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Public Perception and Attitudes Associated with Climate Engineering

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Public Perception and Attitudes Associated with Climate Engineering

by

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Abstract
Climate engineering has begun to enter the scientific mainstream as a potential agent of relief in the event that climate change threatens our food or water security. There has been little research conducted on the potential hazards of climate engineering, yet already has sparked controversy amongst the scientific community, as well as some of the public. The purpose of this research was to gauge current awareness and attitudes associated with climate engineering, and to measure if those attitudes were associated with political affiliation, as well as spirituality. This was done through administering a survey. The other portion of this research sought to understand how the public engages with controversial issues, such as this one. This was done through analyzing several cases of environmental and policy issues that garnered relatively small or large amounts of engagement. These cases were analyzed to determine why these cases resulted the way they did, then were compared to the current opinion on climate engineering.

What was found was that there was no statistical significance between spiritual or political affiliation associated with opinion on climate engineering. The study also found that most people are more fearful than they are optimistic about the potential for climate engineering. Analyzing cases resulted in the finding of a determinant map, seen on page eight. Determinants were mapped based on an adaptation of the Bamberg and Moser Pro-Environment Behavior Model as a means of demonstrating how attitudes associated with an issue resulted in public response. These findings were then compared to the current research available on climate engineering opinion.

Introduction

Geoengineering, often referred to as climate engineering, can be defined as "the intentional large-scale manipulation of the environment, as an effective means of mitigating global warming from anthropogenic greenhouse gas emissions" [32]. Climate engineering is a relatively new idea to many, and somewhat of an ambiguous term. For the sake of clarity, climate can be referred to as weather patterns that occur over decades of time, given that there is not an agreed upon length of time to define climate, and engineering in this phrase simply represents manmade machines or solutions to solve our climate problems, such as off-setting anthropogenic greenhouse gas emissions.

The most commonly proposed method of off-setting anthropogenic emissions is "geoengineering by injection of aerosol" into the stratosphere [13]. Essentially what this means is that a large amount of aerosol (most likely sulfate) is to be released into the stratosphere as a means of deflecting incoming solar radiation that would normally be retained by excess greenhouse gas trapped in the atmosphere [13]. This is due to the nature of the aerosol, where a "light" aerosol is one that does not contain carbon, and therefore does not trap heat, but rather reflects it. The effects of climate engineering are supposed to mimic the effects of a volcanic eruption, where during an eruption large quantities of gas and aerosol matter are ejected into the atmosphere, which in turn results in a localized cooling [2]. This has been observed recently when

in 1991 Mt. Pinatubo erupted producing sulfate particles that remained in the stratosphere resulting in a "measureable cooling for two years over much of the globe" [2].

A common term used in the climate sciences for this climate change mitigation strategy is known as "SRM," which stands for Solar Radiation Management [6]. Solar Radiation Management can be employed through a variety of techniques that all involve increasing Earth's albedo effect, or reflectiveness to radiation from the sun [6]. Out of all the proposed Solar Radiation Management strategies, stratospheric aerosol injection represents the most affordable and time-efficient option that could be implemented [6]. The figure below depicts one possible engineering strategy, which would be stratospheric aerosol injection by use of a weather balloon-like technology.

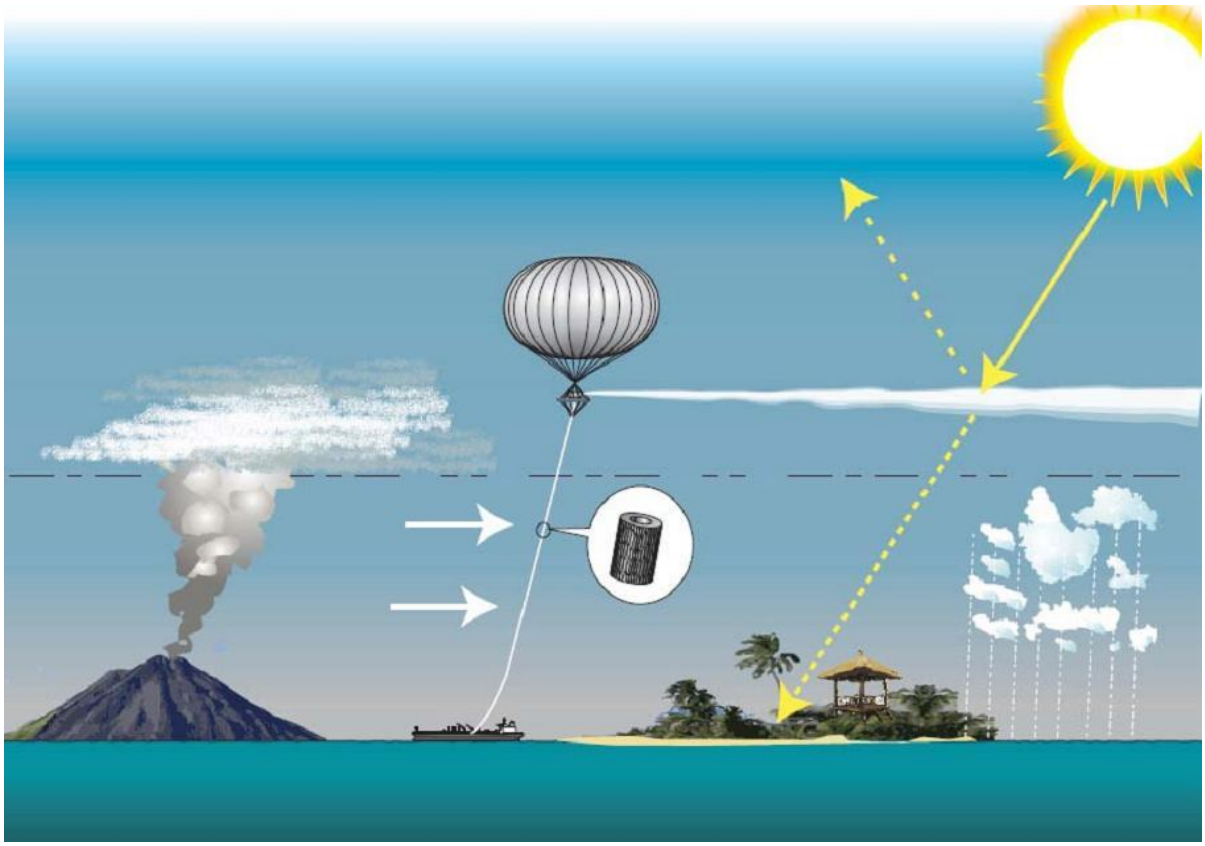


Image Credit: https://en.wikipedia.org/wiki/Stratospheric_Particle_Injection_for_Climate_Engineering

Climate engineering is an idea that is returning to the mainstream after Paul Crutzen, a leading atmospheric chemist, published a "controversial essay" in 2006 calling for a reconsideration of this idea [17]. In a report titled "Geoengineering and the Politics of Science," author Clive Hamilton describes a rift forming in the scientific community over the issue of climate engineering, comparable to the way "Manhattan Project scientists were divided over nuclear weapons after WWII" [17].

An example of this is found in an article entitled “Climate Engineers Get a PR Lesson,” which depicts how back in 2012 a private engineering research group tested the logistics of dispersing sulfate aerosols by releasing water from a balloon released into the atmosphere [4]. The experiment was met with harsh reaction from a Canadian environmental group that made the claim that drought will become more apparent and wide spread from the use of “sun-blocking particles” [4]. The problem here is not who is wrong or who is right, it is the lack of research that has been done.

Significance

Climate engineering represents a “last resort” option for humanity, and so it is important that it is considered realistically as an option if it becomes necessary. While it is not an ideal solution, it is a solution where there may not be one present. Climate engineering could serve as a temporary solution to “buy time” while we continue to develop clean energy. This way we could ensure that if a significant shift occurs in climate, we have a solution ready that might be able to temporarily stabilize our food and water security.

There has already been strong backlash and controversy surrounding the issue, but limited public understanding or research done. It is important to know how this will be received by the public, and how it can be presented in such a way where people can form an opinion based on research. This is also important because as a society we want people to be able to engage with issues and have their opinions heard. An international conference was held in 2010, where climate experts all agreed that “a key recommendation for responsible research” was “public participation and consultation” when it came to research planning [6]. From an ethical standpoint, it appears researchers agree that the public ought to have fair share in the decision making process. The significance of this study is also important to be considered in future studies of public engagement. Further understanding of public engagement will allow us to continue to improve how we make decisions as a society.

However, before any strategies can be implemented, research is only the first step, and one that will take a while. One Harvard physicist, David Keith, suggests a plan of slowly releasing aerosols over ten years, until the point where half of humanity’s emissions have been countered, as a way of gauging this strategy [17]. This of course presents the problem that it will take ten years to get any substantial data to be analyzed [17], [24]. Any study on climate requires years to decades of data to detect change over time, given that climate is considered to differ from weather, which is considered to be on a much shorter time frame. Not studying climate on a long term scale might result in failing to notice drought or other climate phenomena that might not be noticeable over a short time frame. For that reason, it is important to begin research now so climate engineering can be a possible solution if necessary.

Literature Review

Up to this point, several studies have been done on public opinion towards the idea of climate engineering. While the issue has been shown to generate great controversy amongst the scientific community, the public is still rather unaware of the topic of climate engineering, despite of its resurfacing as a potential solution for climate change.

A study was conducted in the United States through a survey done that showed seventy-four percent of Americans "knew nothing of climate engineering" [30], [4]. In comparison to other studies, this figure has been found to be relatively a conservative estimate. Another study found that approximately seven percent of Americans were able to accurately identify what climate engineering was, suggesting that ninety-three percent of Americans were either unaware of climate engineering was or were incorrect as to what they believed climate engineering to be [30].

The study that was conducted that found that seventy-four percent of Americans were unaware of what climate engineering also conducted a study on attitudes toward climate engineering. The subjects were informed about climate engineering, and interviewed about their opinions afterwards. When presented the solution of the solar radiation management strategy of sulfate aerosol injection on its own, about one in three Americans were agreeable to the idea, however those numbers dropped when other solutions were presented, such as focusing entirely on renewable energy [32]. This particular study demonstrates little favorability towards climate engineering, and loses further support when faced with other alternatives, suggesting the public is far from ready to implement a solution like this.

In this study, over 50% of Americans surveyed voiced some concern that this might be a harmful solution. A common perception was they viewed climate engineering as "messing with nature" [30]. According to a report called "Swimming Upstream: Engaging the American Public Early on Climate Engineering," when it comes to educating the public on an issue, "social engagement is most effective at the beginning of an issue" [6]. Recently we have seen this issue arise in several areas of the world in regards to issues such as hydraulic fracturing, or bioengineering. These relatively new areas of science have yet to be thoroughly researched, yet have strong public opinion despite this lack of knowledge.

Research on opinion suggests that climate engineering awareness is still in its beginning phase, however as the chart shown below indicates, it is a subject that is beginning to become more apparent in media. The graph depicts how often the phrase "climate engineering" has been used in publications over a ten-year period. While the lines fluctuate, there is a clear upward trend that is occurring. The graph indicates that the idea of climate engineering is becoming more apparent in mainstream media, contrary to what survey data has suggested thus far. What is also important to note from the graph is that climate engineering is lacking in academic publications, so new academic research on climate engineering is important as awareness continues to trend upward.

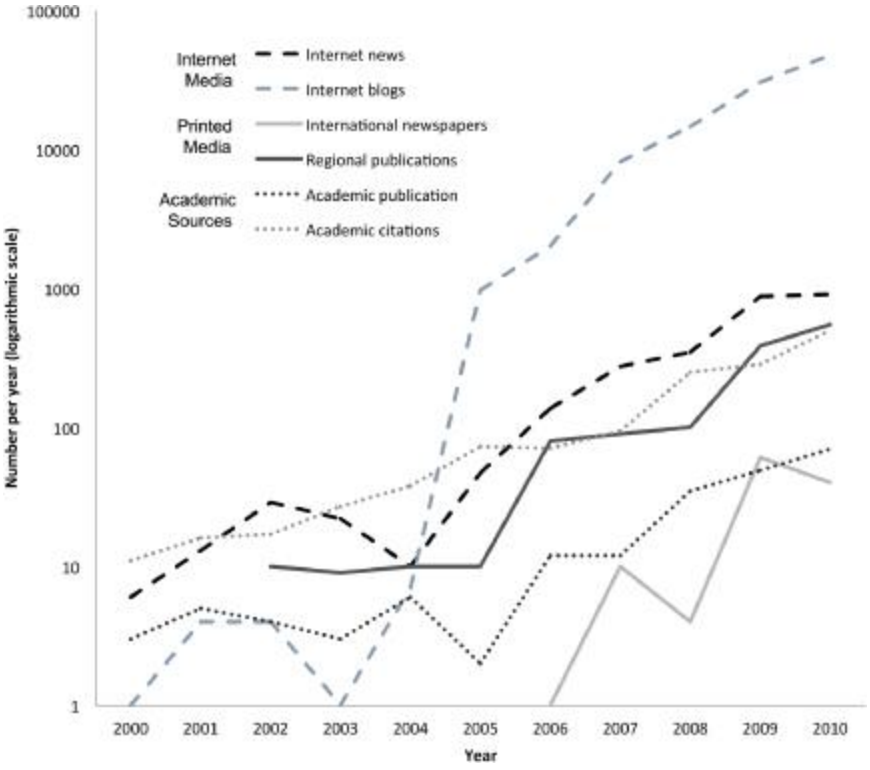


Image credit: Mercer et. al.

Objective and Hypotheses

The objective of this study to is to gauge awareness of climate engineering amongst college students in the natural resources field of study, as well as determine if particular attitudes or spiritual/political affiliation correlates with acceptance or rejection of climate engineering, which some studies suggest will be very important in how people engage with climate engineering [8]. The hypotheses that were tested were the following:

1. Students in the natural resources field of study will have a greater awareness as to what climate engineering is.
2. Respondents who aligned as spiritual would show decreased favorability towards using climate engineering.
3. One political affiliation (Liberal or Conservative) will yield a greater favorability towards climate engineering than the other.

The other objective of the study was to determine how the public engages with a controversial environmental or policy issue in general. This data was then used to create a determinant map of public engagement (which will be described in the methods section) which would then be applied to the current state of climate engineering opinion (wherever data was available) to track how the issue is being received by the public, and what level of engagement it might receive.

Materials and Methods

Procedure for Data Collection:

Survey

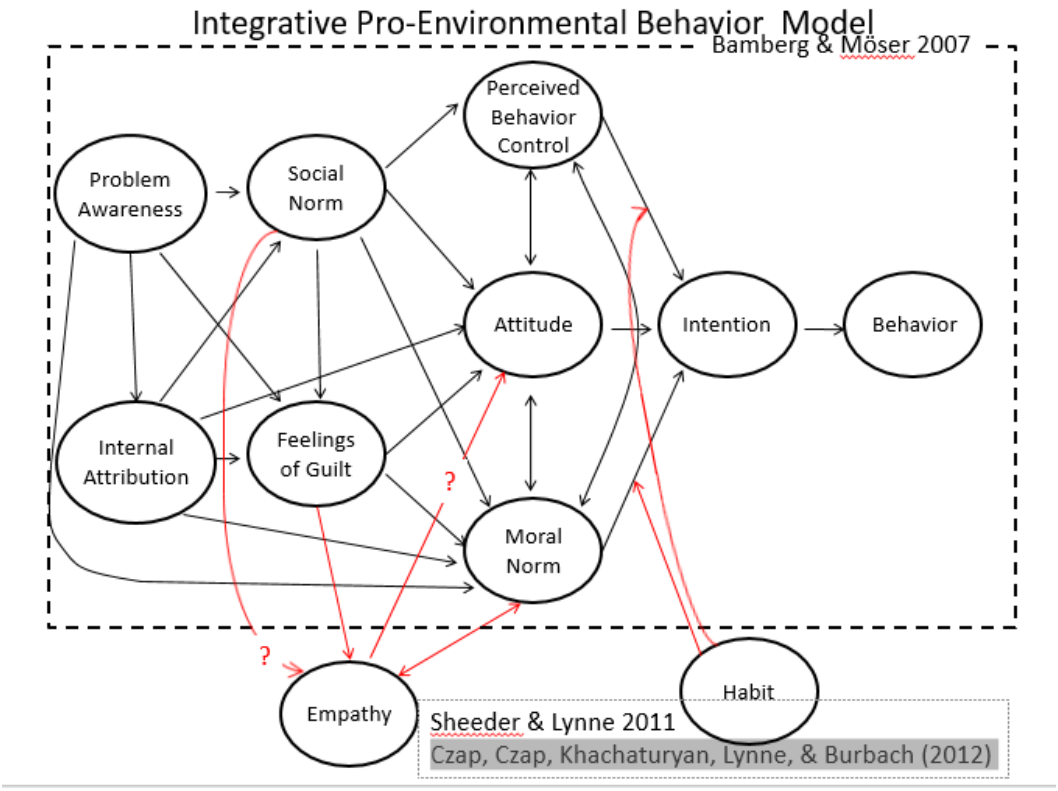
A survey will be administered to predominantly UNL students involved in the natural resources academic areas, in order to gauge awareness of climate engineering amongst students who are familiar with many aspects of current climate research. The survey was created through the online survey tool, "Survey Monkey." A list of survey questions was compiled from several different sources of research that have already been conducted on climate engineering awareness. Along with these questions are basic demographic questions to analyze trends that might differ between males and females, as well as questions regarding spirituality and political ideology. Participants will also be asked to provide a definition of what climate engineering is, as a means of gauging their awareness [30]. Lastly, participants will be informed on a possible climate engineering strategy, and will rank the relative importance of researching that climate engineering strategy compared to two other options where funds might be used, funding clean renewable energy, or subsidy/economic stimulus package. [30]. The intention of the survey is not only to gauge public awareness of climate engineering, but also to determine what trends might suggest increased support for a climate engineering scenario. The following questions were answered in the survey, and analyzed for correlation:

-What is your age (range)?
-What is your gender?
-How would you rate your political affiliation (Likert Conservative to Liberal)?
-Do you consider yourself spiritual or religious (Y or N)?
-What best describes your beliefs towards climate change (Multiple choice)?
-Please rate your familiarity with the concept of climate engineering (Likert).
-If you believe humans could alter the climate, how would you feel about it (Multiple choice).
-How do you feel climate engineering would rank in human accomplishment (Likert)?
-If you had to allocate money for the following, which of the following would you rate to receive the most money (1), all the way to the least amount of money (3) (Rating system).

Literature Review and Comparison

The second portion of the research consisted of a literature review that consisted of case studies of issues that garnered a large amount of public attention or engagement (like climate engineering has), and the determinants involved in the response to those issues. These topics were selected under advisement from an expert in Human Dimensions of Natural Resources. The topics that were selected were hydraulic fracturing in the United States, labeling of GMO's, economic boycotts (mainly the Dolphin-friendly tuna boycotts), public perceptions of international aid, nuclear power generation in European countries, efforts regarding climate change, efforts in climate engineering, as well as research in cognitive psychology was also considered. The idea for this study was based on a study of climate engineering that compared the success of public engagement for the use of federal funding in nanotechnology [6]. This study

also encompasses components of a study done by Bamberg and Moser, and adapted by another team of researchers (Czap, Czap, Khachaturyan, Lynne, & Burbach (2012)), that map the determinants involved in environmental behavior and decision-making. The following map was produced from their research.



The literature review of the listed topics above was used to determine what determinants were most prevalent in attitudes toward publicly-engaged issues. A determinant was applied to the map if it appeared in at least 50% of the issues that were reviewed. When mapping these determinants, sizing of each determinant was used as a scale to demonstrate the increased effect of each determinant. The effect of each determinant was determined in two ways. The first, was based on the frequency of the determinant being mentioned. The next was based on previous research that had already determined the relative strength of each determinant. With an understanding of these determinants, these can be used to gauge the effectiveness of attempts to engage the public with the issue of implementing climate engineering strategies.

Results/Discussion

1. Survey
   Upon testing the hypotheses of spiritual and political affiliation, both were found to be statistically insignificant when compared against favourability towards climate engineering. Calculations to determine the insignificance are shown below for each scenario.

Political Affiliation
Percent of population who aligned as liberal, and didn't favour climate engineering: 78.95% (30 out of 38)
Percent of population who aligned as conservative and didn't favour climate engineering: 78.57% (11 out of 14)

(30 + 11) / 52 (total participants) = .7885

Standard Error = $\sqrt{.7885(1-.7855)(\frac{1}{38}+\frac{1}{14})}$ = .1217

t = (7895 - .7857) / .1217 = .0312 < 1.96

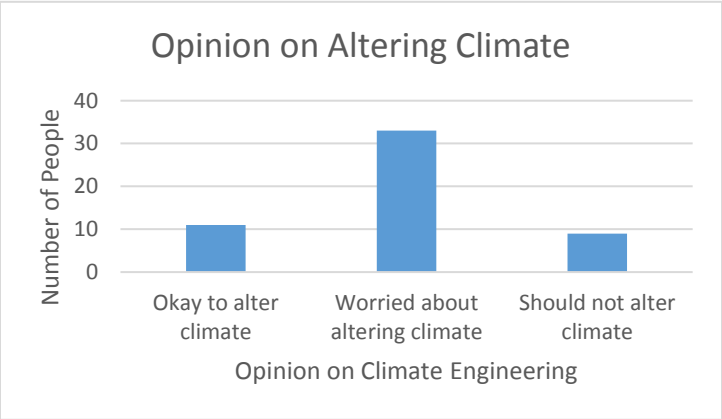
Spiritual Affiliation
Percent of population who aligned as spiritual, and didn't favour climate engineering: 81.81% (18 out of 22)
Percent of population who didn't align as spiritual and didn't favour climate engineering: 82.14% (23 out of 28)

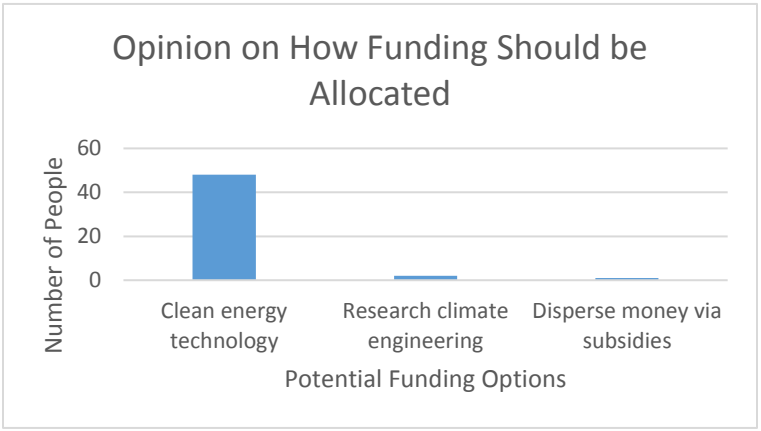
(18 + 23) / 52 (total participants) = .7884

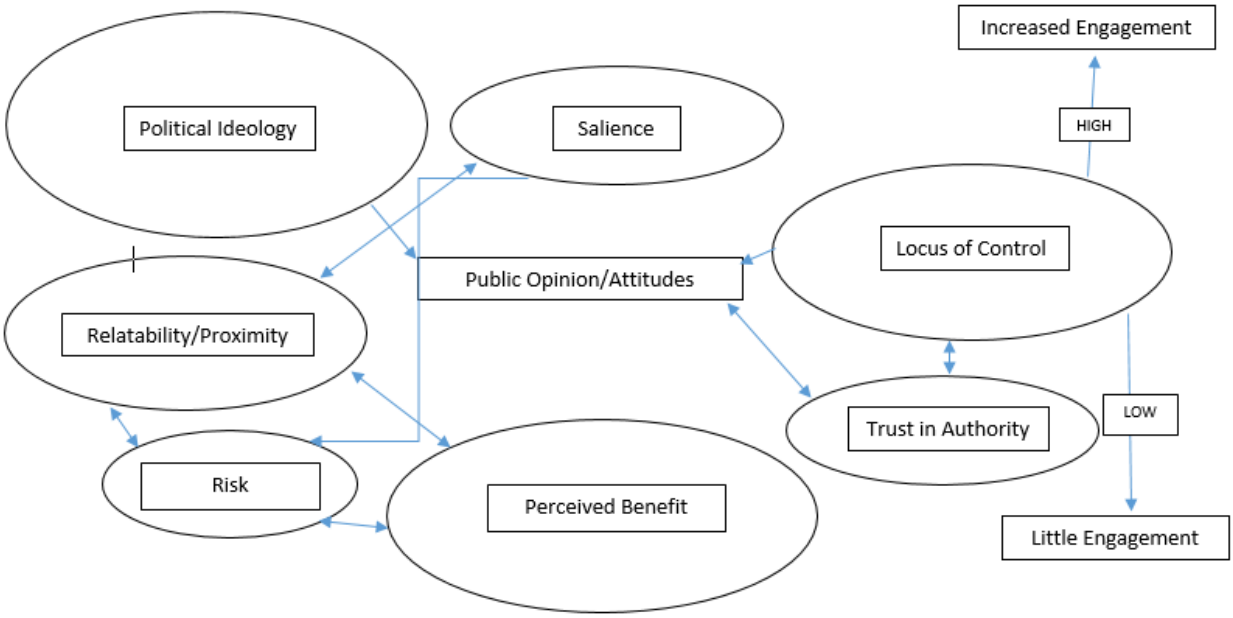
Standard Error = $\sqrt{.7884(1-.7884)(\frac{1}{22}+\frac{1}{28})}$ = .1164

t = (.8181 - .8214) / .1164 = -.0293 ➔ absolute value (-.0293) = .0293 < 1.96

In regards to relative awareness, 57% percent of the population surveyed either was somewhat or very familiar with climate engineering, with the majority rating themselves as somewhat familiar with the concept. This was well above the expected public average of about 25% found in other studies. This is to be expected given that the survey population consisted primarily of environmental studies students, who are probably more familiar with potential solutions to climate change.
Another finding of the survey was that the majority of responses indicated most people would be impressed by the achievement of climate engineering, but see it as a greater potential danger than benefit. This dispels the idea that climate engineering might garner greater support if people believed it would lead to a great technological achievement. The majority of responses indicated climate engineering would "above average" in regards to other achievements. Lastly, for the question of funding, less than 4% considered climate engineering research a priority.







Citations for Connections Between Determinants:
Political Ideology: [11], [7], [14], [15], [19]
Relatability/Proximity ← → Salience: [1], [7], [15], [23], [28], [31]
Perceived Benefit ← → Risk: [7], [10]. [11], [28]
Perceived Benefit/Risk ← → Relatability/Proximity: [10], [11], [14], [23]
Locus of Control ← → Trust in Authority: [1], [12], [16], [18], [19], [21], [22], [29]

2. Literature Review/Comparison to Current Climate Engineering Opinion

The results of the literature review revealed the following determinants to be most prevalent in issues that were engaged with by the public: Political ideology, relatability (of the issue or those affected by the issue)/proximity, salience of the issue, risk/benefits involved, trust in authority, and locus of control. The following map was constructed to demonstrate the strength of each determinant, as well as how they relate and affect each other, which was also determined in the literature review. Citations are provided in a list below the map to validate how two determinants are connected and affect one another.

Relevance of each determinant & Applications to the current state of Climate Engineering:

Political Ideology: Political ideology was proven to be the greatest determining factor in how people aligned with a controversial issue. It was typical for most studies regarding public opinion to include a survey asking for information regarding where people fall on a political ideology scale. When broken down into conservative and liberal, most studies showed the strongest correlation between opinion and how they described themselves politically [14], [11]. Ideology was present in essentially every case study, however was most prevalent in case studies regarding hydraulic fracturing. Liberals tended to place greater importance on the environment, and conservatives to place more importance on the job potential [11].

Political Ideology in Climate Engineering:
The survey results done for this specific study were inconclusive on how political ideology might shape an opinion on climate engineering given that the sample surveyed ended up being largely liberal, with very few conservatives. This is similar to other research done on climate engineering opinion, where there isn't a clear trend based off of political affiliation [6].

Proximity/Relatability: Proximity here refers to how directly people feel this issue affects them. In other words, "how close this hits to home." Relatability is similar in that it describes how a different type of proximity, or "does this affect people similar to me?" This relationship was derived primarily from literature regarding opinion on international aid, compared with literature on reaction to perceived animal cruelty. A question raised by this research was why are people more outraged by the mistreatment of animals than they are interested in supporting fellow humans through international aid [15], [31]. Research in cognitive psychology suggests that we empathize more with an individual (in this case an animal) than a group of people (a country that might be supported through international aid) [31]. This of course also relates to salience. This appeared to be a strong relationship in engagement, and therefore was included on the map.

Proximity/Relatability in Climate Engineering:
Proximity in climate engineering has not become as relevant, given that climate change is not localized in nature, therefore hard to relate as proximate. Polling of potential voters for the 2016 Presidential election indicate that only 6 percent of voters consider climate change as their priority as far as issues associated with the election [7].

Risk vs. Benefit: Risk and benefit were found to be large factors in determining how people engaged with an issue. People are much more likely to discredit a risk if they stand to benefit from it [11], [14]. What case studies such as these have found confirms a theory of cognitive psychology, which claims that when a positive outcome is visible, people tend to minimize the associated risk [14]. This was most prevalent from studies done on people's receptivity to nuclear power in Europe. What studies have found is that people living close to a nuclear power plant are less likely to view it as a risk, compared with people who live farther away from it [14]. This is counterintuitive to what one might normally think, however it was hypothesized that people living closer to the plant benefitted economically.

Risk vs. Benefit in Climate Engineering:

What the survey results clearly indicate is that the majority of people are more concerned about climate engineering than they are excited about its potential. The risks associated with climate engineering are much more prevalent, therefore climate engineering opinion lacks the strong relationship associated with perceived benefit. Climate engineering should be presented in such a way that portrays a solution that will allow us to continue our current lifestyle and maintain our economic status by protecting our resources.

Salience: The overall salience of an issue was determined to be a contributing factor in public opinion. This determinant was found to be prevalent in literature nuclear power generation. The salience of the dangers surround nuclear energy are powerful, given that we have images of nuclear disasters such as Chernobyl, which clearly demonstrate how potentially dangerous nuclear energy can be.

Salience in Climate Engineering:
Salience as a determinant relating to climate engineering is still unclear, given that the public is largely unfamiliar with it, therefore does not have an image associated with it, which means it cannot be deemed salient or not. However, it has been demonstrated that "framing" climate engineering in different context yields a different visibility of the concept, with people seeing it as less harmful when described as a "natural process" [9].

Locus of Control/Trust in Authority:
Locus of control and Trust in Authority are determinants that ultimately determined the level of engagement. Locus of control refers to the belief that one's actions will have any relevant bearing or change in regards to the issue. This was most noticeably noticed in the case study regarding the Dolphin-Friendly Tuna Boycott. Given that not buying tuna is relatively easy, and is something that has direct bearing on the financial well-being of companies that produce tuna, this particular instance yielded high engagement.
Trust in Authority relates to one's belief in their government or relevant authoritative body associated with an issue, and their capability of listening and producing desirable change. As people become more discouraged by the political process, they are less likely to engage [6]. This determinant also relates to opinion in that opinions formed from media often rely on how credible the viewer perceives the media outlet to be.

Locus of Control/Trust in Authority in Climate Engineering:
Once again, given that climate engineering is still in its infancy stage as far as public knowledge, it is difficult to gauge how this determinant compares to climate engineering. What is relevant at this point is how climate engineering will be portrayed in the media. Research suggests that early media coverage tends to be "sticky," in that people are likely to form strong opinions based off of what they hear early on [16].

Limitations in Research
There are several limitations in this research that must be accounted for when considering the results of this study. The first to be considered is the survey. The survey population size was 53, which is low compared to an ideal survey size, so confidence in this survey isn't ideal. Along with inappropriate survey size, most survey responses were from people who aligned mainly as liberal. This is clearly not an objective survey pool, nor is it an ideal survey size. This was why

no statistical significance was found between political ideology and climate engineering favorability.

There are also limitations associated with the literature review that should be accounted for. As mentioned in the methods section, cases were selected under the advisement of an expert in Human Dimensions of Natural Resources, on the basis of whether or not they garnered large or little amounts of public engagement. There is of course no purely objective way of selecting the best cases to study. Along with this lack of objectivity, given time constraints, only a certain number of cases were able to be reviewed, meaning the data may be limited in some areas.

Conclusion

The objectives of the research were to determine the current levels of awareness as well as what perceptions and attitudes were associated with climate engineering. There is not enough evidence to suggest a direct link between spirituality or political affiliation that might make one more inclined to support climate engineering research. Other research has suggested spirituality and religion to be an important part of opinion regarding climate engineering, but no such evidence was found from this study [9]. When considering the issue as a whole, people remain generally more fearful of climate engineering than optimistic about its potential as a climate solution. This confirms previous research done on climate engineering opinion, such as one study that found their surveyed population to be made up of over 50% of people who considered themselves fearful of altering the climate [30].
When considering determinants involved with climate engineering opinion, climate engineering as a public issue lacks engagement primarily from a lack of salience, relatability as an issue, and perceived benefit. These are areas that should be addressed by government or research agencies interested in engaging with the public in regards to climate engineering research and policy. Determinants such as political ideology cannot be manipulated in this scenario, and therefore other determinants are necessary to engage the public.

Suggestions for Further Research

The current literature and research on climate engineering suggests that it is important to continue to monitor and track the current level of awareness in regards to climate engineering, as well as the prevailing attitudes associated with climate engineering [6], [30]. This should be done by continuing to use similar survey items as seen in this research, as well as other methods that might be used to study opinion at the level of the individual. This might be done through the use of interviews or focus groups.

Another possibility of further research would be to use determinants found to be relevant in this study to determine how climate engineering might be framed or illustrated in a certain way that might make people find climate engineering more favorable or a greater priority. Similar research has been done where climate engineering was framed in a way that made it appear more "natural" [9]. For instance, in this study, one of the methods tested was framing carbon sequestration in a way where it was described as "pulling carbon from the atmosphere, like artificial trees" Framing climate engineering in this particular way yielded greater favorability to carbon sequestration as a climate engineering solution [9]. Similar studies might be conducted

using determinants found on the map listed in the results section of this paper. For instance, you might test particular methods or framing climate change salience, as far as urgency, to see if that might yield greater prioritization of climate engineering research.

In conclusion, people remain generally more fearful of climate engineering than excited about its potential. What we know about public engagement with controversial ideas suggests that now is a critical period in determining how people will engage with climate engineering, given that it is an idea that most would consider relatively new. Understanding how the public engages with issues like this is extremely important for when we make policy or decide to begin research because the public has a lot of power. By understanding public attitude and decision-making, we can engage more people in decisions, ensure better representation, and make rational decisions based on research and not speculation. Climate engineering represents a safety net that might have the potential to save humanity one day, and it is a decision that needs more thought and attention in the near future.

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