Surface Albedo Modification

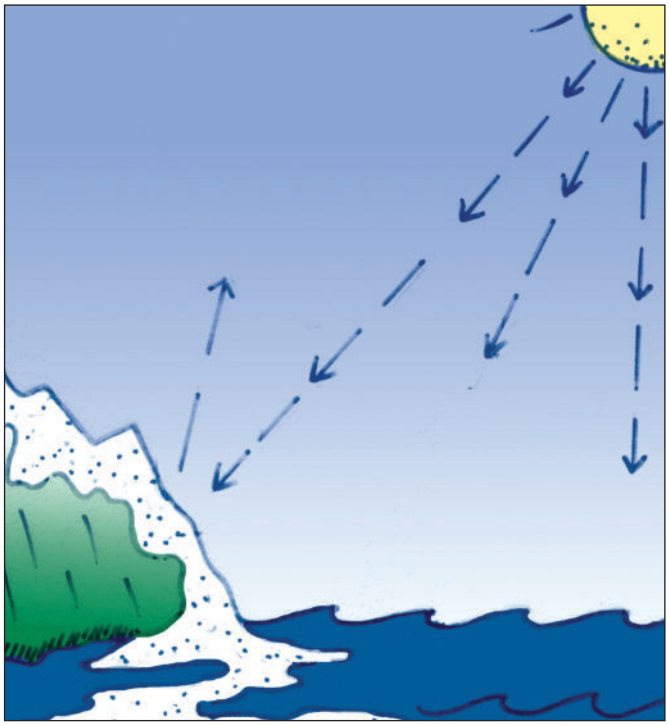
Description and purpose of the technology

Surface Albedo Modification is a theoretical solar geoengineering technique that aims to reflect more sunlight back to space by enhancing earth albedo – the sunlight reflected off the Earth's surface. Proposals span a wide range – from growing crops that reflect more light, to the clearing of boreal forest in snow-covered areas; from covering large desert or ice areas with reflective materials to whitening mountaintops and roofs with white paint – all with a common goal: to increase the earth's surface albedo.

Albedo describes how much solar radiation is reflected by a surface. A high albedo means most solar radiation is reflected, for example polar ice sheets. A surface with a low albedo, for example a dark ocean surface, reflects only a relatively small share and absorbs most of the solar radiation in the form of heat, thus contributing to warming the surrounding area.

Creating large surfaces with a higher albedo could increase the amount of solar radiation reflected from the Earth's surface and could theoretically reduce the temperature of the atmosphere, because surfaces absorb less solar energy. However, the proposal would not reduce the concentration of greenhouse gases in the atmosphere, which would continue increasing. In most cases, the unwanted side effects on the ecosystems, fauna and flora, as well and human communities that depend on those ecosystems could be devastating.

The following outlines different approaches to modify surface albedo, mentions relevant actors involved and describes potential impacts.



Surface Albedo Modification refers to a number of techniques that aim to reflect light back into space by modifying land surfaces like deserts, farmland, or ice

Point of Intervention:

Reality Check:

Ice Covering

This method involves applying a layer of reflective material to the Arctic ice as a "reflective band aid" to insulate rapidly melting snowpack and glaciers.[1] The California-based Arctic Ice Project (former Ice911), founded by Leslie Field in 2007, proposes reflective silica glass as cover material. The material consists mostly of silicon dioxide and comes in the shape of tiny glass spheres. For a decade now, the project has carried out trials on frozen lakes in Canada and the USA and tested various reflective materials. The project's largest trial site is the North Meadow Lake, an Indigenous area near Utqiagvik, Alaska.

Although the local community members have not been consulted and never consented the trials, the testing at this site commenced during winter 2015, covering up to 17,500m^2. The Arctic Ice Project plans to conduct trials on sea ice at the University of Manitoba's sea ice test facility in Winnipeg, while looking for funding and permissions to conduct large-scale testing on arctic ice. Leslie Field proposed to cover up to 100,000km^2 with silica glass in selected arctic regions, e.g. in the Fram Strait or the Beaufort Gyre.

Possible negative effects of this proposal, for example changing weather patterns, changes to the hydrologic cycle and water temperature, or effects on the delicate arctic ecosystems, and the environmental impact of the covering material itself, have not been considered in depth so far. The community members in the North Meadow Lake area fear, inter alia, impacts on the food web and on migrating birds by ingestion or on human health following inhalation of silica dust.[2]

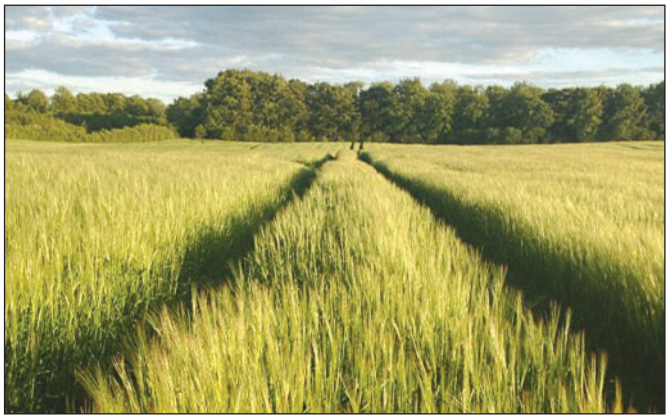
Covering glaciers

A modelling study conducted by researchers at the German Potsdam Institute for Climate Change (PIK) suggested delaying sea level rise by shooting very large amounts of artificial snow onto two glaciers in western Antarctica. PIK has further estimated that more than 12,000 wind turbines would be needed to lift, desalinate and spray this great quantity of water. The entire project would involve ecological devastation on a massive scale with huge disruptions to the sensitive Antarctic marine habitat.[3]

A research group at the Swiss Academia Engiadina hopes to save Switzerland's glaciers with a comparable approach – by blowing reflective artificial snow across their surface. In 2017, the research group conducted a smaller pilot demonstration trial in a section of the Swiss Diavolezzafirn glacier to prove the technology. Further trials will be conducted at the Morteratsch glacier, with funding provided by the Swiss Innovation Agency. The approach requires a very large quantity of water and energy.[4]

Researchers at Ohio State University have proposed covering sections of the Greenland ice sheet with reflective material to prevent glaciers from further melting.

In 2009, the proposal was demonstrated by covering an area of two acres with reflective polypropylene blankets. The idea has been adopted from the Alps where white blankets are regularly used by local mountain lift companies to cover glaciers as a reflective shield to protect skiing areas (and ski resort income). The implementation of this proposal means an increased consumption of fossil raw materials and high costs: The blanket material polypropylene is produced from crude oil and the material costs for covering one square kilometer of glacier ice are estimated at US$ 4,6 million. This estimate excludes the costs for recycling at the end of the product's lifetime.[5]



High-albedo crop? A barley field
Photo from Jens Schott Knudsen via Flickr

High Albedo Crops

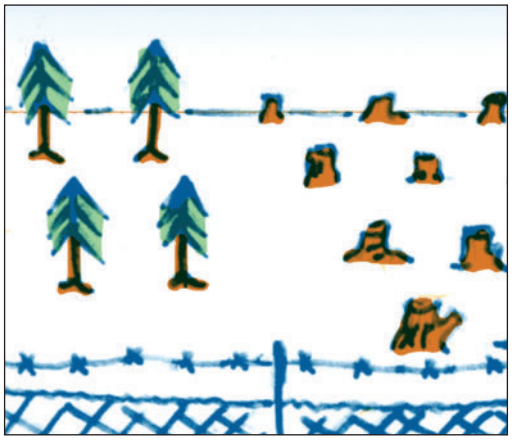
Several researchers, especially a team of researchers at the University of Bristol, UK, proposed to modify agricultural crops to create plants with more reflective leaves. Proponents claim that if crops with a higher albedo would be grown on farmland, this would help to cool the atmosphere by reflecting more solar radiation back into space. To increase crop albedo, both traditional breeding techniques or genetic engineering have been proposed.[6]

Little is known about the potential risks of increased reflectivity for the nutritional content of the plants, their photosynthetic capacity or on surrounding soil.

Genetically engineered plants could spread their "reflectivity" engineered character to other relatives, with unknown consequences: Using genetically modified crops or trees carries all the biosafety and land use impacts of these plantations, including soil erosion and heavy use of contaminating agrochemicals.

Snow Forest Clearance

An international team of researchers modelled the influence of boreal forest areas on the climate and developed the theory that clearing the planet's remaining areas of boreal forest – north of 45 degrees latitude, largely in Russia and Canada – would have a cooling effect because snow cover reflects solar radiation, while nearby boreal forest absorbs the radiation. The studies were led by the forestry school at Yale and by Dartmouth college, with partial funding from the US Department of Energy.



Snow Forest Clearance would involve removing vast swaths of boreal forest

The creation of "white deserts" could destroy subarctic ecosystem productivity, negatively affecting the plants and people that depend on them as well as the caribou, migrating birds and other fauna.[7] Eliminating forest would negatively affect the regulation of regional and local climates. Carbon contained in forest would also be lost. Proponents admit that there are many complexities. It would however be a one-time, final bonanza for timber companies.[8]

Desert Covering

More than a decade ago, entrepreneur Alvia Gaskill laid out a scheme to cover a significant portion of the world's deserts with white, polyethylene film to reflect sunlight and lower surface temperatures.[9]

Deserts have plants, animals and people living in them, and it is difficult to imagine life continuing in a plastic-covered ecosystem. Desert dust, which will be hindered by plastic coverings, is essential for the global climate because it influences solar radiation, cloud formation and even ocean cooling.[10] Cooler desert temperatures may also bring unexpected changes.

Like many geoengineers, Gaskill suggests if there are too many political, ecological or weather challenges (the plastic has to be kept in place for several hundred years, for example), the projects could be local. However, local applications would have a minimal climate effect and would not justify the expense and socio ecological disruption.

Painting roofs, pavements and mountaintops

In 2010, the World Bank awarded a small grant to Glaciares Peru, a company founded by Eduardo Gold, so that he could paint a Peruvian mountaintop white.[11] Painting mountaintops would negatively affect fragile ecosystems, flora and fauna, and seems unlikely to be pursued any further. Urban albedo enhancement – painting surfaces such as roofs and pavements white or adding a reflective layer – has been considered and modelled by various researchers, among them Hashem Akbari of Concordia University in Montreal, who has promoted the idea of government grants to cover rooftops and tarmac with white paint.[12] Several initiatives worldwide have taken up the idea, among them the CoolRoofs Initiative in New York City, which painted 50 hectares of roof surfaces with a bright, reflective coating.[13] Painting roofs could have some local cooling effects, though a Royal Society report states that "the overall cost of a 'white roof method' covering an area of 1% of the land surface would cost about US$300 billion/year, making this one of the least effective and most expensive methods considered."[14] Scientists at Stanford University have suggested that "roofs covered in photovoltaic panels would do a better job, by producing electricity that then obviates the need for more fossil fuel–burning power plants".[15]

Marine albedo enhancement

There are also proposals to alter the albedo (reflectivity) of water surfaces and of marine clouds. These approaches are detailed in the Technology Briefings on Microbubbles/Sea Foam and Marine Cloud Brightening.

Reality check

Until now, most of the described approaches are based on modelling, but various small-scale trials with reflective materials on ice have been conducted and larger-scale trials are envisaged. Research into high-albedo crops aligns with global efforts to engineer the world's food supply, so this idea may gain attention and funding.

All these proposals are clear examples of the narrow-minded, reductionist mentality that characterizes geoengineering, which ignores the profound value of biodiversity and overlooks the multifunctionality and interconnectedness of ecosystems.

Further reading

ETC Group and Heinrich Böll Foundation,

"***Geoengineering Map***",

https://map.geoengineeringmonitor.org/

Endnotes

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9 ETC Group and Heinrich Böll Foundation (2020)

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11 ETC Group and Heinrich Böll Foundation (2020)

12 Akbari: List of publications, Concordia University, http://concordia.academia.edu/HashemAkbari; Biello (2014) Cool Roofs Might Be Enough to Save Cities from Climate Overheating, in Scientific American, published: February 14, 2014, https://www.scientificamerican.com/article/cool-roofs-might-be-enough-to-save-cities-from-climate-overheating/

13 ETC Group and Heinrich Böll Foundation (2020)

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15 Biello (2014)