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Internalising solar radiation management technological externalities: An ethical review on the design of economic instruments

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1. Introduction

A geoengineering approach for removing atmospheric CO_2 is growing in the climate science literature and climate policy research. The recent Fifth Assessment Report (AR5) of The Intergovernmental Panel on Climate Change (IPCC, 2014) which provides a clear and up-to-date assessment of the current state of scientific knowledge relevant to climate change brings climate engineering from the fringes of the policy debate into the mainstream. Solar radiation management (SRM) involves large-scale methods that seek to reduce the amount of absorbed solar energy in the climate systems and could to some degree offset global temperature rise and its effects. It could provide rapid cooling in comparison to CO_2 mitigation. There is some medium confidence that SRM is capable in dealing with the reduction of absorbed solar energy.

SRM technologies however, raise questions about risks and ethical implications of development and future deployment. There are special challenges emerging for international institutions and mechanisms that could coordinate research and possibly restrain testing and deployment (IPCC, 2014). Recently, there are growing literature on the technical options for geoengineering and effects on optimal greenhouse gas emission reduction (Moreno-Cruz, 2015; Weitzman, 2015) and few ethical and desirability of geoengineering (Tor, 2015; Svoboda, 2016; Wong, 2014; Hulme, 2015; Horton, 2014).

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However, there are still scarcity of literature on SRM effects and associated benefits and risks with such methods and technologies. In some recent papers (Svoboda and Irvine, 2014; Svoboda, 2016; Wong, 2014; Horton, 2014), authors have identified various challenges in constructing a just compensation system for geoengineering approaches and methods. The authors further analyse the difficulties in establishing causal links between certain geoengineering impacts and call for assessments of these challenges in the design of such economic instruments. They make a fundamental contribution to understanding the complexities of SRM and compensation payment system in a case where SRM is developed and deployed. This communication seeks to firstly review these papers, secondly, reassess compensation payments principles discussed in them, thirdly provide additional control strategies to internalize SRM externalities. Finally, comment on research need to fully develop ethically control strategy for SRM future deployment or undeployment.

SRM is seen by some climate experts as a possible strategy and an approach to reduce effects of climate change through the increase of the earth reflectivity or albido (Irvine et al., 2009, 2012; Crutzen, 2006; Keith, 2000). Some SRM techniques debated upon include increasing the reflectivity of the land surface (e.g., roofs, crops, or deserts) (Akbari et al., 2009; Ridgwell et al., 2009), brightening marine clouds in order to make them more reflective (Latham, 1990), installing mirrors in space (Angel, 2006), and replicating volcanic eruptions by injecting reflective sulfate aerosols into the stratosphere (Crutzen, 2006; Wigley, 2006). There are mixed findings on SRM research with some authors fundamentally criticising its implementation (MacCracken, 2009). SRM could facilitate a huge change in the earth's radiation balance over time scale, halt or reverse warming within months or years rather than decades or centuries (Schneider, 2009). Goes et al. (2011) and

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Ross and Matthews (2009) found that if SRM application was abruptly stopped, the results could be a rapid global warming at a rather higher rate than if geoengineering had not been initiated at all. The SRM approach even though could be adopted as an international strategy comes with several risks and uncertainties (moral hazards and dilemmas). It could modestly increase ozone losses in the polar stratosphere and also stress systems that are sensitive to the warming rate. SRM would have varying impacts on regional climate variables such as temperature and precipitation, and might result in substantial changes in the global hydrological cycle with uncertain regional effects, for example on monsoon precipitation. SRM schemes could aggravate some inequalities if, as expected, they modify regional precipitation and temperature patterns with unequal social impacts (IPCC, 2014). The geopolitics of SRM, such as international conflicts that may arise from the ability to control the "global thermostat" cannot be overlooked (Hulme, 2015). There are several ethical and technical concerns raised by several authors (Gardiner, 2010; Jamieson, 1996; Morrow et al., 2009; Bunzl, 2009) on SRM implementation. There is still a high risk and uncertainties associated with the SRM (MacNaghten and Owen, 2011; Parson and Keith, 2013) since the strategy is still untested and unimplemented but there is a growing interest to model ways to internalise the externalities from this potential transaction for example though the design of a SRM compensation system to potential victims affected by this externality (Bunzl, 2011; USGAO, 2010; Tor, 2015; Svoboda, 2016; Wong, 2014; Horton, 2014).

2. Institutionalising SRM compensation system

There are several concerns raised on SRM implementation, some authors conclude that deploying SRM would be morally wrong even in climate emergencies (Gardiner, 2010), whether SRM research would create pressure to deploy it regardless of the risks (Jamieson, 1996), the conditions under which a decision to deploy SRM would be procedurally just and the conditions under which field tests of SRM would be permissible (Tuana et al., 2012). In the works of Svoboda (2016), Wong (2014), Hulme (2015) and Svoboda and Irvine (2014), the authors try to demonstrate how to address some of these complexities by trying to institutionalise a SRM compensation system to pay for externalities as discussed by other authors (Bunzl, 2011; USGAO, 2010). These authors try to answer three sets of ethical questions on SRM compensation system: 1) who ought to provide compensation, 2) who ought to receive compensation, and 3) how much compensation ought to be provided. These papers discuss three principles often considered in the climate ethics literature (Singer, 2004), which could be used to determine responsibility for SRM compensation: the polluter pays, the beneficiary pays, and the ability to pay principles. A possible hybrid of these principles is also considered and proposed by Svoboda and Irvine (2014), they argue that it is uncertain what ethical principles should be used to determine who is responsible for providing compensation to victims of SRM. Most authors (Tor, 2015; Svoboda, 2016; Hulme, 2015) agree that implementing a SRM compensation system involves several ethical concerns as equally raised by other authors as well as in the geoengineering development and deployment literature (Wong, 2014; Horton, 2014).

Economic compensation systems are unlikely to internalize externalities from SRM given that some externalities do not seem susceptible to economic compensations and have non-monetary impacts (loss of lives, culture and ecosystem services). Four problems are associated with the compensation payment discussions: 1) Irreversible economic and ecological damages caused by the SRM are not addressed with such an economic compensation system. 2) Intergenerational and other future concerns of a compensation payment is not realistically addressed. Discounting the future generation is a moral hazard that should be avoided. 3) Developing countries are at disadvantage in such a scheme, these regions already faces several historical climate injustices that are not compensated for, hence a future SRM compensation payment should address these regions and their citizenry. 4) Risks and uncertainties outcomes with SRM needed to be integrated properly in such a system that is inherently filled with many large intangible 'surprises'.

Analysis of these principles and compensation payment scenarious also do not take into account property rights institutions (Lambini and Nguyen, 2014). As discussed in the institutional economics literature, bargaining and negotiations could reduce transaction cost and provide an efficient outcomes rather just compensation payment designs in the case of an externality. Institutional approach takes a precaution to protect people from damages based on collective knowledge. Implementation and enforcement of these property rights are however necessary to address SRM externality problem and designing instruments.

3. Reassessment of economic instruments in internalising SRM externalities

Recent analyses of SRM compensation payment debates make two conclusive remarks: 1) SRM creates winners and losers-justice perspective, and 2) SRM compensation payments are complex and creates further technical and ethical risks and uncertainties. As mentioned in the problems associated with these discussions on SRM compensation payments (irreversible economic and ecological damages, intergenerational issues, developing countries at disadvantage and higher risks and uncertainties). These papers take more an economic distributive approach in analysis of compensation than a procedural justice perspective. The analytical method applied in these ethical studies do not allow a holistic analysis of SRM economic compensation payments. These papers fail to recognise that there are other economic instruments and environmental control policies that could be applied in SRM compensation design as commonly discussed in the famous book of Perman et al. (2003). There are command and control instruments such as ban on the deployment of SRM, input and output quotas, regional controls and SRM licensing. Market based control mechanisms could also be applied in SRM deployment