



Geoengineering to Combat Global Warming

Source: IE

Why in News?

A recent study proposes that spraying millions of tonnes of diamond dust annually into the [Earth's upper atmosphere](#) could lower the planet's temperature by **1.6°C**, helping to mitigate [global warming](#).

- This [geoengineering](#) approach suggests that diamonds could be more effective for [Solar Radiation Management \(SRM\)](#) than materials previously considered.

Current Scenario of Climate Change & Global Warming

- [Global temperatures](#) are now approximately **1.2°C above pre-industrial levels** (1850-1900) and are projected to reach 1.45°C in 2023, highlighting the urgent need for innovative solutions.
- Current trends suggest that the **1.5°C warming limit established by the [2015 Paris Agreement](#)** is unlikely to be achieved.
- Achieving climate targets requires a substantial 43% reduction in emissions **from 2019 levels by 2030**, though current efforts may yield only a 2% decrease.

What is Geoengineering?

- **About:**
 - It refers to **large-scale interventions aimed at altering the Earth's climate system** (more specifically solar radiation management) to counteract the effects of global warming.
- **Classification:** It primarily involves two approaches namely **SRM** and **Carbon Dioxide Removal (CDR)**.
 - **SRM:** SRM Involves deploying materials in space to reflect [solar rays](#) away from the Earth. This method, while still conceptual, draws inspiration from natural phenomena such as volcanic eruptions.
 - For example, **Mount Pinatubo's 1991 eruption** in the Philippines reportedly reduced Earth's temperature by 0.5°C that year.
 - **CDR:** Techniques include [Carbon Capture and Sequestration \(CCS\)](#), **Direct Air Capture (DAC)**, and [Carbon Capture, Utilisation and Storage \(CCUS\)](#), with the focus on long-term reduction of atmospheric [Carbon dioxide \(CO2\) levels](#).
 - **CCS:** It is the **main CDR method** in practice. It involves capturing CO₂ emissions from industries and storing it underground in suitable geological formations, effectively reducing emissions.
 - **DAC:** It involves extracting CO₂ directly from ambient air using large devices (**often called "artificial trees"**) for storage or use.
 - DAC has **greater potential benefits** as it can address historical CO₂ emissions, though it also faces more significant challenges.
 - **CCUS:** Some captured CO₂ is repurposed in industrial processes, while the remainder is stored.

▪ Related Challenges:

- **Implementation Barriers:** SRM technologies encounter substantial technological, financial, and ethical challenges.
 - Potential unintended effects include **disrupted weather patterns, negative impacts on agriculture**, and threats to biodiversity.
- **Feasibility of CCS:** While CCS is presently the most widely implemented geoengineering method, relying solely on it may prove economically impractical compared to shifting toward [renewable energy sources](#).

GEO-ENGINEERING

Geoengineering means manipulating the earth's climate to lower its temperature to counter global warming

TYPES OF GEO-ENGINEERING

CARBON DIOXIDE REMOVAL			
Technology/ Method Proposed	Proposed Effects/actions	Potential Side Effects	Feasibility/Cost Effectiveness
Land Use Management	Afforestation/ Reforestation	Minimum Side Effects	High feasibility, Low Cost
Bio-energy with carbon capture and storage (BECCS)	Biomass harvested and used as fuel	Potential land use conflict	Comparatively expensive
Direct CO ₂ Capture	Industrial Process	Minimal	High technical feasibility
Fertilization of the ocean	Increased CO ₂ absorption by promoting algae growth	High potential for adverse side effects	Feasible but not cost-effective
Accelerated Weathering	Pulverization of silicate rocks	Potential respiratory health impact	Could be combined with crop production, a feasible option at scale

SOLAR RADIATION MANAGEMENT			
Technology/ Method Proposed	Proposed Effects/actions	Potential Side Effects	Feasibility/Cost Effectiveness
Stratospheric aerosol Injection	For reflecting sunlight back into space	Likely impact on the hydrological cycle	Feasible and potentially highly effective
Marine cloud brightening	Seeding of marine clouds with seawater aerosol	Likely impact on precipitation pattern	Low to medium cost and feasible at scale
Giant deflectors in outer space	Mirror placed in near earth orbit	Regional climate effects	Capital-intensive and long gestation
Surface albedo approaches	Painting the roof of the building bright white, Installing desert reflector	Major Impact on Desert Ecosystem	High labor and maintenance cost

REGULATION

⬇ No specific international or Indian regulations on geoengineering.

INDIA'S EFFORTS

⬇ **Department of Science and Technology:**

- ◆ Geoengineering climate-modelling research programme (since 2013)

⬇ **IISc:**

- ◆ Initiative to understand the implications of solar geoengineering for developing countries
- ◆ Scientists simulated injecting 20 million tonnes of sulphate aerosols into the Arctic stratosphere

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UPSC Civil Services Examination, Previous Year Questions (PYQs)

Q1. Which of the following statements is/are correct about the deposits of 'methane hydrate'? (2019)

1. Global warming might trigger the release of methane gas from these deposits.
2. Large deposits of 'methane hydrate' are found in Arctic Tundra and under the sea floor.
3. Methane in atmosphere oxidizes to carbon dioxide after a decade or two.

Select the correct answer using the code given below.

- (a)** 1 and 2 only
- (b)** 2 and 3 only
- (c)** 1 and 3 only
- (d)** 1, 2 and 3

Ans: (d)

Q. In the context of which of the following do some scientists suggest the use of cirrus cloud thinning technique and the injection of sulphate aerosol into stratosphere? (2019)

- (a)** Creating the artificial rains in some regions
- (b)** Reducing the frequency and intensity of tropical cyclones
- (c)** Reducing the adverse effects of solar wind on the Earth
- (d)** Reducing the global warming

Ans: (d)

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