ENVIRONMENTAL RESEARCH
COMMUNICATIONS

INCLUSIVE PUBLISHING
TRUSTED SCIENCE

Part of the
ENVIRONMENTAL RESEARCH
SERIES

PURPOSE-LED
PUBLISHING™

PAPER • **OPEN ACCESS**

Stakeholder and expert opinion of solar radiation modification in South Asia: insights into perceptions, geopolitical, and governance concerns in Bangladesh

To cite this article: Md Sadique Rahman *et al* 2026 *Environ. Res. Commun.* **8** 035035

Environmental Research Communications

OPEN ACCESS

RECEIVED
11 October 2025

REVISED
10 December 2025

ACCEPTED FOR PUBLICATION
18 March 2026

PUBLISHED
27 March 2026

PAPER

Stakeholder and expert opinion of solar radiation modification in South Asia: insights into perceptions, geopolitical, and governance concerns in Bangladesh

Md Sadique Rahman[1,*], Fatema Sarker[2], Muhammad Humayun Kabir[3], Chad M Baum[4], Christine Merk[5] and Md Roconuzzaman[2]

[1] Department of Agricultural Finance and Management, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[2] Department of Development and Poverty Studies, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[3] Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[4] Department of Business Development and Technology, Aarhus University, Aarhus, Denmark
[5] Kiel Institute for the World Economy, Kiellinie 66, 24105 Kiel, Germany
[*] Author to whom any correspondence should be addressed.

E-mail: sadique@sau.edu.bd, fatema.sau@gmail.com, mhumayunsau@gmail.com, cmbaum@btech.au.dk, christine.merk@ifw-kiel.de and zamanrocky1707889@sau.edu.bd

Keywords: climate change, climate engineering, climate policy, farmers, qualitative study, solar radiation modification

Supplementary material for this article is available online

Abstract

The potential inadequacy or failure of current climate change adaptation and mitigation initiatives has prompted debates on solar radiation modification (SRM) technologies, which, despite their potential to lower global temperatures, raises numerous ethical, political, social and governance concerns. Bangladesh, a South Asian country, is especially relevant to the SRM discourse owing to its extreme vulnerability to climate change. This study used a multi-method qualitative research design to compare the opinions of experts and different stakeholders within Bangladesh, including farmers, regarding their perceptions of SRM, geopolitical, and governance issues. The study conducted 17 in-depth interviews with climate experts along with a series of 6 focus group discussions with stakeholders in six different climatic hotspots in Bangladesh. The majority of our experts expressed concern regarding the uncertainties associated with SRM and emphasized the need for more research on its effectiveness. According to both the focus groups and interviews, SRM interventions are also of interest to boost crop productivity. Focus groups findings suggested that farmers in drought-prone and urban areas are enthusiastic about SRM technologies, mainly due to climate risks of higher temperatures and extended dry periods they already experienced. However, fifteen of our experts and most focus group participants preferred nature-based approaches and adaptations over SRM. Experts, especially those working at NGOs and public institutions, still expressed support for SRM research, whereas policymakers were more likely to prioritize adaptation and mitigation. Experts stated that developing countries like Bangladesh lack financial as well as negotiating power, making reliance on developed nations and global consensus on the ramifications of SRM essential. Climate experts and policymakers broadly argued that the national government should lead on governance of SRM, with private organizations, researchers, and academia acting in a supporting role.

1. Introduction

There is a fundamental disconnect between the understanding of how climate change adversely impacts those in the global South and the engagement of publics and stakeholders across such countries regarding potential responses. While the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) set a target to maintain the increase in global temperatures to well below 2.0 degrees Celsius -

preferably 1.5 degrees—the pace of emissions reductions to date has been insufficient. This poses a particular risk for countries in the global South, which suffer an undue burden of mortality and economic consequences (Lenton *et al* 2023). South Asian nations stand out nonetheless as acutely susceptible due to their unique geographical, low-lying conditions (Rasul 2021), with Bangladesh potentially the most climate-vulnerable country in this region (World Bank Group 2024). Rising sea levels, intensifying cyclones, erratic monsoons, and heatwaves are currently undermining ecosystems, agriculture, human health, and economic stability in this country (Knox *et al* 2012, Sarker *et al* 2014, Alam *et al* 2017, Hasan *et al* 2019, Hasan and Kumar 2022). Over the last 50 years (1971–2020), Bangladesh has also experienced significant declines in precipitation along with an increase in average temperature of 0.16 degrees per decade (World Bank Group 2024).

Under such circumstances, there is certainly a drastic need for large-scale adaptation and mitigation measures. Conventional adaptation and mitigation measures such as climate-smart agriculture, coastal embankments, and use of renewable energy offer vital assistance; however, they may be inadequate as climatic disturbances intensify. Solar radiation modification (SRM), a geoengineering technology, is proposed as a potential idea to decrease the global temperature by sending back the radiation of the sun from the earth's surface (Kumler *et al* 2025). Due to the insufficient understanding of the risk and benefits, SRM technologies are still controversial around the scientific community. Though SRM is suggested to offer the possibility of keeping temperatures to a more desirable level (Honegger *et al* 2021), there are many ethical, political, social, economic, and governance uncertainties (Quaas *et al* 2024). There is moreover a core need to broaden discussions and engagement to a wider circle of stakeholders beyond scientists and policymakers, including but not limited to publics in the global South (Low *et al* 2024, Baum *et al* 2024a).

The agriculture sector is the mainstay of Bangladesh's economy and vital for the nation's food security (Rashid *et al* 2023). Yet, farming communities in Bangladesh are particularly vulnerable to the effects of climate change due to their frequent exposure to climatic hazards, broad dependence on agriculture, often for basic subsistence, and geographical location between the Himalayas and the Bay of Bengal (Huq *et al* 2015; Bokhtiar *et al* 2023). Given Bangladesh's high exposure to severe and rapidly intensifying climate impacts, which is also expected to only rise in the future, its involvement in SRM discussions is both relevant and increasingly urgent. Nevertheless, empirical research into perceptions of Bangladeshi experts and other stakeholders, including farmers, about SRM are practically non-existent. Several studies examine public perceptions of SRM, using quantitative or qualitative designs (Asayama *et al* 2017, Wibeck *et al* 2017, Braun *et al* 2018, Mahajan *et al* 2019, Raimi *et al* 2019, Baum *et al* 2024a). The findings primarily indicate that there is a lack of public awareness regarding SRM, and to some degree, there is support for SRM research. In a study conducted by Sugiyama *et al* (2020), participants from the global South exhibited a greater inclination to consider geoengineering as a viable option. The handful of other studies examining at least one global South and one global North country have identified a similar pattern (Visschers *et al* 2017, Contzen *et al* 2024, Baum *et al* 2024a, Sugiyama *et al* 2025). Dannenberg and Zitzelsberger (2019) also suggested that experts were more inclined to endorse geoengineering when they expect severe climate impacts in their own country; however, the more general pessimism about climate impacts or the effectiveness of mitigation activities motivated opposition among experts. This research highlights the importance of local climate impacts on perceptions. Using a cross-country survey, Baum *et al* (2024b) examined perception and governance issues of SRM in Mexico, UK, and USA. While perceptions of risks and benefits of SRM did not vary, support was once again higher in Mexico—indeed, there emerged a slight preference for SRM activities to be conducted in Mexico among Mexican participants (albeit under a suitable national-level governance regime). Using the expert elicitation method, Dai *et al* (2021) indicated that experts from China and the US largely agree on the expected impacts of climate change, and the future need for solar geoengineering research. Finally, through expert interviews focused on southeast Asia, Delina (2021) identified a general ambivalence regarding SRM approaches, with numerous individuals expressing preference for 'natural' carbon dioxide removal methods. Respondents, however, did express support for further research into SRM technology.

Overall, research into SRM perceptions has predominantly neglected voices and perspectives across the global South, both from experts and stakeholders. No research has been undertaken in Bangladesh, where discourse on SRM is in its early stages, l*et al*one in a way that would be able to uncover regionally informed viewpoints on risk, ethics, and governance. Research into stakeholder perceptions along those with scientists, academia, and non-governmental organizations (NGOs) is, however, crucial for establishing standards for governance and regulation, and to ensuring any decisions have broad and deep support across society (McLaren and Corry 2021, Fritz *et al* 2024, Buck *et al* 2025). Here we also highlight that while existing research has provided insights into viewpoints of publics and other stakeholders, there is no understanding of how farmers perceive SRM. Given that SRM might affect food production in both positive and negative ways, with regionally diverse impacts (Fan *et al* 2021, Kravitz 2021), the failure to engage farmers is another key gap in the literature—also since agriculture underpins much of the economy in many countries, including Bangladesh.

To address the lack of research into vulnerable developing countries such as Bangladesh, the current article uses a multi-methods qualitative research design to explore perceptions on SRM of experts and various stakeholders, including farmers.. Using both interviews and multi-actor focus groups, we provide insights into the following research questions: (i) to what extent are respondents in Bangladesh aware of climate change and its related impacts? (ii) how do respondents view the potential benefits and risks of SRM technology in addressing climate impacts in Bangladesh, and (iii) how do political, social, and governance concerns guide respondents' views regarding SRM in Bangladesh?

2. Methodology

2.1. Site selection, expert interviews and focus groups

The present expert and stakeholder perceptions research on solar radiation modification (SRM) is novel, both in the South Asian context as well as its involvement of farmers. In order to give rich voice to the perspectives and opinions of diverse stakeholders, we employ a multi-method qualitative research design. Though there have been two studies in Pakistan (Hussain *et al* 2024) and India (Sugiyama *et al* 2025), the present study in Bangladesh is an attempt to fill the knowledge gaps extensively, including farmers to policymakers with rigorous qualitative research combining interviews and focus group discussions. The intention of conducting both expert interviews and focus groups is to triangulate the study findings in a reasonable way. The study is structured in a manner that the expert interviews were conducted first, and then, based on certain emergent insights of interviews, focus groups were conducted—with a broader set of stakeholders. However, expert interviews and focus groups do not follow the same discussion checklist, as they were prepared with their suitability for the participants in mind (details are provided in the supplementary file). Both activities lasted for around an hour at most.

To identify and compile a list of SRM experts, we searched the websites of various government and non-governmental organizations that work on climate change-related issues in Bangladesh. We identified five individuals with expertise in SRM. Due to the limited number of SRM experts, we then employed a snowball sampling technique to identify additional participants, by soliciting recommendations as part of the interview. Following the recommendations of experts, we compiled a list of 12 additional participants who specialize in climate research and policy, with whom we scheduled in-person interviews. In total, 17 semi-structured expert interviews were conducted: three directly involved in policymaking, seven from non-governmental organizations (NGOs), the rest researchers or academics (table 1). The set of questions for the interviews was divided into six major overarching areas: current urgency of climate action in the country, the level of understanding, awareness, and knowledge of SRM, perceived benefits and risks of SRM, SRM governance in Bangladesh, and willingness to support SRM research (details are given in supplementary material).

As a next step, we organized six focus group discussions in the different climatic hotspot zones in Bangladesh. In this way, we collected the thoughts and attitudes of the different stakeholders who are experiencing the adverse, disparate effects of climate change at present. These climatic hotspot zones are coastal areas, drought-prone areas, flash flood-affected areas, riverine islands, hill tracts, and urban areas. Each of the focus groups included 12 participants, with stakeholders such as 4 farmers, 4 students from related disciplines (e.g. environment or geography or agriculture), 4 civil service actors from government, and/or non-government organizations focused on climate change (table 2). We largely relied on contacts at the local Department of Agricultural Extension (DAE) office to select four farmers from each climatic hotspot. The DAE is the largest extension organization in Bangladesh and is used to directly engaging with farmers. We also asked the administration of the largest educational institution in each of the selected areas to recommend four students who have interest in participating in focus groups and with a basic understanding of topics related to climate change. For civil service officials, we explored the websites of organizations engaged in climate change-related activities in the relevant areas and selected 4 civil service officials from each area. In order to solicit discussions across different stakeholder groups, the focus groups were heterogenous in nature. Farmers, students, and civil service actors were selected as focus group participants to ensure a diverse array of perspectives on SRM in Bangladesh. Farmers represent a group that is particularly exposed to the impacts of climate change in Bangladesh, although the degree of vulnerability varies across climatic hotspots. Students represent the voice of the youth, those who will bear the disproportionate burden of the impacts of climate change, and future decision-makers along with being those trained in the latest methods and scientific knowledge, while civil service participants bring policy insights and real-world expertise to discussions. These heterogenous groups ensure a comprehensive understanding of both grassroots and institutional concerns, as well as the perspective of multiple generations.

The questions in the focus groups were divided into two sections, firstly, about participant perceptions of climate change and their ideas about possible solutions, and then more focused discussions about SRM, which included possible positive and negative aspects. The latter also specifically considered SRM in relation to the

Table 1. Description of expert interviewees.

Sl#	Description	Category	Given ID[a]
1	Over 28 years of experience in climate modeling and risk assessment. Hold a PhD Working in a non-government organization.	NGO	N11
2	Water resources management and climate change specialist. Hold a PhD Working in an academic institution.	Researcher and academia	R12
3	Climate change specialist with about 20 years of experience. Hold a PhD Working in a non-government organization.	NGO	N13
4	Over 32 years of experience as a climate and development expert. Hold a PhD Working in a non-government organization.	NGO	N14
5	Over 26 years of experience. Hold M.Sc in Natural Resources Management. Working in a non-government organization.	NGO	N15
6	Over 20 years of experience in agri-climate-related issues. Hold a PhD Working as a scientist in an agricultural research institute.	Researcher	R16
7	Over 20 years of experience. Hold PhD Working as a Scientist in a health research institute.	Researcher	R17
8	Over 25 years of experience in water sciences and climate change-related issues. Hold a PhD Working in an academic institution.	Researcher and academia	R18
9	Over 40 years of experience. Hold a PhD Worked in academia for more than 18 years.	Researcher	R19
10	Over 30 years of experience in environmental and climate change-related issues. Hold a PhD Working in a government-established non-profit organization.	Policy maker	P110
11	Working at the Ministry of Planning, Government of Bangladesh.	Policy maker	P111
12	Over 25 years of experience. Hold a PhD Working as a scientist in a research institute.	Researcher	R112
13	Over 30 years of experience in climate change and environmental economics-related issues. Hold a PhD Working in an academic institution.	Researcher and academia	R113
14	Over 40 years of experience in the environment, nature conservation, and climate change. Hold a PhD Working in a non-government organization.	NGO	N114
15	Over 20 years of experience in climate-resilient and sustainable development practices. Hold a M.Sc in Climate Change. Working in an intergovernmental organization.	NGO	N115
16	Working at the Ministry of Environment, Forest, and Climate Change, Government of Bangladesh.	Policy maker	P116
17	Over 25 years of experience in the field of GIS, information technology, and climate change. Hold a M.Sc. in Geography.	NGO	N117

[a] The IDs are provided anonymously. The initial value of 1 is consistent across all expert interviewees. For example, P111 signifies that he/she was the 11th person interviewed as an expert. With 17 expert interviewees, the maximum value is 117.

need for climate change adaptation and mitigation. At the start of each focus group, the researchers gave a brief presentation describing SRM technologies and their potential benefits and risks, this was done to avoid any misunderstanding and to form a solid foundation for the discussions (details are given in supplementary material). The standards of the qualitative research were followed to safeguard the scientific robustness of the study. For instance, key quality criteria included a detailed literature review and in-depth data collection by the researchers, guided by a pre-established research design and continuing until saturation was reached in terms of repetition of topics and arguments, as well as clear description of the analytical process to ensure transferability, and safeguarding of ethical standards such as guaranteeing prior and informed consent of participants (Santiago-Delefosse *et al* 2016, Yadav 2022).

2.2. Data analysis

Except for 4 interviews, all interviews and focus groups were audio-recorded and subsequently transcribed. In all instances, participants provided consent for written notes to be taken. Since the focus groups and expert interviews were conducted in the local language, Bangla, they were transcribed and translated into English. Key themes were identified through an inductive thematic analysis of the translated interviews and focus groups (Ayre and McCaffery 2022). All transcripts were first organized in Microsoft Excel, where preliminary codes and significant quotations were sorted. Transcripts were coded manually, with themes organized around the key guideline areas. A member of the research team conducted manual coding, allowing themes to emerge directly from the data rather than being predetermined. Other team members subsequently reviewed these codes to ensure analytical rigor and consistency. This approach was undertaken to ensure the quality and rigor of the coding process, while an inductive approach was used given the predominantly exploratory nature of the research (Thomas 2006, Proudfoot 2023).

Table 2. Description of focus group participants.

Climate hotspot	Category of participants	Description
Coastal area (vulnerable to cyclones, salinity intrusion, and tidal surges)	Farmer	Farmers are primarily small-scale, low-income producers who encounter significant environmental stress due to climate change, especially saline intrusion. The farmers were selected following consultation with the local agricultural extension organization.
	Student	All students are postgraduate level students from Patuakhali Science and Technology University (PSTU) with backgrounds in agricultural science and rural development. PSTU is the only higher education institute in the study area.
	Civil service official	Among the four civil service participants, two are affiliated with academia, while the other two are engaged as agricultural extension and development professionals.
Drought-prone area (characterized by low rainfall and water scarcity)	Farmer	Farmers in a drought-prone region were selected with the assistance of an agricultural research institute operating in the area. The farmers mostly engage in crop farming and have training in climate-smart agriculture.
	Student	The students were selected from Rajshahi University, one of the largest public universities in Bangladesh. All are post-graduate-level students with backgrounds in geography and environmental studies.
	Civil service official	Two are affiliated with a government agricultural research institute, one represents academia, and one is associated with a non-governmental organization.
Flash flood affected area (characterized by pre-monsoon flood damage to standing crops)	Farmer	Farmers selected from the Gowainghat area, characterized by substantial rainfall predominantly occurring from May to September, and susceptible to flash floods. Farmers primarily cultivate rice as their principal crop.
	Student	Two are postgraduates with backgrounds in geography and environmental studies, while the other two are graduate students in agricultural economics.
	Civil service official	All are affiliated with government organizations. Two of them are engaged in agroforestry issues, while the other two have expertise in agricultural economics and policy.
Riverine island (Flood-prone with poor access to services)	Farmer	The farmers were selected from a riverine island in northern Bangladesh, which is characterized by riverbank erosion, flooding, and inconsistent water flow due to upstream controls. The farmers are mainly involved in rice and vegetable farming.
	Student	All are graduate-level students in the Department of Geography and Environmental Studies at the only public university in the study area.
	Civil service official	Two were affiliated with governmental policy-level organizations and two were from academic institutions.
Hill tracts area (characterized by steep terrain and soil erosion)	Farmer	The farmers were selected from a region experiencing substantial alterations in land use and land cover, characterized by the expansion of human settlement, agriculture, and hillside deforestation due to population growth, resulting in environmental deterioration.
	Student	All are postgraduate-level students in the Department of Geography and Environmental Studies from a public university.
	Civil service official	Two were scientists affiliated with a governmental agricultural research institute, and two had backgrounds in environmental science from academic institutions.
Urban area (Densely populated and facing challenges of high temperature)	Farmer	The farmers were selected from a region adjacent to the capital city because of their adoption of high-value crops, intensive practices, and diverse agriculture in response to diminishing land and urban pressures.
	Student	The selected students are postgraduate students with backgrounds in agriculture and environmental studies.
	Civil service official	One has an engineering background and is working in a government institution, one is affiliated with an NGO, and two are associated with government academic institutions.

2.3. Positionality statement

Reflecting on our positionality provides full transparency regarding how our affiliations and disciplinary perspectives may intersect with study outcomes. The authors have diverse disciplinary and institutional backgrounds: four of the authors are experts in agricultural development economics, technology adoption, and climate change adaptation measures, affiliated with Sher-e-Bangla Agricultural University in Bangladesh; the other two authors are from the global North and have expertise in climate policy, public perceptions, risk, and governance issues, including but not limited to SRM. The collaboration of the authors was initiated through a non-governmental organization dedicated to building capacity in developing countries to evaluate SRM. We underscore that, besides providing funding for the research to be conducted, the organization played no further part in design and execution of the research, or had any impact on the writing or editing of the manuscript. Before the focus group discussions, participants were provided with brief information on climate change, adaptation, mitigation, and SRM technologies. The information sheet mainly discussed the characteristics of these technologies, including examples of adaptation and mitigation strategies, particularly within the context of Bangladesh. This focus was employed to help participants better understand how such technologies might be relevant to and potentially deployed in the actual living situations. We acknowledge that the design and presentation of this content could potentially influence participants' perceptions and responses, especially for novel and unfamiliar topics such as SRM. The author team attempted to mitigate any such risks by focusing on technology characteristics and where impacts needed to be discussed, ensuring that balanced information about risks and benefits was provided. We also made sure that SRM was never discussed as any kind of panacea but always alongside other strategies such as climate mitigation and adaptation.

3. Results

3.1. Experiences with climate change and urgency of action

The participants' experiences with the impacts of climate change can be categorized into the three domains: the effects on environmental resources, livelihoods, and health/life risks. Such discussions primarily emerged in the focus groups, though the expert interviews provided complementary insights regarding the urgency for action. Notably, expert interviews broadly indicated how climate change is profoundly impacting the whole country, with increasing temperatures and altered rainfall patterns generating a series of issues, including crop losses and population displacement.

3.1.1. Effects on environmental resources

Focus groups were particularly helpful for discussing the already visible or experienced effects from the perspective of the participants. Most of them identified the increase in temperatures as the worst consequence of climate change. A farmer mentioned that

> *Rise in the temperature is the most experienced climatic change in our lifetime. (Farmer, drought prone area)*

Participants of the focus groups further suggested that increasingly erratic rainfall patterns are also a serious effect of climate change. This was specifically highlighted by farmers, who confirmed that the desirable or expected rainfall is not happening at the required time. In areas like the northern region (riverine island), farmers are unable to plough their land in a timely fashion as a result, whereas other, more low-lying regions have suffered crop losses on rice paddies because of early floods.

Farmers also observed changes in seasonal patterns, like the intensity and duration of the winter season decreased, while the intensity and duration of summertime have increased. The greater frequency of flash floods along with prolonged drought and water scarcity have made crop production even more vulnerable than before.

3.1.2. Effects on livelihoods

Twelve out of the 17 interviews and all farmers in the focus groups across all climatic hotspots stated that agricultural productivity is substantially hindered due to climate change. They perceived that crop production was relatively easy in the past due to more favorable climatic conditions, even though agricultural tools were less modern. Nevertheless, numerous farmers have recounted their experiences with the availability of more climate-tolerant varieties and how, in response to poor weather conditions, they now have to switch crops. One focus group participant from a flash flood-affected area said,

Climate change has affected our cropping pattern, the crops that were cultivated by our elders are no longer feasible to cultivate nowadays. (Student, flash flood affected area)

Meanwhile, other farmers in the drought-prone area (north-western part of the country) stated that one of the famous eggplant varieties can no longer be cultivated there. Previously, this variety was the most-highly demanded all over the country. Increased temperatures have led to an upsurge in insect infestations in eggplants and numerous other crops. According to one focus group participant in a drought-prone area:

Approximately 70%–80% of crops are affected due to the changing climatic conditions (civil service official, Government wing)

Crucially, not only crop production but also livestock and fisheries production are seriously hampered. Participants noted that heat strokes among livestock are increasingly common. The majority of participants in focus groups from all groups across all climatic hotspots stated that reduced agricultural productivity affects the livelihood in a significant fashion, with follow-on effects for food security in households, in the affected regions, and across the country.

3.1.3. Effects on health and lives

All the 17 participants from interviews also highlighted the health risks for the national population due to increased temperature, as well as due to the increasing frequency of extreme weather events. Health issues like the intensity of diseases and heat strokes have become increasingly common across the country. One expert stressed that climate change severely affected women in particular in the coastal areas (southern part) of the country. They explained by drawing on their own research:

…..in coastal areas, women have to use saline water for household purposes, leading to severe health issues. Young girls, as young as 12 or 13, take birth control pills just to stop menstruation because of the difficulties caused by saline water. This has led to a reproductive health crisis in the southwestern region. The high rate of uterus removal among coastal women is alarming. (N11, expert, NGO)

As a result, there was a broad consensus among all experts of the urgent need for robust climate action in Bangladesh.

3.2. Awareness regarding the SRM

Across the expert interviews, the awareness of SRM varied widely. Most experts acknowledged that SRM is a vastly technical, largely experimental, and globally controversial approach. While five of the key informants (working at NGOs) had in-depth knowledge of SRM methods such as stratospheric aerosol injection and marine cloud brightening, many admitted that their understanding was limited or based on secondary sources. We found that there was a lack of awareness of SRM, particularly among policymakers. Even within the scientific community, few institutions or researchers were actively involved in SRM-related modeling or experimentation in Bangladesh, which helps to explain the minimal familiarity with SRM in Bangladesh.

When it comes to potential use of SRM, some experts noted that SRM was a possible last resort or complementary tool, but not a replacement for mitigation or adaptation. Others were more skeptical of SRM, considering it to be a distraction from necessary adaptation and emission reduction strategies—i.e. so-called 'moral hazard' or 'mitigation deterrence' (McLaren 2016, Schoenegger and Mintz-Woo 2024). A total of two experts working at NGOs and all three policy makers emphasized that there is no need for such technologies right now and that scientists and world leaders should focus more strongly on the reduction of emissions and necessary adaptation and mitigation measures. More broadly, most experts demanded more proof of its effectiveness while not being willing to acknowledge SRM as a good option to fight climate change. One expert specifically argued:

Why should we prioritise SRM when there are so many pressing climate issues? (N15, expert, NGO)

Meanwhile, for most of the participants in focus groups, this was the first time they had heard about SRM. This led to the majority being perplexed regarding the techniques and efficacy SRM, specifically how and to what extent these strategies can avoid increases in global temperatures. One of the focus group participants responded that:

In my opinion, SRM feels like science fiction, I don't find it entirely practical at this moment (civil service official, hill tracts area)

However, some of the farmers from the focus groups, particularly those from drought-prone and urban areas were relatively more willing to accept SRM, if it could help to reduce the negative effects of climate change in crop production. One of the focus group participants opined that:

If the temperature drops, that would be a good thing (Farmer, urban area)

Other participants in focus groups were of the general opinion that if SRM could lower temperatures, it would be beneficial. The majority of the focus groups participants, particularly from urban, coastal and drought prone area, were positive about the implementation of SRM if it resulted in weather patterns where crop cultivation became less difficult or reduced impacts on their health. The need to weigh the risks and benefits for affected individuals is noted as such by one civil service official in a coastal area:

When we get sick, we take tablets, so when there is a problem in the God-made environment, for the betterment of humankind we may take steps. But they should not be harmful to others as well. (civil service official, coastal area)

3.3. Perception of benefits and risks of SRM

Since the effects of climate change have already been experienced by most of the participants, there was broad agreement on the pressing need to identify solutions. Regarding SRM, much of the discussion of the interviews focused on how well such technologies can perform sustainably: the specific risks highlighted (along with their frequency of mention and an illustrative quote) are summarized in table 3. Among the 17 interviews, risks related to uncertainty about effectiveness and insufficient proof of evidence were each identified by 11 of the experts. Meanwhile, about half of the experts (7) highlighted issues concerning the limited availability of technical skills and expertise as well as proper risk management for SRM. And then around one-quarter of the experts noted increased uncertainty with monsoon patterns (5) and questions about financial issues and compensation (4).

Turning to the perceived benefits of SRM in the expert interviews (table 4), we first highlight that far fewer benefits than risks were mentioned overall (five in total), and that the frequency with which benefits were mentioned was lower as well. Just over one-third of experts (6) mentioned that SRM may help improve crop productivity by reducing temperature increases. Indeed, this was the only benefit mentioned by more than two experts—with other benefits of lower temperatures including the reduced need for crop irrigation, declines in the incidence of health issues and disease incidence, and the greater ability for farmers to work in the field. It is notable that, in the Bangladeshi context, most of the benefits focused on farmers and agriculture.

However, ten of our experts agreed that a holistic approach needs to be taken to weigh the benefits and risks of SRM. As such, they contended that such discussions were not merely a local issue, but needed to be handled at an international level. Notably, there could be cases where the local impacts may be minimal, but the extent of the global effects requires meticulous assessment.

During the focus groups, we also invited discussion about the risks and benefits of SRM. Although farmers in the discussions noted their limited understanding of SRM, they nevertheless foresaw potential advantages of SRM that broadly align with those expressed in interviews. These particularly concerned lower temperature stress, increased crop yield, and increased water availability. One of the participants in the drought-prone area focus group stated that:

If we can control the temperature, the scarcity of irrigation water will automatically decrease… the excessive heat will decrease, thereby vegetables and fruits will improve. (Farmer, drought prone area)

Another focus group participant from a coastal area added that:

It might help mitigate the effects of heat waves. I have seen that major crops like rice and jute suffer from heat waves. (Student, coastal area)

Table 3. Perceived risks of SRM according to expert interviews.

Perceived risks	Number of experts mentioning it	Illustrative quotes from the participants
Uncertainty about the effectiveness	11	*Reflecting on the experiences in Dubai (sudden rainfall and flooding), [such risks] can be unexpected, such an intervention may not be easy at first. (P111, policy maker, public institute)*
Lack of proof and evidence	11	*SRM is still in a premature stage. More research is needed to assess long-term efficacy since this type of application is irreversible. (R112, researcher, public institute)*
Proper management risk	7	*The management of such technologies needs complete attention, which is difficult. (P116, policy maker, public institute)*
Technical expertise and durability	7	*I understand that the entire endeavor needs technical experts, though we have some dedicated organizations, but their efficacy is currently not at that level. (N14, expert, NGO)* *Since it needs maintenance and also several attempts to reduce the temperature, and once it starts it will be continuous process, otherwise there will be serious side effects, then who will ensure its continued deployment in the long run? (R18, Researcher, public institute)*
Unpredictable change in monsoon pattern	5	*If rainfall patterns change due to the reduction of global temperature, the food crop production might be hampered. (N13, expert, NGO)*
Financial issues and compensation	4	*We are already suffering from climate change and still not able to get the demanded compensation. Therefore, who guarantees compensation for unwanted risks or misuse of SRM? (P110, policy maker, public institute)*
Disease infestation pattern might get changed	2	*Since vector-borne diseases are influenced by the climatic conditions, there is the possibility of global rearrangement of how disease is spread out. (R17, independent researcher, non-government institute)*
Mitigation deterrence	2	*It is my fear that the efforts for the reduction of GHG emissions and other adaptation and mitigation measures will get less attention. What will be the scenario of future climate with increased GHGs (R16, Researcher, public institute)*
Need for alternative crops/ varieties	1	*The current agricultural crops are cultivated based on the current climate and people are used to it, a drastic change might come with a reduction of the temperature in many regions, so preparedness is urgent (N117, expert, NGO)*

Table 4. Perceived benefits of SRM according to expert interviews.

Perceived benefits	Number of experts mentioning it	Illustrative quotes from the participants
Improving crop productivity	6	*In a suitable temperature some of the crops will give maximum yield. (N11, expert, NGO)*
Possible heat control helps reduce adverse health issues	2	*Heat stroke and other health issues will be reduced. Moreover, the incidence of the different vector-borne diseases like malaria and Dengue will be low in this region (R17, independent researcher, non-government institute)*
Farmers can work in the field comfortably	2	*Many of the farmers complain about the high temperatures during their work in the field, so they might continue their cultivation comfortably. (R12, academia and researcher, private university)*
Increasing availability of water	2	*Reduced temperatures might increase the water availability in the dry regions. (R18, Researcher, public institute)*
Minimum post-harvest losses in highly perishable crops	1	*We might have the opportunity to save some energy investing in cold storage (R16, Researcher, public institute)*

3.4. SRM versus nature-based approaches

When asked in the interviews to consider SRM alongside more nature-based approaches, fifteen of our key informants expressed their preference for nature-based solutions to reduce the effects of climate change. Meanwhile, government policy makers were more likely to suggest that the existing national adaptation plan was the most suitable strategy for Bangladesh. Expert researchers however suggested that more research on the effectiveness of SRM, and its potential costs and risks, would be needed to better evaluate SRM. This was seen as

a necessary step before any of the possible benefits could be considered. The most serious argument that emerged from the interviews centered on the current situation of greenhouse gas emissions. At the same time, two experts working at NGOs and one from academia were also positive about the research and small-scale implementation of SRM. One of the experts suggested that,

> *…nowadays technology has the potential to yield positive outcomes, we must acknowledge and identify the most beneficial advancements for the humankind. (N11, expert, NGO)*

During the focus groups, on the other hand, maximum participants also suggested prioritizing nature-based approaches and adaptation over more high-tech global interventions like SRM. They emphasized the need for agroforestry, adjustments to the crop calendar, and greater use of rainwater harvesting. One farmer in the drought-prone area stated that:

> *Previously we needed less irrigation. Now water demand is higher. We need better water-harvesting support. (*Farmer, drought prone area)

One participant in the civil service said that future studies should take farmers' perspectives into account because of their experience and exposure to the effects of climate change:

> *Farmers are already more adaptive than we are. They work under extreme conditions. We should engage with them in learning and research.* (Civil service official, hill tract area)

Another civil service official added that:

> *'We should ensure natural solutions are fully implemented before considering risky technologies like SRM.' (civil service official, drought prone area)*

Students in the focus groups also highlighted the long-term sustainability of nature-based approaches and emphasized the need for greater community awareness and policy integration, for instance:

> *Climate change adaptation should be aligned with farmers' interests. Agroforestry and rainwater harvesting would help both large and small farmers. (Student, hill tract area)*

3.5. Geopolitical considerations

Due to the limited understanding and knowledge of the focus group participants regarding SRM, the questions about geopolitical considerations were mainly directed to experts in the interviews. The experts articulated several concerns outlined, notably regional differences in how SRM is perceived, issues of risk and compensation, alternate solutions for dealing with climate change, and questions of power and negotiation.

3.5.1. Regional differences in how SRM is perceived

Given that climate change has unequal impacts around the world, regional preferences for the use of SRM are likely to differ. Those countries that might benefit, even if only relatively, from a warming globe could have incentives to act differently. One of the experts of the interviews stated:

> *Russia might gain more arable land, whereas low-lying countries like Maldives are at risk of submersion (N117, researcher, NGO)*

In Bangladesh, a reduction in temperature levels is welcomed by almost everyone. This did not necessarily correspond to a desire to use SRM at the moment given that many pros and cons of SRM are largely unknown.

3.5.2. Uncertainty around burden of risks and compensation

Since there will be uncertainties and risks if SRM were not properly implemented, another key concern was, first, who would bear much of the risks at a global level and, second, would any compensation be provided. Since such an endeavor would already require huge investment, the need to understand how responsibility would be allocated should any unexpected situation arise is critical. Noting that such an outcome is quite probable, one NGO expert considered:

> *If we radically alter global climate circulation, who will take responsibility for the consequences? (N15, expert, NGO)*

3.5.3. SRM as alternative justification for not reducing carbon emissions

Another theme related to the relationship between SRM and the responsibility and necessity of developed countries to reduce their emissions. Five key informants working at NGOs and all the policy makers contended that the inability or unwillingness of developed nations to reduce their emissions was sufficient to justify the consideration of SRM as an effective technology to fight climate change. Rather, one policy maker contended that SRM risked serving as an excuse for not undertaking necessary emissions reductions.

> *Industrialized countries cannot reduce emissions as promised, so they are exploring alternative justifications (P111, policy maker, public institute)*

Other experts asserted that global climate governance lacks clarity, raising questions regarding accountability and how to accurately quantify (and financially compensate) climate damages. One NGO expert gave the following example:

> *For example, if any developed country claims that after spending 20 or 200 billion, they have taken the initiative to reduce temperature and now they are exempt from the responsibility, but how will we measure if that is done? (N15, expert, NGO)*

3.5.4. In terms of power and negotiation

A total of twelve experts also expressed skepticism about how SRM could be implemented given the lack of financial capacity and expertise in developing countries like Bangladesh. For this reason, it was suggested that reliance on developed nations would be necessary, also owing to the insufficient negotiating power of developing countries in multilateral forums. Several experts indicated that some kind of a global consensus on the ramifications of SRM is essential. Such consensus was seen to be even more crucial since the use of SRM at a global level could have diverse impacts across countries, indeed, even if SRM technologies were to be deployed locally and on a limited scale, nearby countries could still suffer consequences. One of the experts therefore stated that:

> *Advanced nations might dominate these interventions, so to preserve the rights of the people all over the world, some kind of agreement is needed. (N15, expert, NGO)*

3.6. Governance and policy framework

When it comes to who should take the lead on the governance, most experts in the interviews asserted that it should be the government in a country like Bangladesh (to note, while we asked one question about policies in the focus groups, the answers were insufficiently descriptive to be included here). NGOs, research institutions, and universities would still be important in a supporting role. Experts also opined that, considering the global nature of SRM, Bangladesh should advocate for regional cooperation. However, in the current absence of evidence demonstrating the effectiveness of SRM, it was suggested that the government would be reluctant to integrate SRM into the national climate policy. One of the experts stated that:

> *Historically, the government has been hesitant to allow experimental approaches without substantial evidence, so such an initiative currently cannot get into national policy. (N11, expert, NGO)*

4. Discussion

The present study employed a multi-methods qualitative research design to examine different stakeholders and experts' perceptions on SRM in different climatic hotspots in Bangladesh. The farmers, students, and civil service representatives who took part in the focus group discussions were broadly aware of climate change, with some having experienced severe impacts already and were thus motivated to identify potential solutions. The expert participants in the interviews meanwhile emphasized the urgent need to enhance climate action, asserting that the existing adaptation programs are inadequate and that mitigating measures are likely to be

insufficient. To maintain ongoing progress in economic development, appropriate adaptation and mitigation measures were thus argued to be essential, as also indicated by previous research (Chowdhury *et al* 2021, World Bank Group 2022).

The study revealed that while a few climate experts are knowledgeable about SRM techniques, most participants know nothing at all about SRM—particularly in the focus group discussions. This finding is not so surprising, as it echoes other public perception studies of geoengineering (Mercer *et al* 2011, Visschers *et al* 2017, Delina 2021, Baum *et al* 2024a). Moreover, experts were not entirely persuaded regarding the effectiveness of SRM. A significant number of the experts considered the risks associated with SRM to be substantial, aligning with earlier studies (Merk *et al* 2018). In general, the experts employed a more cautious viewpoint, arguing that additional proof and demonstration would be necessary (Haywood *et al* 2025). The majority of the experts were specifically concerned about the uncertainty of the effectiveness of SRM and the lack of available technical expertise. However, there were notable differences between the stakeholder groups. For instance, experts with stronger research backgrounds preferred to continue to research and explore SRM, notably as a last resort for combating global warming (Contzen *et al* 2024). Policymakers, on the other hand, largely asserted that all research and funds should be completely directed towards adaptation and mitigation strategies, financing for sophisticated techniques like SRM was however seen to be unnecessary in the context of Bangladesh. Given that other research has revealed that technological uncertainties can lead to rejection among experts (Delina 2021), such reluctance among policymakers could be because of climatic uncertainties, effects on people's livelihoods, not to mention the financial, technical, and governance challenges.

Echoing other studies in the global South, however, we find that the focus groups participants showed a somewhat open attitude towards SRM technologies (Visschers *et al* 2017, Baum *et al* 2024b, Sugiyama *et al* 2025). This was particularly the case among farmers from drought-prone and urban areas, who were positive about SRM due to the significant climatic challenges posed by extreme heat and longer dry periods. However, they simultaneously articulated major concerns regarding potential risks, such as unpredictable change in rainfall pattern. While most of the participants in the current study were conscious of climate change and, in certain instances, significantly affected by its adverse impacts, farmers stood out in this respect. For them, it is already the issue of doing something against the impacts they are already experiencing versus the mitigation of more distant future climate risks for participants in global North studies. The fact that this made them more willing to consider a wider range of potential solutions demonstrates both the need to engage with the over-looked perspective of farmers and why their unique experiences with climate change may be especially relevant for SRM discussions. Even if SRM was used to slow down global warming, they would still have to adapt to the increased temperatures.

Concerning the benefits of SRM, most of the experts indicated that Bangladesh might improve crop productivity as well as water availability if temperatures were limited to a certain increase. Bangladesh's agriculture frequently endures excessively high temperatures, particularly during the flowering and grain-filling phases of rice cultivation. Research indicates that temperatures exceeding 35 °C are detrimental to grain formation, limiting farmers' ability to attain maximum potential yields (Hussain *et al* 2019). Marginal reduction in temperature levels throughout the crucial developmental phases can mitigate heat-induced sterility, improve grain formation, and boost crop yield, allowing farmers to achieve their maximum potential harvest. Focus group participants also identified improved water availability as key advantages of SRM. Implementing SRM to decrease temperatures could mitigate evapotranspiration as well, thereby reducing agricultural water requirements in Bangladesh's drought-affected areas. Such a solution could also be crucial for coastal areas of Bangladesh, where water scarcity limits agricultural productivity (and human well-being). In this respect, we can see the key relevance of the water-agriculture nexus in Bangladesh, for instance, with reduced irrigation requirements also creating substantial savings on energy and fuel expenses for farmers given the reliance on diesel and electric pumps for irrigation. The interviews and focus groups also revealed that SRM could mitigate health-related concerns such as vector-borne diseases and heat stress, which may be viewed as a significant advantage for Bangladesh. Hussain *et al* (2025) also found that use of climate interventions, such as stratospheric aerosol injection, may gradually reduce the transmission of malaria in South Asia.

Another key feature of the discussions was that most of the participants' perspectives were predominantly moderate and unpolarized—another key point of departure from studies in western contexts, specifically the United States (Bolsen *et al* 2025, Buck *et al* 2025). Indeed, both interviews and focus group participants expressed the opinion that, if risks associated with SRM were minimal and it might positively impact agriculture, they would be willing to accept it. This finding could be due, in part, to the fact that, prior to participating in our study, individuals were unfamiliar with SRM and hence did not have a strong opinion about it. As a result, their opinions were primarily based on the information we presented about SRM during the discussion, which could result in biases.

Despite a potential openness to SRM among some participants, there was still a preference for nature-based approaches more generally. Respondents' support for nature-based approaches in Bangladesh can be

attributed to the value attached to agriculture, forestry, and coastal regions, in addition to their personal experiences (Anjum *et al* 2024, Iqbal *et al* 2025). Additionally, the nature-based approaches are already well-known, ready to be put into action in the community, and are readily understood by local communities and policy makers. They also require less financial investment, significant for a country like Bangladesh. Bangladesh's existing climate policy and development frameworks also put a lot of emphasis on nature-based approaches, which means they are the status quo—this can explain why policymakers in the interviews tended to be more supportive of such solutions. Prior research also indicated that experts, overall, possessed greater practical experience with nature-based approaches compared to other high-tech alternatives, potentially affecting their preferences (Delina 2020, Sovacool *et al* 2022).

The present study also analyzed a handful of geopolitical issues in relation to SRM perceptions. In specific, diverse regional impacts from climate change issues of risk, power asymmetry, and negotiation capacity, and the need for multilateral discussion and coordination are some of the important topics related to the use of SRM in Bangladesh. Since Bangladesh is also especially vulnerable to climate change, there was also an undercurrent of fear in discussions, particularly among experts, of the current lack of effective governance and political aspects regarding SRM. All participants favored a reduction in temperatures, but they were also cognizant that developing countries like Bangladesh lack the requisite competence to implement SRM, not to mention their inability to collect sufficient evidence to weigh the costs and benefits. Bangladesh, moreover, lacks the capacity to finance such initiatives, even on a small scale. Consequently, experts in Bangladesh asserted that discussions around SRM would perpetually favor developed countries, leaving the developing countries to be reliant on the protection or sponsorship of more powerful states (Low *et al* 2024). Prior research has also argued that solar geoengineering could serve as a potential catalyst for geopolitical tension, distrust, and disinformation, highlighting significant risks overlooked in governance-oriented assessments (Corry *et al* 2024). There is a necessity of comprehensive international collaboration, including transfer of technological and financial resources, to establish future SRM discussions on solid ground (Brutschin *et al* 2024).

Regarding SRM governance, climate experts and policy makers in the present study contended that it was the national government in Bangladesh who should take leadership, while NGOs and academic and research organizations could play a supportive role. For SRM to best raise awareness and gain some kind of legitimacy, it would moreover be important to get the public involved, especially in communities affected by climate change (Fritz *et al* 2024). According to Brent *et al* (2025), current informal governance plans are insufficiently detailed and there is not enough oversight or enforcement. Therefore, formal domestic governance is a prerequisite for research of SRM, l*et al*one implementation. According to Jinnah and Dove (2025), decision-makers, researchers, and others all around the globe must engage in inclusive deliberation to define SRM governance. Given the transboundary nature of the potential risks of SRM, including weather patterns and monsoon systems, Bangladesh should also advocate for regional cooperation and push for a legally binding international framework.

5. Conclusions

The findings of this study indicate that the perceptions and views of stakeholders and experts in Bangladesh reflect an intricate mixture of interest, caution, and concern regarding SRM and its potential role in addressing climate change. In particular, we integrated the views of farmers, which have so far been omitted in the literature despite their severe vulnerability to climate impacts and importance in global South countries like Bangladesh. Farmers in climate hotspot areas perceive SRM as a potential method to mitigate heat stress and boost crop productivity; nevertheless, experts remain uncertain, specifically about the associated risks, potential effectiveness, and governance implications. Indeed, there is a clear preference for nature-based adaptation over the deployment of SRM in both expert interviews and focus groups. Nevertheless, the majority of experts concurred that further research into SRM is essential to comprehend the potential risks and implications, particularly given that Bangladesh lacks the financial and political power to influence global SRM decisions. These findings specifically highlight the perceived necessity of transparent, national government-led governance frameworks, efforts to build increased national research capabilities, and public engagement to ensure that future SRM decisions are informed, context-specific, and inclusive—that is, both within countries and at a global level.

Though the present study provides valuable insights into perceptions of risks, benefits, socio-political aspects, and governance of SRM using multi-methods qualitative research focused on an under-researched and highly vulnerable developing country, some shortcomings exist. First, the study only had a limited number of participants who were previously aware of SRM. While scenario narratives were utilized to provide some background information, such information was necessarily limited. Hence, the responses of participants, especially those less familiar with SRM, might have been biased as a result—that is, despite the best efforts of the researchers to remain neutral. Such a problem, it must be noted, is ever-present for research into potentially unfamiliar

topics, let alone ones that are likely to be controversial (Merk *et al* 2015). Furthermore, literature suggests that SRM could affect broad ecological systems, including monsoon-dependent ecosystems, biodiversity, and hydrological cycles. As our data did not include perceptions related to ecosystems, this represents a crucial area for future research. Consequently, studies exploring stakeholder or public perceptions of SRM in Bangladesh should include issues regarding ecological risks, impacts on natural systems, and the values of planetary stewardship to achieve a thorough understanding of societal viewpoints.

Acknowledgments

The authors thank the data collectors and participants for their cooperation during the data collection process. Additionally, Chad M. Baum acknowledges funding from the European Union's Horizon 2020 research and innovation programme under the European Research Council (ERC) Grant Agreement No. 951542-GENIE-ERC- 2020-SyG, 'GeoEngineering and NegatIve Emissions pathways in Europe' (GENIE) and Christine Merk acknowledges funding via the Co-Create project co-funded by the European Union (Grant agreement No. GAP-101137642) and the UKRI; these grants were independent of and not directly used for the present work. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency.

Funding

This project has been funded by The Degrees Initiative, United Kingdom, under their Socio-Political Fund, Grant Agreement No. RGA-SPF24BGD000. The findings of this study do not reflect the official opinion of the Degrees Initiative, and the Degrees Initiative exercised no influence or direction on the conduct of the research.

Data availability statement

The data utilized in this work are not publicly available due to legal/ethical considerations; however, they can be obtained from the corresponding author upon reasonable request.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethical consideration

The Sher-e-Bangla Agricultural University Research System (SAURES) granted ethical approval of the survey materials. The approval number is SAURES/SAU/2025/293. Each participant granted verbal informed permission after being informed of the study's objectives, importance, and the range of information needed. Respondents' participation in the survey was voluntary. Participants had the autonomy to decline or terminate the interview/discussion at any time.

Author contributions

Md Sadique Rahman 0000-0001-8175-2164
Conceptualization (equal), Funding acquisition (lead), Methodology (equal), Project administration (lead), Supervision (equal), Writing – original draft (equal), Writing – review & editing (equal)

Fatema Sarker
Data curation (equal), Formal analysis (equal), Methodology (equal), Writing – original draft (equal), Writing – review & editing (equal)

Muhammad Humayun Kabir
Conceptualization (equal), Investigation (supporting), Project administration (equal), Supervision (supporting), Writing – review & editing (equal)

Chad M Baum 0000-0002-6513-5518
Writing – original draft (equal), Writing – review & editing (equal)

Christine Merk 0000-0003-1941-2702
Writing – original draft (equal), Writing – review & editing (equal)

Md Roconuzzaman 0009-0003-2457-3241
Data curation (equal), Writing – original draft (supporting)

References

Alam G M M, Alam K and Mushtaq S 2017 Climate change perceptions and local adaptation strategies of hazard-prone rural households in Bangladesh *Clim. Risk Manag.* **17** 52–63
Anjum B, Sultana R and Saddaf N 2024 The effectiveness of nature-based solutions to address climate change in Dhaka, Bangladesh *Soc. Sci. Humanit. Open.* **10** 100985
Asayama S, Sugiyama M and Ishii A 2017 Ambivalent climate of opinions: tensions and dilemmas in understanding geoengineering experimentation *Geoforum* **80** 82–92
Ayre J and McCaffery K J 2022 Research note: thematic analysis in qualitative research *J. Physiother.* **68** 76–9
Baum C M, Fritz L, Low S and Sovacool B K 2024a Public perceptions and support of climate intervention technologies across the Global North and Global South *Nat. Commun.* **15** 2060
Baum C M, Fritz L, Low S and Sovacool B K 2024b Like diamonds in the sky? Public perceptions, governance, and information framing of solar geoengineering activities in Mexico, the United Kingdom, and the United States *Environ. Politics.* **33** 868–95
Braun C, Rehdanz K and Schmidt U 2018 Exploring public perception of environmental technology over time *J. Environ. Plann. Man.* **61** 143–60
Brent K, Simon M and McDonald J 2025 From informal to formal governance of solar radiation management *Clim. Policy.* **25** 947–64
Brutschin L, Baum C M, Fritz L, Low S, Sovacool B K and Riahi K 2024 Drivers and attitudes of public support for technological solutions to climate change in 30 countries *Environ. Res. Lett.* **19** 114098
Bokhtiar S M, Samsuzzaman S, Jahiruddin M and Panaullah G M 2023 Agricultural Development for Fragile Ecosystems in Bangladesh Bangladesh Agriculural Research Council Dhaka 1215 Bangladesh
Bolsen T, Palm R and Kingsland J T 2025 How scientific and partisan media shape support for research on stratospheric aerosol injection *Environ. Politics.* **34** 464–85
Buck H J, Shah P, Yang J Z and Arpan L 2025 Public concerns about solar geoengineering research in the United States *Commun. Earth Environ.* **6** 609
Chowdhury M M I, Rahman S M, Abubakar I R, Aina Y A, Hasan M A and Khondaker A N 2021 A review of policies and initiatives for climate change mitigation and environmental sustainability in Bangladesh *Environ. Dev. Sustain.* **23** 1133–61
Corry O, McLaren D and Kornbech N 2024 Scientific models versus power politics: how security expertise reframes solar geoengineering *Rev. Int. Stud.* (https://doi.org/10.1017/S0260210524000482)
Contzen N *et al* 2024 Public opinion about solar radiation management: a cross-cultural study in 20 countries around the world *Clim. Change* **177** 1–25
Dai Z, Burns E T, Irvine P J, Tingley D H, Xu J and Keith D W 2021 Elicitation of US and Chinese expert judgments show consistent views on solar geoengineering *Humanit. Soc. Sci. Commun.* **8** 18
Dannenberg A and Zitzelsberger S 2019 Climate experts' views on geoengineering depend on their beliefs about climate change impacts *Nat. Clim. Change* **9** 769–75
Delina L L 2020 Potentials and critiques of building a Southeast Asian interdisciplinary knowledge community on critical geoengineering studies *Clim. Change* **163** 973–87
Delina L L 2021 Southeast Asian expert perceptions of solar radiation management techniques and carbon dioxide removal approaches: caution, ambivalence, risk precaution, and research directions *Environ. Res. Commun.* **3** 125005
Fan Y, Tjiputra J, Muri H, Lombardozzi D, Park C E, Wu S and Keith D 2021 Solar geoengineering can alleviate climate change pressures on crop yields *Nat. Food.* **2** 373–81
Fritz L, Baum C M, Low S and Sovacool B K 2024 Public engagement for inclusive and sustainable governance of climate interventions *Nat. Commun.* **15** 4168
Hasan M K and Kumar L 2022 Changes in coastal farming systems in a changing climate in Bangladesh *Reg. Environ. Change.* **22** 113
Hasan M M, Alauddin M, Rashid S M A, Jakaria M and Alamgir M 2019 Climate sensitivity of wheat yield in Bangladesh: implications for the United Nations sustainable development goals 2 and 6 *Land Use Policy* **87** 104023
Haywood J M, Boucher O, Lennard C, Storelvmo T, Tilmes S and Visioni D 2025 World Climate Research Programme lighthouse activity: an assessment of major research gaps in solar radiation modification research *Front. Clim.* **7** 1–22
Honegger M, Michaelowa A and Pan J 2021 Potential implications of solar radiation modification for achievement of the Sustainable Development Goals *Mitig. Adapt. Strateg. Glob. Change.* **26** 1–20
Hussain A, Latif M, Shoaib M and Khan V 2025 Projected malaria transmission risk under climate intervention in South Asia *Environ. Res. Commun.* **7** 035020
Hussain S, Khaliq A, Ali B, Hussain H A, Qadir T and Hussain S 2019 Temperature extremes: impact on rice growth and development *Plant Abiotic Stress Tolerance* ed M Hasanuzzaman, K Hakeem, K Nahar and H Alharby (Springer) https://doi.org/10.1007/978-3-030-06118-0_6
Hussain A, Sipra H F, Waheed A and Ukhurebor K E 2024 Exploring the academic perceptions of climate engineering in developing countries *Atmósfera* **38** 311–325
Huq N, Hugé J, Boon E and Gain A K 2015 Climate change impacts in agricultural communities in rural areas of Coastal Bangladesh: a tale of many stories *Sustainability* **7** 8437–60
Iqbal M H, Naznin M T and Hossen M Z 2025 Harnessing nature-based solutions for resilient coastal agriculture: a case study of southwest Bangladesh *Nat. Sol.* **7** 100209
Jinnah S and Dove Z 2025 Solar radiation management: a history of the governance and political milestones *Environ. Sci. Atmos.* **5** 656–73

Knox J, Hess T, Daccache A and Wheeler T 2012 Climate change impacts on crop productivity in Africa and South Asia *Environ. Res. Lett.* **7** 034032
Kravitz B 2021 Effects of climate engineering on agriculture *Nat. Food.* **2** 320–1
Kumler A *et al* 2025 Potential effects of climate change and solar radiation modification on renewable energy resources *Renew. Sustain. Energy Rev.* **207** 114934
Lenton T M *et al* 2023 Quantifying the human cost of global warming *Nat. Sustain.* **6** 1237–47
Low S, Fritz L, Baum C M and Sovacool B K 2024 Public perceptions on carbon removal from focus groups in 22 countries *Nat. Commun.* **15** 3453
Mahajan A, Tingley D and Wagner G 2019 Fact, cheap, and imperfect? U.S. public opinion about solar geoengineering *Environ. Politics.* **28** 523–43
McLaren D 2016 Mitigation deterrence and the 'moral hazard' of solar radiation management *Earth's Futur.* **4** 596–602
McLaren D and Corry O 2021 The politics and governance of research into solar geoengineering *WIREs Clim. Change.* **12** e707
Mercer A M, Keith D W and Sharp J D 2011 Public understanding of solar radiation management *Environ. Res. Lett.* **6** 044006
Merk C, Pönitzsch G and Rehdanz K 2018 Do climate engineering experts display moral-hazard behaviour? *Clim. Policy.* **19** 231–43
Merk C, Pönitzsch G, Kniebes C, Rehdanz K and Schmidt U 2015 Exploring public perceptions of stratospheric sulfate injection *Clim. Change* **130** 299–312
Proudfoot K 2023 Inductive/Deductive hybrid thematic analysis in mixed methods research *J. Mix. Methods Res.* **17** 308–26
Quaas J *et al* 2024 *Solar Radiation Modification: SAPEA Evidence Review Report* (European Commission)
Rashid M H, Bokhtiar S M, Uddin M J and Ali M S 2023 Research Priorities in Bangladesh Agriculture Project Implementation Unit National Agricultural Technology Program-Phase II Project Bangladesh Agricultural Research Council (BARC) Dhaka-1215 Bangladesh
Rasul G 2021 Twin challenges of COVID-19 pandemic and climate change for agriculture and food security in South Asia *Environ. Challenges.* **2** 100027
Raimi K T, Maki A, Dana D and Vandenbergh M P 2019 Framing of geoengineering affects support for climate change mitigation *Environ. Commun.* **13** 300–19
Sarker M A R, Alam K and Gow J 2014 Assessing the effects of climate change on rice yields: An econometric investigation using Bangladeshi panel data *Econ. Anal. Policy.* **44** 405–16
Santiago-Delefosse M, Gavin A, Bruchez C, Roux P and Stephen S L 2016 Quality of qualitative research in the health sciences: analysis of the common criteria present in 58 assessment guidelines by expert users *Soc. Sci. Med.* **148** 142–51
Schoenegger P and Mintz-Woo K 2024 Moral hazards and solar radiation management: Evidence from a large-scale online experiment *J. Environ. Psychol.* **95** 102288
Sovacool B K, Baum C M and Low S 2022 Determining our climate policy future: expert opinions about negative emissions and solar radiation management pathways *Mitig. Adapt. Strateg. Glob. Change.* **27** 58
Sugiyama M, Asayama S, Kosugi T, Ishii A and Watanabe S 2025 Public attitude toward solar radiation modification: results of a two-scenario online survey on perception in four Asia–Pacific countries *Sustain. Sci.* **20** 423–38
Sugiyama M, Asayama S and Kosugi T 2020 The north–south divide on public perceptions of stratospheric aerosol geoengineering?: A survey in six Asia-Pacific countries *Environ. Commun.* **14** 641–56
Thomas D R 2006 A general inductive approach for analyzing qualitative evaluation data *Am. J. Eval.* **27** 237–46
Visschers V H M, Shi J, Siegrist M and Arvai J 2017 Beliefs and values explain international differences in perception of solar radiation management: insights from a cross-country survey *Clim. Change* **142** 531–44
Wibeck *et al* 2017 Making sense of climate engineering: a focus group study of lay publics in four countries *Clim. Change* **145** 1–14
World Bank Group 2022 Bangladesh Country Climate and Development Report Retrieve from: https://hdl.handle.net/10986/38181
World Bank Group 2024 *Climate Risk Country Profile: Bangladesh* Retrieve from: https://preventionweb.net/media/104806/download?startDownload=20250719
Yadav D 2022 Criteria for good qualitative research: a comprehensive review *Asia-Pac. Educ. Res.* **31** 679–89