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Geoengineering Research under U.S. Law

By Norman F. Carlin and Robert A. James*

In this article, the authors examine principles of United States law applicable to geoengineering research projects.

Geoengineering, the deliberate modification of global climate to offset the effects of anthropogenic greenhouse gas ("GHG") emissions, was once dismissed or marginalized but is now receiving increased attention from scientists, policymakers, and the public. Late in 2017, two subcommittees of the House Science, Space and Technology Committee held a hearing to discuss the viability of emerging technologies. Rep. Jerry McNerney (D-Calif.) introduced the Geoengineering Research Evaluation Act (H.R. 4586), which would require the National Academies of Sciences, Engineering, and Medicine to develop a recommended research agenda and governance mechanisms for atmospheric invention strategies, including guidance on both laboratory studies and field experimentation. Earlier in the year, a bill was introduced in the Rhode Island legislature, the Geoengineering Act of 2017 (H.R. 6011), requiring a state license, environmental impact review, and public hearings for "any and all contemplated geoengineering activities."

BACKGROUND

These stirrings of legislative interest mark a major shift. Any mention of the topic has been adamantly opposed by advocates of strict GHG regulation, arguing that the science is unproven, the risk of adverse consequences too great, and the risk of diverting from the commitment to reduce emissions greater still. For the same reasons, discussing climate adaptation (that is, adaptation of infrastructure to the impacts of climate change) was formerly anathema. Adaptation, however, has now become a mainstream, even bipartisan concern.

Geoengineering may well follow. Many observers are concerned that plausible emission reduction scenarios may not suffice to avoid unacceptable consequences. Though scientific and political uncertainties remain, we appear to be approaching, if not already at, the point at which active climate intervention—even if only as a stop-gap measure to buy time for more robust

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energy decarbonization and adaptation efforts—can no longer be seen as mutually exclusive with GHG reductions.

As with other potentially game-changing technologies, research into geoengineering techniques is urgently needed. The claim that we should eschew such knowledge, for fear that we will be tempted to use it, is uncomfortably reminiscent of the science denialism that rejects the study of climate change to avoid corroborating inconvenient truths. Rather than speculating in ignorance, we should study both the benefits and risks, to provide decision-makers and the public with an informed basis for considering the options.

Legal thinking on this subject has largely focused on governance mechanisms at the trans-national level and on the specter of unilateral state or private action. Research, which must precede consideration of geoengineering deployment, has received relatively little legal attention. In this article, we examine principles of domestic United States law applicable to geoengineering research projects. A key aspect of the investigation stage is that, in contrast to any actual attempts at implementation, such studies will operate at too small a scale and for too short a period to either benefit or harm the earth's climate. However, experimental studies may have localized adverse consequences that ordinarily would be given weight in traditional impact and cost-benefit analysis under environmental and tort laws. The need to understand the geoengineering option is sufficiently pressing that domestic legal standards should be construed, and modified if necessary, to facilitate an incremental and responsible advance in knowledge.

GEOENGINEERING TECHNIQUES

The proposed techniques fall into two broad categories. The first, solar radiation management, seeks to reduce the sun's warming effect by reflecting part of its radiation back into space. One proposed method is releasing sulfates or other aerosols into the upper atmosphere, mimicking the effect of volcanoes. A "natural experiment," the 1991 eruption of Mount Pinatubo, released 20 million tons of sulfur aerosol particles and measurably lowered global temperatures for years. Dispersion by aircraft or drones could be relatively simple and cost-effective, although repeat applications would be needed as particles settle out of the atmosphere. In 2018, Harvard scientists plan to launch a high-altitude balloon spraying a fine particle mist into the upper atmosphere, to study resulting reflectivity changes. A critical research question is the effectiveness of different particle chemistries, with different radiation-scattering properties, settling rates, and risks of adverse side-effects such as ozone loss.

Other proposed methods of solar radiation management would operate at lower altitudes. Such methods include dispersing sea salt or other small particles from planes or ships into clouds, to increase their reflectivity. In 2011, University of California at San Diego researchers studied smoke and aerosol discharges from cargo ships off the coast of California and used satellites to track the resulting cloud brightening. However, clouds are extremely variable, greatly complicating the task of tracking and quantifying results in these studies.

The second broad category of techniques involves removing GHGs, primarily carbon dioxide (“CO_2”), from the atmosphere. Such approaches include carbon capture and sequestration from industrial sources or the ambient air; processing agricultural waste and other biomass into stable carbon-storing form; and planting and promoting growth of terrestrial and aquatic vegetation that draws carbon from the atmosphere by photosynthesis. Ocean iron fertilization (“OIF”), seeding oceans with iron to stimulate growth of plant plankton, has generated particular interest as it is easily deployed. When the plankton die, some portion will sink to the sea floor, permanently sequestering their carbon content, though some would decay closer to the surface and re-release carbon to the atmosphere. Since 1993, over a dozen OIF experiments—most or all in international waters—have produced observable plankton growth and local CO_2 uptake. In 2012, the Haida Salmon Restoration Corporation, an indigenous organization, released 100 tons of iron powder off British Columbia, resulting in a large plankton bloom. This experiment was controversial in the scientific community due to its lack of oversight. While investigators have successfully triggered plankton growth, more study is needed to determine its effectiveness, as it is difficult to quantify the amounts of carbon permanently sequestered in the depths and re-released at the surface in open ocean experiments.

U.S. ENVIRONMENTAL LAW

It is no surprise that OIF experiments to date have largely taken place in international waters, beyond the reach of national laws (though in 2017, one group sought a permit from the Chilean government for a small-scale OIF study in coastal waters). If a U.S. research program as contemplated by H.R. 4586 gets under way, however, such studies will be subject to the domestic legal regime. The application of U.S. law to intentional climate manipulation is not entirely novel. Regulation of and liability for deliberate weather modification have existed since the post-World War II development of cloud seeding techniques intended to alter rain patterns by releasing substances into the air. Nonetheless, it is safe to say that the usual U.S. environmental statutes and regulations were not designed with geoengineering in mind.

National Environmental Policy Act

The National Environmental Policy Act (“NEPA”) is the principal statutory mechanism for evaluating the environmental consequences of actions undertaken, funded, or permitted by federal agencies. For example, NEPA applies to Federal Aviation Administration permits which are required for experiments using suborbital rockets, of the type that could be used to release sulfate particles in the upper atmosphere. The statute requires federal agencies to identify and evaluate the potentially significant environmental impacts of a project, as well as alternatives and mitigation measures that would avoid or reduce those impacts, before deciding to approve or carry out the project. NEPA review can take the form of an abbreviated Environmental Assessment ("EA"), if the agency determines that the project would result in no significant impacts, or a full Environmental Impact Statement ("EIS") if that determination cannot be made. A federal program implementing a research agenda developed under H.R. 4586 could be evaluated in a programmatic EIS, to be followed by EAs for individual projects as necessary. Public comment on EISs (and in some cases EAs) is a central part of the process, and public participation doubtless will be prominent in the evaluation of controversial geoengineering research.

Categories of actions otherwise subject to NEPA may be excluded from review if they are found to have no significant effect on the environment. Research and technical studies typically are "categorically excluded" for this reason. There is an exception for "extraordinary circumstances" in which normally excluded actions may have significant impacts requiring review. While most research projects funded by National Science Foundation grants are exempt, an EA or EIS is required if potential environmental effects may result from carrying out the research, including "weather modification, or other techniques that may alter a local environment." That provision evidently was aimed at cloud-seeding experiments, but is potentially applicable to geoengineering as well. By contrast, the "long term effect of the accumulation of human knowledge" generally is insufficient to trigger NEPA as "such long term effects are basically speculative and unknowable in advance."[1]

Some will urge that the risk of adverse outcomes from potential future large-scale deployment of the techniques proposed for study constitutes an "extraordinary circumstance" requiring a full EIS or at least an EA for research projects. We believe the better argument is that a research project should be excluded from NEPA if no significant impacts from the research itself can be identified. Moreover, EAs and EISs for geoengineering experiments that do have such immediate impacts should focus on those impacts, rather than on potential ultimate consequences of using the knowledge gained.

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[1] 45 C.F.R. § 640.3(b).

Critics of geoengineering have emphasized the potential for adverse effects from attempts to modify the global climate. Such concerns include, among others, large-scale changes in weather patterns as a result of releasing upper atmosphere particles or brightening clouds, with cascading effects on biological, agricultural, hydrological and other weather-dependent resources; ozone-depleting effects from sulfur aerosols; toxic plankton blooms and disruption to marine ecosystems and fisheries from OIF; and accelerated warming if sequestered GHG escapes or atmospheric particulate levels are not maintained by repeated releases. In addition, solar radiation management to control the temperature could reduce the incentive to control emissions and indirectly worsen impacts from ambient levels, in particular ocean acidification due to absorption of CO_2.

The consequences that most worry geoengineering critics—such as the risk of worsened warming if solar radiation management is later discontinued—tend to apply on the planetary scale. But many of these effects may also be triggered on a smaller scale by experimental studies, which could require evaluation in an EA or EIS. Such impacts could include local toxic plankton growth and ecosystem disruption, or local weather modification (which, after all, is the intended result of traditional cloud seeding). Even modest changes in rainfall patterns may affect local hydrology, agriculture, and wildlife and plants, including endangered species. Mitigation measures could include restricting experiments to periods outside the breeding season of sensitive species, or avoiding sites where such species are present. Another local effect, though temporary, would be emissions from the aircraft and vessels used in experiments. Ironically, geoengineering researchers might find themselves purchasing GHG reduction offsets as mitigation for their research activities.

Courts often avow that analysis of alternatives, including the "no action" alternative, is "the heart of NEPA." For many research projects, the no action alternative will be the only practical alternative to the project as designed. Although a scaled-down project alternative to reduce local impacts may be feasible in some cases, the experimental protocol must be capable of producing a detectable result (which may itself be an environmental impact, such as a plankton bloom). The no action alternative, of course, would avoid any locally adverse impacts attributable to carrying out the experiment. However, NEPA does not compel federal agencies to choose environmentally preferable outcomes; rather, it ensures that the public and agency decision-makers are fully informed of the impacts of a proposed action before the decision is made. Equipped with such information, the agency can weigh the immediate adverse consequences in light of the project purpose: to improve understanding of techniques available to respond to climate change.

Many states have environmental impact review statutes analogous to NEPA, which apply to state and local agency actions and approvals. A prominent example is the California Environmental Quality Act ("CEQA"), which would apply should that state or its local jurisdictions adopt a license requirement similar to that in the Rhode Island geoengineering bill. Unlike NEPA, CEQA *does* compel agencies to choose environmentally preferable outcomes, unless the agency finds that alternatives or mitigation measures are infeasible or would not satisfy basic project objectives, and decides the unavoidable adverse impacts are acceptable to obtain specific overriding project benefits. For geoengineering research projects, scaled-down alternatives may not be feasible or able to satisfy objectives, and the overriding benefit of increased knowledge should be weighed against any unavoidable local impacts.

Other Environmental Laws

Some U.S. environmental laws may have implications for large-scale geoengineering deployment, but may be less applicable on the research scale. For example, sulfur dioxide is regulated under the Clean Air Act. Indefinitely repeated releases of sulfate aerosols to maintain high atmospheric levels could affect attainment of ambient air quality standards. However, short-term experimental releases from mobile sources such as rockets and aircraft should not come under this statute. Research-scale activities linked to potential local adverse effects on endangered species or (in the case of OIF) marine mammals and essential fish habitat could trigger consultation or permit requirements under the Endangered Species Act, Marine Mammal Protection Act and Magnuson-Stevens Fishery Conservation and Management Act. The Clean Water Act requirement of permits for pollutant discharges into waters of the United States, including ocean waters, could apply to OIF research efforts.

The Marine Protection, Research and Sanctuaries Act ("MPRSA"), which codifies the international London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972), regulates the transport and ocean discharge of material that could adversely affect human health and welfare or the marine environment. A permit from the U.S. Environmental Protection Agency ("EPA") is required to transport such material from the U.S. or on a U.S.-flagged vessel for purposes of discharge in international waters, or to discharge in the U.S. territorial sea of material transported from outside the U.S. Research permits are authorized by both the MPRSA and the London Convention if the scientific merit of the study outweighs potential environmental harm. In 2007, a private company, Planktos, announced an OIF project in international waters to study the prospect of generating GHG reduction credits for sale. EPA advised Planktos that a permit under the MPRSA might be required, and ultimately the project did not proceed. Following this attempt, the International Maritime Organization ("IMO") issued a statement that such commercial OIF was not justifiable given gaps in scientific knowledge. In 2010, the IMO adopted an assessment framework for OIF research.

U.S. TORT, PROPERTY, AND CONTRACT LAW

In addition to the environmental laws discussed above, tort, property, and contract principles may be applied to geoengineering research activities. As in the regulatory sphere, the core issue is that the economic, public health and safety, and other actual or alleged impacts of experiments will be localized, affecting neighboring citizens or interests, while benefits from future implementation are widespread and attenuated. Applying traditional liability and contract tests, such as standing and causation, may pose difficulties for parties, courts, and legislatures when considering speculative global benefits.

Tort Law

Trespass, the intentional interference with the plaintiff's possession of property, has favorable remedies for those challenging an activity. Claims can be brought where hazardous substances intrude upon another's land, by land disposal of waste or releases to the air, surface waters, or groundwater. In principle, no actual damages from the intrusion need be shown in a trespass action, although plaintiffs usually endeavor to plead and prove such damages to enhance the relief they receive. Exposure to trespass claims against geoengineering research projects will depend on whether the contemplated activity physically invades the property interests of others. Even intangible intrusions that cause physical damage, such as noise and vibrations, have been held to qualify as trespasses. Nevertheless, trespass exposure seems a remote risk for sulfur aerosols dispersed 20 kilometers above the ground or for open-sea OIF experiments, far outside the proprietary interests of others.

The twin torts of private and public nuisance may be more likely to bear on geoengineering research. These causes of action apply to intentional, negligent, or abnormally dangerous conduct interfering with the use and enjoyment of private land in the case of a private nuisance, or with the public interest in the case of a public nuisance. Unlike trespass, nuisance requires no physical invasion. An intentional nuisance claim does require showing that the interference complained of is both substantial and unreasonable. Particulates, gases, and other intangible sources of interference have been held to be nuisances. Nuisance actions might be premised on similar releases in a solar radiation management experiment that are allegedly linked to adverse weather modification, damaging private property, or harming the public welfare.

Negligence, by contrast, applies where a duty of care, a failure to exercise reasonable care, and resulting damage are alleged. For specialized activities performed by persons with technical expertise, the standard of care may be increased to that of an expert in the particular field. The activities subject to the duty of care may include the underlying conduct, or a responsibility to warn or to provide information about that conduct. In addition, strict liability may be imposed for conducting abnormally dangerous activities or for failure to warn before doing so. Other tort claims could include interference with prospective economic advantage, e.g., by commercial fishermen claiming adverse effects to their businesses from OIF due to toxic blooms or marine ecosystem disruption.

For intentional nuisance claims, reasonableness is determined from an objective point of view, by balancing the gravity of the alleged harm against the broad social utility of the defendant's conduct. For negligence claims, however, reasonableness is determined by balancing considerations from the perspective of the defendant itself. A geoengineering research project that observed every feasible safeguard might be free of negligence, but still exposed to nuisance claims based on harm to the plaintiff or the public. Such nuisance exposure might be reduced for geoengineering research undertaken by public agencies, or by private partners in close cooperation with agencies that act in the public interest. Even for private projects, reviews by and permits from relevant public agencies would help support the reasonableness of the activity to a considerable extent. Still, a purely private project (or one which appears more commercial than scientific, like the Planktos project) might face greater scrutiny of the reasonableness of local adverse effects. A project with some form of public character may be easier to defend with the prospect of long-term benefits from future implementation of the techniques under study.

Property and Contract Law

A geoengineering research project may require use of property of others, such as airports, seaports, or spacecraft launch facilities. Local agencies may grant leases, easements or licenses for the possession or use of public property. Governments, utilities, and other businesses affected with a public interest may be obliged to serve the research project. In other cases, securing the needed proprietary consents will be essential. A party to such a negotiation, even a public agency, generally might withhold its consent, or condition it on concessions on unrelated points.

Intellectual property law will be relevant to geoengineering in several ways. If a party intends to secure and exploit proprietary rights in discoveries or processes, that project may be seen in a much different light than a project where the results and any inventions are made freely available, or available to others on reasonable and non-discriminatory terms.

The right to use facilities or technology may be limited or articulated by means of detailed contracts, which can allocate liabilities and responsibilities among a variety of stakeholders. As with project development and finance more generally, those liabilities and responsibilities can be allocated to those parties, both public and private, that are best equipped to discharge, transfer, or bear them.

Geoengineering research proposals must anticipate these concerns and build in sufficient safeguards, mitigations, and inducements to respond to the interests and concerns of stakeholders. Project proponents should focus on both present and future public and government relations. A community's acceptance of research activity can change with a shift in the political tide or an adverse incident.

CONCLUSION

Critics claim that it is premature to consider implementing geoengineering as a response to climate change, emphasizing the uncertainties and risks. They are right. We do not know enough about the feasibility, effectiveness, and potential adverse consequences of the techniques to begin considering deployment. But that is an argument in favor of further study, not against it. In addition, commentators have suggested that a governance mechanism ensuring international consensus should precede any attempt to intentionally alter the earth's climate, and that choosing geoengineering as a solution for warming could undercut the political will to carry out economically painful emission reductions. These legitimate concerns are also less relevant at the research stage than at the stage of deciding whether to undertake global-scale efforts.

It is no less premature to presume, in advance of the data, that the risks are so great and benefits so small as to rule out the geoengineering option, even as an interim measure in tandem with GHG emission reductions. To that end, existing domestic law should be applied flexibly so as not to thwart the process of gaining the information needed to evaluate the available methods. NEPA review and environmental permitting decisions should focus appropriately on the localized impacts of the experiments themselves, rather than on speculative future outcomes from the knowledge gained. Proposed studies should be undertaken by or in close collaboration with public entities, to help support public interest benefit of the activity as against tort claims. Only by encouraging research will it be possible to make appropriate decisions on whether to deploy geoengineering at the scale and for the duration needed to help combat climate change.