthy nations over the well-being of communities and the planet. Decisions fueled by short-term gains led to devastating consequences that amplified the crises

they were meant to solve.

As relentless heatwaves scorched landscapes and violent storms battered cities, agricultural systems collapsed under extreme weather. The technologies designed to protect our future deepened inequality, igniting conflicts over dwindling resources. Abandoned geoengineering projects now stand as monuments to humanity's misguided reliance on short-sighted solutions,

highlighting how greed and negligence pushed us toward destruction.

This series of images invites you to explore a future where we failed the Anthropocene.













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1
Movie Dune: Part One

2
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