Public Perception and Influence on Implementation of Climate Change Technologies

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An Approach to Climate Change

Climate change is a current, devastating problem, causing a wide range of impacts from increasingly severe floods to ecosystem loss. Studies have shown that the trajectory of climate change is approaching a threshold that could lead Earth down a pathway towards hotter conditions that cannot be reversed. Right now, mitigation approaches such as emission standards and renewable energy are the only strategies in slowing down the inevitable rate of climate change. While reducing emissions is imperative, it may not be sufficient in maintaining healthy ecosystems on earth. Therefore, scientists have been researching and developing technologies under the general terms of "geoengineering" or "climate engineering," which refer to the deliberate large-scale manipulation of the climate to curb the effects of climate change. Since risk perceptions are directly associated with participation, investigating how the public perceives risks due to climate change could shed light on how steps towards implementing these geoengineering technologies or other mitigation strategies might be treated and also determine drivers for engagement in geoengineering implementation. Using a risk society, as described by Ulrich Beck, that identifies modern risks and emphasizes a social order based on risk provides a framework to look at how different risks impact the usage of these climate engineering technologies (Beck, 2000). Utilization of the risk framework presents a discussion on the influence of risk perception on participation and implementation of climate change efforts.

Historical Case Studies and Policy Analysis for Studying Risk

The research question that this paper investigates is: "How are climate mitigation technologies affected by public risk perceptions and how have these perceptions shaped societal demands of implementing these technologies?" Using risk analysis, historical case studies, and policy analysis of climate change mitigation strategies, the following analysis addresses real

world situations in which the potential of geoengineering technologies is not fully addressed due to a lack of acknowledgement of risks. The historical case studies are comprised of secondary sources that examine situations in which the amount of perceived risks correlates with the amount of climate change mitigation in a period of time. Along with historical case studies, another method that is used in this paper is analyzing policies and implementations that currently tackle the problems presented by climate change. As policies are a reaction to perceived risks, finding the root cause of how these policies came into existence provides valuable information about how public perception of risks influences climate change adaptation. Specifically, the analysis dives into risk perception of the general public towards climate change and geoengineering, risk perception of those particularly vulnerable to climate change, and response to a previous controversial wide-scale technology to examine how risk affects technology implementation.

History of Geoengineering

Modernization has created climate change problems through anthropogenic activities resulting in carbon emissions, with the United States creating 25% of global emissions despite only representing 5% of the world's population (Leiserowitz, 2006). In the same way that these problems are manufactured by humans, there have also been attempts to develop and implement technologies that will provide relief to the problems. Currently, climate change strategies seek to only reduce carbon emissions by a certain percentage. While drastic, geoengineering technologies take climate mitigation strategies a step further by proposing to reverse and halt the damage humans have inflicted. These technologies include a large variety of options, but most of these use one of two strategies in "reversing" climate change, whether through machines or natural processes: solar radiation management (SRM) and carbon dioxide removal (CDR). SRM

methods aim to reflect a percentage of sunlight into space to reduce further heating of the earth through technologies such as stratospheric aerosols or space mirrors (Corner, 2010). Meanwhile CDR methods focus on physically removing carbon dioxide from the atmosphere and past proposals have included carbon capture and ocean fertilization (Corner, 2010).

In regards to risk perception in relation to climate change, there are many factors, from political to social, that need to be considered. Public opinion polls show that the public is aware of climate change problems but place environmental conditions low on national priorities. The amount of risk perceived by Americans is moderate and is typically concerned with other people, with little concern of climate change's impacts on themselves (Leiserowitz, 2006). This lack of perceived risks for themselves is a primary cause of why climate change is seen as a low priority issue and is a major barrier in engaging the public to participate in climate mitigation strategies.

Because the potential impacts of geoengineering technologies are so widespread, identifying major stakeholders and public perception of risks from geoengineering is important in supporting efforts to curb climate change. Currently, there are low levels of awareness and even lower levels of understanding among the public about geoengineering technologies and their risks. However, in studies where participants are given ample information about different geoengineering technologies, support for geoengineering increased as a whole, with more support for CDR methods over SRM methods (Poumadere, 2011). As the public becomes more aware of geoengineering, a better picture of how to overcome the barriers of governance in regard to public perception can be constructed. During studies on public perceptions of controversial technologies, it was found that participants that viewed climate change to be a graver problem than other participants were more supportive of radical approaches such as geoengineering (Poumadere, 2011). At this moment, implementation of any geoengineering

technology would stir controversy and is widely rejected as an option, but the technology could be considered positively in the future when climate change problems become more apparent and widespread.

Defining a Risk Society

The controversial nature of geoengineering has resulted in barriers from governance and the public. One way to recognize how best to overcome these barriers is through identifying risks through the lens of a "risk society." Ulrich Beck, the first to coin this subject, described modern risks as human induced and manufactured rather than natural and argued that modernity becomes reflexive, meaning that the society is concerned with the unintended consequences and risks of its foundations of activity and objectives because they will ultimately backfire (Beck, 2000). Beck further states that a risk society allows "hazards to begin to shape actions and facilitate the creation of international institutions" (Beck, 2000). Due to society being constantly exposed to a variety of risks and with new developments constantly being produced, the risks are never ending. While some of these risks are local, others are global and layer on top of old risks, requiring society to adapt in order to deal with the new set of risks. Even though some critics of the risk society framework deem it incomplete due to its failure to acknowledge public trust in societies, the basic concepts of a risk society are still applicable to society today (Cantelli, 2010).

Several characteristics of the climate change problem fit within Beck's definition of modern risks in a risk society. The risks from climate change are the result of human activity and modernization, with gases such as methane and carbon dioxide becoming unintended consequences of modernity as the world has developed and industrialized. These effects, caused mainly by developed countries, are inescapable and felt by people all around the world as well as

impact future generations, a trait Beck reiterates when describing his definition of risks. In response to these climate change effects, struggles for influence on climate change policies between groups have surfaced, each with different interests, ultimately requiring cooperation between scientists and policymakers to mediate the risks (Beck, 2000). While there have been efforts to attack the climate change problem, the amount of perceived risk must align with what the effort seeks to accomplish.

The risk society framework examines the risk factors and relevant groups to form conclusions about future reactions and potential solutions in implementing geoengineering technologies. The interactions between the public and policy makers is important in finding how much risk must be perceived before geoengineering is seen as a viable option rather than an abstract concept, as it currently is. Furthermore, this framework provides information on how scientists should proceed with geoengineering, as well as actions that should be taken in order to gain public acceptance of geoengineering. Figuring out a solution to the problem of climate change is an iterative process and requires close examination of what risks different groups perceive and experience.

Geoengineering and Public Risk Perception

There is a disconnect in the extent to which an individual perceives risks caused by climate change. Current society does not reflect the risk society as described by Ulrich Beck. Examining the public attitude provides insight how the society might undergo reflexive rather than linear modernization by understanding and responding to the consequences of society's actions. While there is a general consensus that climate change is harming others, the public is generally not concerned about climate change personally affecting their lives. Due to this low risk perception, moves to push forward climate mitigation strategies have been limited. In order

to create an interest in geoengineering technologies, the perceived risks must not only increase, but also be more personal in nature. The public will continue to be disengaged in climate change mitigation strategies unless the perceived risk of climate change expands to be greater than potential risks of geoengineering technologies.

As a country, there is a consensus among the public that climate change is a serious problem despite the fact that environmental and climate change problems are still ranked relatively low on the list of national priorities (Whitmarsh, 2008). While the majority of Americans are worried about climate change and view it as harmful to others, only 40% believe that it will harm them personally (Marlon et al., 2015). When asked whether local, regional, and global impacts of climate change were of greatest concern to them, respondents were mostly concerned about other people around the world, with only 13% concerned with local impacts (Leiserowitz, 2006). Even in studies with participants living in localities considered vulnerable to climate change effects, participants had difficulty relating climate change impacts to their daily lives and connections were only identified in issues that immediately had an impact (Lorenzoni & Pidgeon, 2006). A risk society demands for acknowledgement of the risks not being distributed according to a social order or geography, but affecting society as a whole. This public perception of risks distributes risks to certain areas, not realizing that the risks ultimately affect all.

The contradiction in American attitudes towards climate change is further exemplified in policy preferences. Studies on policy preferences found that national regulation of carbon dioxide and international steps towards climate change mitigation were widely supported, but policies that would affect Americans directly out-of-pocket were strongly opposed (Leiserowitz, 2006). Individuals also expect that the damage caused by climate change would be compensated

by state social institutions. Combined with the lack of acknowledgement of the climate change's direct effects and beliefs that the benefits with current lifestyles outweigh climate change's possible risks, a detachment from involvement in possible solutions is created (Lorenzoni & Pidgeon, 2006). Therefore, the current attitude towards climate change makes it hard to spur the general public to participate in discussions in policies regarding climate change.

While individuals feel that current climate change policies are insufficient and that the public should have a voice in climate change decision-making, most individuals were indifferent about personally being involved in said discussions (Poortinga & Pidgeon, 2003; Lorenzoni & Pidgeon, 2006). Although the public is not the only voice in policy decisions, public perception of risks is identified as a major barrier to geoengineering development and the public's support may push forward or stop progress of climate change governance (Poumadere et al., 2011). Reflexive modernization requires knowledge and information in making the risks apparent to the public so that the foundations of a risk society become the center of discussion and scrutiny. The lack of initiative to participate in climate change policies despite having knowledge of the risks associated is important to note in analyzing the magnitude of risk that must be acknowledged before alterations in climate change policies can occur.

In a case study, researchers assessed rural areas in Nevada and the influence of vulnerability to climate change on risk perception, as the livelihoods of Nevada farmers and ranchers depend on natural resources, making them one of the most vulnerable groups in Nevada due to the increasing droughts (Safi et al., 2012). Sensitivity (extent of harm or benefit from a hazard) and adaptive capacity (ability to respond to a hazard) were found to significantly increase risk perception while physical vulnerability did not have an impact (Safi et al., 2012). Nevada farmers who were accustomed to living in a drought prone area have developed ways to

adapt to droughts, therefore causing minimal difference in risk perceptions due to physical location. However, individuals more sensitive to climate change hazards saw increased risks due to concerns of their jobs, and those who had a higher adaptive capacity (e.g. higher income or education) and had more to lose with climate change also perceived higher risks due to climate change. Consequently, increased urgency to tackle the issue of climate change is correlated with the extent to which climate change affects an individual's personal life, with more perceived risks in areas whose livelihoods are more dependent on natural resources. Without discerning a connection between local climate events and global climate change, the public may deal with their local issues (flooding, in this case) and the issue of climate change separately. Again, this distribution of perceived risks prevents people from understanding the full consequences of their actions, resulting in a more linear modernization rather than a reflexive one.

The public not only sees risks from climate change but also from the geoengineering technologies designed to curb climate change. Many see geoengineering as "messing with nature" and express concern over geoengineering's ability to alter the interaction between humans and nature (Corner et al., 2013). Due to the large risks associated with geoengineering, people are open to continuing geoengineering research but are uncomfortable with potential deployment or implementation of such technologies especially since, once deployed, geoengineering does not allow anybody the option to opt-out and will neglect to accommodate diverse backgrounds (Macnaghten & Szerszynski, 2013). Hence, support for geoengineering usually came with conditions, such as having an intervention plan or thorough research prior to deployment (Scheer & Renn, 2014). In surveys regarding geoengineering, the unexpected consequences of these technologies created the most unease in participants, with the risk of uncontrollable results that could "bite back" the focus of most discussions and a dominant

mindset of using geoengineering as a Plan B in response to emergency (Corner et al., 2013). Opposition to geoengineering and change again reinforces the linear modernization happening in society, in which the public accepts the status quo over responding to the results of society's actions. Therefore, uncertainty over geoengineering's benefits and risks is one of the biggest factors in determining public acceptance and engaging the public in climate mitigation strategies.

Narrowing down geoengineering technologies into SRM and CDR technologies further outlines the importance in balancing risks and benefits to the general public. While both techniques remain controversial, CDR technologies are typically preferred over SRM technologies on the basis that CDR technologies tackle the root of climate change, CO_2 emissions (Wright et al., 2014). The risks associated with CDR technologies are more predictable as it proposes to remove CO_2 from the atmosphere in an attempt to restore the natural composition of the atmosphere. On the other hand, studies have found that the more people knew about SRM, the less they supported those technologies, believing SRM technologies to be uncontrollable, irreversible, and potentially not effective enough (Scheer & Renn, 2014). The impacts and risks of SRM are less predictable and can only be known through deployment over a substantial time period, resulting in beliefs of higher stakes in investing in SRM technologies over CDR technologies.

Since the geoengineering technologies that are currently active are tested on a small scale, the public is still relatively uninformed of and unaffected by these projects. A similar case study on nuclear power reactors in the UK, however, sheds light on public acceptance due to changing risk perception, giving an indication of how the public might react to geoengineering. While media reports following the Fukushima Daiichi nuclear disaster heightened concern over nuclear energy, the public has shown to have greater but somewhat reluctant acceptance of the

nuclear industry due to concerns about climate change and high prices of oil and gas (Corner et al., 2011). Although public support for nuclear energy remains fragile due to the possibility of nuclear disaster, the shift of attitudes towards nuclear energy has been partly attributed to an urgency for reducing carbon emissions and concerns over energy security (Poumadere et al., 2011). In this case, the society closely aligned with the character of a risk society through formation of actions based on risk rather than social norms. Even though the social and environmental risks for geoengineering are different than those of nuclear energy, the magnitude of both techniques' attempts in curbing global warming lend knowledge in how shifts in risk perception may lead to acceptance of geoengineering implementation.

Since there is a lack of risk perception among the general public, a risk society that reflects on the effects of its actions cannot exist. Once the public recognizes that the results of modern processes are creating risks that impact everyone, progress can be achieved through interaction between different groups. By becoming reflexive, the issues of climate change can be realized through the political and scientific exchanges it creates. The current modernity of climate change due to anthropogenic activities can be changed to a new modernity of increased climate change mitigation strategies. Geoengineering technologies require that a risk society be established in order for implementation to be possible.

The extent of discussing geoengineering technologies is limited by the lack of data and progress of these technologies since these technologies are still being research and developed. Due to the restricted use of geoengineering and its current small-scale implementation, there are few, if any, real life situations on which to base predictions or analyses. Data on public perception of geoengineering is limited to only a few studies, making analysis difficult and

possibly inaccurate when generalized to a larger population. The time constraint of one semester of college also constrained more thorough research on the topic.

Further research on this topic could focus on obtaining more data on public perception and attitudes towards geoengineering. Scientists are constantly testing potential new geoengineering technologies. With continued education in order to expand knowledge about geoengineering in the general public, there can be increased dialogue between scientists and other potential stakeholders. A risk analysis on these dialogues can help to identify causes of risk perception changes and result in a compromise in which geoengineering is seen more favorably as an option.

Conclusion

Without any interference, the current trajectory of climate change due to anthropogenic activities will lead to more extreme and frequent catastrophes. The public acknowledges risks from climate change but generally do not believe the risks to be large enough to demand drastic measures such as geoengineering. Actions to curb climate change's effects are hindered by the lack of participation by the general public and governance, as either do not see climate change as a priority. Using this knowledge, interacting with the public through discourse and public engagement to pinpoint how risk perception of climate change can be amplified and create a greater sense of urgency among the public would allow governance to focus more resources on climate change effects. In the same way the public slowly accepted nuclear power as an alternate form of energy, geoengineering technologies can steadily gain traction if the right risks are presented and enforced in the public mind.

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