THE ROYAL SOCIETY

Det Norske Videnskaps-Akademi
The Norwegian Academy of Science and Letters

UK-Norway bilateral workshop on science and the law of the environment

Summary and briefing note from event on 9 – 10 March 2023

Introduction

There are many environmental issues where relevant scientific knowledge and applicable international law are both incomplete, and/or do not interact adequately. In order to explore ways in which this situation could be improved, the Royal Society the Royal Society and the Norwegian Academy of Science and Letters (DNVA) convened a bilateral workshop meeting in Oslo 9 – 10 March 2023.

Two contrasting and controversial topics were selected for discussion, one in the atmosphere and one in the ocean, and one where international law is already developed and one where it is lacking. These topics were the Deep Sea Mining of minerals (DSM), and Solar Radiation Management or solar geoengineering (SRM), in particular the Stratospheric Aerosol Injection (SAI) method.

The purpose was:

a) to improve mutual understanding of the capabilities, limitations and interactions of science and the law relating to these topics; and

b) to produce briefing documents on them, to inform senior policy makers in the UK and Norway (and elsewhere) about the state of knowledge on the technical feasibility and environmental impacts of these two topics, and the implications for the application and development of international law. The participants comprised scientists and lawyers with expertise in each of the topics , together with additional experts invited to facilitate the process. This Summary and Briefing Note is a record of these discussions, and is not a formal statement of the policies of the Royal Society or DNVA.

General observations

I. Of the 12 worst natural disasters globally in 2021, 11 were related to climate and climate change.

II. There is a serious risk that progress in reducing greenhouse gas emissions will be inadequate to avoid breaching climate thresholds such as the 1.5C warming of the Paris Agreement, and lead to pressure to deploy geoengineering methods such as SRM.

III. There is moreover a risk of unilateral SRM deployment by an individual State or a non-State actor (eg a corporation), and there are currently no specific rules of international law on SRM to prevent or regulate such action.

IV. There is therefore need for international governance of some sort bringing together political and commercial parties (as well as relevant research on both the technical feasibility and environmental impacts of SRM).

V. Widespread and rapid adoption of electric alternatives to fossil fuels (especially for transport) requires greatly increased use of battery technology. Supplies of some minerals currently needed for this are expected to become inadequate, and Deep Sea Mining (DSM) of such minerals is being actively pursued.

VI. DSM is regulated by the International Seabed Authority (ISA) established under the UN Law of the Sea (UNCLOS). However the environmental impacts of DSM are uncertain, and need to be determined, as they could lead to loss of biodiversity and serious harm to the environment, which may limit the scope for its deployment and development unless adequately mitigated.

VII. It is thus possible that foregoing DSM on account of its environmental impacts could impede the transition to low-carbon technologies that is needed to reduce the impacts of climate change.

VIII. There is therefore a potential link between the two topics, since if DSM were to be abandoned, that might delay the transition away from fossil fuels, and increase the likelihood that SRM may be implemented.

IX. In both these areas, the requirement is therefore to balance the likely risks (and benefits) of doing something, against the risks (and benefits) of doing nothing. In such situations the Precautionary Principle/Approach is a helpful (and widely accepted) prerequisite guiding principle, but it does not by itself provide answers to specific questions of what measures need to be taken, and by whom.

X. The Precautionary Principle therefore needs to be operationalised to determine what actions are necessary to ensure that irreversible risks can be avoided, and that risks of adverse impacts, especially those on the most vulnerable people and/or ecosystems, can be kept sufficiently small, both now and in the future, for example by requiring that a pessimistic estimate of the likely benefits outweighs a comparably pessimistic estimate of the likely risks.

XI. The discussion of SRM was focused on the SAI technique, and that of DSM on exploitation in areas beyond national jurisdiction. However many of the conclusions on SRM would also apply to other techniques such as marine cloud brightening (MCB), and many of those on DSM would also be relevant in areas within national jurisdictions.

Solar radiation management (SRM)

In relation to solar radiation management, the participants noted that:

1. SRM is a high-risk response to climate change which could potentially be deployed to achieve a temporary reduction in atmospheric temperatures to protect national, commercial or indeed global interests if temperature continues to increase, overshooting the goals of the Paris Agreement. However, SRM is likely to cause a range of foreseen and unforeseen side-effects, requiring trade-offs since these may include damages as well as benefits to both people and the environment.
2. Regionally and globally we are already encountering an increasing number of extreme weather situations with significant potential for societal damage and instability. The pressure for SRM to be deployed is likely to grow, but we are as yet not prepared as a global community if a stakeholder with the political and/or financial resources were to unilaterally go ahead and do a full-scale experiment with or deployment of SRM (eg stratospheric aerosol injection).
3. We therefore urgently need to advance the state of knowledge related to all aspects of SRM, and thereby enable society to be prepared for a situation in which pressure for SRM deployment increases. This could conceivably happen abruptly and rapidly, for instance in response to extreme events exacerbated by global warming.
4. SRM may distract the attention from climate mitigation. The international governance structure for SRM is immature. Unilateral SRM has the potential to create international conflict. The chances for unilateral SRM action grow as the gap widens between societal impacts and risks associated with climate change, and the success of mitigation measures. Research and field experiments may receive funding and be carried out in organisational structures that are not transparent or open for independent critical review and discussion.
5. Stratospheric aerosol injection (SAI, mimicking stratospheric volcanic injection), and marine cloud brightening (MCB, mimicking ship emissions) are examples of solar radiation management.[1] Of these there is greater confidence that SAI could produce a cooling effect that would measurably counteract global warming, and that could be realised in technical and cost terms.
6. There is a GeoMIP programme that is part of CMIP (the Climate Model Intercomparison Project, a part of World Climate Research Programme WCRP co-sponsored by WMO, IOC and UNESCO) which organises SRM-related model experiments and keeps track of the publications arising thereof.
7. In climate model calculations SAI causes reduced global and regional temperatures that are broadly similar to the results of model experiments where CO2 emissions are reduced, although regionally the induced temperature changes can be significantly different. The calculated changes in precipitation are however much more variable and more uncertain than the temperature response, and even the sign of the regional changes often does not agree among models. Thus SRM offsets climate change only imperfectly, it only masks the warming, and the prediction of its effects is uncertain..
8. With SRM deployed to mask the effects of carbon emissions, ocean acidification would continue.
9. The lifetime of stratospheric aerosols is typically around two years, and SRM is therefore a measure that would have global impacts. For SRM to have a long-term (decadal or longer) effect, a similar long-term commitment to maintaining the stratospheric aerosol level would be required. Aerosols in the troposphere that would cause marine cloud brightening would be removed in a matter of weeks. MCB is therefore a regional measure that would have to be maintained on a continual basis.
10. SRM research to understand the consequences of SRM includes earth system modelling, field experiments and process studies (eg. of aerosol-cloud interactions and their changes as the stratosphere is loaded with aerosols). Earth system modelling is relatively advanced, but still leaves very large uncertainties to be addressed. It would be highly controversial to move out of the laboratory to do large-scale experiments. Governance, liability and compensation mechanisms have not yet been adequately addressed. SRM would be likely to make the sky slightly hazier, add slightly to acid rain and delay the ozone layer recovery by several decades.
11. It is not inconceivable that stratospheric aerosol injection could actually enhance regional (and even global) heating. For instance, if it turns out that SAI causes rainfall patterns to change so as to dry out rain forests, this would be likely to trigger enhanced CO2 emissions from soils causing a further warming of the climate.

1 Cirrus cloud thinning (CCT) targets infrared (not solar) radiation, and aims to thin/remove cirrus cloud, not produce more.

12. There has as yet been only a little open and transparent international research on SRM, and no field experiments of importance. There are no international mechanisms for research funding or for assessing environmental impacts, no framework for international policy making, and no regulations framed specifically with SRM in mind. There is a significant risk that SRM could be used selfishly by the powerful, and it is conceivable that scientists may have to make definite statements about the effects of SRM before they have adequate confidence in them. In such circumstances, only an international advisory body would have adequate credibility, and it would be desirable for an international body (such as the WMO) to assemble relevant evidence and develop authoritative consensus statements
13. International law of the atmosphere constitutes a 'classic regime complex' covering both regional and global issues. There are at least ten relevant international treaties, but none of these instruments govern SRM comprehensively.
14. In addition to treaty instruments, there are customary law rules and principles which may apply, but these are general in their application and lack the specificity of detailed regulatory measures, or dedicated oversight and compliance mechanisms.. Relevant principles are also found in key documents such as the 1992 Rio Declaration Principles on Environment and Development.[2]
15. The UN International Law Commission's (ILC) work on Protection of the Atmosphere 2013 – 2021, resulting in draft guidelines on the protection of the atmosphere[3] is highly relevant, and failure to develop these into legislation may be seen as a major missed opportunity.
16. Scientific knowledge and uncertainty urgently need to be addressed, especially through a commitment to collect (and share) more data. An equivalent example in treaty form is article 7 of the BBNJ treaty[4] which requires for its implementation "use of the best available science and scientific information" and establishes a dedicated Scientific and Technical Body to promote this.
17. Although SRM activities are not specifically covered by international law, they would not take place within a legal vacuum. If there are risks of significant transboundary harm, the general rules of international law require: cooperation; prior notification and consultation; environmental impact assessment (EIA) including screening; and due diligence measures to prevent significant harm, including for activities carried out by private actors. Failure to comply with these rules could lead to international responsibility and liability, and potentially affected States may also be able to take anticipatory action.
18. Potential adverse impacts of SRM activities on vulnerable populations and ecosystems will also bring into play global and regional treaty regimes that address human rights obligations (eg the right to food) and environmental obligations such as the conservation of biological diversity under the Convention on Biological Diversity.

They concluded that it would be highly desirable:

1. To apply some form of the precautionary principle/ approach and prioritise long-term over short-term goals.
2. To improve understanding of the crucial issue of how SRM (SAI) would be likely to impact on regional and global weather patterns, by making appropriate investments in earth system modelling and supporting observations (c.f. the Destination Earth Digital Twin concept under development in Europe) including government support for the creation of a small international network of high-resolution climate prediction centres, each with dedicated exa-scale computing capability, to develop and run small multi-model ensembles of the kilometre grid-scale models needed to do so.
3. To refrain from implementation of SRM before accepted governance structures are established. These should include sharing of data, economic benefits and procedures, since these are principal concepts in international law (solidarity; transparency; equity) and apply to all involved (nations and international organisations) and to the different aspects (science, national strategic security interests, commercial interests, governance interests).

2 Report of the United Nations Conference on Environment and Development. 1992. See: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf (accessed 21 February 2024).

3 *Yearbook of the International Law Commission*, 2021 vol. II, Part Two, https://legal.un.org/ilc/texts/instruments/english/draft_articles/8_8_2021.pdf (accessed 24 February 2024).

4 Global negotiations recently concluded on the landmark Treaty of the High Seas on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ).
See https://protect-eu.mimecast.com/s/5b2ZCO7XvHp0KDGHrPi_O?domain=daccess-ods.un.org (accessed 26 February 2024).

4. To follow the Oxford Principles, as appropriate general principles of conduct for research, including their preamble.[5]
5. To develop relevant international law, building upon the work done by the International Law Commission on the Protection of the Atmosphere, as soon as possible in order to ensure that a regime is in place before SAI becomes an operational reality.. However, since formal agreement and adoption of a new (or modified) international treaty is not likely in the near future, states should meanwhile comply with existing general applicable rules and voluntarily apply the non-binding ILC Guidelines. Through practice consistent with the Guidelines, such application could influence the emergence of customary international law.
6. To create an international and interdisciplinary task force of scientists and political and commercial stakeholders, in order to build SRM knowledge and risk assessments, monitor any plans for implementation, technological and commercial solutions and distribute the information in a transparent manner. Such a voluntary but international coalition-like body could:
    a) Adopt principles for scientific advice for policy making[6] allowing for the Involvement of independent science experts;
    b) Motivate and contribute to an IPCC Special Report on SRM;
    c) Consider the conclusions and where appropriate pursue the recommendations of the Climate Overshoot Commission;[7]
    d) Work in collaboration with established and successful global organisations, like the WMO or UNEP, and UK, Norwegian and other national scientific academies eg to establish scenarios and storylines, and use these as a basis for evaluating options;
    e) Provide information relevant to possible Resolutions by the IUCN[8] or other international bodies;
    f) Consider whether there is a need for an international entity for the brokering of 'cooling credits' in the future.
7. For the Royal Society and DNVA, in concert with other Academies (including in those in developing countries) to set up a task force to inform their national governments about the precarious state of knowledge, transparency and the possible risks and benefits related to SRM, in order to stimulate a diplomatic effort to reduce these deficiencies and to voluntarily establish responsible rules, regulations and other governance.

The participants therefore suggest that:

1. SRM research should take full advantage of the extensive gathering of climate variables through the operational practices of weather prediction, climate adaptation and climate mitigation (emissions) where WMO is the global organising entity. [Note: weather and climate data are a public good].
2. A clearing house for information on proposals for SRM experiments would be beneficial and could be established voluntarily
3. Additional public (and transparent) funding for all aspects of SRM research and knowledge enhancement is urgently needed, to complement the philanthropic funding that dominates at present. Such funding would likely have most impact if invested in relatively large coordinated and interdisciplinary projects, in which the problem is addressed holistically, as opposed to in disciplinary 'silos' in which only certain aspects of SRM are studied in isolation.
4. Diplomatic efforts to promote global agreements of the kind required for responsible handling of SRM need to be stepped up by nations that are particularly concerned, since the current geopolitical situation is demanding and not conducive for this.

5 Steve Rayner, Clare Heyward, Tim Kruger, Nick Pidgeon, Catherine Redgwell, Julian Savulescu, 'Oxford Principles', *Climatic Change* 121, 499-512 (2013) DOI 10.1007/s10584-012-0675-2. The direct reference to the Principles, complete with the preamble, submitted to the House of Commons Science and Technology Select Commmittee in 2009, is here https://www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/oxford-principles/principles/ (accessed 21 February 2024).

6 OECD (2015-04-20), *Scientific Advice for Policy Making: The Role and Responsibility of Expert Bodies and Individual Scientists*, *OECD Science,* Technology and Industry Policy Papers, No. 21, OECD Publishing, Paris. See: http://dx.doi.org/10.1787/5js33l1jcpwb-en (accessed 21 February 2024).

7 The Climate Overshoot Commission is holding the necessary conversations about whether and how these additional approaches could reduce the risks of a warming climate, and will recommend an integrated governance strategy. See: https://www.overshootcommission.org/ (accessed 21 February 2024).

8 International Union for Conservation of Nature (IUCN) is a membership Union uniquely composed of both government and civil society organisations.

Deep sea mining

In relation to deep sea mining of minerals (DSM), the participants noted that:

1. There have been substantial developments in international law[9] since the adoption of UNCLOS in 1982 and the 1994 Agreement on the implementation of Part XI, that will significantly affect the procedures of the International Seabed Authority (ISA) for managing exploration and exploitation of deep sea minerals, especially in relation to protection of the marine environment and its biodiversity.
2. Some substantive consequences of these developments (for example requirements relating to Environmental Impact Assessments and Management Plans) may conflict with some operational targets such as the two-year rule, and may eventually have to take precedence over them.
3. There is nevertheless at present considerable urgency to define the environmental thresholds for action required for implementation of the ISA exploitation regulations under current schedules.
4. The size of long-term future markets for minerals that are at present in short supply (notably nickel and cobalt) are uncertain, especially because rapid development of alternative battery technologies may lead to reductions of demand, reducing the economic incentives to undertake deep sea mining.
5. There are major uncertainties (knowledge gaps) in our understanding of the structure and function of deep-sea ecosystems, that limit our ability to ensure that the marine environment and biodiversity are adequately protected
6. The ISA is responsible both for regulating exploration and exploitation activities in the deep seabed, consistent with the common heritage of mankind principle, while ensuring that mining activities are undertaken in a manner that ensures effective protection of the marine environment, and there are tensions imposed by the need to reconcile these objectives
7. Some states have called for a moratorium on exploitation, but the legal basis for this, the level of support for it, and practical aspects of its application all remain uncertain, given the near universal international acceptance of the UNCLOS regime for DSM, and the difficulties likely to be encountered in seeking to amend or otherwise suspend the regime.
8. The Legal and Technical Commission (LTC) of the ISA has limited capacity for the evaluation of environmental issues, and would benefit from further development of partnerships that facilitate greater access to relevant external expertise.
9. The ISA Strategic Plan for Marine Science (ISBA/25/A/15) includes Strategic Direction 4: – to provide and encourage marine scientific research in the Area by forming a strategic alliance to assist in the promotion of marine scientific research directed towards providing the scientific knowledge necessary to ensure effective protection of the marine environment.

They concluded that it would be highly desirable:

1. To continue to establish new strategic partnerships to facilitate access by the ISA and LTC to appropriate independent expertise on marine environmental science, in accordance with Strategic Direction 4, as is being planned for the establishment of the thresholds for action required for the finalisation of the ISA exploitation regulations.
2. For the ISA to establish the Inspectorate envisaged under the exploitation regulations, in good time to minimise any conflict of interest and to ensure that sufficient pre-exploitation monitoring is undertaken to establish environmental baseline conditions with adequate precision
3. For Environmental Impact Assessments, and scientific investigations such as monitoring that are conducted by contractors and consultants, to be peer-reviewed by appropriate groups of independent experts, as part of the public consultations required by the draft regulations for exploitation.
4. For the large-scale development of exploitation to be delayed until scientific understanding of the deep sea environment and its ecosystems is sufficient for the impacts of deep sea mining to be adequately assessed, and for a mechanism to fund the necessary research to have been established.

9 These include: The Convention on Biological Diversity (CBD, 1992) and associated Protocols; The Protocol to the London Convention (LCP, 1996); The Johannesburg Declaration on Sustainable Development (2002) and the adoption of the Sustainable Development Goals (2015). Most recently the Agreement on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ) in 2023.

5. To ensure transparency by facilitating public access to reports of the results of scientific investigations and of the proceedings of relevant expert groups, for example by ensuring that environmental data produced by contractors are made available in a timely way through the ISA DeepData portal, and that EIAs are made available for peer review by the Council before decisions are made as to the issuing of contracts for exploitation.
6. To promote capacity-building for scientific investigations to address the high uncertainties especially in relation to the structure and function of deep-sea ecosystems
7. To ensure adequate attention to ethical aspects of exploitation of resources, especially in relation to issues of informed public consent, and inter-generational equity

The participants therefore suggest that:

1. The Royal Society and DNVA could assist the ISA:
   a) to set up strategic partnerships, ideally with participation of appropriate international organisations such as the Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP);
   b) to convene expert scientific and technical working groups to provide urgent advice that may be required to enable finalisation of the exploitation regulations.
2. The Royal Society and DNVA could organise expert workshops and facilitate links to expertise, to assist the ISA in their development of the exploitation and exploration regulations, standards and guidelines, and advise on:
   a) the evaluation of scientific knowledge gaps, and the research necessary to close such gaps;
   b) expanding the potential for industrial co-funding of relevant research;
   c) the scope, scale and quality standards for monitoring, including independent monitoring needed to verify that undertaken by contractors, and to extend this beyond exploited areas to determine any far-field effects;
   d) the appropriate application of the precautionary approach, for example by limiting the rate of expansion of exploitation activity (a possible subject of a workshop with the ISA and contractors).
3. Advice on the composition and effective operation of scientific advisory groups could be based on that available from the OECD and others.
4. Monitoring outside the exploited areas could well be coordinated and financed by a consortium of contractors, using the Joint Industry Programme model used by the Oil & Gas industry.
5. The ISA could consider setting in advance a progressive upper limit on the total area where exploitation is permitted (or the quantity of minerals that can be harvested), in a way that does not benefit one contractor over another , and so enable the results of research and monitoring to be used to guide the gradual development of both exploitation activity and measures to ensure its satisfactory regulation.

To view the full workshop report, visit: **royalsociety.org/uk-norway-bilateral-workshop-science-law-environment**