Informed and Uninformed Opinions on New Measures to Address Climate Change

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Abstract

Climate engineering (CE) and carbon capture and storage sub-seabed (CCS-S) are currently controversially debated options to address climate change. Our paper provides empirical evidence on the public perception of two different CE measures, namely, stratospheric sulphate injection (SSI) and afforestation, as well as CCS-S. Using data from a novel large-scale survey, we analyse the determinants of acceptance of these measures in Germany. We also provide experimental evidence on how additional information on these measures changes the respondents' acceptance. We show that the acceptance differs strongly between the three measures. Afforestation is strongly favoured over CCS-S and SSI. This ranking holds independent of the amount of information provided. For all three measures, we find that, on average, additional information decreases acceptance. However, the sign and the strength of the information effect strongly depend on personal characteristics, such as gender and risk attitude.

Keywords

Climate Engineering, Solar Radiation Management, Carbon Capture and Storage, Climate Change, Public Perception, Information, Risk Attitude

1. Introduction

Most countries have accepted a temperature increase of 2°C above pre-industrial levels as the maximum tolerable limit for global warming. Reaching this 2°C goal, however, becomes increasingly unlikely given the current trajectories (IPCC 2014). Therefore, scientists and politicians have recently begun to consider new measures to address climate change. Many of these measures involve large-scale interventions into the climate system and have been summarised under the term climate engineering (CE). CE encompasses two broad approaches: solar radiation management (SRM) and carbon dioxide removal (CDR) (Royal Society 2009). While SRM measures influence the temperature directly, CDR measures reduce the atmospheric concentration of CO_2. Another new measure is carbon capture and storage (CCS). For CCS, CO_2 from industrial processes is captured before it enters the atmosphere and is transported to long-term storage.

The costs, benefits, and risks of these new measures, especially CE, currently are not well understood, and uncertainties remain regarding their effectiveness and side effects (Royal Society 2009; UBA 2008). Further research on these measures must be conducted before it can be determined whether they could become part of a portfolio to address climate change. However, even limited field research on CE and CCS is often met with widespread public protests. For instance, planned field tests in the UK investigating the feasibility of stratospheric particle injection—an SRM measure—led to strong public protests (Pidgeon et al. 2013). Consequently, the field tests were stopped. A field experiment on ocean iron fertilisation—a CDR measure—in the South Atlantic created considerable protest among the German public. Consequently, the German Federal Ministry for the Environment called for an immediate stop of the experiment.[1] Several CCS demonstration projects in Germany faced strong opposition from both the public and local politicians (Dütschke 2010). In some instances, the explorations have been stopped entirely because of public protests.[2] These examples show that public acceptance will crucially determine the future of CE and CCS. It is an open question, however, whether the public protests have been mainly caused by a lack of information about the new measures or, the other way around, whether more information would lead to even stronger opposition. Informing the public and taking into account its concerns may thus have a strong impact on acceptance.

Our paper sheds light on the perception of these new measures to address climate change. More specifically, our paper addresses the following research questions: (1) How does the public perceive different measures? (2) How does the acceptance of the measures differ between uninformed and informed respondents? (3a) How do personal characteristics influence the perception of the measures, and (3b) can personal characteristics explain differences in the acceptance between uninformed and informed respondents?

To address these questions, we conducted a large online experiment with more than 3500 participants in Germany. We elicit the perceptions of a heterogeneous set of three measures. The first measure is stratospheric sulphate injection (SSI). It is a SRM measure where sulphate is injected at a high altitude to block part of the incoming sunlight and thus reduces the global temperature. The second measure is large-scale afforestation, a CDR measure where large areas like the Sahara and the Australian Outback are afforested. The third measure is carbon capture and storage sub-seabed (CCS-

[1] http://www.bmbf.de/_media/press/Univ_Heidelberg_zu_LOHAFEX.pdf, 10.06.2014
[2] http://www.iea.org/media/workshops/2011/ccstalk/Fischer.pdf, 03.06.2014.

S). It is a type of CCS where CO_2 is stored underneath the seabed. All measures differ with respect to their expected effectiveness, expected side effects and the uncertainty about both.

Systematic evidence on research question (1), i.e., the measures' public perception, is still scarce, and most studies focus on only one measure. Among the three measures, the perception of CCS is the most thoroughly researched thus far. Respondents from a broad range of countries are often either sceptical or undecided about CCS (e.g., Curry 2004; Duan 2010; Itaoka et al. 2012; Krause et al. 2014; Miller et al. 2008). The studies, however, show considerable variation, which is most likely due to different national contexts, the specific storage location or the information respondents receive. Studies on SSI report generally low levels of acceptance (Mercer et al. 2011; Merk et al. forthcoming; Sugiyama 2012). Studies on afforestation report generally high levels of acceptance (Curry et al. 2005; Lin et al. 2012). A direct comparison of the acceptance of the three measures has not yet been performed.

While there are many studies that address research question (2), the effect of additional information on the acceptance of CCS[3], there are none for SSI and afforestation. The studies on CCS find conflicting results. On the one hand, several studies find a decrease in acceptance when respondents receive more information (Ha-Duong et al. 2009; Itaoka et al. 2009; L'Orange et al. 2011). Moreover, initially neutral respondents are significantly more likely to have a negative attitude toward CCS after receiving more information (Itaoka et al. 2012). On the other hand, several studies find an increase in acceptance when respondents receive more information (Curry 2004; Curry et al. 2005; Curry et al. 2007; De Best-Waldhober et al. 2009; Itaoka et al. 2004; Shackley et al. 2005; Tokushige et al. 2007a; Tokushige et al. 2007b). Pietzner et al. (2011) show that the effect of information differs between European countries. To determine the effect of additional information, we experimentally varied the amount of information our respondents received. The control group received only basic information (BI), whereas the treatment group received full information (FI) on a measure.

There is hardly any systematic evidence on the role that personal characteristics might play for the conflicting results on the effect of additional information. While the influence of personal characteristics on acceptance (research question 3a) has been analysed before, the interaction of the treatment effect of additional information with personal characteristics (research question 3b) has not yet been researched. Therefore, in an exploratory analysis, we test the same characteristics to answer research question 3b that we test for by answering research question 3a.

For SSI, the influence of several characteristics on acceptance has been analysed before. Previous studies find an impact on the acceptance of SSI for the perceived seriousness of climate change (Mercer et al. 2011; Merk et al. forthcoming; Pidgeon et al. 2012; Sugiyama 2012), egoistic values (Corner and Pidgeon 2014), ecological values (Merk et al. forthcoming), religiousness (Carr 2014) as well as specific attitudes toward the technology (Mercer et al. 2011). Trust in institutions positively influences the acceptance of CCS as well as SSI (Terwel et al. 2009; Mercer et al. 2011). The previous findings for education are contradictory (Pidgeon et al. 2012; Merk et al. forthcoming). Education might also be a proxy for whether decisions are made intuitively. People who make more intuitive decisions are more risk-averse and more impatient than more reflective people (Frederick 2005, Oechssler et al. 2009). Additionally, more intuitive people are more susceptible to behavioural biases

[3] Only a few studies focus explicitly on CCS-S (Itaoka et al. 2004, 2009; Shackley et al. 2005; Tokushige et al. 2007a). The other studies cited above focus either on different types of CCS or do not define the type of CCS in more detail.

(Oechssler et al. 2009, Bergman et al. 2010, Hoppe and Kusterer 2011), which could be relevant in the context of processing information.

In addition, there are further socio-demographic variables that potentially influence acceptance. Respondents from regions where there have been protests against onshore CCS before, such as Schleswig-Holstein and Lower Saxony, should be more sceptical about CCS-S. Furthermore, previous studies find that women tend to be more sceptical about CCS (Ha-Duong et al. 2009; Miller et al. 2007), while the results for CE measures are less clear (Pidgeon et al. 2012; Corner and Pidgeon 2014; Merk et al. forthcoming). The gender difference might be caused by the framing and the amount of information. L'Orange et al. (2011) find lower levels of acceptance for women than for men in a basic information setting. Additional information on the monitoring of CCS has only a downward impact on men's level of acceptance, which is then similar to the impact on women.

Altogether, our study contributes to the existing literature in various ways. First, we provide insights into the perception of a heterogeneous set of new measures in Germany and compare them using a consistent framework for all three measures. Second, we are able to directly compare the levels of acceptance and their determinants across measures. Third, we analyse the effect of information on the acceptance of the three measures. Hence, we can address potential differences in the direction and the magnitude of the effect of information between the measures. Fourth, we are the first to broadly analyse the interaction of information with personal predispositions, values and attitudes. This approach may provide insights into the reasons for the hitherto inconclusive results on the effect of information, which could be caused by differences in the sample composition or the national context of previous studies.

2. Data and Survey Design

Our study uses novel data from an online survey that we conducted in August/September 2013. Respondents were randomly assigned to one of the three measures—SSI, afforestation, or CCS-S. For each measure, we implemented two treatments using a between-subjects design. The two treatments differed only with respect to the amount of information that respondents received about the measure. Respondents aged 18 or above were recruited via an online panel. They were sampled using quotas for the characteristics of gender, age, and state of residence. In total, our working sample includes 3526 observations.[4] The average age was 47 years. Half of our respondents were male. Thirty-six percent of our respondents have a higher education entrance certificate. The average number of observations per treatment is 588, ranging from 577 to 608.

The survey consisted of the following four parts. Table A-1 in the appendix reports all survey items used in our analysis and the scales on which they are measured.

In the first part, we elicited respondents' risk attitude using the scale implemented by Dohmen et al. (2011). Next, we elicited respondents' perception of the seriousness of climate change and their ecological values. The ecological values were measured by five items from the New Ecological Paradigm Scale (NEP, Dunlap et al. 2000). Before we provided respondents in the next part of the

[4] A total of 3909 respondents completed the survey. We dropped observations from respondents whom we identified as either speeders or straight-liners. Speeders are respondents who completed the survey in less than 9 minutes. Straight-liners are respondents who ticked the same answer within at least two blocks of questions.

survey with information on one of the measures, we asked them about their awareness of the respective measure.

The second part contained the information treatment. Our aim was to present the information in a clear yet scientifically correct way. In contrast to previous studies, we provided information using animated graphics videos. The animations explained the information graphically and were supported by verbal explanations spoken by a professional radio presenter.[5] The videos were embedded into the survey. Respondents who were not able to listen to or to play the video were excluded at the beginning of the survey. It was not possible to skip or fast-forward the video. The video first provided respondents with information on anthropogenic climate change and its likely consequences. The video then introduced mitigation, adaption and either SSI, afforestation or CCS-S as three possibilities to address climate change.[6] Afterwards, the video explained the respective measure in more detail. The video contained either basic information (BI treatment) or full information (FI treatment) on the respective measure. In the BI treatment, respondents received background information, i.e., the measure's underlying mechanisms and its impact on climate change. In the FI treatment, respondents watched the BI information video, but in addition, the video informed them about the current state of research and the potential benefits and risks of the specific measure. The information was based on peer-reviewed papers and scientific reports (taken from, e.g., Crutzen 2006, IPCC 2007; IPCC 2012; Ornstein et al. 2009; Royal Society 2009; UBA 2008). External experts checked the information for correctness and clarity. After watching the video, we asked respondents about the clarity of the video. More than 98% of the respondents across all treatments indicated that they understood the video well or very well.

In the third part, we elicited respondents' acceptance of the respective measure. Next, we elicited respondents' attitude toward a measure such as 'humans should not interfere with nature in this way' or '[…] is the easy way out'. We also measured trust in various actors or institutions to act in the interest of society and the environment. Thereafter, we elicited respondents' egoistic, altruistic and security values. These values were measured using items from the Schwartz Personal Value Questionnaire (PVQ5X, Schwartz et al. 2012, Beyerlein personal communication). Next, respondents completed the cognitive reflection test (Frederik 2005). The cognitive reflection test (CRT) indicates whether a respondent is a rather intuitive (low CRT score) or a rather reflective person (high CRT score).

The fourth part contained questions on the socio-demographic characteristics of respondents. In particular, we elicited information on the respondents' gender, age, state of residence and education. A respondent with a higher education entrance certificate is coded as having a high level of education in our analysis. In addition, we elicited the respondents' religiousness.

Respondents could refrain from answering. The option 'don't know' was included in every question.

3. Methodology

[5] An English translation of the German script of the video is provided in the appendix.

[6] The video introduces stratospheric sulphate injection (SSI) as 'spraying sulphate particles into the atmosphere at high altitude' to reflect sunlight. When referring to the technology, both the video and the survey use the term solar radiation management or the abbreviation SRM. The video and the survey on carbon capture and storage sub-seabed (CCS-S) use the abbreviation CCS.

Our analysis consists of two steps. In the first step, we use a descriptive analysis to compare the respondents' perception of the different measures (research question 1) and make a first assessment of the differences in the effect of information on acceptance. In the second step, we use a regression framework to analyse the determinants of acceptance for the three different measures as well as the size of the treatment effect. We further investigate whether respondents react differently to information depending on their personal characteristics. To address research questions (2) and (3a) on the determinants of acceptance and the role of information, we estimated, separately for each measure, the following equation:

$$(I) \quad acceptance_i = \alpha + \beta info_i + \gamma X_i + \varepsilon_i.$$

To address research question (3b) on the interaction of information and personal characteristics, we estimated the following type of equation:

$$(II) \quad acceptance_i = \alpha + \beta info_i + \gamma X_i + \delta(x_i \times info_i) + \varepsilon_i.$$

The dependent variable *acceptance* measures respondent *i*'s level of acceptance of a specific measure. It takes ordered values from 0 ('strongly disagree') to 3 ('strongly agree'). The dummy variable *info* takes a value of 0 if the respondent participated in the BI treatment and 1 if she participated in the FI treatment. *X* is a vector of personal characteristics (risk attitude, perceived seriousness of climate change, values, attitudes, trust, cognitive reflection, awareness, and socio-economic characteristics. The responses for ecological values (NEP), egoistic values, altruistic values, security values, and trust are standardised indices. The characteristic awareness controls for the influence of information from sources other than ours. It is included as a dummy variable, which takes a value of 0 if a respondent had never heard about a measure before and 1 if the respondent had heard at least a little bit about the measure before. The coefficient of the interaction term δ shows how the information effect changes with a one-unit change in the personal characteristic.

Summary statistics can be found in Table A-2 in the appendix.

4. Results

4.1 Descriptive statistics

Self-reported awareness differs significantly and strongly between SSI, CCS-S and afforestation (Wilcoxon rank sum tests $p \leq 0.001$). SSI is not well known: Less than a quarter of respondents have heard at least a little bit about it (22%). In contrast, a majority of respondents have heard at least a little bit about CCS-S (52%). For afforestation, we find an even higher awareness than for CCS-S. 60% of respondents state that they have heard at least a little bit about afforestation before.

Figure 1 shows respondents' acceptance of SSI, CCS-S and afforestation in the BI treatment and FI treatment. In general, we find that the share of respondents who strongly or somewhat agree with the use of a measure is highest for afforestation, followed by CCS-S and SSI. This ranking holds irrespective of the amount of information respondents received.[7]

[7] In the following, we use the term 'agree' when respondents choose 'strongly agree' or 'somewhat agree' and the term 'disagree' when respondents choose 'strongly disagree' or 'somewhat disagree'.

Figure 1: Acceptance of SSI, CCS-S and afforestation in the FI and BI treatments

[Figure 1 here]

Concerning the effect of information, our results show a clear picture. For each measure, we find that additional information (FI treatment) has a negative effect on acceptance (Wilcoxon rank sum tests, SSI $p < 0.001$, CCS-S $p = 0.007$, afforestation $p < 0.001$). The decrease in acceptance is weakest for CCS-S. 53% of the respondents who received only basic information on CCS-S agree that CCS-S should be used to counteract climate change. The share decreases only marginally to 51% in the full information treatment. The effect of information is strongest for SSI (44% versus 26%). For afforestation, the share of respondents who agree with using afforestation to counteract climate change is 8 percentage points lower in the FI treatment than in the BI treatment (87% versus 79%).

4.2 Regression analysis

Table 1 provides, for each measure, the results of equation (I) on the determinants of acceptance and the role of information. Table 2 provides the results of equation (II) on the interaction effects. In columns (2) to (6) of Table 2, we sequentially add interaction terms between *info* and one personal characteristic. While we ran regressions including interaction terms with all personal characteristics, Table 2 only reports coefficient estimates for interaction terms that are statistically significant for at least one measure.[8] Tables A-3 to A-5 in the Appendix report the complete regression results. All results are based on OLS regressions.[9]

Determinants of acceptance

Our results presented in Table 1 reveal that, for each of the three measures, the treatment variable *info* has a significantly negative effect on acceptance. This finding confirms our descriptive finding that acceptance is generally lower in the FI treatment than in the BI treatment. We find the strongest effect for SSI. The acceptance of SSI decreases by 0.29 points between the BI and FI treatments. The acceptance of CSS-S is 0.17 points lower in the FI treatment than in the BI treatment. The results are similar for afforestation: the acceptance decreases by 0.18 points between the BI and FI treatments. Thus, we find for all three measures systematic evidence that information generally reduces acceptance.

Table 1: OLS Regression Results Equation (I)

[Table 1 here]

Our regression results also show that, for SSI, *awareness* is a significant determinant of acceptance. For SSI, respondents who were aware of SSI before the survey show a lower acceptance. For CCS-S and afforestation, we do not find any significant effect of awareness on acceptance. Moreover, we find that respondents' *risk attitude* has a significant effect on the acceptance of SSI and CCS-S: Risk-seeking respondents are more likely to accept the use of a measure than risk-averse respondents. The perception of the *seriousness of climate change* also determines acceptance. Respondents who perceive climate change as a more serious problem also have a higher acceptance of any measure.

[8] Regression results for all other possible interaction terms are available from the authors upon request.

[9] As a robustness check, we also performed ordered logit regressions. The results are very similar to the OLS results.

Values are also important determinants of acceptance. For SSI, we find that more egoistic respondents tend to accept the measure more readily than less egoistic respondents. For CCS-S, security loving respondents show a statistically significant higher acceptance than less security loving respondents. For afforestation, respondents with higher scores on ecological values and more egoistic respondents have a significantly higher acceptance.

We also find that *attitudes* significantly affect the acceptance of all three measures. Respondents who either think that a given measure is the easy way out or that humans should not manipulate nature this way have a significantly lower acceptance. *Trust* in institutions has a significant positive effect. *Cognitive reflection* has a significant negative effect on acceptance of all three measures.

Finally, we also find that socio-demographic variables influence acceptance. For both SSI and afforestation, more religious respondents reveal a significantly higher acceptance. For SSI, women show a higher acceptance than men. In contrast, we do not find significant gender differences for the acceptance of CCS-S and afforestation. We also analysed whether the level of acceptance varies between the different states in Germany. We find that the acceptance of CCS in Schleswig-Holstein and Lower Saxony is 0.21 points lower than in the rest of Germany. For SSI and afforestation, we do not find significant regional differences in the level of acceptance.

Interaction terms

We find evidence that individuals' reactions to information depend to a certain extent on their personal characteristics (Table 2).

Table 2: OLS Regression Results Equation (II)

[Table 2 here]

For SSI and afforestation, we find that the negative effect of information on acceptance is larger for *women* than for *men*; women react much more strongly to information than men do. For SSI, men's acceptance is 0.20 points lower in the FI treatment than in the BI treatment (SSI-2: *info*). However, the acceptance of women is even 0.41 points lower in the FI treatment than in the BI treatment (sum of *info* and *female * info*). Thus, the decline in acceptance is 0.21 points higher for women than for men, and this difference is statistically significant at the 5% level. This gender difference can be further characterised: In the BI treatment, women have a 0.22-point higher acceptance than men (SSI-2: *female*). However, this gender difference in acceptance vanishes in the FI treatment; between the two treatments, the acceptance of women declines by 0.21 points more than that of men. For afforestation, the acceptance of men does not differ statistically significantly between the FI treatment and the BI treatment (Aff-2: *info*). The acceptance of women, in contrast, is significantly lower in the FI treatment than in the BI treatment (sum of *info* and *female * info*). Hence, for afforestation, the negative overall effect of information is mostly explained by the negative effect on women.

For SSI, we also find that the effect of information depends on respondents' *risk attitude* (SSI-3: *risk attitude * info*). Respondents who are risk-seeking react less negatively to information than do risk-averse respondents. More specifically, the effect of information increases by 0.05 points for every one-unit increase in the risk-seeking factor. A plausible explanation for the positive sign of the interaction term is that risk-averse respondents put a higher weight on the risks of SSI when being informed about its risks and benefits. We also find for SSI that the perceived *seriousness of climate*

change determines the effect of information (SSI-4). Respondents who perceive climate change as a serious problem react more negatively to information than respondents who do not perceive climate change as a serious problem. A one-point increase in the perceived seriousness of climate change decreases the effect of information by 0.14 points (SSI-4: *seriousness of climate change * info*). A likely explanation is that respondents who consider climate change to be a serious problem are more likely to consider the use of SSI in the first place (SSI-4: *seriousness of climate change*). Only for these respondents is additional information relevant to their acceptance. Conversely, respondents who do not perceive climate change as serious are not likely to consider the use of SSI, irrespective of the amount of information they receive.

We also find, that the negative effect of information on the acceptance of SSI is less pronounced for more *egoistic* respondents (SSI-6). They might perceive the additional information on the benefits more strongly and/or the additional information on the risks and side effects less strongly than less egoistic respondents. They might, therefore, show a less negative reaction to the additional information. Finally, we find for CCS-S that more altruistic respondents react more negatively to information than less altruistic respondents (CCS-S-5).

Interaction terms between *info* and all other personal characteristics are not statistically significant determinants of the acceptance of any of the three measures. Interestingly, neither education nor cognitive reflection matter for the effect of additional information on acceptance. This finding suggests that the information provided is not understood differently depending on cognitive capacities.

5. Discussion and Conclusion

This paper provides novel survey evidence for Germany on the perception of SSI, CCS-S and afforestation. These measures are currently controversially debated options to address climate change. Unlike previous surveys, we use a consistent research design for all measures and can thus directly compare the perceptions of the three measures. By examining the effect of information on perception, our paper also provides a possible projection on how acceptance might evolve in the future—as more and more information on CE and CCS-S becomes available. Finally, we also provide initial insights into how the effect of information differs across different subgroups of society.

Our results are as follows: First, we find that current levels of awareness differ strongly between SSI, CCS-S and afforestation. SSI is rather unknown to the public. In contrast, CCS-S and afforestation are known to slightly more than half of the respondents.

Second, we find strong differences in the acceptance between the measures. Acceptance is generally highest for afforestation, followed by CCS-S and SSI. The difference in acceptance is substantial. Our results mirror previous survey findings (e.g., Mercer et al. 2011; Curry et al. 2005). However, in contrast to earlier studies, our study allows for a direct comparison of the acceptance of the three measures as well as their determinants.

Third, we examine a variety of potential determinants of acceptance. For most determinants, we find consistent results across all measures and extend previous findings to a variety of measures. We find that the perception that climate change is serious increases acceptance (e.g., Mercer et al 2011). Also attitudes, e.g., that 'humans should not manipulate nature', significantly decrease acceptance (e.g., Pidgeon et al. 2012). We also find that trust has a positive effect on acceptance (e.g., Terwel et al.

2009). Novel to the literature, we find that cognitive reflection significantly decreases acceptance, even when controlling for education and risk attitudes.

Among socio-demographic characteristics, we find the following effects on acceptance: High education significantly decreases the acceptance of SSI and CCS-S. This finding is in line with the results of Merk et al. (forthcoming). Women show a higher acceptance of SSI after having received basic information. Religious respondents show a higher acceptance of both SSI and afforestation. Finally, our results indicate that the acceptance of CCS-S is lower in regions that faced public protest against onshore CCS in the past.

Fourth, additional information significantly decreases the acceptance of all three measures—without changing their relative rankings. The difference in acceptance between the three measures is substantial before receiving full information and remains substantial after receiving full information. In particular, for SSI, we find a strong effect of information. While previous findings on the effect of additional information for CCS were mixed (e.g., Ha-Duong et al. 2009; De Best-Waldhober et al. 2009), we find a consistent negative effect of information on acceptance for the three measures analysed. We thus could expect acceptance of CE and CCS-S to decrease in the future, when more information becomes available.

Fifth, the size and direction of the information effect vary by personal characteristics. For instance, we find that women respond particularly strongly to information. In contrast to the findings of L'Orange et al. (2011) regarding CCS, we find, for SSI, that woman have a higher acceptance than men after having received basic information. However, this gender difference in acceptance vanishes after having received full information, as woman react much more negatively to information than men. In addition, other personal characteristics such as risk attitude or values determine how information affects acceptance. This finding suggests that information is particularly important for certain subgroups of society. Communication strategies would have to take this into account. This result also suggests that differences in the sample composition might explain why previous studies on the effect of information on the acceptance of CCS have reached conflicting conclusions. We find the strongest indication of individual-specific differences in the effect of information for SSI. Presumably, this is because the effect of information is greatest for this measure.

Overall, our results provide insights into the current perception of three hotly debated measures to address climate change. They also help to project how public opinions might evolve in the future when more information on the risks and benefits of these measures becomes available. Thus, our paper contributes to the dialog between policymakers, scientists and the general public on suitable ways to address climate change. The strong effects of information on public acceptance found in our study underscore the necessity for stakeholders to provide complete and balanced information. Future discussion should find ways to establish the necessary transparency. The variability in acceptance found in our data also suggests that communication with the public should be an on-going process and that public opinions must be taken into account to ensure the legitimacy of research (Carr et al. (2013).

Given the novelty of the measures analysed, the information of our respondents is mostly drawn from the video shown in the survey. While we made sure that the information in the video is regarded as complete and balanced by scientists, our study can only provide a snapshot of public acceptance at a time when strong media coverage and lively public discourse are still absent. Hence,

it provides an indication for current and future acceptance based on the assumption that scientists regard the provided information as neutral. Yet, the future discourse on CE and CCS might be strongly influenced by information from the media, from NGOs or from the industry. Such information might be unbalanced and shape perceptions differently.

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8. Figures and Tables

Figure 1: Acceptance of SSI, CCS-S and afforestation in the FI and BI treatments

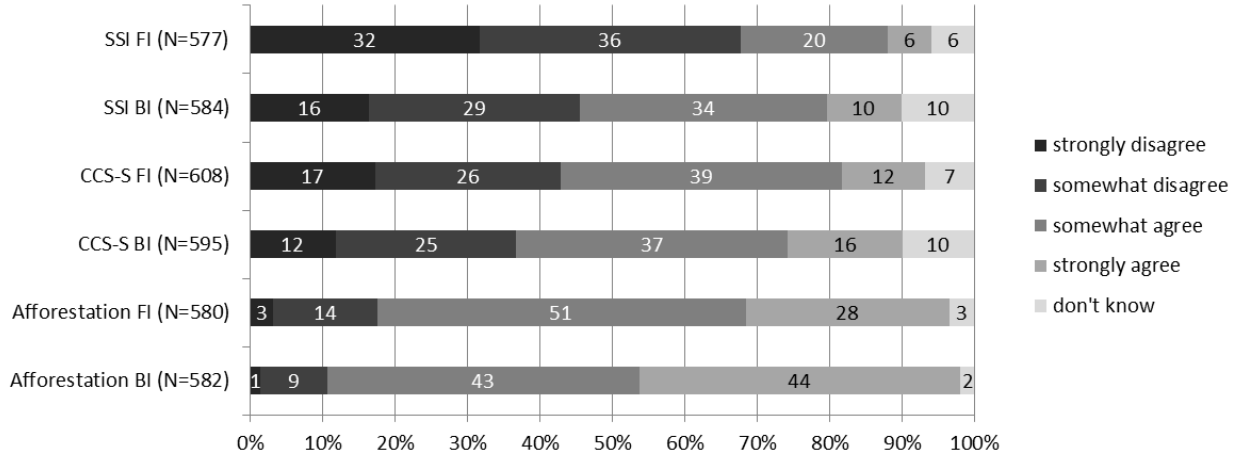

Figure 1: Acceptance of SSI, CCS-S and afforestation in the FI and BI treatments.
Note: The survey asked the following question: "We should use […] to counteract climate change." Own presentation.

Table 1: OLS Regression Results Equation (I)

Acceptance	SSI	CCS-S	Afforestation
info	-0.29***	-0.17***	-0.18***
	(0.05)	(0.05)	(0.04)
awareness	-0.12**	-0.02	0.04
	(0.06)	(0.05)	(0.04)
risk attitude	0.05***	0.03**	0.02
	(0.01)	(0.01)	(0.01)
seriousness of climate change	0.13***	0.14***	0.13***
	(0.04)	(0.04)	(0.04)
Values			
ecological	-0.00	-0.09*	0.11**
	(0.05)	(0.05)	(0.04)
altruistic	-0.03	0.01	-0.02
	(0.04)	(0.04)	(0.03)
egoistic	0.11***	0.04	0.09***
	(0.04)	(0.04)	(0.03)
security	0.06	0.11***	0.07**
	(0.04)	(0.04)	(0.03)
Attitudes			
is easy way out	-0.14***	-0.14***	-0.11***
	(0.04)	(0.04)	(0.03)
not manipulate this way	-0.43***	-0.39***	-0.26***
	(0.04)	(0.04)	(0.03)
Other Factors			
trust	0.31***	0.32***	0.24***
	(0.04)	(0.04)	(0.04)
cognitive reflection	-0.09***	-0.09***	-0.04*
	(0.02)	(0.02)	(0.02)
Socio-demographics			
religiousness	0.07***	0.00	0.05**
	(0.02)	(0.02)	(0.02)
female	0.11**	0.08	-0.03
	(0.05)	(0.05)	(0.05)
high education	-0.13**	-0.10*	-0.06
	(0.05)	(0.05)	(0.05)
age	0.00	0.00	0.00*
	(0.00)	(0.00)	(0.00)
region	-0.04	-0.21***	-0.03
	(0.06)	(0.07)	(0.06)
constant	2.02***	2.22***	2.23***
	(0.18)	(0.18)	(0.16)
Observations	846	897	898
Adjusted R^2	0.4775	0.4412	0.3202

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Acceptance is measured on a scale of 0 (strongly disagree) to 3 (strongly agree).

Table 2: OLS Regression Results Equation (II)

	SSI					CCS-S					Afforestation				
Acceptance	(SSI-2)	(SSI-3)	(SSI-4)	(SSI-5)	(SSI-6)	(CCS-S-2)	(CCS-S-3)	(CCS-S-4)	(CCS-S-5)	(CCS-S-6)	(Aff-2)	(Aff-3)	(Aff-4)	(Aff-5)	(Aff-6)
info	-0.20***	-0.55***	0.20	-0.29***	-0.30***	-0.13**	-0.08	0.14	-0.16***	-0.17***	-0.07	-0.23**	0.20	-0.18***	-0.18***
	(0.06)	(0.12)	(0.24)	(0.05)	(0.05)	(0.07)	(0.14)	(0.27)	(0.05)	(0.05)	(0.06)	(0.11)	(0.27)	(0.04)	(0.04)
female	0.22***	0.11**	0.10**	0.11**	0.11**	0.12	0.08	0.08	0.08	0.08	0.09	-0.03	-0.03	-0.03	-0.03
	(0.07)	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
risk attitude	0.05***	0.02	0.05***	0.05***	0.05***	0.03**	0.04*	0.03**	0.03**	0.03**	0.01	0.01	0.02	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
seriousness of climate	0.13***	0.13***	0.21***	0.13***	0.13***	0.14***	0.14***	0.18***	0.14***	0.14***	0.13***	0.13***	0.18***	0.13***	0.13***
change	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)
altruistic	-0.04	-0.03	-0.04	-0.03	-0.03	0.01	0.01	0.01	0.07	0.01	-0.02	-0.02	-0.02	0.01	-0.02
	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
egoistic	0.11***	0.11***	0.11***	0.11***	0.04	0.05	0.04	0.04	0.05	0.05	0.09***	0.09***	0.09***	0.09***	0.07*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
female * info	-0.21**					-0.08					-0.25***				
	(0.09)					(0.09)					(0.08)				
risk attitude * info		0.05**					-0.02					0.01			
		(0.02)					(0.02)					(0.02)			
seriousness of climate			-0.14**					-0.09					-0.11		
change * info			(0.07)					(0.07)					(0.07)		
altruistic * info				0.00					-0.11*					-0.06	
				(0.07)					(0.07)					(0.06)	
egoistic * info					0.13**					-0.01					0.04
					(0.07)					(0.07)					(0.06)
Other controls	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All
Observations	846	846	846	846	846	897	897	897	897	897	898	898	898	898	898
Adjusted R^2	0.4801	0.4802	0.4801	0.4769	0.4798	0.4410	0.4409	0.4417	0.4427	0.4406	0.3260	0.3196	0.3221	0.3202	0.3199

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Note: Acceptance is measured on a scale of 0 (strongly disagree) to 3 (strongly agree). Other controls include: awareness, ecological values, security values, attitudes, trust, cognitive reflection, religiousness, high education, age, and region.

9. Appendix

Table A-1: Survey Items

Question and items	*response scale*
Risk attitude	
Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?	risk averse (0) - risk seeking (10)
Seriousness of climate change	strongly disagree (0) - strongly agree (3)
Global warming is a serious problem.	
Ecological values (Cronbach's α = 0.5756)	strongly disagree (0) - strongly agree (3)
The Earth is like a spaceship with very limited room and resources.	
Humans were meant to rule over the rest of nature.	
The balance of nature is very delicate and easily upset.	
Humans will eventually learn enough about how nature works to be able to control it.	
If things continue on their present course, we will soon experience a major ecological catastrophe.	
Altruistic values (Cronbach's α = 0.7224)	
She thinks it is important that every person has equal opportunities in life.	very dissimilar (0) - very similar (3)
She works to promote peace among diverse groups	
Protecting society's weak and vulnerable members is important to her.	
Caring for the well-being of people she is close to is important to her.	
Egoistic values (Cronbach's α = 0.7724)	very dissimilar (0) - very similar (3)
She wants people to do what she says.	
Being wealthy is important to her.	
It is important to her to be the one who tells the others what to do.	
It is important to her to be the most influential person in any group.	
Security values (Cronbach's α = 0.7114)	very dissimilar (0) - very similar (3)
Her personal security is extremely important to her.	
She avoids anything that might endanger his safety.	
It is important to her to live in secure surroundings.	
Having order and stability in society is important to her.	
Awareness	
Have you ever heard about […] before or have you never heard about it before?	No, I have never heard about it Yes, I have heard a little about it. Yes, I have heard a lot about it
Acceptance	strongly disagree (0) - strongly agree (3)
We should use […] to counteract climate change.	
Attitudes	strongly disagree (0) - strongly agree (3)
[…] is the easy way out.	
Humans should not be manipulating nature in this way.	

Questions and items (continued)	*response scale*
Trust (Cronbach's α = 0.7942)	
How strongly do you trust that these groups will act in the interest of society and the environment?	strongly disagree (0) - strongly agree (3)
Federal government	
Companies involved in […] projects	
Environmental organisations	
Media	
Researchers studying at publicly funded research institutes	
United Nations	
European Union	
Cognitive reflection	
A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?	any number
If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?	
In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?	
Religiousness	not religious at all (0)
How religious are you?	- very religious (3)
Education	
What is your highest degree?	7 degrees
Region	
In which Federal State do you live?	16 states

Table A-2: Summary Statistics

		SSI		*CCS-S*		*Afforestation*	
Variables	***Domain***	***mean***	***standard deviation***	***mean***	***standard deviation***	***mean***	***standard deviation***
Acceptance	0 - 3	1.21	0.93	1.56	0.93	1.20	0.74
Awareness	0 (have never heard); 1 (have heard at least a little bit)	0.22		0.52		0.60	
Risk attitude	0 - 10	5.39	2.26	5.36	2.20	5.37	2.31
Seriousness of climate change	0 - 3	2.51	0.71	2.51	0.71	2.51	0.70
Ecological values	standardised index	-0.029	0.61	0.017	0.61	0.001	0.61
Altruistic values	standardised index	-0.023	0.74	0.039	0.74	-0.026	0.74
Egoistic values	standardised index	0.001	0.77	-0.024	0.74	0.032	0.80
Security values	standardised index	-0.002	0.74	0.019	0.73	-0.025	0.73
Attitudes_ Easy way out	0 - 3	2.17	0.84	2.09	0.85	1.69	0.85
Attitudes_Not manipulate in this way	0 - 3	2.19	0.85	2.02	0.88	1.21	0.85
Trust	standardised index	-0.021	0.67	-0.059	0.67	0.095	0.66
Cognitive reflection test	0 - 3	0.98	1.03	1.06	1.03	1.05	1.03
Religiousness	0 - 3	1.01	0.94	1.04	0.97	1.02	0.96
Female	0 (Male); 1 (Female)	49%		50%		49%	
High education	0 (other); 1 (A level)	36%		35%		36%	
Age	18 - 87	47	15.33	48	15.33	47	15.15
Region	0 (other); 1 (Schleswig-Holstein or Lower Saxony)	14%		12%		13%	
N		1161		1203		1162	

Table A-3: OLS Regression Results for SSI

Acceptance of SSI	(SSI-1)	(SSI-2)	(SSI-3)	(SSI-4)	(SSI-5)	(SSI-6)
info	-0.29***	-0.20***	-0.55***	0.20	-0.29***	-0.30***
	(0.05)	(0.06)	(0.12)	(0.24)	(0.05)	(0.05)
awareness	-0.12**	-0.11**	-0.12**	-0.12**	-0.12**	-0.11**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
risk attitude	0.05***	0.05***	0.02	0.05***	0.05***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
seriousness of climate	0.13***	0.13***	0.13***	0.21***	0.13***	0.13***
change	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)
Values						
ecological	-0.00	-0.01	0.00	-0.01	-0.00	-0.00
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
altruistic	-0.03	-0.04	-0.03	-0.04	-0.03	-0.03
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)
egoistic	0.11***	0.11***	0.11***	0.11***	0.11***	0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
security	0.06	0.06	0.06	0.06	0.06	0.06
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Attitudes						
is easy way out	-0.14***	-0.14***	-0.14***	-0.14***	-0.15***	-0.14***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
not manipulate this way	-0.43***	-0.43***	-0.43***	-0.42***	-0.43***	-0.43***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Other Factors						
trust	0.31***	0.31***	0.31***	0.31***	0.31***	0.31***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
cognitive reflection	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Socio-demographics						
religiousness	0.07***	0.07***	0.07***	0.07***	0.07***	0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
female	0.11**	0.22***	0.11**	0.10**	0.11**	0.11**
	(0.05)	(0.07)	(0.05)	(0.05)	(0.05)	(0.05)
high education	-0.13**	-0.13**	-0.14***	-0.13**	-0.13**	-0.14***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
age	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
region	-0.04	-0.05	-0.05	-0.04	-0.04	-0.04
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Interaction Terms						
female * info		-0.21**				
		(0.09)				
risk attitude * info			0.05**			
			(0.02)			
seriousness of climate				-0.14**		
change * info				(0.07)		
altruistic * info					0.00	
					(0.07)	
egoistic* info						0.13**
						(0.07)
constant	2.02***	1.95***	2.15***	1.82***	2.02***	2.00***
	(0.18)	(0.18)	(0.19)	(0.21)	(0.18)	(0.18)
Observations	846	846	846	846	846	846
Adjusted R^2	0.4775	0.4801	0.4802	0.4801	0.4769	0.4798

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-3: OLS regression of SSI acceptance. Note: Acceptance is measured on a scale of 0 (strongly disagree) to 3 (strongly agree). All other variables are also measured on scales of 0 to 3. Exceptions are dummy variables (info, awareness, female, high education, region), risk attitude (scale is from 0 to 10), and age. Variables for values and trust are standardised indices.

Table A-4: OLS Regression Results for CCS-S

Acceptance of CCS-S	(CCS-S-1)	(CCS-S-2)	(CCS-S-3)	(CCS-S-4)	(CCS-S-5)	(CCS-S-6)
info	-0.17***	-0.13**	-0.08	0.14	-0.16***	-0.17***
	(0.05)	(0.07)	(0.14)	(0.27)	(0.05)	(0.05)
awareness	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
risk attitude	0.03**	0.03**	0.04*	0.03**	0.03**	0.03**
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
seriousness of climate	0.14***	0.14***	0.14***	0.18***	0.14***	0.14***
change	(0.04)	(0.04)	(0.04)	(0.06)	(0.04)	(0.04)
Values						
ecological	-0.09*	-0.09*	-0.09*	-0.09**	-0.10**	-0.09*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
altruistic	0.01	0.01	0.01	0.01	0.07	0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)
egoistic	0.04	0.05	0.04	0.04	0.05	0.05
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)
security	0.11***	0.11***	0.11***	0.10***	0.10***	0.11***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Attitudes						
is easy way out	-0.14***	-0.14***	-0.14***	-0.15***	-0.15***	-0.14***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
not manipulate this way	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Other Factors						
trust	0.32***	0.32***	0.33***	0.33***	0.32***	0.32***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
cognitive reflection	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Socio-demographics						
religiousness	0.00	0.00	0.00	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
female	0.08	0.12	0.08	0.08	0.08	0.08
	(0.05)	(0.07)	(0.05)	(0.05)	(0.05)	(0.05)
high education	-0.10*	-0.10*	-0.10*	-0.10*	-0.10*	-0.10*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
age	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
region	-0.21***	-0.21***	-0.21***	-0.21***	-0.21***	-0.21***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Interaction Terms						
female * info		-0.08				
		(0.09)				
risk attitude * info			-0.02			
			(0.02)			
seriousness of climate				-0.09		
change * info				(0.07)		
altruistic * info					-0.11*	
					(0.07)	
egoistic* info						-0.01
						(0.07)
Ccnstant	2.22***	2.20***	2.18***	2.09***	2.21***	2.22***
	(0.18)	(0.18)	(0.19)	(0.22)	(0.18)	(0.18)
Observations	897	897	897	897	897	897
Adjusted R^2	0.4412	0.4410	0.4409	0.4417	0.4427	0.4406

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-4: OLS regression of CCS acceptance. Note: Acceptance is measured on a scale of 0 (strongly disagree) to 3 (strongly agree). All other variables are also measured on scales of 0 to 3. Exceptions are dummy variables (info, awareness, female, high education, region), risk attitude (scale is from 0 to 10), and age. Variables for values and trust are standardised indices.

Table A-5: OLS Regression Results for Afforestation

Acceptance of Afforestation	(Aff-1)	(Aff-2)	(Aff-3)	(Aff-4)	(Aff-5)	(Aff-6)
info	-0.18***	-0.07	-0.23**	0.20	-0.18***	-0.18***
	(0.04)	(0.06)	(0.11)	(0.27)	(0.04)	(0.04)
awareness	0.04	0.04	0.04	0.04	0.04	0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
risk attitude	0.02	0.01	0.01	0.02	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
seriousness of climate	0.13***	0.13***	0.13***	0.18***	0.13***	0.13***
change	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)
Values						
ecological	0.11**	0.11**	0.11**	0.11**	0.11**	0.11**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
altruistic	-0.02	-0.02	-0.02	-0.02	0.01	-0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
egoistic	0.09***	0.09***	0.09***	0.09***	0.09***	0.07*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
security	0.07**	0.06*	0.07**	0.07**	0.07**	0.07**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Attitudes						
is easy way out	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
not manipulate this way	-0.26***	-0.25***	-0.25***	-0.26***	-0.25***	-0.25***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Other Factors						
trust	0.24***	0.24***	0.24***	0.24***	0.24***	0.24***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
cognitive reflection	-0.04*	-0.05**	-0.04*	-0.04*	-0.04*	-0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Socio-demographics						
religiousness	0.05**	0.05**	0.05**	0.05**	0.05**	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
female	-0.03	0.09	-0.03	-0.03	-0.03	-0.03
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
high education	-0.06	-0.05	-0.06	-0.06	-0.06	-0.06
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
age	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
region	-0.03	-0.03	-0.03	-0.04	-0.03	-0.04
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Interaction Terms						
female * info		-0.25***				
		(0.08)				
risk attitude * info			0.01			
			(0.02)			
seriousness of climate				-0.11		
change * info				(0.07)		
altruistic * info					-0.06	
					(0.06)	
egoistic* info						0.04
						(0.06)
constant	2.23***	2.17***	2.26***	2.11***	2.24***	2.23***
	(0.16)	(0.17)	(0.17)	(0.19)	(0.16)	(0.16)
Observations	898	898	898	898	898	898
Adjusted R^2	0.3202	0.3260	0.3196	0.3221	0.3202	0.3199

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-5: OLS regression of afforestation acceptance. Note: Acceptance is measured on a scale of 0 (strongly disagree) to 3 (strongly agree). All other variables are also measured on scales of 0 to 3. Exceptions are dummy variables (info, awareness, female, high education, region), risk attitude (scale is from 0 to 10), and age. Variables for values and trust are standardised indices.

Information Provided in the SSI Video:

Information provided both in the Basic and Full Information Video:

Sunlight warms the Earth and its atmosphere. Greenhouse gases in the atmosphere such as CO_2 ensure that some warmth remains close to the Earth's surface. This makes the Earth warm enough for humans, animals, and plants to live on.

Since the start of industrialisation around 1850, people have emitted a great amount of greenhouse gases by burning coal, oil, and gas. These gases trap more heat in the atmosphere and cause a gradual increase in the average global temperature.

Since 1900, the global temperature has risen by approximately 0.8°C. Almost all countries agree that the increase in the average global temperature should not exceed 2°C compared to pre-industrial levels. This is called the 2°C goal.

By 2100, a further increase in temperature between 0.9 and 5.4°C is expected. The development depends strongly on the amount of greenhouse gases emitted in the future. To reach the 2°C goal, the current level of emissions would have to be cut by more than half until 2050. By 2100, greenhouse gas emissions would have to be reduced to almost zero.

It is virtually certain that climate change will cause a rise in sea levels. The frequency of heat waves is very likely to increase as well as the number of heavy precipitation events in many regions. It is likely that in the future, more areas will be affected by longer droughts and that the frequency and intensity of tropical cyclones will increase. In addition, part of the emitted CO2 is absorbed by the ocean, causing ocean acidification.

There are different ways to deal with climate change:

We can reduce greenhouse gas emissions or adapt to the new climate by building dikes. Another option is to reduce the global temperature by deploying solar radiation management (SRM).

Via SRM, some sunlight is reflected before it can warm the Earth. This can be accomplished by, for example, spraying sulphate particles into the atmosphere at a high altitude.

A similar phenomenon can be observed in nature: When large volcanoes erupt, similar particles are distributed across wide areas of the Earth's atmosphere, cooling the Earth.

The particles remain in the higher regions of the atmosphere for approximately two years. To prevent the Earth from heating up again, the spraying would have to be continued until the cause of global warming is removed. Because CO2 remains in the atmosphere for a very long time, SRM might have to be used for several centuries. However, using SRM will not stop ocean acidification.

Information provided additional in the Full Information Video:

Currently, the risks, the benefits, and the feasibility of SRM are being researched.

The use of SRM entails benefits as well as risks. One of the benefits is that global warming could be slowed more quickly than by cutting greenhouse gas emissions. This would buy additional time to remove the cause of climate change, i.e., the high concentration of greenhouse gases in the atmosphere. Massive and irreversible changes in the climate could be stopped before too much damage is done. Furthermore, it would be possible to stop climate change even if certain countries do not want to reduce their greenhouse gas emissions. Deploying SRM would be less expensive than reducing the consumption of fossil fuels.

The risks include a change in the amount of precipitation in most regions. Arid regions in particular would have to cope with even less rain. If the deployment of SRM was suddenly stopped, the global temperature would rise abruptly. The speed of this rise in temperature would lead to severe problems for humans and the environment. Because possible side effects would be trans-boundary, the use of SSI could cause international conflicts. Once used, SRM could take away people's motivation to change their lifestyle, and greenhouse gas emissions would continue to increase. Furthermore, there would be the possibility of further unknown and unforeseeable risks arising.

Information Provided in the CCS-S Video

Information provided both in the Basic and Full Information Video:

Sunlight warms the Earth and its atmosphere. Greenhouse gases in the atmosphere such as CO_2 ensure that some warmth remains close to the Earth's surface. This makes the Earth warm enough for humans, animals, and plants to live on.

Since the start of industrialisation around 1850, people have emitted a great amount of greenhouse gases by burning coal, oil, and gas. These gases trap more heat in the atmosphere and cause a gradual increase in the average global temperature.

Since 1900, the global temperature has risen by approximately 0.8°C. Almost all countries agree that the increase in the average global temperature should not exceed 2°C compared to pre-industrial levels. This is called the 2°C goal.

By 2100, a further increase in temperature between 0.9 and 5.4°C is expected. The development depends strongly on the amount of greenhouse gases emitted in the future. To reach the 2°C goal, the current level of emissions would have to be cut by more than half until 2050. By 2100, greenhouse gas emissions would have to be reduced to almost zero.

It is virtually certain that climate change will cause a rise in sea levels. The frequency of heat waves is very likely to increase as well as the number of heavy precipitation events in many regions. It is likely that in the future, more areas will be affected by longer droughts and that the frequency and intensity of tropical cyclones will increase. In addition, part of the emitted CO2 is absorbed by the ocean, causing ocean acidification.

There are different ways to deal with climate change:

We can reduce greenhouse gas emissions or adapt to the new climate by building dikes. Another option is carbon capture and storage sub-seabed (CCS).

The CCS technology captures CO2 from the industrial combustion of fossil fuels. The CO2 is compressed and stored in suitable geological formations under the seabed. It is not released into the atmosphere. This process additionally uses approximately 25% of the generated energy, which increases the overall demand for fossil fuels.

On a small scale, CO2 has already been stored in the ground for approximately 30 years. CO2 is injected for the recovery of oil and gas to make this process easier. The experiences indicate a high level of storage safety.

Former oil and gas fields as well as sub-seabed saline aquifers are considered to be safe and permanently suitable deposits.

Pipelines and ships carry the compressed CO2 to the deposits.

There, it is pumped into tiny hollows of the sub-seabed deposit, where it has to be stored for several thousands of years. During this time it merges with the rock and it is rendered permanently harmless.

Information provided additional in the Full Information Video:

Scientists think further applied research on CCS would be useful. The processes, benefits and risks are already well understood.

Some expected benefits and risks of CCS are now introduced to you.

Benefits of CCS are that global warming as well as acidification of the oceans would be slowed down. Furthermore, deploying CCS would be less expensive than an energy transition from fossil fuels to renewable energies.

The risks of sub-seabed CCS include the possible leakage of CO2 from the well or from the deposits caused by increased pressure. This could lead to a local acidification, which would endanger the biodiversity of that area.

Information Provided in the Afforestation Video

Information provided both in the Basic and Full Information Video:

Sunlight warms the Earth and its atmosphere. Greenhouse gases in the atmosphere such as CO_2 ensure that some warmth remains close to the Earth's surface. This makes the Earth warm enough for humans, animals, and plants to live on.

Since the start of industrialisation around 1850, people have emitted a great amount of greenhouse gases by burning coal, oil, and gas. These gases trap more heat in the atmosphere and cause a gradual increase in the average global temperature.

Since 1900, the global temperature has risen by approximately 0.8°C. Almost all countries agree that the increase in the average global temperature should not exceed 2°C compared to pre-industrial levels. This is called the 2°C goal.

By 2100, a further increase in temperature between 0.9 and 5.4°C is expected. The development depends strongly on the amount of greenhouse gases emitted in the future. To reach the 2°C goal, the current level of emissions would have to be cut by more than half until 2050. By 2100, greenhouse gas emissions would have to be reduced to almost zero.

It is virtually certain that climate change will cause a rise in sea levels. The frequency of heat waves is very likely to increase as well as the number of heavy precipitation events in many regions. It is likely that in the future, more areas will be affected by longer droughts and that the frequency and intensity of tropical cyclones will increase. In addition, part of the emitted CO2 is absorbed by the ocean, causing ocean acidification.

There are different ways to deal with climate change:

We can reduce greenhouse gas emissions or adapt to the new climate by building dikes. Another option is large-scale afforestation.

Growing trees gradually absorb CO2 from the atmosphere and store it in the wood. By logging mature trees and replacing them with new ones, CO2 can be continuously absorbed from the atmosphere. To prevent the CO2 from re-entering the atmosphere, the logged trees are, for example, used as building material or buried.

To slow down climate change through afforestation, very large areas would have to be covered with trees. Suitable areas are especially tropical areas, the Sahara Desert and the Australian Outback.

Information provided additional in the Full Information Video:

Scientists agree that the local effects have already been sufficiently researched. Further research is needed on the long-term effects on natural cycles.

Some expected benefits and risks of large-scale afforestation are now being introduced to you.

Benefits of large-scale afforestation are that global warming as well as acidification of the ocean would be slowed down. In addition, the quality of soil and water would be improved.

The risks include the high water consumption for the afforestation, which could lead to regional water scarcity. For the afforestation, agricultural areas would also have to be used. The afforestation of these areas could lead to food scarcity and thus increase food prices.

Furthermore, large-scale afforestation would slow down climate change more slowly than the mitigation of greenhouse gas emissions.