Flood Warning and Mitigation Strategies for Flood Prone Areas in Charlottesville
(Technical Paper)

Public Perception and Influence on Implementation of Climate Change Technologies
(STS Paper)

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On my honor as a University Student, I have neither given nor received
unauthorized aid on this assignment as defined by the Honor Guidelines
for Thesis-Related Assignments

Introduction

Flooding is a widespread problem that has created more than $260 billion in damages since the 1980s, with climate change only amplifying such effects on communities (Lightbody, 2017). In addition to flooding, climate change is intensifying the severity of other natural disasters. In order to adapt and lessen the impacts of climate change, collective action from the general public is necessary. There have been more efforts in reducing carbon emissions and increasing interest in climate engineering technologies that have the potential to reverse global warming, but before anything can be fully implemented, the public needs to be motivated to create change (Poumadere, 2011). While most of the public acknowledge the increasing concerns for the environment and the negative impacts that climate change creates, the issue currently lies in the current perception of risk in the use of climate change technologies. Risk perceptions are directly associated with participating in solutions, so delving into the effects of a wide range of factors can help determine the drivers for engagement in geoengineering implementation.

The technical topic of this paper will address flood mitigation strategies for areas in Charlottesville using city-wide flood mapping, water level sensors that can be deployed at multiple sites, and GIS modeling of infrastructure changes at a specific site. Providing models in stormwater strategies can be helpful in contributing an example to look back to and for anticipating future flooding events not only in Charlottesville, but in other areas. The STS topic of this paper will evaluate the effect of perception of risk by the public on the implementation of climate change adaptation and mitigation technologies, specifically geoengineering technologies. Exploring this topic will facilitate identifying main stakeholders and obstacles of geoengineering implementation from the public.

Technical Topic

Flooding causes many negative impacts including loss of life and property damage, affecting more people than any other disaster type ("Flooding affected more," 2019). The technical portion of this paper will address flooding mitigation strategies for flood prone areas in Charlottesville. This topic is an extension of a previous capstone project that developed a flood data system for Norfolk, VA, to be used in flood prediction models (Carlson et al., 2019). Throughout Charlottesville, there are areas that are susceptible to flooding during heavy rain events, a large portion of which are residential and privately owned areas that Charlottesville's utility service is unable to fix without the landowner's permission. In order to account for and help alleviate problems with the current situation, the project will create strategies to monitor and reduce stormwater impacts through three sub-projects focused on attacking the flooding problem at the city-wide level, multiple sites, and a specific site with flood-mapping, sensors, and infrastructure changes, respectively. The team consists of seven students (as listed on the cover) and advisor, Professor Jonathan Goodall.

While the city is aware of many flood prone areas, there is not yet a model for analyzing current and potential problem areas under different intensity rain events or infrastructure changes. In order to find the areas that should be prioritized in flood reduction and develop appropriate water control systems, the project will create flood maps of the current conditions using available GIS data and investigate how different areas are affected by changing parameters. The resulting model would point out the most vulnerable areas around the city that require immediate attention.

Even after problem spots have been identified, there is little information on specific water levels in these areas during rain events. To gather more data and information on how high water levels reach, the project also aims to create and deploy sensors that can record water level data at certain locations while being able to withstand the environment in which they are deployed and uploading the measured data onto a database. With the data, real time visualization of the water levels can be created and assessed to see how much flooding occurs in identified trouble spots.

Lastly, a specific site on St. Clair Avenue has been identified as a flood prone area. During heavy rain events, rain from two properties flow down to collect at the end of the properties, which then begins to overflow to a downstream property that does not have sufficient piping to carry away the water to a discharge channel. The city has noted that the flooding at this site has become especially problematic after the addition of an asphalt driveway on one of the properties, creating more runoff from impervious surfaces. By testing changes in the system using GIS and SWMM and looking at the available data of the area and best management practices, feasible solutions can be chosen depending on the constraints of the properties (Barco, 2008). Any solutions should also take into account not only environmental constraints, but social and financial constraints.

Even though the outcomes of this project address problems in Charlottesville, the concepts within the modeling and monitoring system can be applied to different flood prone areas. The systems created in order to identify flood prone areas, measure specific flood data, and implement relevant infrastructure changes could be applied to different data and provide similar results.

STS Topic

German sociologist Ulrich Beck reviews his concept of a “risk society” in his chapter “Risk Society Revisited: Theory, Politics, and Research Programmes,” describing that most modern risks are human-induced rather than natural and that there is a necessity to transition to a social order based on risk rather than classes (Beck, 2000). People have always been exposed to a variety of risks and with new developments in science and technology, the risks are ever plentiful. While some of these risks are local, some are global and affect all, layering on top of old risks and requiring the society to adapt in order to deal with these new risks. Beck further urges modern society to break out of conventional social science and politics to be sensitive to changes. Criticism of the risk society concept presented by Beck have called the risk society concept incomplete due to its failure of acknowledging public trust in societies, but the core fundamentals of risk societies still stand (“Questioning World Risk Society,” n.d.).

Climate change is happening now, causing a wide range of impacts from increasingly severe floods to large wildfires. Modernization has created these problems through the enormous amount of carbon emissions put into the atmosphere due to anthropogenic activities. In the same way that these problems are manufactured by humans, they need to be assessed and mitigated by humans. Geoengineering techniques have been a drastic proposal in “reversing” climate change. Hence, public perception on risks of these climate change technologies is important. The governance and mitigation technologies must reflect global risks imposed on societies. Investigating how the public perceives risks from implementation of these technologies is critical to motivating successful climate change adaptation and mitigation efforts. Most people believe that climate change will harm people globally but only 40% believe that climate change will impact them personally (Leiserowitz, 2006). This disparity in risk perception is a major barrier to engaging the public in participating in and permitting the use of geoengineering techniques.

In addition to the risk society concept, the social construction of technology (SCOT) framework is useful in analyzing how climate mitigation technologies develop through an interactive process between relevant social groups (Klein, 2002). Geoengineering is not yet a widely used process and their use depends on the meanings that different social groups impart onto the technologies. Climate change technologies raise social, moral, economic, and ethical uncertainties that need to be addressed by the public and other stakeholders (Corner, 2012). In this case, the stakeholders are communities affected by climate change, policymakers, and scientists. Using the SCOT framework will allow looking at how these different groups affect technology implementation and how conflicts between them could be stabilized through iterations of geoengineering techniques. While SCOT has been criticized in not discussing the structure of group interactions, the framework can still be helpful in determining each group's relations to each other and the artifact in question (Klein, 2002). The potential range of impacts will require a deep dive into how diverse actors will be affected and be encouraged to contribute to responsible usage of geoengineering technologies.

Research Question and Methods

The research question that the STS topic hopes to investigate is: "How are climate mitigation technologies affected by public risk perceptions and how have these perceptions shaped societal demands of implementing these technologies?" By first analyzing case studies and then current policies on climate change, the research question can be applied to real world situations in which the potential of geoengineering technologies is not fully addressed due to a lack of acknowledgement of risks.

Historical case studies will be a relevant methodology to analyze past perceptions of technologies with global impacts. Climate change has garnered attention since the 1990s, and exploring reasons as to why perceptions of risks have changed throughout the years could help to answer the research question. To develop a full understanding of how risk perception influences technology implementation, several case studies could be analyzed to see how the amount of risks correlates with the amount of climate change mitigation for that period. These studies include assessments of risk perceptions in three specific western U.S. cities (Sullivan, 2019), early responses to geoengineering (Pidgeon, 2012), and a specific geoengineering technology project (Tollefson, 2017).

Along with case studies, another method that will be used is looking at policies and implementations that currently tackle the problems presented by climate change. These policies were created to react to perceived risks, and finding the root cause of how these policies came into existence could provide valuable information about how public perception of risks influences climate change adaptation (Tjernstrom, 2008). Some examples of existing climate change policies include the Kyoto Protocol and Cancun Agreements (“Climate Change Policies”, 2016). The problem of climate change is all-encompassing, touching on the political, social, economic, and technological aspects of society; therefore, organizing the policies by the risks that caused their formation would demonstrate the importance of different risks in technology implementation and the leverage of different groups’ opinions on what technology is eventually developed.

Conclusion

The final results of the technical project will be a report and poster presenting the results of the flood mapping model, data from the water sensors, and final infrastructure recommendations for the site-specific flooded area. With the data and modeling from the project, these deliverables should provide examples of how to identify flood prone areas and frameworks of investigating and recommending flood mitigation strategies. Final recommendations will be created with feasibility in mind and will be viewed by the city of Charlottesville in the hopes that they can be applied to the flood prone site.

The STS research paper will focus on how public perception of risks from climate change influence the use of geoengineering as well as how potential steps towards implementing the technologies might be treated. By using the ideas of a risk society and previous case studies, the final result should present a conclusion with regard to engagement of the public in attacking the problem of climate change through climate engineering. While the public may be initially hesitant over such large-scale technologies, the perceptions of risk and urgency by different social groups may be the final factor in stopping or slowing down climate change.

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