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Public attitudes to solar radiation modification:

Preliminary results of a two-scenario online survey on perception in four Asia-Pacific countries

Masahiro Sugiyama
Assistant Professor, Institute for Future Initiatives, The University of Tokyo

Shinichiro Asayama
Senior Researcher, National Institute for Environmental Studies

Takanobu Kosugi
Professor, College of Policy Science, Ritsumeikan University

Atsushi Ishii
Associate Professor, Tohoku University

東京大学未来ビジョン研究センター
Institute for Future Initiatives, The University of Tokyo

Abstract

Solar geoengineering, solar radiation modification (SRM), or climate engineering, is looming large as a potential response to human-induced climate change, but it is deeply mired in controversies surrounding environmental and societal risks. Given the high-stake, uncertain characteristic of SRM, it is essential to understand the public perceptions to facilitate public debates. Here we present the results of a 2022 online survey conducted in Australia, India, Japan, and the Philippines, in which we presented two SRM scenarios that differ in mitigation efforts and climate tipping points. The between-country differences in responses dominated the between-scenario differences. The Indian and Philippine respondents were more concerned about climate change and more supportive of SRM than the Japanese and Australian survey participants, which confirms the findings from an earlier, pre-pandemic survey with undergraduate students. The Indian and Philippine survey participants also tended to feel the future scenarios with SRM deployment more realistic. Despite these differences, many voiced concerns about environmental and governance risks of SRM, implying the need for enlarging critical discussions on SRM governance.

1. Introduction

The recent IPCC reports confirmed that the human influence on climate change is "unequivocal," and that the impact of climate change are worsening and climate change might exceed the limit of adaptation, and that limiting global warming to 1.5 degrees Celsius above the pre-industrial level requires CO_2 emissions reduction to net zero in the 2050s (IPCC, 2021, 2022a, 2022b) . The remaining carbon budget for the 1.5-degree warming, a goal adopted in the 2015 Paris Agreement and reaffirmed in the 2021 Glasgow Climate Pact, is about 500 $GtCO_2$, and the world may soon see the temperature exceeding this temperature mark. Scholars and stakeholders are increasingly worried about the temperature overshoot, a period of exceedance of the temperature beyond 1.5 degrees. In fact, even a Global Commission on Governing Risks from Climate Overshoot was recently established (Paris Peace Forum, n.d.).

Against this backdrop, solar radiation modification (SRM), solar geoengineering, or climate engineering, is now looming large as a potential, additional option to deal with the increasing climate change risks (National Academies of Sciences, Engineering, and Medicine, 2021; Patt et al., 2022). By cooling the climate system directly, there is a potential to reduce some of the risks of climate change. However, it involves novel risks, both on the societal and climatic sides. The "cure" might be worse than the "disease." Because of this situation, SRM is a very controversial and there is an ongoing debate about this technology (Biermann et al., 2022; H. J. Buck, 2022).

As a recent comprehensive report noted (National Academies of Sciences, Engineering, and Medicine, 2021), it is crucial to engage the publics in the decision making on research and development. Scholars began engagements with the public using qualitative interviews, workshops, quantitative surveys, or experimental approaches, covering the general attitudes (Mercer et al., 2011), sensemaking strategies across different countries (Wibeck et al., 2017), support for different types of research (Merk et al., 2015; Sugiyama et al., 2020), moral hazard (reduced incentives due to the knowledge about SRM) (Cherry et al., 2021; Merk et al., 2016) and the role of affect (Merk & Pönitzsch, 2017) and the influence of framing (Corner & Pidgeon, 2015). There have also been many useful reviews in the literature (Burns et al., 2016; Cummings et al., 2017; Flegal et al., 2019; McLaren & Corry, 2021; Patt et al., 2022; Raimi, 2021; Scheer & Renn, 2014).

Some general conclusions can be drawn from these works. The publics are largely unaware of the option. The studies therefore provided information about SRM to elicit opinions from the publics, and the framing of SRM does matter to the publics' responses. The publics are mostly against the deployment of SRM, but they can differentiate between research and deployment, and they cautiously and conditionally support research and international governance. Many factors do influence the perception, including trust in scientists, naturalness, affect, and values. Note that the earlier literature mixes SRM and CDR but following the IPCC, we intended to treat them separately; in fact, they are related closely because of the carbon budget (Asayama et al., 2021). Phasing out SRM and lowering the global mean temperature requires large-scale deployment CDR, for instance.

Despite significant advances of the literature, there are limitations to these studies, including geographical coverage. The literature is concentrated in high-income countries and biased toward Global North, and more studies on diverse areas including Global South and vulnerable communities are vitally needed (H. J. Buck, 2018; Rahman et al., 2018; Sugiyama et al., 2020; Visschers et al., 2017; Winickoff et al., 2015). Our previous (Sugiyama et al., 2020) study conducted an online survey in six Asia-Pacific countries (Australia, China, Japan, India, the Philippines, and South Korea) but the respondents were restricted to college students. Undergraduate students, who arguably have comparable knowledge about climate change, might have opinions different from the rest of the country, since education is a key determinant of attitudes toward climate change (T. M. Lee et al., 2015). It is therefore necessary to explore the perceptions of broader samples.

Another important deficiency is that the literature so far hasn't delved into the characteristics of SRM as a *future* option. SRM needs to be evaluated in the context of scenarios. In fact, the choice of scenarios strongly affects the evaluation of SRM (Lockley et al., 2022; MacMartin et al., 2022; Patt et al., 2022; Sugiyama et al., 2018). How the perception varies with the SRM scenario is thus a crucial research and policy question, and the previous research has not fully explored it. For instance, one of the most worrying risks of solar geoengineering is the possibility of a termination shock (Kravitz et al., 2013; Matthews & Caldeira, 2007) as recently popularized by a speculative, science fiction novel *Termination Shock: A novel* (Stephenson, 2021). If this cooling effect of solar geoengineering mask is suddenly scrapped, a sudden increase in global average temperature is expected. However, the magnitude of the risk is proportional to the masking of global warming. A termination would not result in such a huge amount of warming with moderate SRM (Kosugi, 2013). This suggests the public perception might be affected by how the information is presented about solar geoengineering.

Lastly, whether the attitudes toward SRM have stayed similar or changed over time is a crucial question. Especially, the COVID-19 global pandemic affected every corner of our life through health damages, lockdowns, and economic recessions. The pandemic also brought to the fore numerous science and policy issues, including the trust in scientists and politicians, risk perceptions of COVID-19 itself and vaccination, etc. Whether and how such a shock affected people's attitudes toward climate change and SRM is an important question.

This study presents the results of an online survey in from the four Asia-Pacific countries about attitudes toward climate change and SRM. The rest of the paper is organized as follows. Section 2 describes the survey instrument as well as our sampling strategy. This is followed by the results in Section 3. Section 4 concludes.

2. Method

2.1. Sample

In this study, we conducted a series of online surveys in four target countries: Japan, Australia, the Philippines, and India. The countries were chosen as a subset of our previous work (Sugiyama et al., 2020). Japan and Australia are both high-income countries with substantial per-capita emissions. India is a emerging economy, and because of its large population, has significant emissions of greenhouse gases. India and the Philippines are both vulnerable to climate change. In other words, we have two countries from Global North and two from Global South.

The sample size was about 600 for each country (about 300 per each of the scenario-country combination). The survey was conducted in February-March 2022. We used the panel maintained by Cross Marketing Inc., a survey firm based in Japan, and its international partners. The age and gender distributions were adjusted to those of the average of the target countries. Among the Indian respondents, the share of those with graduate degrees was extremely high (51%) (See the Appendix, Q20), which might have led to biased results in the present study. We nevertheless do not implement any corrections in the following results.

To test the effect of scenarios, we randomly assigned each respondent to one of the two scenarios we developed. The details of the scenario are presented below.

2.2. Survey instrument

Our survey instrument has been informed by previous research. It consists of:

(1) Six questions (Q1-Q6) on attitudes toward climate change based on previous studies (Bell et al., 2021; van der Linden et al., 2017);

(2) One question (Q7) on prior knowledge about SRM;

(3) Two SRM scenarios, each of which is randomly assigned to each survey participant (see the next section);

(4) Three questions (Q8-Q10) regarding scenarios;

(5) Four questions (Q11-Q14) on attitudes toward SRM, including support of research and deployment, based on earlier works (Mahajan et al., 2018; Mercer et al., 2011; Sugiyama et al., 2020);

(6) Four questions (Q15-Q18) on attitudes toward environment, society, and science (Braun et al., 2018);

(7) One question (Q19) on trust in institutions (Mercer et al., 2011; Merk et al., 2015);

(8) One question (Q20) on the respondent's highest academic degree; and

(9) One question (Q21) on the simple math to assess the level of concentration.

In the results, we excluded respondents who did not provide the right answer to the concentration check (Q21), and those who provided repeated answers (e.g., 1, 1, 1, 1, …) to different questions.

As for terminology in the survey instrument, since SRM is not well known in the public, we chose to use climate engineering (CE), which, in our opinion, sounds more intuitive than SRM. In the following, we use these two terms interchangeably.

2.3. Scenarios

SRM is a putative technology and an SRM system at the scale envisaged by researchers does not currently exist. This necessitates some form of scenarios about SRM for evaluation and public discussion, be them explicit or implicit. However, such scenarios might have significant impacts on the communication about SRM itself.

The literature includes many different scenarios, whose primary scientific objectives include the improvement of the overall climate response (Kravitz et al., 2011, 2015), the magnitude of deployment (Kosugi, 2013; Matthews & Caldeira, 2007; Sugiyama et al., 2018), main actors (Parson & Reynolds, 2021), and the design aspects (Kravitz et al., 2016; W. Lee et al., 2020). Though the literature covers a wide range of scenarios, these have rarely been directly used to inform public engagement.

We designed our scenarios based on the following considerations. First, SRM is increasingly invoked in the context of the Paris Agreement temperature goal of either well below 2 degrees or 1.5 degrees (MacMartin et al., 2018, 2022). Second, there is an increasing concern about climate tipping points (Armstrong McKay et al., 2022; Lenton et al., 2008). Therefore, we developed the following two scenarios (Table 1): (1) "supplement," where SRM supplements mitigation efforts to reach the 1.5-degree goal and avoid climate tipping points; and (2) "salvage," where SRM is invoked to salvage the 1.5-degree goal in case of the failure of global policy efforts. For simplicity, we did not explore the aspect of actors that could deploy SRM, and simply assumed an globally coordinated deployment program.

Table 1. Scenario A ("Supplement") and Scenario B ("Salvage"). Note that during the translation between Japanese and English, a few errors were introduced and some parts of Scenarios A and B do not match perfectly. Those parts are marked with square brackets. The Japanese version is presented in Appendix 3.

Scenario A ("Supplement")	Scenario B ("Salvage")
Future Scenario 2030 Increases in carbon dioxide (CO_2) in the atmosphere, which are mainly from burning fossil fuels (coal, oil, and natural gas), are causing global warming by trapping more heat in the Earth's atmosphere, which increases the number of extreme weather events (heat waves, wildfires, floods, droughts, etc.).	
Studies have shown that by limiting the increase in global average temperature to 1.5°C since pre-industrial times, we can reduce the risk of extreme weather events and manage to maintain our way of life.	
In 2021, the international community agreed to work towards limiting the temperature rise to 1.5 °C, with the goal of significantly reducing CO_2 emissions to virtually zero by mid-century by [curbing / reducing] fossil fuel use.	
As of 2030, as a result of the concerted efforts of the international community to reduce emissions, it is more likely that we will be able to limit the temperature increase to 1.5 °C.	As of 2030, large emitters and developing countries with rapidly growing economies and populations have not reduced their emissions, and the temperature increase is expected to exceed 1.5 °C in the near future.
However, the latest research shows that, even if the temperature increase is limited to 1.5 ° C, the melting of large ice sheets in Antarctica and Greenland could accelerate sea level rise, and the melting of Arctic permafrost could release large amounts of methane (a powerful greenhouse gas), which would accelerate global warming.	If this trend continues, there are fears that in the near future, the melting of the large Antarctic and Greenland ice sheets could accelerate sea level rise. In addition, the melting of Arctic permafrost could release large amounts of methane (a powerful greenhouse gas), which would accelerate global warming.
Against this backdrop, a new method [to artificially cool / for artificially cooling] the Earth, known as 'climate engineering', [has been / is being] considered to combat global warming.	
The International Earth Cooling Programme was launched with the [aim / goal] of starting to implement climate engineering in 2035.	
Technology that uses airplanes and other devices to sow sunlight-reflecting particles into the atmosphere is under consideration.	
While [research / research conducted] during the past 20 years has confirmed that this technology does produce a cooling effect, there are some concerns about its environmental side effects, including precipitation changes in some areas and [the potential for ozone / potential ozone] layer destruction.	
The International Earth Cooling Programme aims to safely use small-scale climate engineering to prepare for the potential melting of ice sheets and permafrost, while simultaneously reducing CO2 emissions.	The International Earth Cooling Programme aims to ensure the safe use of large-scale climate engineering to prevent the melting of ice sheets and permafrost because concerted emission reduction efforts by the international community are unlikely.

3. Results

This section reports our main results, focusing on questions on climate change and SRM. All descriptive results can be found in the Appendix (1 and 2) to this working paper.

3.1. Concerns about climate change

The respondents believe the human influence on climate change, are concerned about the impacts of climate change, and think that they should strengthen their work. Though about or more than half of the respondents in all the four countries believed that climate change is caused entirely or mostly by human activities (Q1, Figure 1). More than 80% of respondents in all the countries are very worried, worried, or somewhat worried about global climate change, with the fractions in India and the Philippines reaching about 95% (Q2, Figure 2). More than 70% of the respondents across the countries are very or somewhat concerned about personal harms from climate change. In India and the Philippines, the share of those very concerned is high and about 70% (Q3, Figure 3). In general, concerns are greater in India and the Philippines than in Australia and Japan.

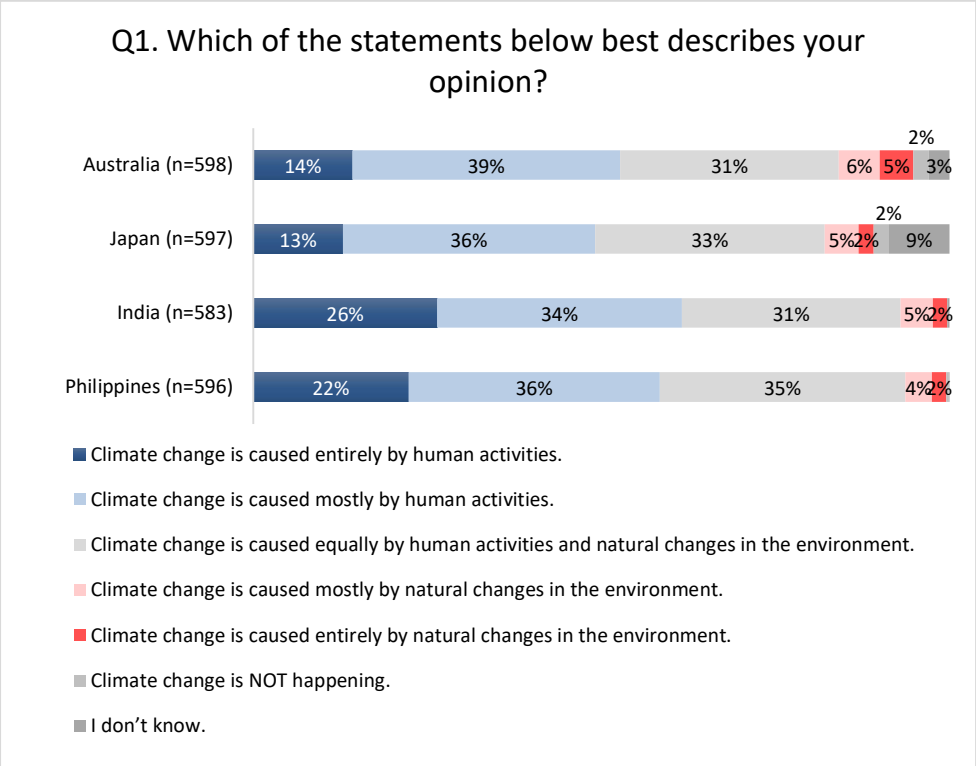


Figure 1. Responses to Q1. Which of the statements below best describes your opinion?

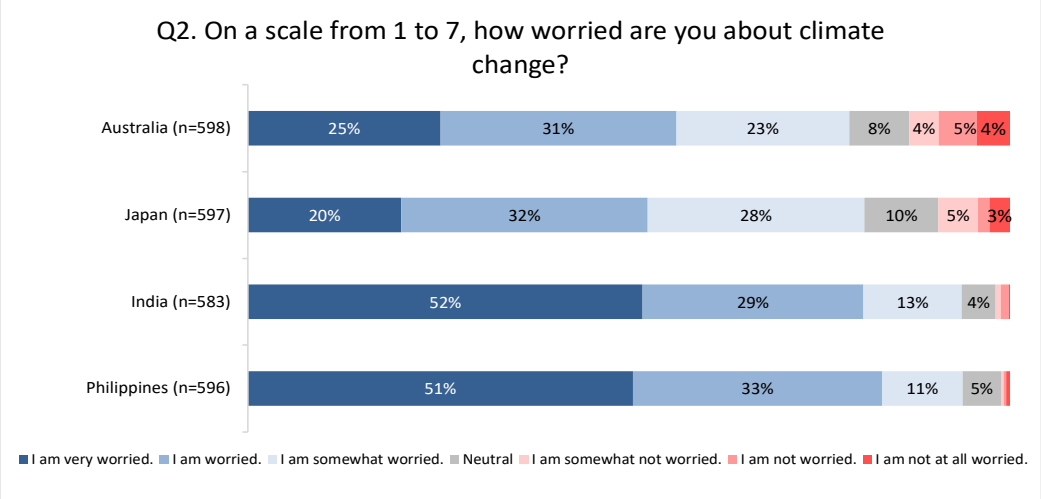


Figure 2. Responses to Q2. On a scale from 1 to 7, how worried are you about climate change?

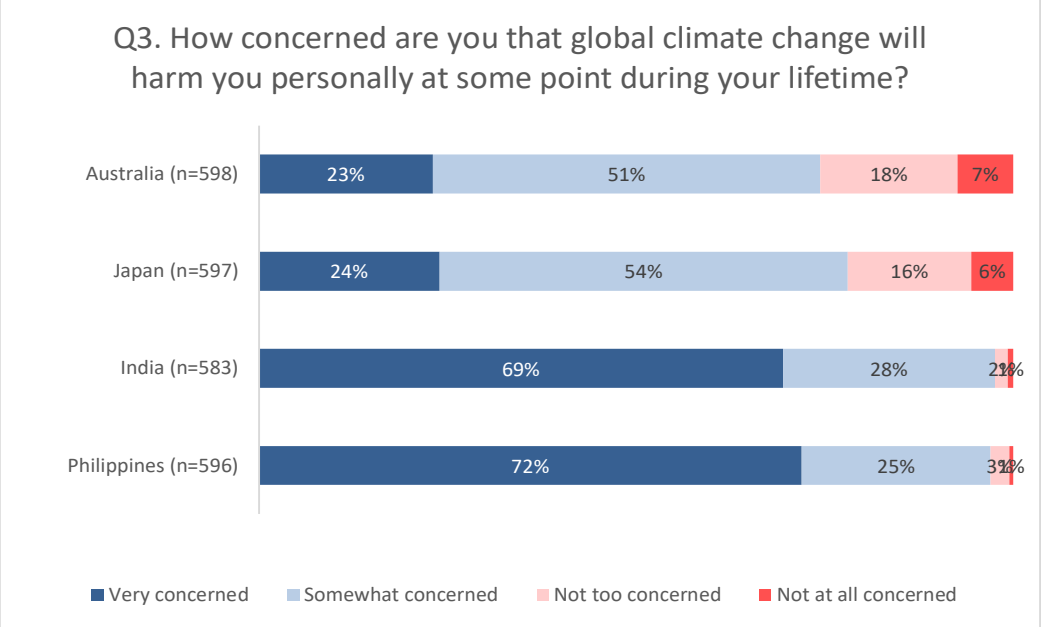


Figure 3. Responses to Q3. How concerned are you that global climate change will harm you personally at some point during your lifetime?

In terms of climate action, more than 60% of respondents said people and governments should do much more or more across the surveyed countries, with the highest share from the Philippines and the lowest from Japan (Q4, Figure 4 and Q5, Figure 5). On the personal action, about 60% of the respondents in India and the Philippines answered that they are willing to change their life a lot to mitigate climate change. The share was 29% in Australia, and 8% in Japan (Q6, Figure 6).

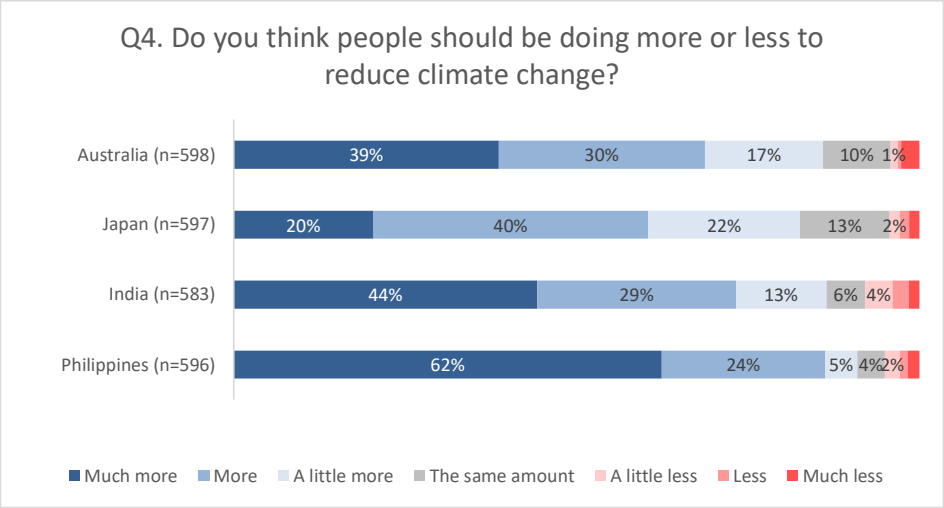


Figure 4. Responses to Q4. Do you think people should be doing more or less to reduce climate change?

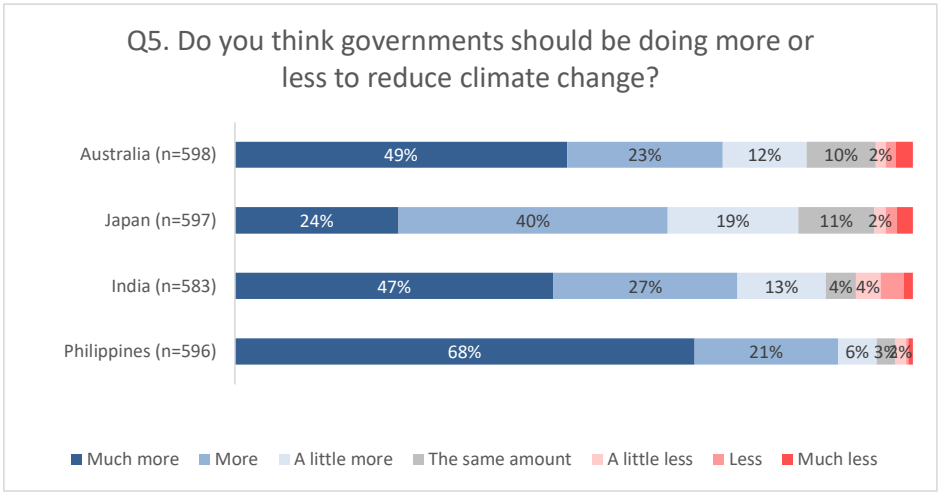


Figure 5. Responses to Q5. Do you think governments should be doing more or less to reduce climate change?

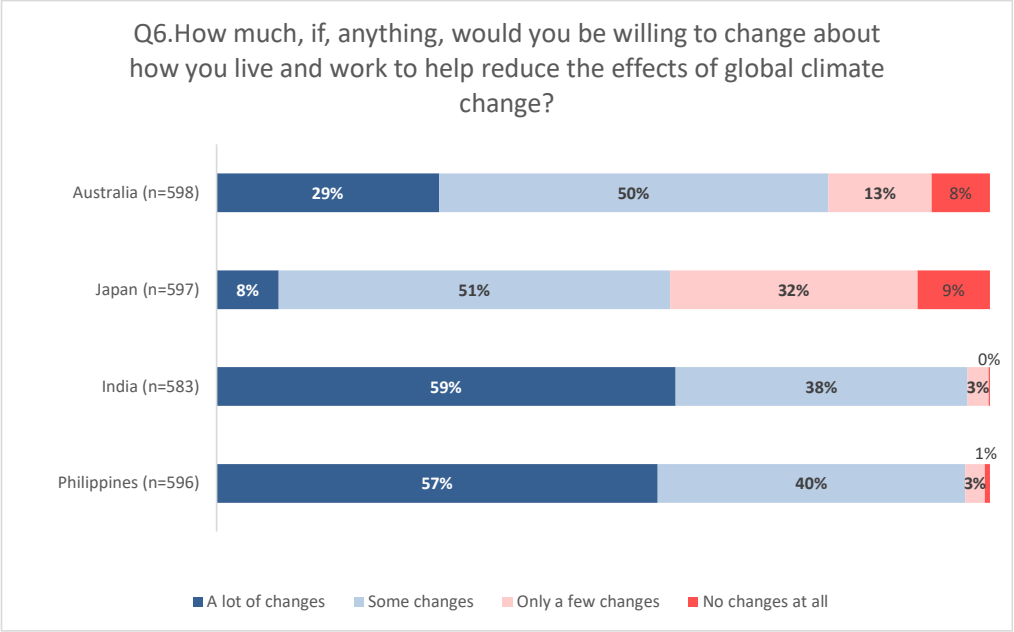


Figure 6. Responses to Q6. How much, if, anything, would you be willing to change about how you live and work to help reduce the effects of global climate change?

3.2. Prior knowledge of climate engineering

A clear division was found between Global North and Global South regarding perceived, prior knowledge of SRM. The 71% of the Indian respondents and the 53% of the Philippine ones know either a lot or a little about SRM, whereas the shares in Japan and Australia are 18% and 27%, respectively. A similar tendency was found by our own previous work (Sugiyama et al., 2020). It is not clear if this has to do with the amount of media coverage in respective countries, or it might be related to some biases (e.g., Indians and the Filipinos overly confident or Australians and Japanese overly conservative). Or they might have associated CE with weather modification or other types of technologies such as geotechnical engineering or geothermal (Mercer et al., 2011).

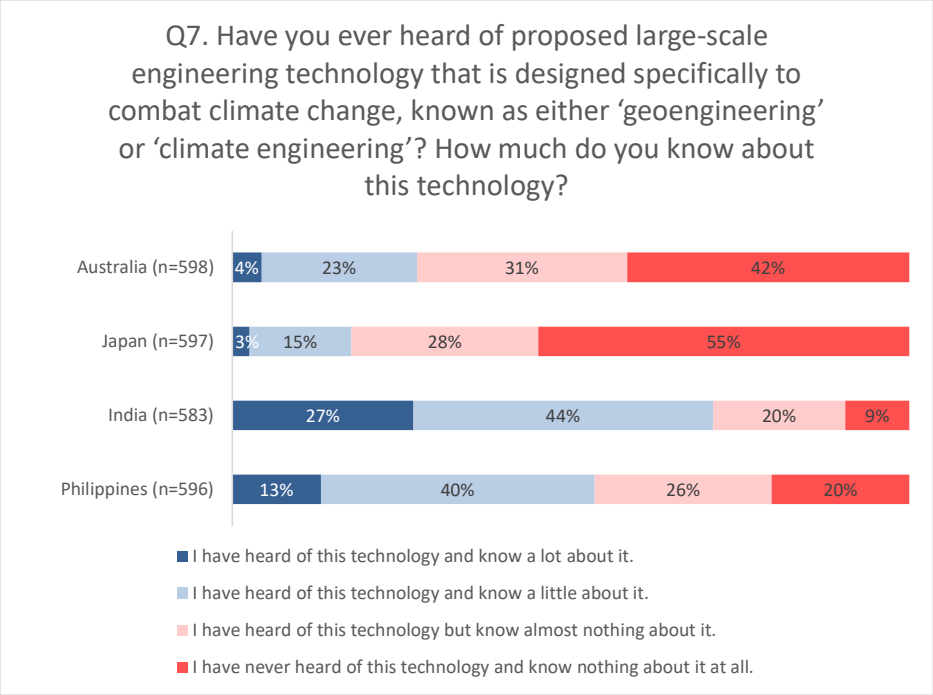


Figure 7. Responses to Q7. Have you ever heard of proposed large-scale engineering technology that is designed specifically to combat climate change, known as either 'geoengineering' or 'climate engineering'? How much do you know about this technology?

3.3. Perceptions of scenarios

After asking about prior knowledge on SRM, we presented the two SRM scenarios: Scenario A (SRM as a supplement) and Scenario B (SRM as a salvage). We then asked questions regarding the comprehension about the elements in the scenarios. Though comprehension is not a prerequisite for exploring public attitudes toward SRM, it would be useful to examine which aspects of SRM is more difficult to communicate.

We grouped comprehension questions into five categories: progress in emissions reduction (Q8-1 and Q8-2), the temperature exceedance beyond 1.5 degrees (Q8-3 and Q8-4), the melting of ice sheets and permafrost (Q8-5 and Q8-6), a consideration of SRM or lack thereof, and the scale of SRM to be deployed. Figure 8 shows the fractions of respondents who chose the correct descriptions that match with the scenarios they had read. In general, the comprehension level was low, and often less than 50%. Figure 9 shows the distribution of the correct pairs by scenario. The distribution is skewed toward a low number, regardless of the scenario presented.

This low level of comprehension is consistent across countries; unlike the prior knowledge, concerns about climate change, attitudes toward SRM, those from India and the Philippines do not show a consistently higher or lower level of comprehension than those from Australia and Japan. Though it varies with country and scenario, there are broad differences across questions. The respondents tended to choose the right descriptions of the scenario aspects such as progress of mitigation and the exceedance of the 1.5-degree temperature goal, while the comprehension was lower for the aspects concerning the melting of ice sheets and permafrost and the SRM scale.

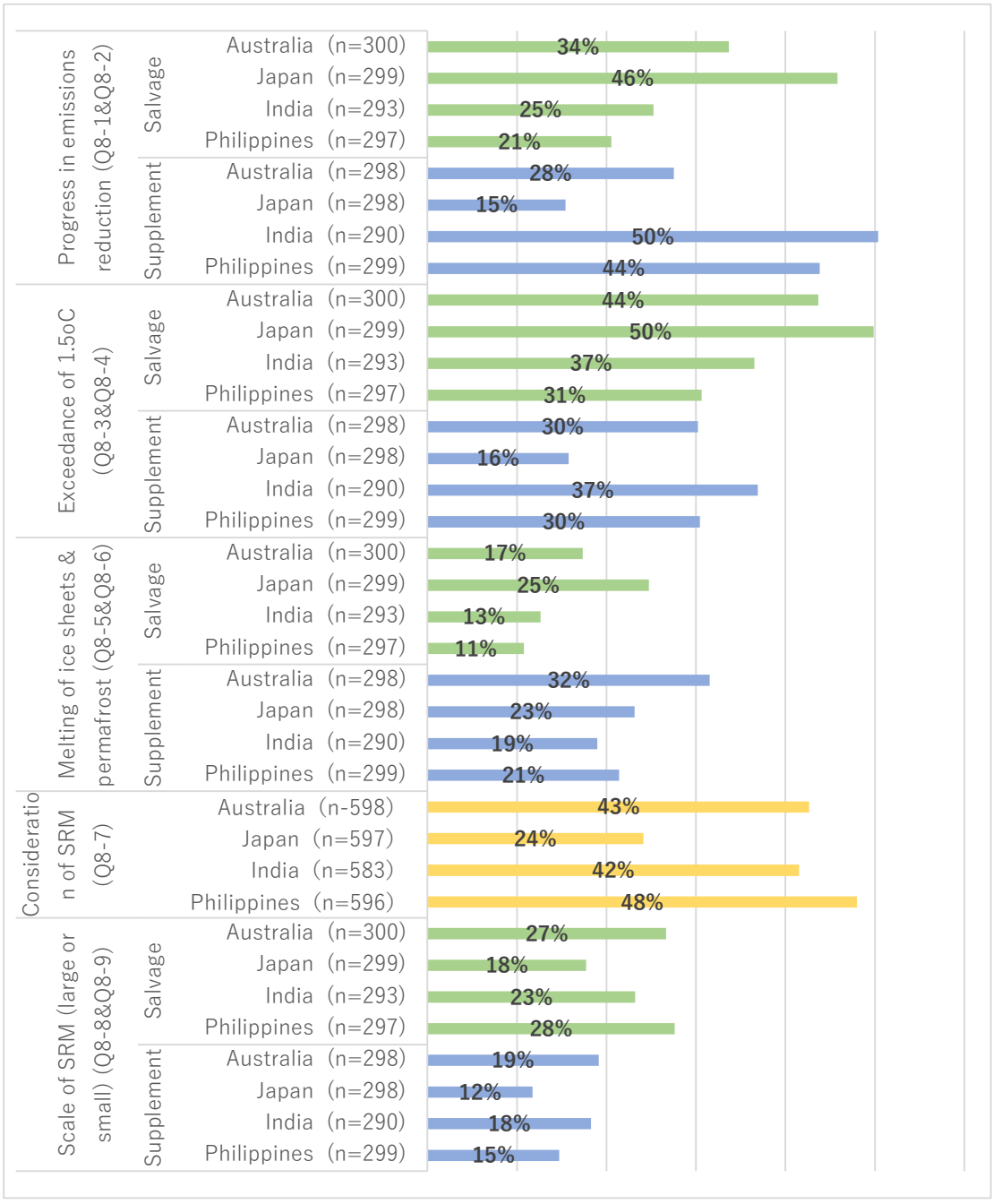


Figure 8. Responses to Q8 comprehension questions. Shown are the shares of the respondents in choosing the correct responses.

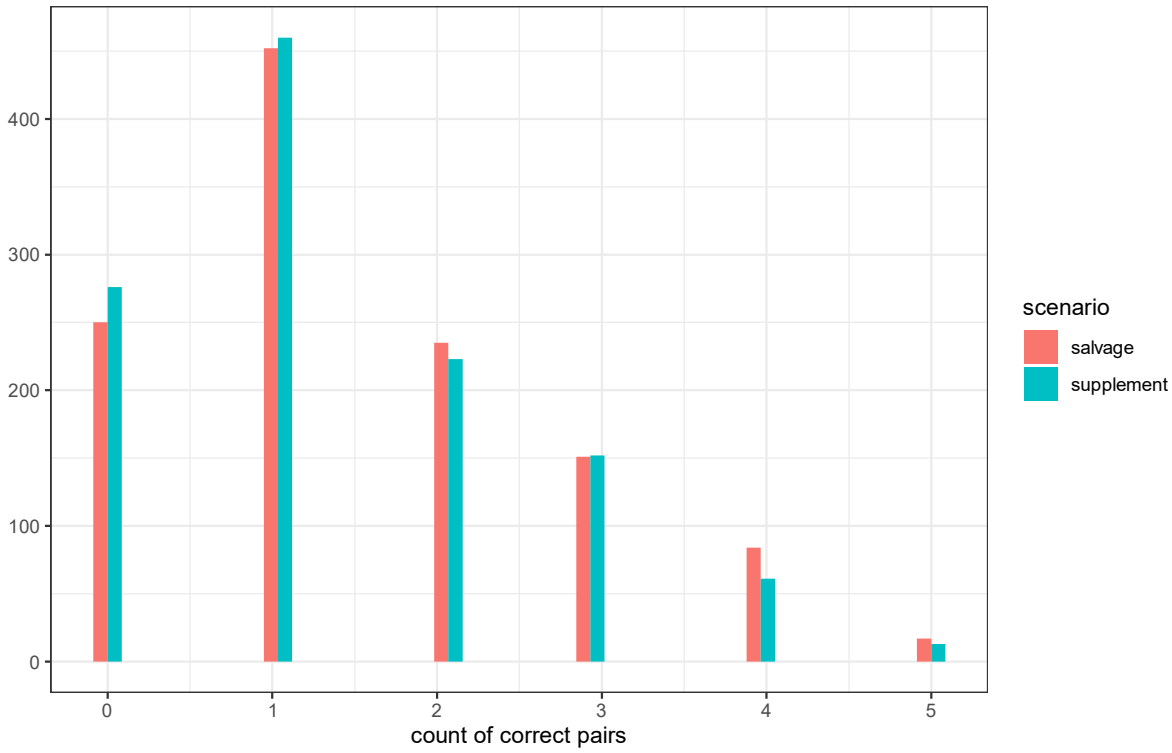


Figure 9. Distribution of the responses to Q8 comprehension questions by scenario.

After comprehension questions, we posed questions regarding various aspects related to SRM. We have 8 groups (4 countries times 2 scenarios). In general, the country-to-country difference is much larger than that of between-scenario difference. Perhaps this is due to the low level of comprehension about the details of each scenario. We therefore pooled the data between the two scenarios and present the responses only by country in the following. For the results by scenario, please refer to Appendix 1.

Across all the surveyed countries and the two scenarios, more than 90% of all the respondents said it was important or somewhat important to limit the temperature increase to 1.5°C, with those in India and the Philippines expressing a stronger opinion (Figure 9, Q9).

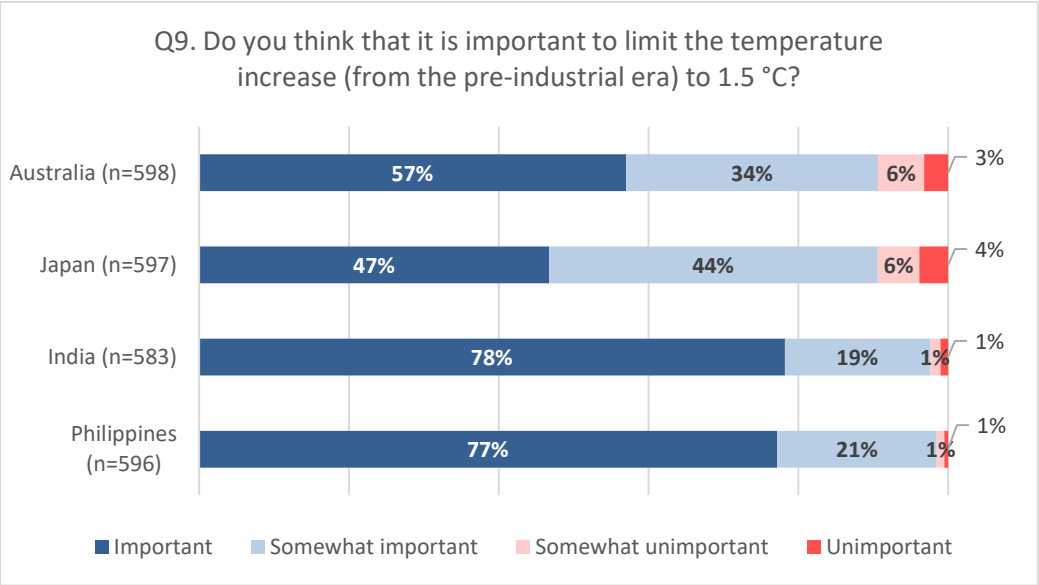
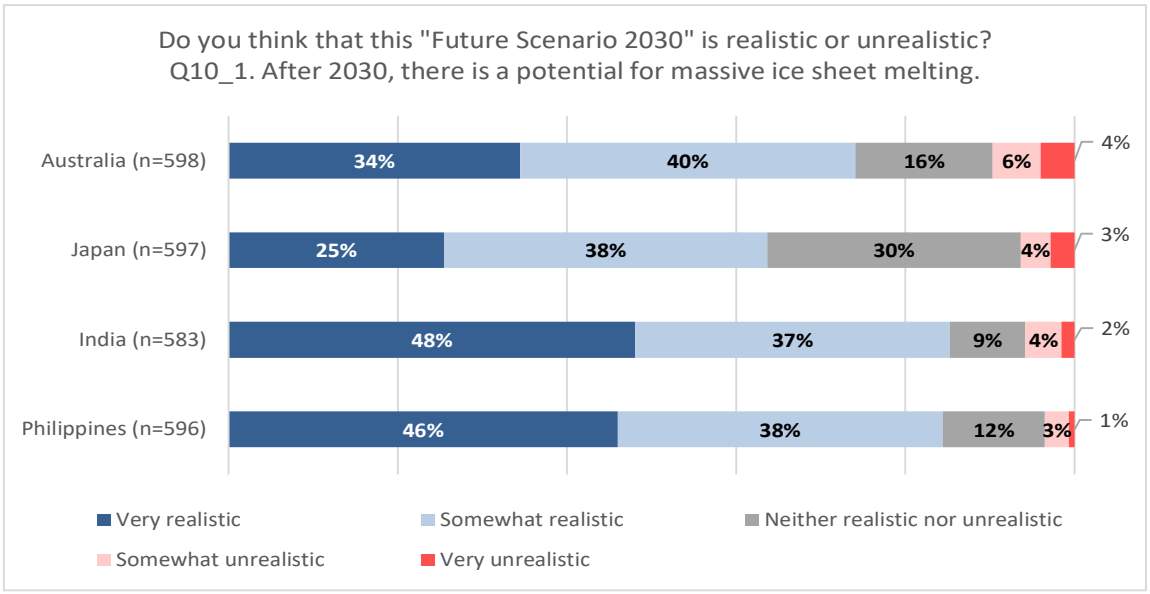
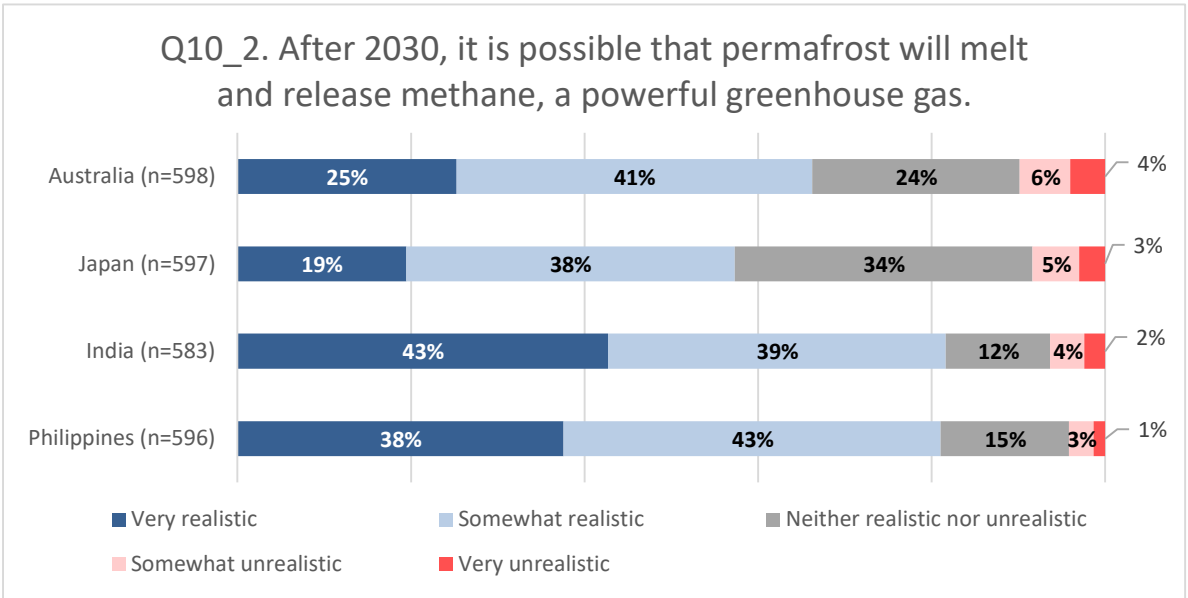
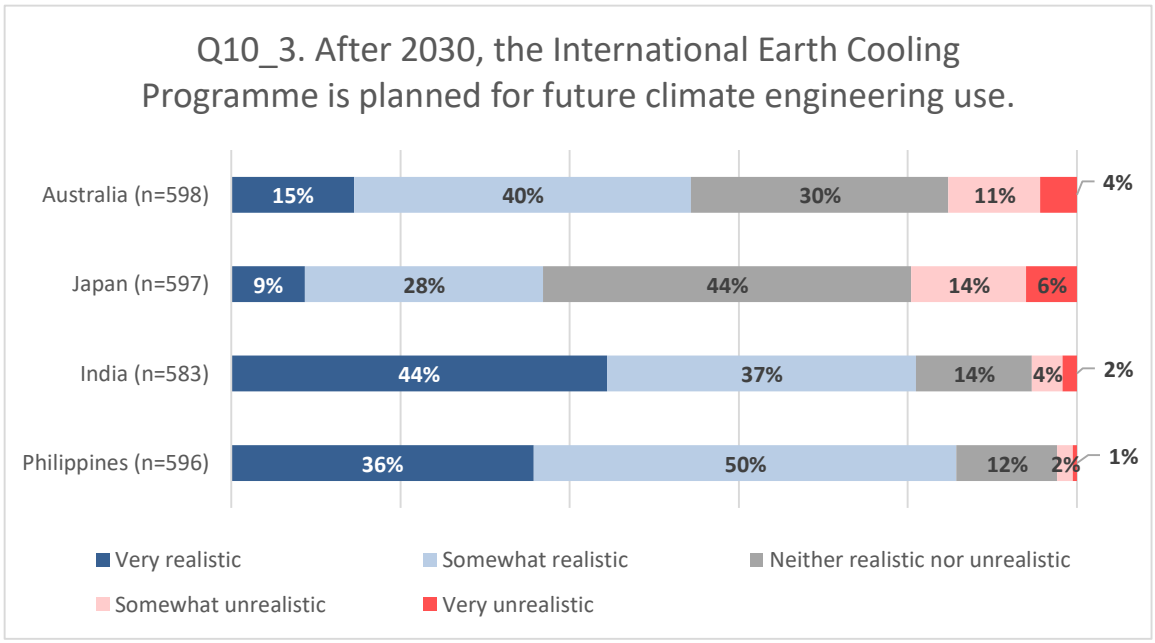


Figure 10. Responses to Q9 regarding the importance of limiting the temperature increase to 1.5 degrees Celsius.

Next, we asked about the realism of different aspects of the two scenarios. Again, across-country differences are much larger than the between-scenario difference. Note that unlike the previous comprehension questions, there is no "correct" response to the realism questions. The Indian and Philippine respondents consistently found the scenario elements realistic, including massive ice sheet melting, permafrost melting, the planning and the actual start of the International Earth Cooling Program; more than 80% of the respondents answered that those elements were either very or somewhat realistic (Figure 10, Q10-1 through Q10-4). The level of perceived realism was lower in Australia and Japan. Also, the percentage of respondents giving neutral answers "Neither realistic nor unrealistic" was much higher in Australia and Japan (full range: 20%-46%) than in India and the Philippines (full range: 8% - 17%).







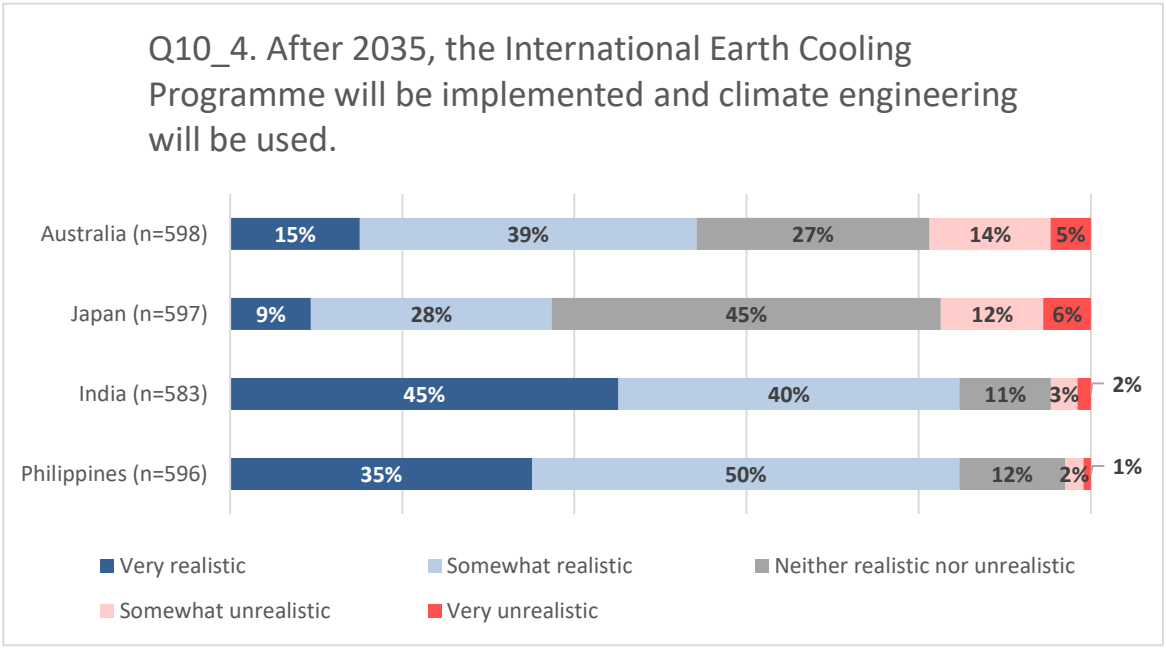


Figure 11. Responses to Q10 about realism of different aspects of scenarios.

It is instructive to examine the correlation coefficient between each of the response to Q10's and the count of correct pairs of scenario understanding. The level of understanding is weakly correlated with the perceived realism of scenarios.

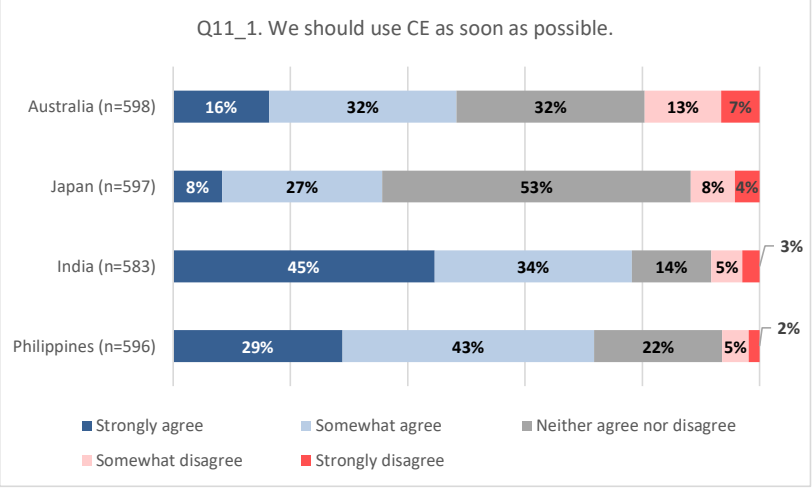
Table 2. Coefficient of correlation with the count of correct pairs in the comprehension questions. A negative value indicates that the perceived realism increases with the numbef of correct answers to the comprehensive questions.

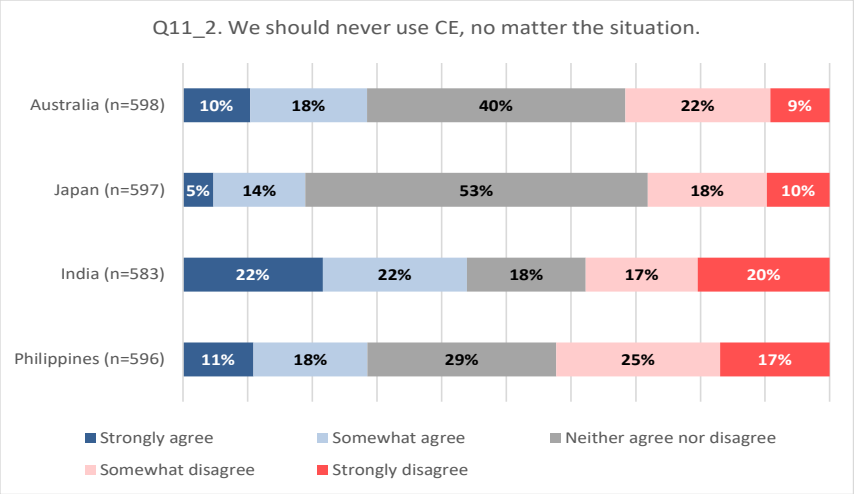
Q10_1	-0.14475073
Q10_2	-0.16998704
Q10_3	-0.10337351
Q10_4	-0.07063659

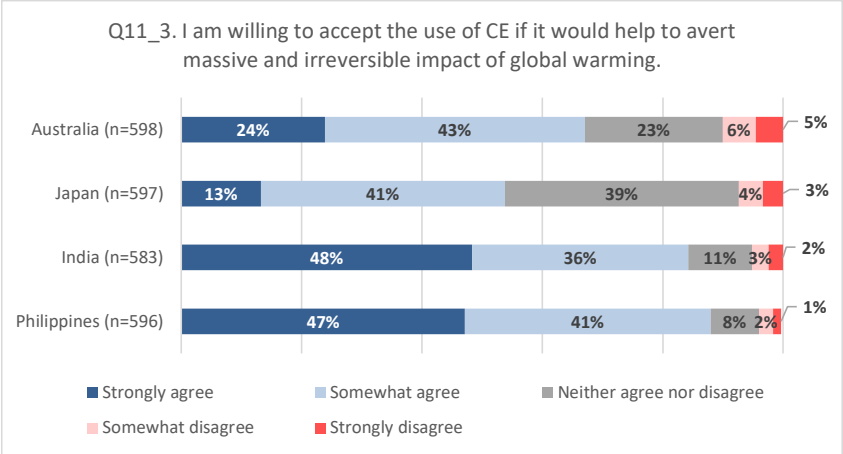
3.4. Attitudes toward climate engineering

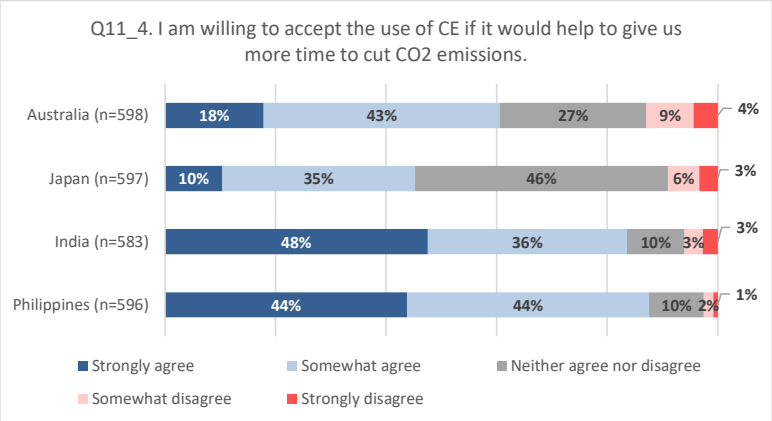
After questions on scenarios themselves, we posed questions regarding attitudes toward SRM. Here again, the between-country differences stand out compared to the between-scenario differences. As in the previous question, the respondents from India and the Philippines are more positive about SRM than those from Australia and Japan (Figure11, Q11-1 through Q11-6). For instance, the share of respondents who either strongly agreed or somewhat agreed with the immediate use of SRM was highest in India (79%), followed by the Philippines (72%), Australia (48%), and Japan (35%). Notably, more than 50% of the respondents chose "neither agree or disagree" for this question in Japan. Also, the responses to questions regarding conditional acceptance (Q11-3 and Q11-4) are more favorable than those to unconditional deployment (Q11-1), though the magnitude of differences vary with country.

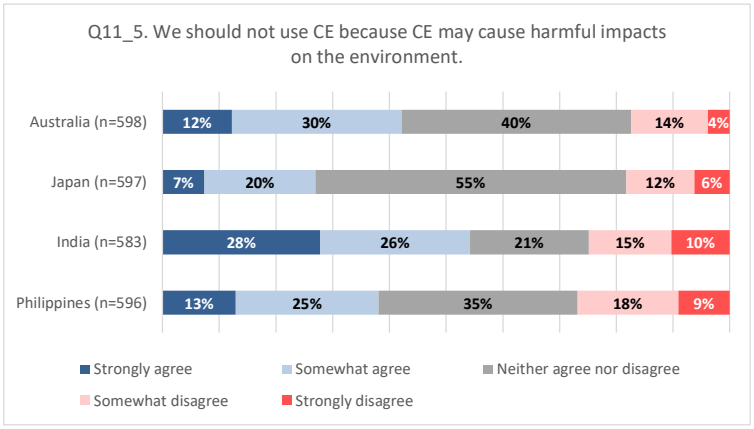
Responses are somewhat ambivalent, however, in particular in India: though 79% of the survey participants either strongly agreed or somewhat agreed with the immediate use of SRM (Q11-1), 44% either strongly or somewhat agreed to the statement "We should never use CE, no matter the situation" (Q11-2), and more than 50% of the respondents either strongly or somewhat agreed not using CE because of environmental side effects (Q11-5) and moral hazard or reduced incentives for reducing CO_2 emissions (Q11-6). The general tendencies are similar in other countries, though Japanese and Australians tended to choose "neither agree or disagree" more often.




Q11_2. We should never use CE, no matter the situation.
Australia (n=598)
10%
18%
40%
22%
9%
Japan (n=597)
5%
14%
53%
18%
10%
India (n=583)
22%
22%
18%
17%
20%
Philippines (n=596)
11%
18%
29%
25%
17%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree


Q11_3. I am willing to accept the use of CE if it would help to avert massive and irreversible impact of global warming.
Australia (n=598)
24%
43%
23%
6%
5%
Japan (n=597)
13%
41%
39%
4%
3%
India (n=583)
48%
36%
11%
3%
2%
Philippines (n=596)
47%
41%
8%
2%
1%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree


Q11_4. I am willing to accept the use of CE if it would help to give us more time to cut CO2 emissions.
Australia (n=598)
18%
43%
27%
9%
4%
Japan (n=597)
10%
35%
46%
6%
3%
India (n=583)
48%
36%
10%
3%
3%
Philippines (n=596)
44%
44%
10%
2%
1%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree



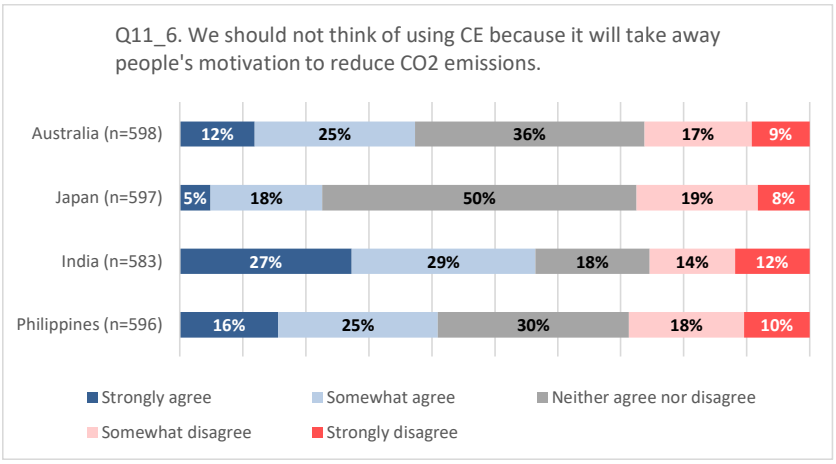


Figure 12. Responses to Q11. Suppose it is the year 2030 and "Future Scenario 2030" has become a reality. What is your opinion of each of the following statements related to the future use of climate engineering (CE)?

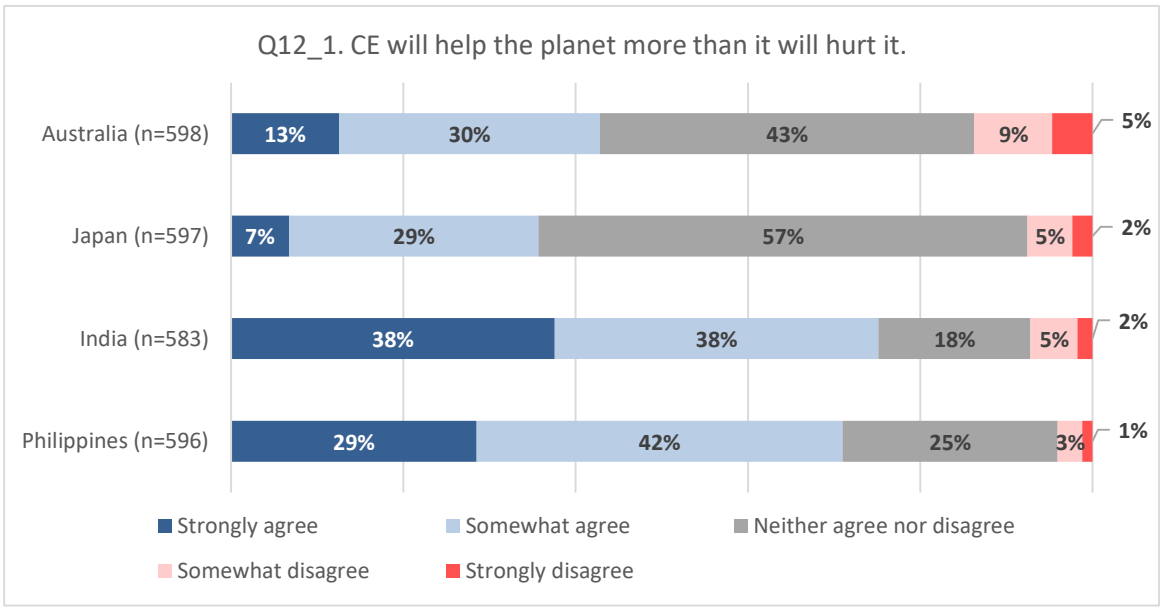
As with perceived scenario realism, we examined the correlation between Q11's and scenario comprehension (Table 3). The level of understanding is weakly correlated with to the perception of SRM.

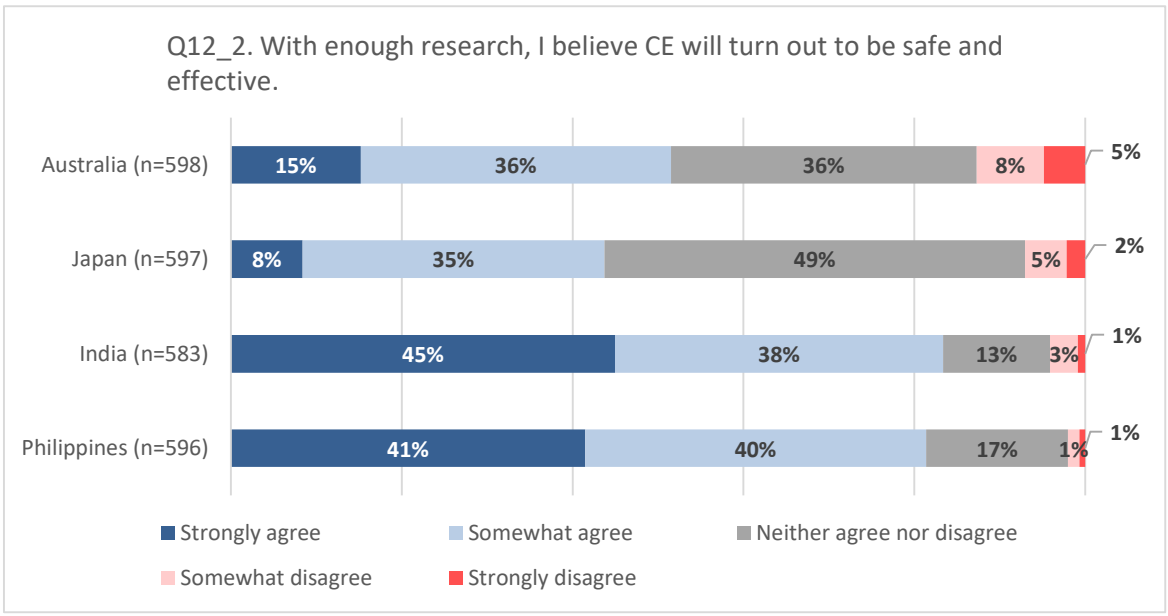
Table 3. Coefficient of correlation with the count of correct pairs in the comprehension questions. A negative value indicates that the agreement with the Q11 statement increases with the numbef of correct answers to the comprehensive questions.

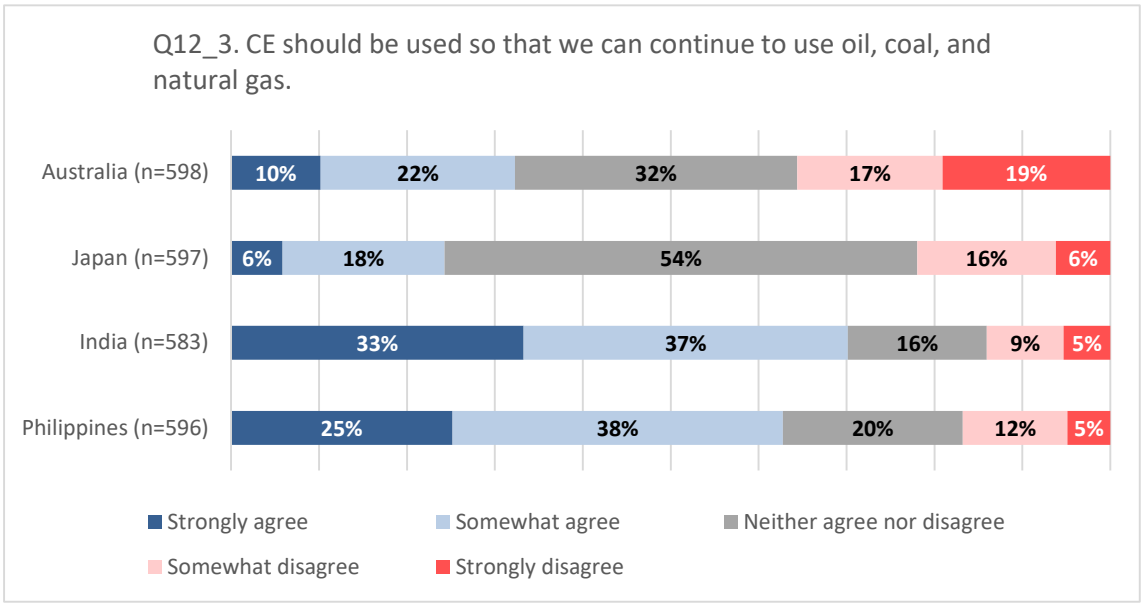
Q11_1	-0.02
Q11_2	0.19
Q11_3	-0.12
Q11_4	-0.07
Q11_5	0.08
Q11_6	0.14

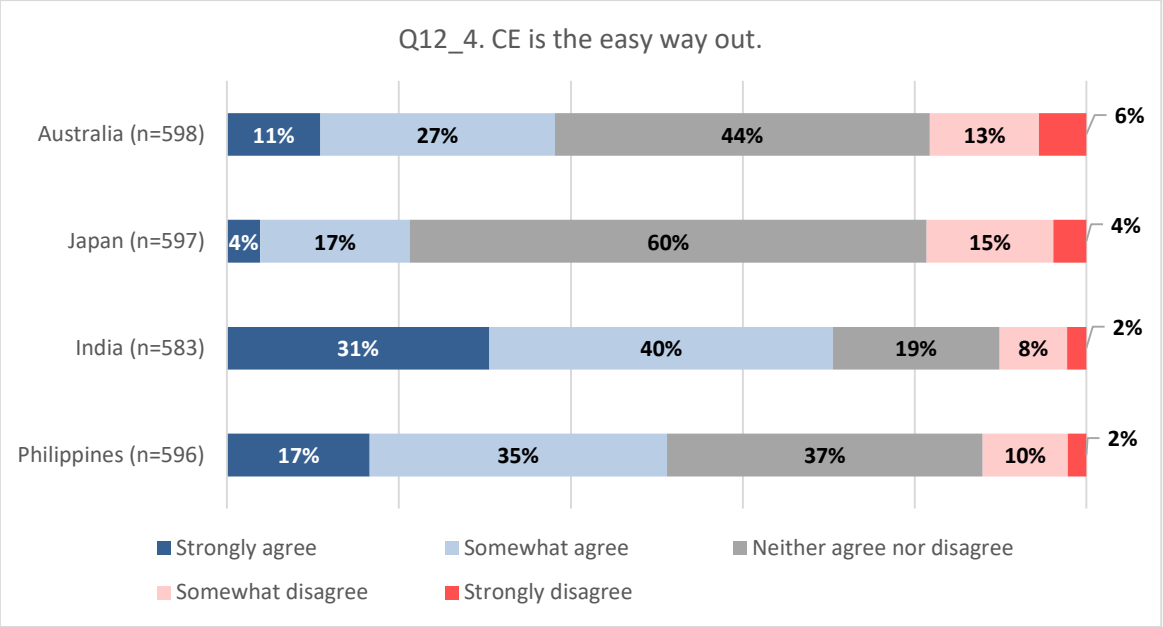
We posed more detailed aspects about SRM, and the respondents showed ambivalent responses too (Figure 12). Also there are more neutral responses in Australia and Japan. For instance, while the respondents tend to think that SRM is likely to help the planet than harm it (Q12-1), about or more than 60% across countries also strongly or somewhat agree that the Earth's temperature is too complicated for a single-technology solution (Q12-6), and about half or more from Australia, India, and the Philippines feel that humans should not be using SRM to manipulate the Earth (Q12-7) (the share from Japan is 37%).

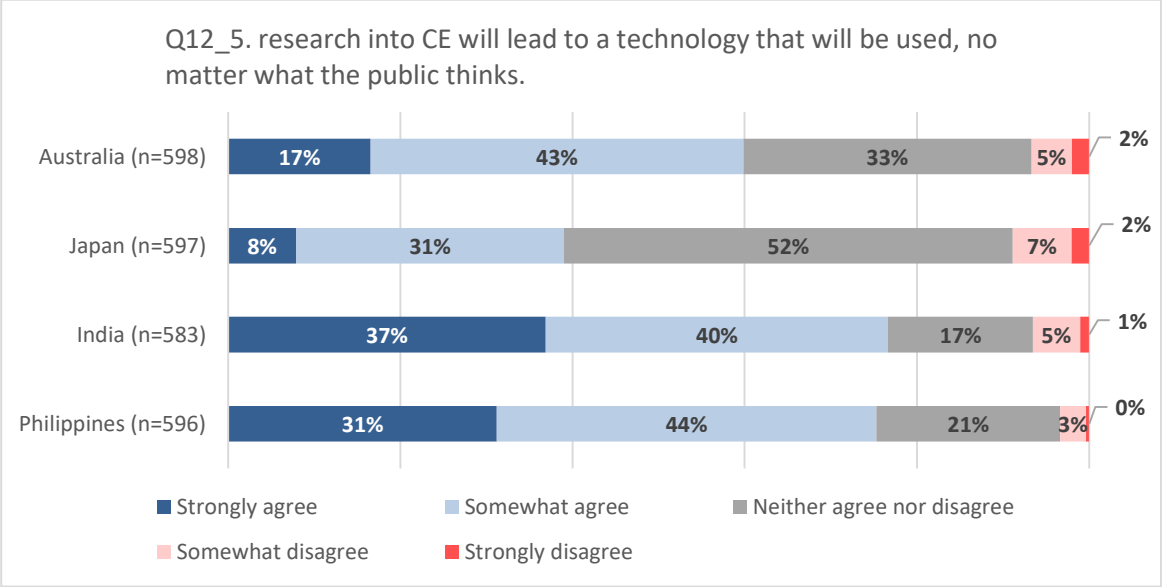
Similarly, 43% of Japanese, 51% of Australians, 81% of the Filipinos, and 84% of the Indians strongly or somewhat agree that sufficient research can make CE safe and effective (Q12-2) while 39%, 60%, 75%, and 77%, respectively, strongly or somewhat agree that CE research will inevitably lead to deployment regardless of the public's opinion (Q12-5).

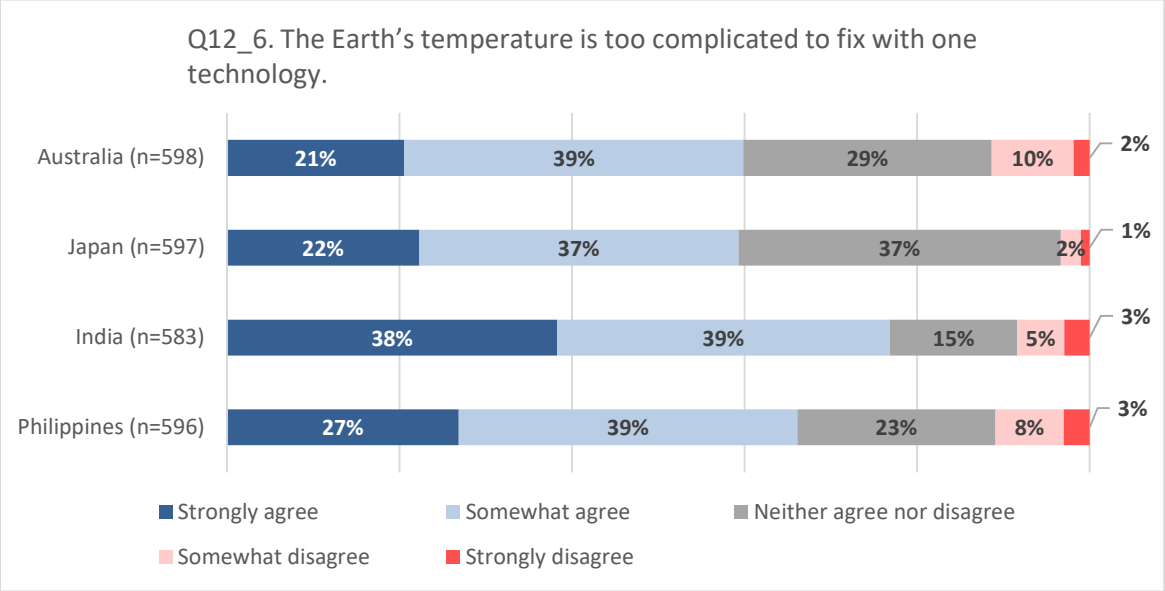


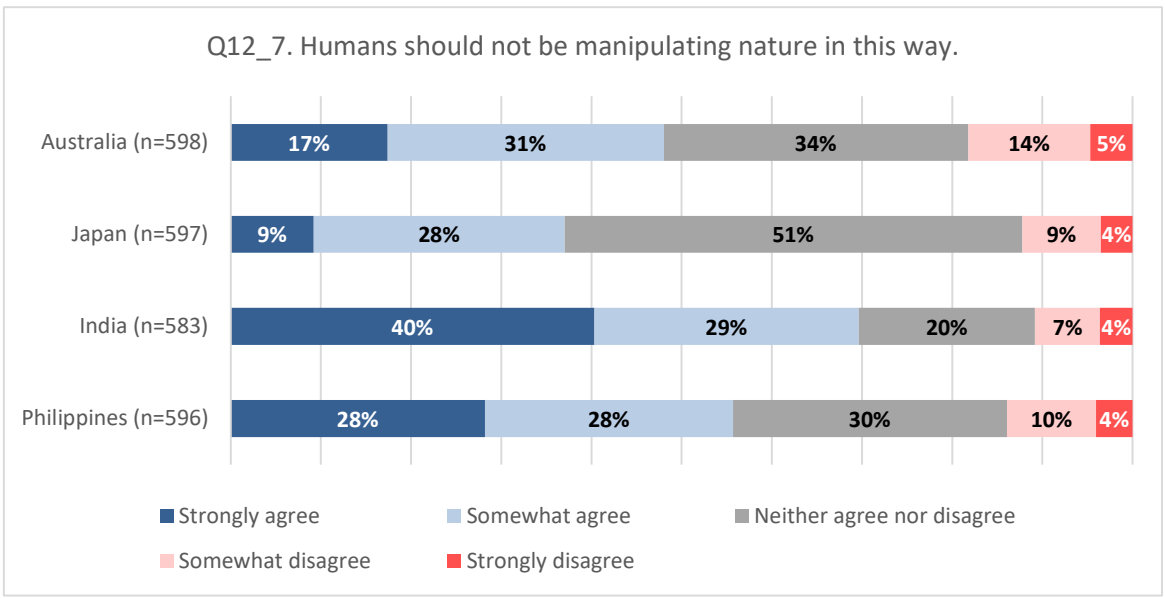

Q12_2. With enough research, I believe CE will turn out to be safe and effective.
Australia (n=598)
15%
36%
36%
8%
5%
Japan (n=597)
8%
35%
49%
5%
2%
India (n=583)
45%
38%
13%
3%
1%
Philippines (n=596)
41%
40%
17%
1%
1%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree

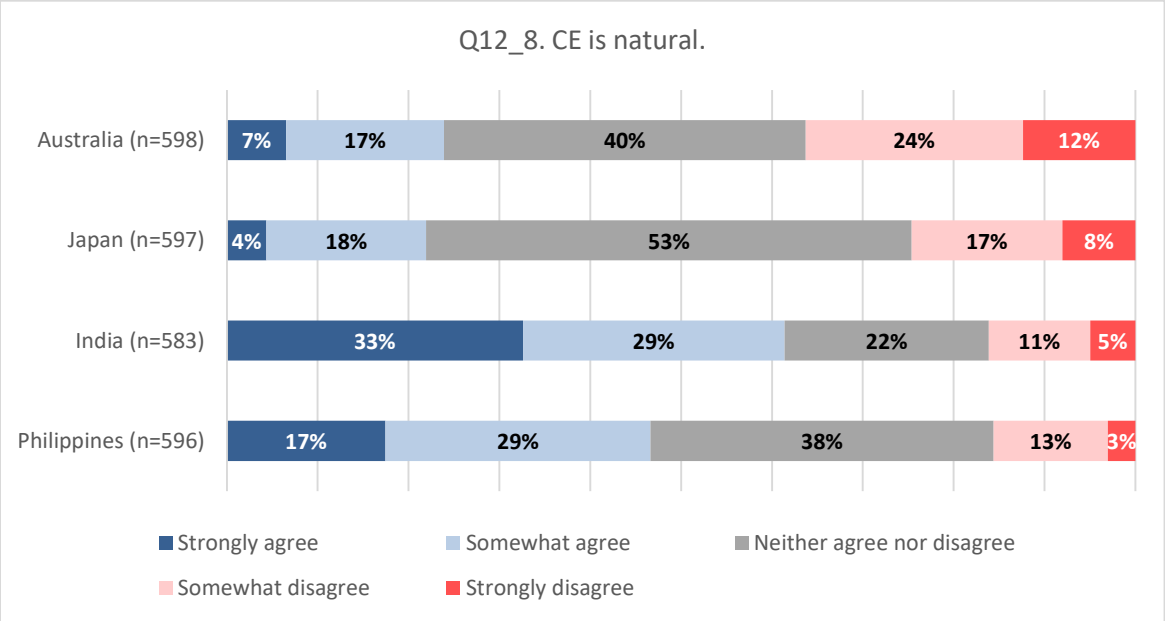

Q12_3. CE should be used so that we can continue to use oil, coal, and natural gas.
Australia (n=598)
10%
22%
32%
17%
19%
Japan (n=597)
6%
18%
54%
16%
6%
India (n=583)
33%
37%
16%
9%
5%
Philippines (n=596)
25%
38%
20%
12%
5%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree


Q12_4. CE is the easy way out.
Australia (n=598)
11%
27%
44%
13%
6%
Japan (n=597)
4%
17%
60%
15%
4%
India (n=583)
31%
40%
19%
8%
2%
Philippines (n=596)
17%
35%
37%
10%
2%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree


Q12_5. research into CE will lead to a technology that will be used, no matter what the public thinks.
Australia (n=598)
17%
43%
33%
5%
2%
Japan (n=597)
8%
31%
52%
7%
2%
India (n=583)
37%
40%
17%
5%
1%
Philippines (n=596)
31%
44%
21%
3%
0%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree


Q12_6. The Earth's temperature is too complicated to fix with one technology.
Australia (n=598)
21%
39%
29%
10%
2%
Japan (n=597)
22%
37%
37%
2%
1%
India (n=583)
38%
39%
15%
5%
3%
Philippines (n=596)
27%
39%
23%
8%
3%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree


Q12_7. Humans should not be manipulating nature in this way.
Australia (n=598)
17%
31%
34%
14%
5%
Japan (n=597)
9%
28%
51%
9%
4%
India (n=583)
40%
29%
20%
7%
4%
Philippines (n=596)
28%
28%
30%
10%
4%
Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree



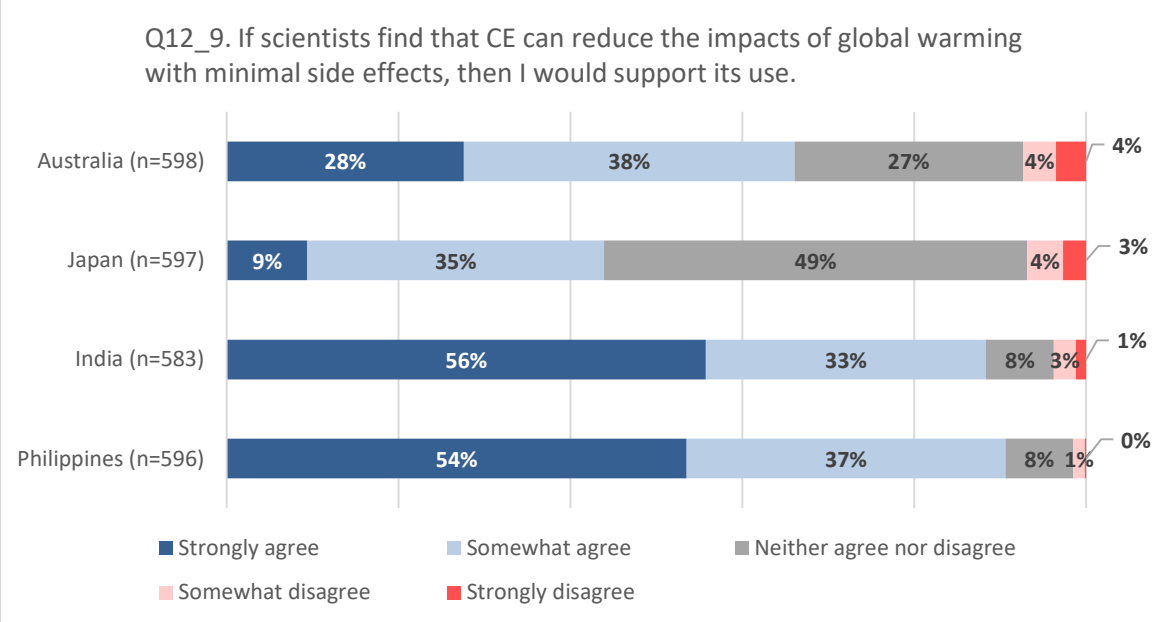
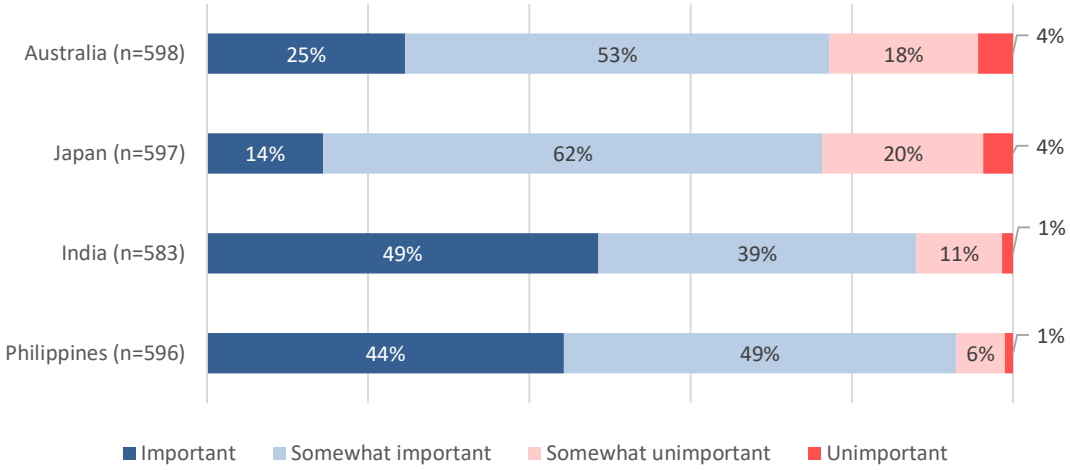


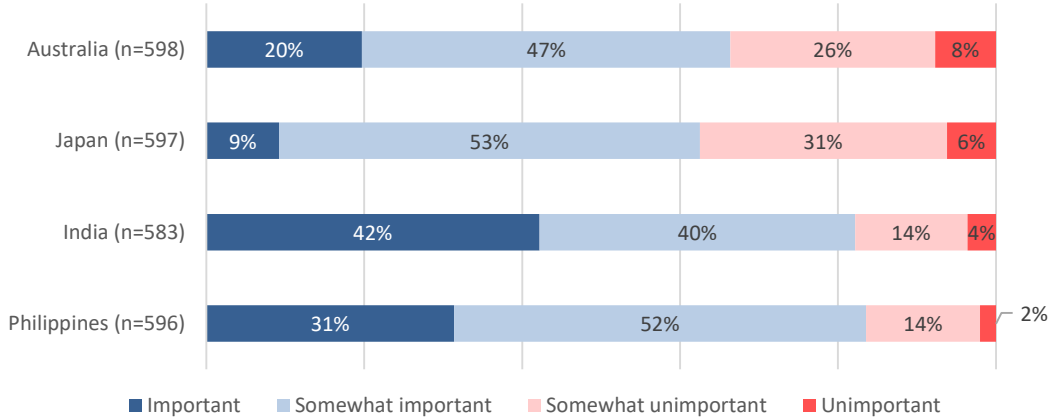
Figure 13. Responses to Q12. What is your opinion about each of the following statements?

We have included additional questions on the benefits and risks (Figure 13, Q13). As in the previous question, India, the Philippines, Australia, and Japan, in that order, indicated that the benefits of CE were important to them (Q13-1 through Q13-6), except for only Q13-7 ("CE will potentially cause something to happen that we can't predict") (regarding the share of respondents choosing "important").

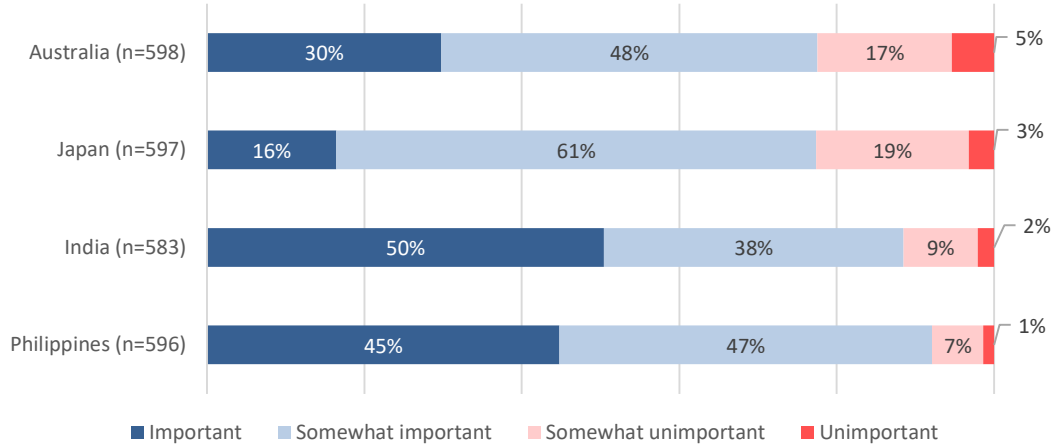
Q13_1. CE will quickly slow global warming and reduce global warming's dangerous impacts, giving us more time to cut CO2 emissions.



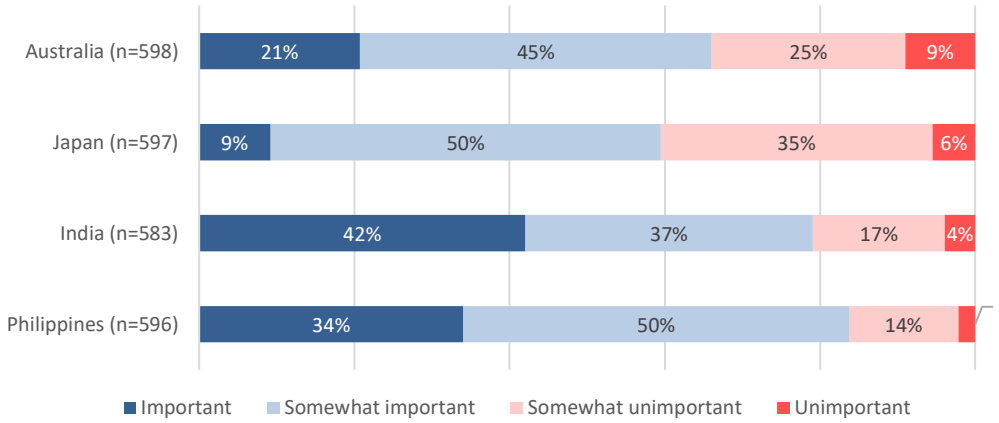
Q13-2. CE is the only way to manage the risk of rising temperatures (caused by long-lasting CO2) during this century.



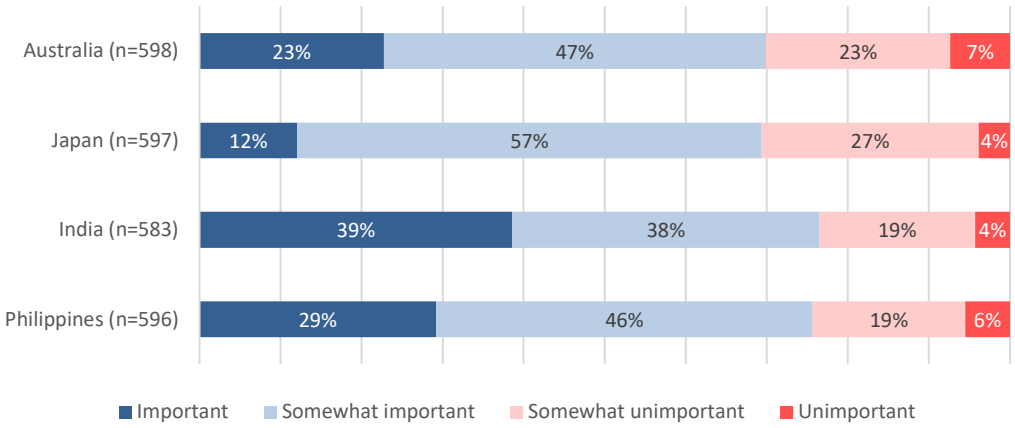
Q13-3. CE will stop a climate emergency before too much damage is done.



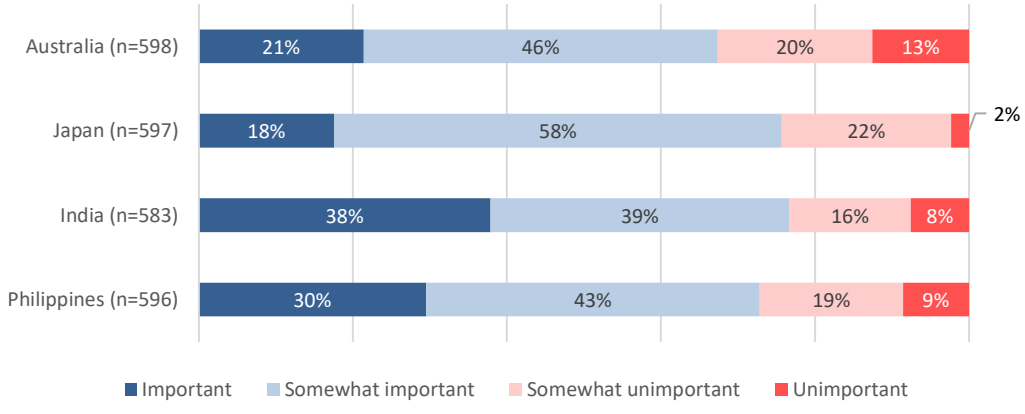
Q13-4. CE will be much cheaper than stopping our use of fuels that release CO2.



Q13-5. CE will take away society's motivation to cut its use of coal, oil, and natural gas.



Q13-6. CE will allow coal, oil, and natural gas companies to keep releasing CO2 into the atmosphere.



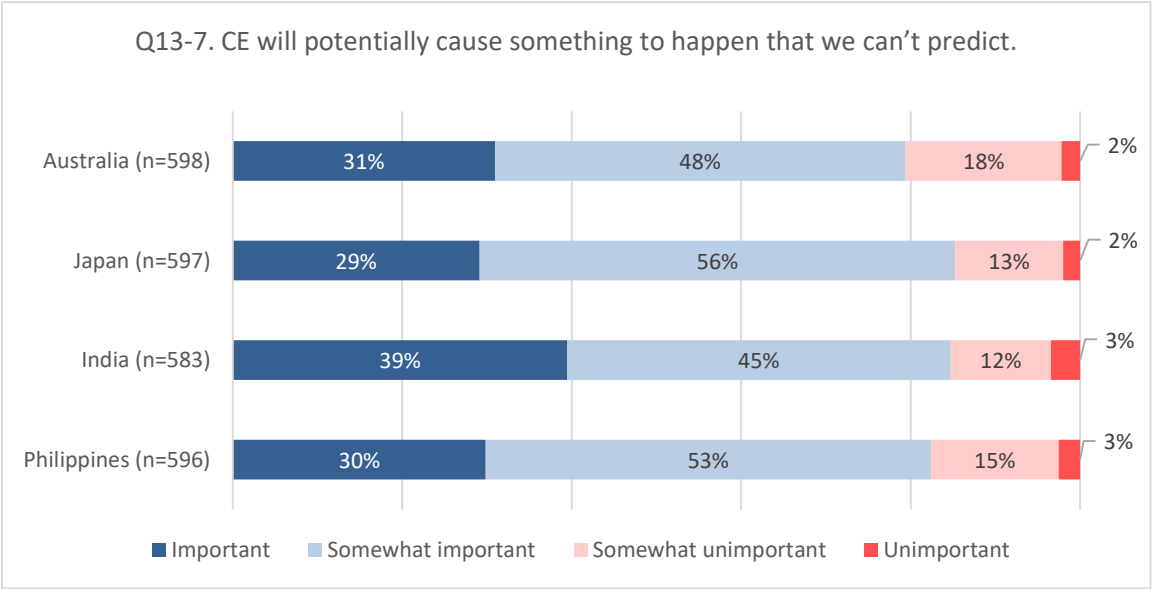


Figure 14. Responses to Q13. Please rate the importance of each of the following risks and benefits to you in forming your opinion about climate engineering (CE).

4. Discussion and conclusions

This study presented the results of a 2022 online survey on SRM in four countries: Australia, Japan, India, and the Philippines. We presented two SRM scenarios that differ in global mitigation efforts and the risk of climate tipping points (e.g., ice sheet melting). Though there are many nuances, the between-country differences in responses dominated the between-scenario differences. In fact, the level of comprehension about the details of the scenarios was generally low. As in the previous, pre-pandemic literature, those from emerging and developing economies (India and the Philippines) were more supportive of SRM than those from Australia and Japan. Their attitudes were, however, ambivalent, as the majorities simultaneously exhibited the support for SRM and concerns about various risks.

One interesting observation from the survey is that the respondents struggled to comprehend the details of the scenarios. Nevertheless, the perceived realisim of scenarios and attitudes toward SRM are not correlated with the level of comprehension.

This paper presented preliminary results of the survey and statistical analysis (e.g., those between attitudes and sociodemographic and peoples' values as well as comprehension levels) is left for future research.

Communicating about climate futures and future choices is a daunting task, and the media (and academia as well) has tended to frame SRM in a binary fashion. Presenting the choices and accompanying ambiguities of this putative technology should facilitate discussions toward responsible innovation and governance.

5. Ethical review

This survey procedure was reviewed and approved by the Research Ethics Committee of The University of Tokyo (21-378).

6. Acknowledgments

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Appendix 1. Survey instrument in English and summary statistics.

In the following, country names are abbreviated as follows: AU for Australia, JP for Japan, ID for India, PH for the Philippines.

Please indicate your gender.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Male	49%	49%	53%	49%
Female	50%	50%	46%	50%
Non-binary/Third gender	0%	0%	0%	0%
Prefer not to answer	1%	1%	0%	0%

Please indicate your age.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
20-29	21%	16%	30%	31%
30-39	23%	19%	26%	25%
40-49	21%	24%	21%	20%
50-59	19%	21%	16%	15%
60-69	16%	21%	8%	9%

Please select your occupation and status.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Civil servant	4%	5%	1%	2%
Company executive/officer	1%	2%	6%	2%
Company employee (full-time)	33%	40%	48%	33%
Company employee (part-time)	13%	11%	7%	4%
Professional (lawyer, accountant, etc.)	4%	1%	3%	4%
Self-employed	7%	5%	18%	21%
Freelancer	1%	3%	3%	7%
Student (Ph.D.)	0%	0%	0%	1%
Student (Master's Degree)	1%	0%	2%	1%
Student (Bachelor's Degree)	2%	1%	4%	5%
Student (Other)	0%	0%	1%	2%
Homemaker	7%	17%	4%	6%
Unemployed/retired	21%	14%	3%	11%
Other	6%	2%	1%	3%

Q1. Which of the statements below best describes your opinion?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Climate change is caused entirely by human activities.	14%	13%	26%	22%
Climate change is caused mostly by human activities.	38%	36%	35%	36%
Climate change is caused equally by human activities and natural changes in the environment.	31%	33%	31%	35%
Climate change is caused mostly by natural changes in the	6%	5%	5%	4%
Climate change is caused entirely by natural changes in the environment.	5%	2%	2%	2%
Climate change is NOT happening.	2%	2%	0%	0%
I don't know.	3%	9%	0%	0%

Q2. On a scale from 1 to 7, how worried are you about climate change?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
I am very worried.	25%	20%	52%	51%
I am worried.	31%	32%	29%	33%
I am somewhat worried.	23%	28%	13%	11%
Neutral	8%	10%	4%	5%
I am somewhat not worried.	4%	5%	1%	0%
I am not worried.	5%	2%	1%	0%
I am not at all worried.	4%	3%	0%	1%

Q3. How concerned are you that global climate change will harm you personally at some point during your lifetime?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very concerned	23%	24%	69%	72%
Somewhat concerned	51%	54%	28%	25%
Not too concerned	18%	16%	2%	3%
Not at all concerned	7%	6%	1%	1%

Q4. Do you think people should be doing more or less to reduce climate change?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Much more	39%	20%	44%	62%
More	30%	40%	29%	24%
A little more	17%	22%	13%	5%
The same amount	10%	13%	6%	4%
A little less	1%	2%	4%	2%
Less	1%	1%	2%	1%
Much less	3%	2%	2%	2%

Q5. Do you think governments should be doing more or less to reduce climate change?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Much more	49%	24%	47%	68%
More	23%	40%	27%	21%
A little more	12%	19%	13%	6%
The same amount	10%	11%	4%	3%
A little less	2%	2%	4%	2%
Less	2%	2%	3%	0%
Much less	3%	2%	1%	1%

Q6. How much, if, anything, would you be willing to change about how you live and work to help reduce the effects of global climate change?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
A lot of changes	29%	8%	59%	57%
Some changes	50%	51%	38%	40%
Only a few changes	13%	32%	3%	3%
No changes at all	8%	9%	0%	1%

Q7. Have you ever heard of proposed large-scale engineering technology that is designed specifically to combat climate change, known as either 'geoengineering' or 'climate engineering'? How much do you know about this technology?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
I have heard of this technology and know a lot about it.	4%	3%	27%	13%
I have heard of this technology and know a little about it.	23%	15%	44%	40%
I have heard of this technology but know almost nothing about it.	31%	28%	20%	26%
I have never heard of this technology and know nothing about it at all.	42%	55%	9%	20%

Next, we want to know your opinions on climate engineering (or geoengineering).
Climate engineering is a technology that is currently being researched, and it is up to society to choose how to develop it.
Please read the potential future scenarios below and answer the questions after thinking about them.

Scenario1

Future Scenario 2030 >>

Increases in carbon dioxide (CO2) in the atmosphere, which are mainly from burning fossil fuels (coal, oil, and natural gas), are causing global warming by trapping more heat in the Earth's atmosphere, which increases the number of extreme weather events (heat waves, wildfires, floods, droughts, etc.).
Studies have shown that by limiting the increase in global average temperature to 1.5°C since pre-industrial times, we can reduce the risk of extreme weather events and manage to maintain our way of life.
In 2021, the international community agreed to work towards limiting the temperature rise to 1.5 °C, with the goal of significantly reducing CO2 emissions to virtually zero by mid-century by curbing fossil fuel use.
As of 2030, as a result of the concerted efforts of the international community to reduce emissions, it is more likely that we will be able to limit the temperature increase to 1.5 °C.
However, the latest research shows that, even if the temperature increase is limited to 1.5 °C, the melting of large ice sheets in Antarctica and Greenland could accelerate sea level rise, and the melting of Arctic permafrost could release large amounts of methane (a powerful greenhouse gas), which would accelerate global warming.
Against this backdrop, a new method to artificially cool the Earth, known as 'climate engineering', has been considered to combat global warming.
The International Earth Cooling Programme was launched with the aim of starting to implement climate engineering in 2035.
Technology that uses airplanes and other devices to sow sunlight-reflecting particles into the atmosphere is under consideration.
While research during the past 20 years has confirmed that this technology does produce a cooling effect, there are some concerns about its environmental side effects, including precipitation changes in some areas and the potential for ozone layer destruction.
The International Earth Cooling Programme aims to safely use small-scale climate engineering to prepare for the potential melting of ice sheets and permafrost, while simultaneously reducing CO2 emissions.

Scenario2

Future Scenario 2030 >>

Increases in carbon dioxide (CO2) in the atmosphere, which are mainly from burning fossil fuels (coal, oil, and natural gas), are causing global warming by trapping more heat in the Earth's atmosphere, which increases the number of extreme weather events (heat waves, wildfires, floods, droughts, etc.).
Studies have shown that by limiting the increase in global average temperature to 1.5°C since pre-industrial times, we can reduce the risk of extreme weather events and manage to maintain our way of life.
In 2021, the international community agreed to work towards limiting the temperature rise to 1.5 °C, with the goal of significantly reducing CO2 emissions to virtually zero by mid-century by reducing fossil fuel use.
As of 2030, large emitters and developing countries with rapidly growing economies and populations have not reduced their emissions, and the temperature increase is expected to exceed 1.5 °C in the near future.
If this trend continues, there are fears that in the near future, the melting of the large Antarctic and Greenland ice sheets could accelerate sea level rise. In addition, the melting of Arctic permafrost could release large amounts of methane (a powerful greenhouse gas), which would accelerate global warming.
Against this backdrop, a new method for artificially cooling the Earth, known as 'climate engineering', is being considered to combat global warming.
The International Earth Cooling Programme was launched with the goal of starting to implement climate engineering in 2035.
Technology that uses airplanes and other devices to sow sunlight-reflecting particles into the atmosphere is under consideration.
While research conducted during the past 20 years has confirmed that this technology does produce a cooling effect, there are concerns about its environmental side effects, including precipitation changes in some areas and potential ozone layer destruction.
The International Earth Cooling Programme aims to ensure the safe use of large-scale climate engineering to prevent the melting of ice sheets and permafrost because concerted emission reduction efforts by the international community are unlikely.

Q8. Which of the following do you think apply to the "Future Scenario 2030" that you read? Please select all future scenarios that apply.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
All countries have made progress in reducing their CO2 emissions.	30%	22%	22%	21%	59%	46%	45%	40%
No progress was made in reducing CO2 emissions by large emitters and some developing countries.	21%	36%	46%	52%	23%	32%	14%	24%
The temperature increase is likely to be limited to 1.5 ° C.	33%	18%	17%	8%	45%	35%	34%	24%
The temperature increase is likely to exceed 1.5 ° C in the near future.	27%	47%	33%	52%	28%	48%	26%	36%
There is potential for large-scale ice sheet and permafrost melting.	42%	41%	33%	28%	28%	39%	30%	33%
Large-scale melting of ice sheets and permafrost is imminent.	18%	32%	30%	35%	25%	26%	22%	20%
Technology called climate engineering is being considered to lower atmospheric temperatures by spraying sunlight-reflecting particles in the atmosphere.	43%	43%	24%	24%	40%	43%	48%	47%
Small-scale climate engineering implementation is being considered by the International Earth Cooling Programme.	21%	11%	14%	9%	25%	19%	23%	15%
Large-scale climate engineering applications are being considered by the International Earth Cooling Programme.	23%	31%	21%	21%	26%	30%	32%	33%

Q9. Do you think that it is important to limit the temperature increase (from the pre-industrial era) to 1.5 ° C?	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	56%	58%	46%	47%	76%	80%	75%	79%
Somewhat important	34%	33%	44%	43%	22%	17%	23%	20%
Somewhat unimportant	6%	6%	6%	5%	1%	1%	1%	1%
Unimportant	3%	3%	3%	4%	1%	1%	1%	0%

Do you think that this "Future Scenario 2030" is realistic or unrealistic? Q10_1. After 2030, there is a potential for massive ice sheet melting.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Very realistic	33%	36%	28%	23%	44%	52%	44%	48%
Somewhat realistic	38%	42%	36%	41%	39%	36%	40%	37%
Neither realistic nor unrealistic	19%	13%	30%	30%	9%	9%	14%	10%
Somewhat unrealistic	4%	7%	4%	3%	6%	3%	1%	4%
Very unrealistic	6%	2%	3%	3%	2%	1%	0%	1%

Q10_2. After 2030, it is possible that permafrost will melt and release methane, a powerful greenhouse gas.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Very realistic	24%	26%	21%	18%	42%	43%	36%	39%
Somewhat realistic	37%	45%	37%	38%	39%	39%	44%	43%
Neither realistic nor unrealistic	28%	20%	34%	35%	11%	13%	17%	12%
Somewhat unrealistic	5%	6%	5%	6%	5%	3%	2%	3%
Very unrealistic	6%	2%	3%	3%	2%	2%	0%	3%

Q10_3. After 2030, the International Earth Cooling Programme is planned for future climate engineering use.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Very realistic	15%	14%	9%	9%	45%	44%	38%	33%
Somewhat realistic	40%	40%	27%	29%	36%	37%	48%	52%
Neither realistic nor unrealistic	30%	31%	43%	44%	13%	15%	13%	11%
Somewhat unrealistic	10%	11%	14%	13%	4%	3%	0%	3%
Very unrealistic	5%	3%	7%	5%	3%	1%	0%	1%

Q10_4. After 2035, the International Earth Cooling Programme will be implemented and climate engineering will be used.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Very realistic	14%	16%	10%	9%	43%	47%	36%	34%
Somewhat realistic	36%	42%	27%	29%	43%	36%	48%	51%
Neither realistic nor unrealistic	29%	25%	46%	44%	8%	13%	14%	11%
Somewhat unrealistic	14%	14%	12%	12%	3%	3%	1%	3%
Very unrealistic	6%	3%	5%	6%	2%	1%	1%	1%

Q11. Suppose it is the year 2030 and "Future Scenario 2030" has become a reality. What is your opinion of each of the following statements related to the future use of climate engineering (CE)?
Q11_1. We should use CE as soon as possible.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	16%	17%	10%	7%	42%	47%	31%	26%
Somewhat agree	28%	36%	27%	28%	34%	33%	41%	44%
Neither agree nor disagree	35%	30%	52%	53%	16%	11%	22%	22%
Somewhat disagree	14%	12%	7%	8%	6%	5%	4%	5%
Strongly disagree	8%	5%	5%	3%	2%	3%	1%	3%

Q11_2. We should never use CE, no matter the situation.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	12%	9%	5%	4%	20%	23%	12%	10%
Somewhat agree	18%	18%	13%	15%	24%	20%	17%	19%
Neither agree nor disagree	42%	38%	53%	53%	20%	17%	32%	26%
Somewhat disagree	19%	26%	18%	18%	14%	20%	23%	27%
Strongly disagree	9%	10%	10%	10%	21%	20%	15%	19%

Q11_3. I am willing to accept the use of CE if it would help to avert massive and irreversible impact of global warming.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	22%	25%	13%	13%	48%	48%	46%	48%
Somewhat agree	39%	47%	37%	44%	35%	37%	42%	40%
Neither agree nor disagree	27%	19%	42%	36%	13%	9%	9%	7%
Somewhat disagree	7%	4%	4%	4%	2%	3%	1%	4%
Strongly disagree	5%	4%	3%	3%	1%	3%	1%	2%

Q11_4. I am willing to accept the use of CE if it would help to give us more time to cut CO2 emissions.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	17%	19%	11%	10%	45%	50%	41%	46%
Somewhat agree	39%	46%	32%	38%	37%	35%	47%	41%
Neither agree nor disagree	28%	25%	48%	44%	11%	10%	10%	10%
Somewhat disagree	11%	6%	6%	5%	4%	3%	1%	2%
Strongly disagree	5%	3%	3%	3%	3%	3%	1%	1%

Q11_5. We should not use CE because CE may cause harmful impacts on the environment.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	16%	9%	9%	6%	29%	27%	13%	13%
Somewhat agree	29%	31%	19%	20%	26%	27%	24%	26%
Neither agree nor disagree	40%	41%	53%	57%	24%	18%	40%	30%
Somewhat disagree	11%	16%	12%	12%	13%	16%	15%	20%
Strongly disagree	4%	4%	7%	5%	8%	13%	8%	10%

Q11_6. We should not think of using CE because it will take away people's motivation to reduce CO2 emissions.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	11%	13%	4%	5%	27%	27%	18%	13%
Somewhat agree	24%	26%	16%	20%	31%	27%	25%	26%
Neither agree nor disagree	40%	33%	53%	47%	18%	18%	33%	27%
Somewhat disagree	15%	19%	17%	21%	15%	12%	15%	22%
Strongly disagree	9%	9%	9%	7%	9%	15%	9%	11%

Q12. What is your opinion about each of the following statements? Note: climate engineering (CE)
Q12_1. CE will help the planet more than it will hurt it.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	12%	13%	7%	6%	35%	40%	27%	30%
Somewhat agree	28%	33%	28%	30%	38%	38%	45%	39%
Neither agree nor disagree	46%	41%	57%	57%	20%	16%	24%	26%
Somewhat disagree	9%	9%	6%	5%	6%	5%	3%	3%
Strongly disagree	5%	4%	2%	2%	1%	2%	1%	2%

Q12_2. With enough research, I believe CE will turn out to be safe and effective.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	14%	17%	8%	8%	42%	48%	41%	41%
Somewhat agree	34%	39%	38%	33%	40%	37%	39%	40%
Neither agree nor disagree	38%	34%	48%	50%	13%	12%	16%	17%
Somewhat disagree	9%	7%	3%	7%	4%	2%	2%	0%
Strongly disagree	6%	4%	2%	2%	0%	1%	1%	1%

Q12_3. CE should be used so that we can continue to use oil, coal, and natural gas.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	10%	10%	7%	5%	32%	34%	26%	24%
Somewhat agree	20%	24%	19%	17%	36%	38%	38%	37%
Neither agree nor disagree	33%	31%	52%	56%	18%	13%	21%	20%
Somewhat disagree	13%	20%	15%	16%	9%	8%	10%	13%
Strongly disagree	23%	15%	7%	6%	4%	6%	5%	5%

Q12_4. CE is the easy way out.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	10%	12%	5%	3%	29%	32%	18%	15%
Somewhat agree	24%	30%	16%	19%	40%	40%	37%	32%
Neither agree nor disagree	48%	39%	62%	58%	20%	19%	33%	40%
Somewhat disagree	13%	13%	13%	17%	9%	7%	10%	10%
Strongly disagree	5%	6%	4%	3%	2%	2%	2%	3%

Q12_5. research into CE will lead to a technology that will be used, no matter what the public thinks.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	16%	17%	9%	6%	32%	41%	33%	29%
Somewhat agree	39%	48%	30%	33%	42%	38%	45%	43%
Neither agree nor disagree	37%	30%	52%	52%	19%	15%	19%	24%
Somewhat disagree	5%	4%	7%	6%	6%	5%	3%	3%
Strongly disagree	3%	1%	2%	2%	1%	1%	0%	1%

Q12_6. The Earth's temperature is too complicated to fix with one technology.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	20%	21%	23%	22%	39%	38%	27%	27%
Somewhat agree	38%	41%	35%	39%	37%	41%	43%	36%
Neither agree nor disagree	32%	25%	40%	35%	16%	14%	22%	24%
Somewhat disagree	9%	10%	2%	3%	7%	4%	6%	10%
Strongly disagree	1%	3%	1%	1%	3%	3%	3%	3%

Q12_7. Humans should not be manipulating nature in this way.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	18%	17%	12%	7%	39%	42%	32%	24%
Somewhat agree	33%	29%	26%	29%	27%	31%	27%	28%
Neither agree nor disagree	34%	34%	51%	51%	22%	17%	27%	33%
Somewhat disagree	11%	16%	8%	10%	7%	7%	8%	11%
Strongly disagree	5%	5%	3%	4%	4%	3%	4%	4%

Q12_8. CE is natural.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	6%	7%	4%	4%	30%	35%	16%	19%
Somewhat agree	15%	19%	16%	19%	30%	27%	31%	27%
Neither agree nor disagree	41%	38%	53%	54%	24%	21%	37%	38%
Somewhat disagree	23%	25%	18%	15%	12%	10%	12%	13%
Strongly disagree	14%	10%	9%	7%	4%	6%	3%	3%

Q12_9. If scientists find that CE can reduce the impacts of global warming with minimal side effects, then I would support its use.	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Strongly agree	26%	30%	10%	9%	55%	57%	54%	53%
Somewhat agree	37%	40%	36%	33%	34%	31%	38%	36%
Neither agree nor disagree	28%	25%	48%	51%	8%	8%	7%	8%
Somewhat disagree	5%	3%	5%	3%	2%	3%	1%	2%
Strongly disagree	4%	3%	2%	3%	0%	2%	0%	0%

Q13. Please rate the importance of each of the following risks and benefits to you in forming your opinion about climate engineering (CE). Note: Some of these risks and benefits may not have been covered in the informational passage.
Q13_1. CE will quickly slow global warming and reduce global warming's dangerous impacts, giving us more time to cut CO2 emissions.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	22%	27%	12%	17%	44%	53%	46%	43%
Somewhat important	53%	52%	61%	63%	43%	36%	48%	49%
Somewhat unimportant	20%	17%	22%	18%	11%	10%	5%	7%
Unimportant	5%	4%	5%	2%	1%	1%	1%	1%

Q13_2. CE is the only way to manage the risk of rising temperatures (caused by long-lasting CO2) during this century.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	17%	22%	9%	9%	39%	45%	33%	29%
Somewhat important	48%	45%	50%	57%	41%	39%	51%	54%
Somewhat unimportant	27%	25%	34%	29%	17%	12%	15%	14%
Unimportant	7%	8%	7%	6%	3%	4%	1%	3%

Q13_3. CE will stop a climate emergency before too much damage is done.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	28%	32%	16%	16%	50%	51%	47%	43%
Somewhat important	46%	49%	60%	62%	37%	39%	46%	49%
Somewhat unimportant	20%	14%	19%	19%	11%	8%	6%	7%
Unimportant	6%	5%	4%	2%	2%	2%	1%	1%

Q13_4. CE will be much cheaper than stopping our use of fuels that release CO2.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	21%	21%	9%	10%	43%	41%	32%	36%
Somewhat important	44%	46%	48%	52%	36%	39%	53%	47%
Somewhat unimportant	24%	26%	38%	32%	17%	17%	13%	15%
Unimportant	11%	7%	5%	6%	4%	4%	2%	2%

Q13_5. CE will take away society's motivation to cut its use of coal, oil, and natural gas.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	23%	22%	12%	12%	36%	41%	30%	28%
Somewhat important	48%	47%	56%	58%	39%	37%	47%	45%
Somewhat unimportant	21%	24%	27%	27%	21%	17%	18%	20%
Unimportant	8%	7%	5%	3%	3%	5%	4%	7%

Q13_6. CE will allow coal, oil, and natural gas companies to keep releasing CO2 into the atmosphere.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	20%	22%	16%	19%	37%	39%	30%	29%
Somewhat important	47%	45%	57%	59%	41%	36%	43%	43%
Somewhat unimportant	20%	20%	24%	20%	16%	16%	18%	20%
Unimportant	12%	13%	3%	2%	6%	9%	9%	8%

Q13_7. CE will potentially cause something to happen that we can't predict.

	AU Supplement (n=298)	AU Salvage (n=300)	JP Supplement (n=298)	JP Salvage (n=299)	IN Supplement (n=290)	IN Salvage (n=293)	PH Supplement (n=299)	PH Salvage (n=297)
Important	29%	33%	26%	33%	37%	42%	31%	29%
Somewhat important	52%	45%	60%	52%	48%	43%	52%	53%
Somewhat unimportant	18%	19%	12%	14%	11%	12%	15%	15%
Unimportant	2%	3%	3%	1%	4%	3%	2%	3%

(Responsese to Q14 are omitted for brevity.)

Q15. Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
0	6%	9%	2%	0%
1	5%	6%	2%	2%
2	10%	14%	3%	1%
3	14%	21%	3%	4%
4	8%	15%	6%	7%
5	20%	17%	12%	19%
6	13%	8%	10%	13%
7	16%	6%	15%	20%
8	7%	2%	20%	17%
9	1%	1%	13%	8%
risk-seeking	1%	1%	14%	9%

Q16. To what extent do you agree or disagree with each of the following statements? Q16_1. The Earth is like a spaceship, with very limited room and resources.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly agree	35%	38%	45%	38%
Somewhat agree	42%	50%	37%	33%
Somewhat disagree	19%	11%	11%	20%
Strongly disagree	4%	2%	7%	9%

Q16_2. Humans were meant to rule over the rest of nature.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly agree	9%	7%	34%	29%
Somewhat agree	24%	23%	27%	31%
Somewhat disagree	34%	33%	16%	23%
Strongly disagree	33%	37%	23%	17%

Q16_3. The balance of nature is very delicate and easily upset.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly agree	46%	33%	51%	52%
Somewhat agree	44%	52%	37%	39%
Somewhat disagree	8%	13%	9%	9%
Strongly disagree	1%	2%	2%	1%

Q16_4. Humans will eventually learn enough about how nature works to be able to control it.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly agree	13%	4%	46%	42%
Somewhat agree	38%	28%	40%	42%
Somewhat disagree	34%	42%	11%	12%
Strongly disagree	14%	26%	3%	3%

Q16_5. If things continue on their present course, we will soon experience a major ecological catastrophe.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly agree	40%	27%	55%	65%
Somewhat agree	45%	56%	36%	31%
Somewhat disagree	11%	16%	8%	4%
Strongly disagree	4%	2%	1%	1%

Q17. The following gives descriptions of various people. To what extent do you think you are similar or dissimilar to the people described below? Q17_1. They believe it is important for everyone to have equal opportunities in life.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	43%	15%	57%	61%
Somewhat similar	45%	58%	34%	34%
Somewhat dissimilar	9%	22%	6%	5%
Very dissimilar	4%	4%	3%	1%

Q17_2. They work to promote peace among diverse groups of people.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	30%	5%	52%	51%
Somewhat similar	49%	43%	39%	44%
Somewhat dissimilar	16%	40%	6%	5%
Very dissimilar	5%	12%	2%	0%

Q17_3. Protecting the weak and vulnerable members of society is important to them.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	40%	11%	53%	53%
Somewhat similar	46%	55%	37%	40%
Somewhat dissimilar	10%	28%	8%	7%
Very dissimilar	4%	6%	2%	1%

Q17_4. Caring for the well-being of people who they are close to is important to them.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	46%	20%	58%	64%
Somewhat similar	44%	58%	32%	32%
Somewhat dissimilar	9%	18%	9%	4%
Very dissimilar	2%	4%	1%	1%

Q17_5. They want people to do what they say.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	20%	5%	40%	28%
Somewhat similar	35%	30%	39%	39%
Somewhat dissimilar	30%	46%	15%	22%
Very dissimilar	15%	19%	6%	11%

Q17_6. Being wealthy is important to them.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	15%	7%	41%	24%
Somewhat similar	34%	47%	39%	39%
Somewhat dissimilar	34%	38%	14%	26%
Very dissimilar	17%	8%	6%	12%

Q17_7. It is important for them to be the one who tells others what to do.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	13%	4%	38%	28%
Somewhat similar	29%	28%	40%	35%
Somewhat dissimilar	33%	47%	17%	28%
Very dissimilar	25%	20%	5%	10%

Q17_8. It is important for them to be the most influential person in any group.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	12%	4%	41%	28%
Somewhat similar	30%	27%	40%	29%
Somewhat dissimilar	31%	39%	13%	31%
Very dissimilar	26%	30%	6%	12%

Q18. Please read the following descriptions of various people. To what extent are you similar or dissimilar to each of the people described below? Q18_1. Their personal security is extremely important to them.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	46%	34%	56%	63%
Somewhat similar	45%	51%	34%	32%
Somewhat dissimilar	8%	13%	8%	4%
Very dissimilar	1%	2%	2%	1%

Q18_2. They avoid anything that might endanger their safety.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	30%	19%	48%	58%
Somewhat similar	49%	56%	40%	35%
Somewhat dissimilar	17%	21%	10%	7%
Very dissimilar	4%	4%	2%	1%

Q18_3. It is important for them to live in secure surroundings.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	45%	36%	59%	70%
Somewhat similar	46%	50%	33%	27%
Somewhat dissimilar	8%	12%	6%	3%
Very dissimilar	1%	2%	2%	0%

Q18_4. Order and stability in society are important to them.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	37%	27%	55%	64%
Somewhat similar	49%	57%	37%	31%
Somewhat dissimilar	12%	13%	7%	3%
Very dissimilar	2%	3%	2%	1%

Q18_5. Their livelihood has been impacted by the COVID-19 pandemic.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	22%	13%	48%	60%
Somewhat similar	38%	41%	37%	31%
Somewhat dissimilar	25%	35%	11%	8%
Very dissimilar	16%	11%	4%	1%

Q18_6. They're scared of getting infected with COVID-19.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	25%	21%	45%	57%
Somewhat similar	37%	53%	40%	34%
Somewhat dissimilar	23%	20%	11%	6%
Very dissimilar	15%	6%	4%	3%

Q18_7. They're willing to receive the recommended number of COVID-19 vaccine injections.				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Very similar	44%	27%	58%	52%
Somewhat similar	35%	44%	33%	36%
Somewhat dissimilar	12%	19%	7%	9%
Very dissimilar	9%	9%	3%	3%

Q19. How much do you trust the following groups as a source of information about society and the environment? Q19_1. National government				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly trust	11%	4%	51%	29%
Somewhat trust	33%	24%	36%	44%
Neither trust nor distrust	26%	43%	8%	18%
Somewhat distrust	16%	16%	3%	7%
Strongly distrust	13%	13%	2%	2%

Q19_2. Private companies				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly trust	4%	3%	27%	18%
Somewhat trust	26%	28%	44%	44%
Neither trust nor distrust	40%	56%	21%	30%
Somewhat distrust	18%	9%	7%	7%
Strongly distrust	11%	4%	2%	1%

Q19_3. Environmental organisations				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly trust	20%	5%	55%	49%
Somewhat trust	45%	31%	35%	40%
Neither trust nor distrust	22%	46%	8%	9%
Somewhat distrust	6%	10%	2%	1%
Strongly distrust	7%	9%	1%	1%

Q19_4. Media (newspapers, television broadcasts, etc.)				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly trust	7%	3%	34%	16%
Somewhat trust	28%	26%	42%	44%
Neither trust nor distrust	30%	47%	15%	27%
Somewhat distrust	20%	12%	5%	9%
Strongly distrust	15%	12%	4%	4%

Q19_5. Researchers at universities or government institutions				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly trust	26%	6%	56%	45%
Somewhat trust	46%	37%	34%	43%
Neither trust nor distrust	19%	47%	6%	9%
Somewhat distrust	5%	5%	2%	1%
Strongly distrust	4%	5%	1%	0%

Q19_6. United Nations and other international organisations				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly trust	15%	4%	47%	40%
Somewhat trust	41%	28%	40%	43%
Neither trust nor distrust	25%	48%	9%	14%
Somewhat distrust	10%	11%	2%	2%
Strongly distrust	9%	9%	2%	2%

Q19_7. Friends and family				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Strongly trust	36%	24%	53%	53%
Somewhat trust	42%	42%	34%	35%
Neither trust nor distrust	18%	30%	9%	11%
Somewhat distrust	3%	3%	2%	1%
Strongly distrust	2%	2%	1%	0%

Q20. What is your highest academic degree or certificate?				
	AU (n=598)	JP (n=597)	IN (n=583)	PH (n=596)
Less than a high school degree	7%	3%	0%	2%
High school degree or equivalent (e.g. GED)	27%	26%	3%	12%
Some college, but no degree	19%	8%	6%	18%
Associate’s degree	11%	18%	2%	5%
Bachelor’s degree	27%	41%	38%	56%
Graduate degree	9%	5%	51%	6%

Appendix 2. Charts for other questions

The order of countries with the most risk-taking respondents is India, the Philippines, Australia, and Japan.

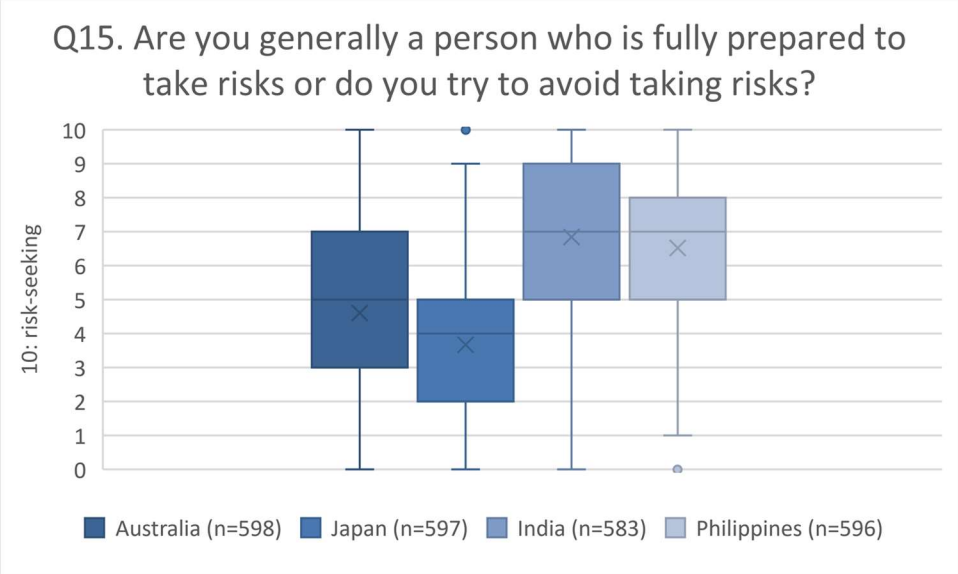
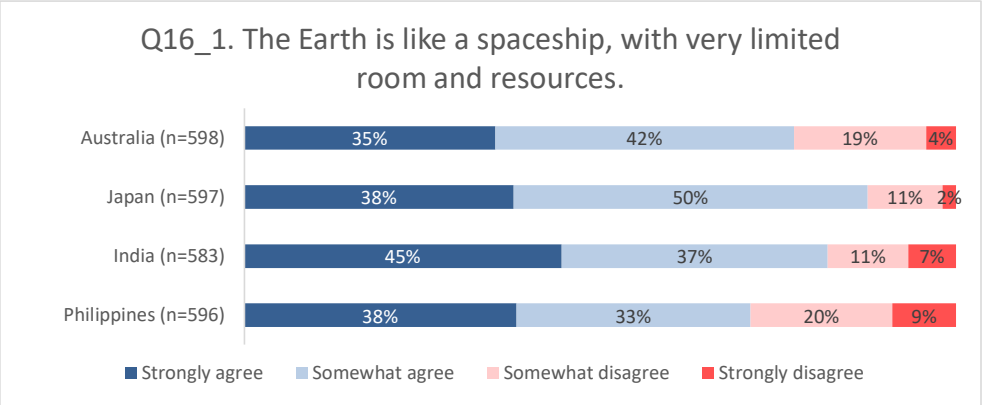
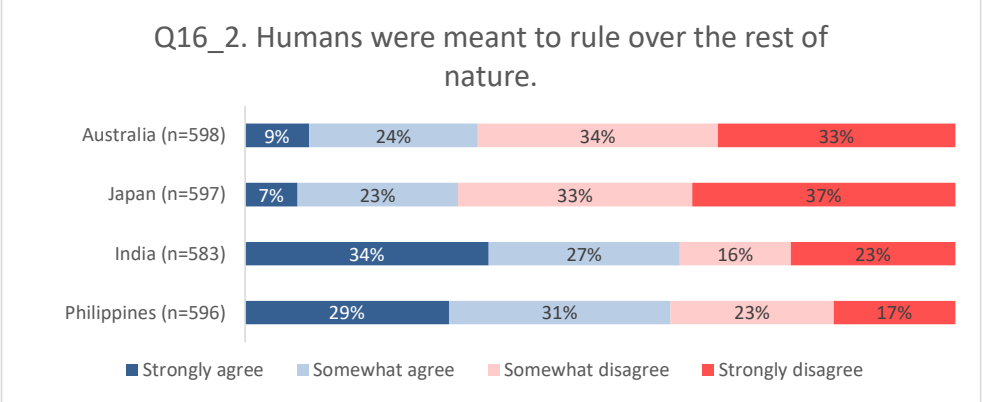
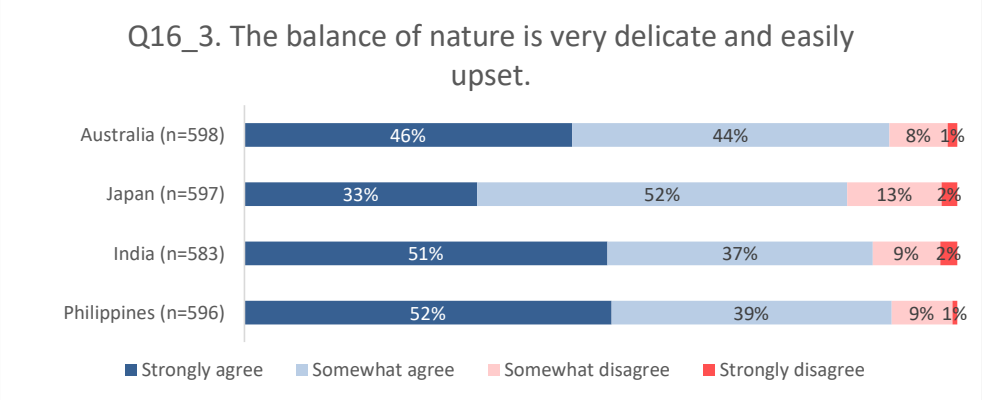


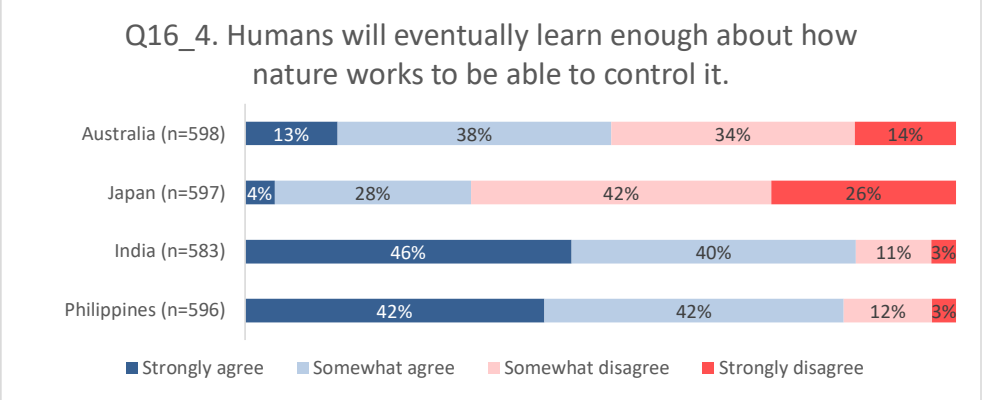
Figure 15. Responses to Q15. Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?

Two questions about attitudes toward nature were answered differently by the North and the South (Q16_2 and Q16_4). In particular, the South (India: 46%; the Philippines: 42%) agreed more strongly than the North (Australia: 13%; Japan: 4%) on the idea that humans would be able to control nature.









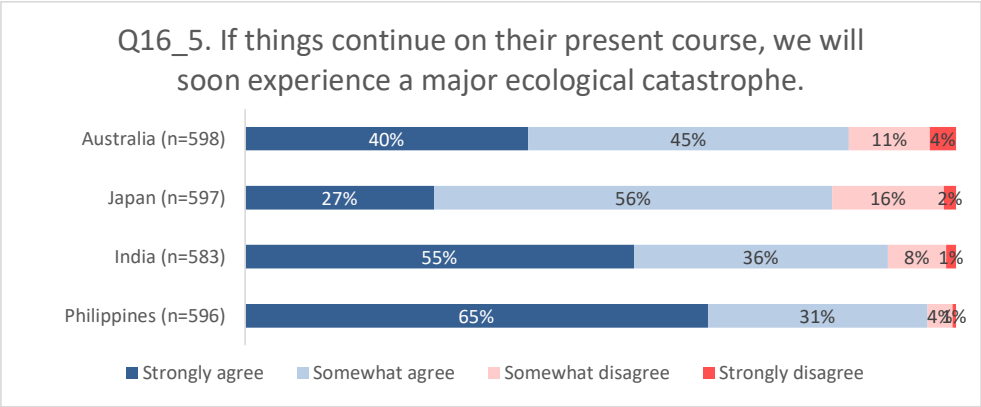
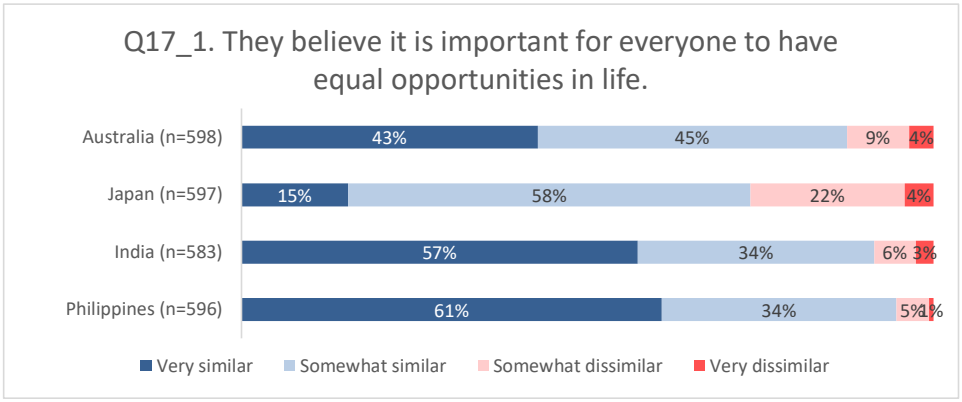
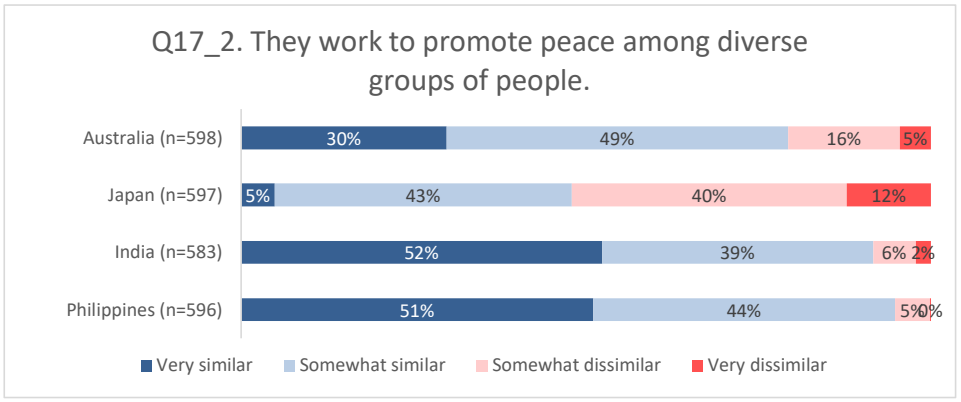
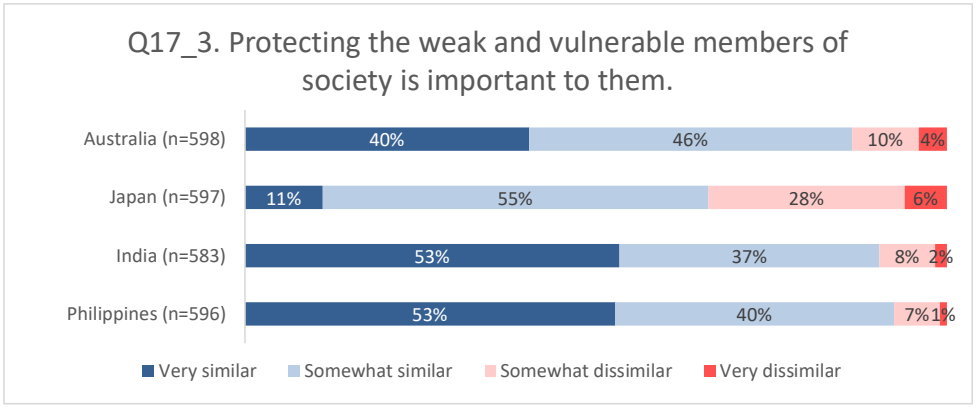


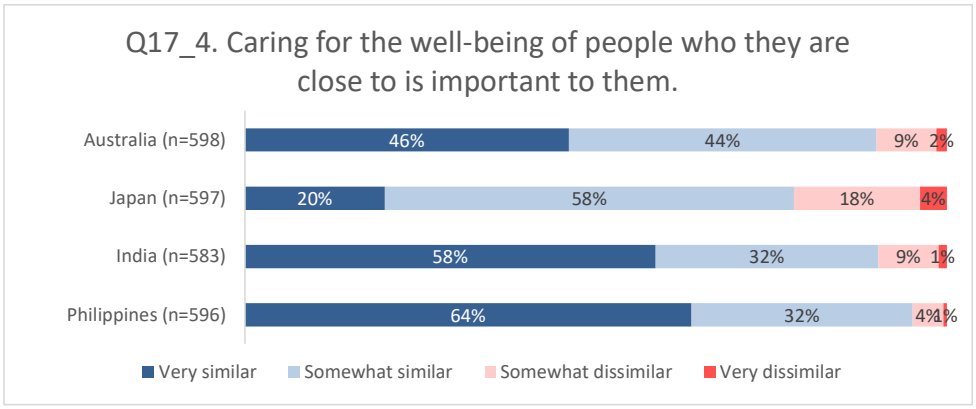
Figure 16. Responses to Q16. To what extent do you agree or disagree with each of the following statements?

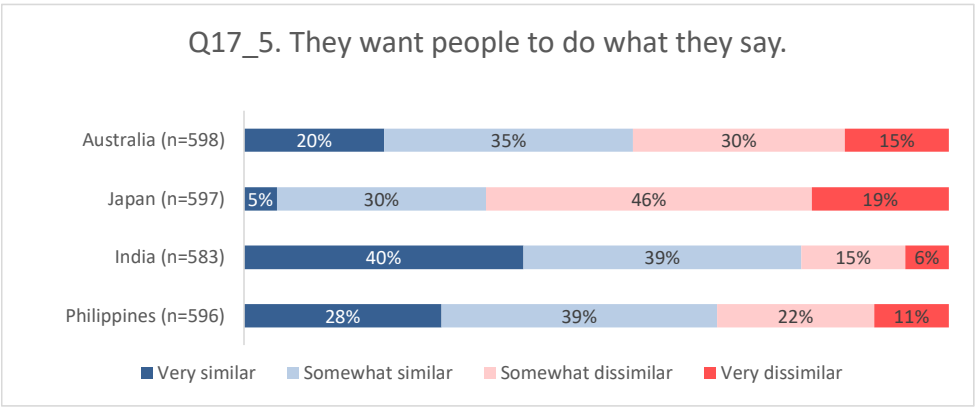
Two questions about personality were answered differently by the North and the South (Q17_7 and Q17_8). In particular, the South (India: 41%; the Philippines: 28%) responded that they were more strongly similar than the North (Australia: 12%; Japan: 4%) with regard to the most influential person. A majority of the respondents in Japan said they were very or somewhat dissimilar peace-promoter or control-seekers, while a majority of the respondents in the other three countries said they were very or somewhat similar (Q17_2 and Q17_5).

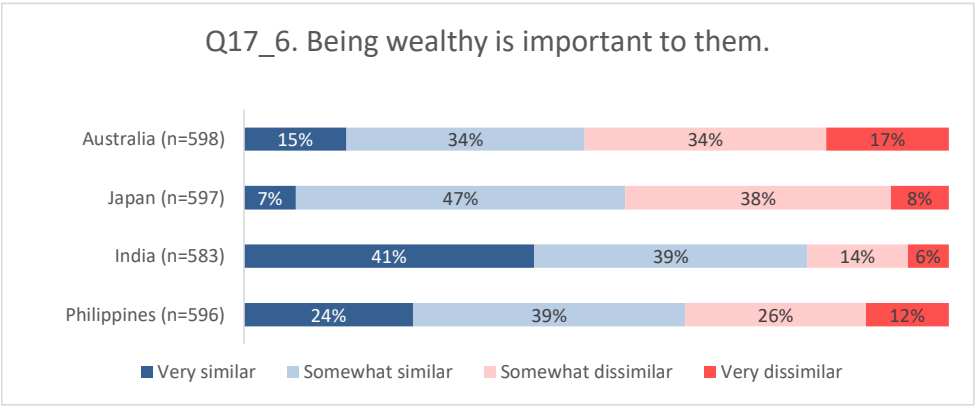


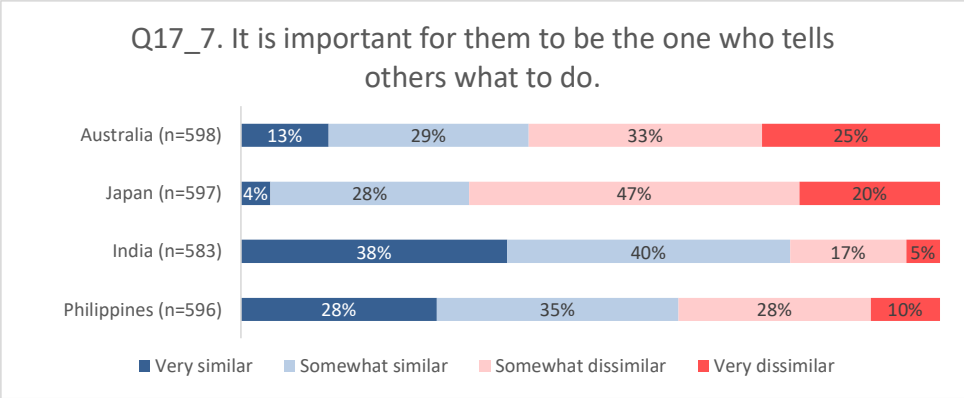



Q17_3. Protecting the weak and vulnerable members of society is important to them.
Australia (n=598)
40%
46%
10%
4%
Japan (n=597)
11%
55%
28%
6%
India (n=583)
53%
37%
8%
2%
Philippines (n=596)
53%
40%
7%
1%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar


Q17_4. Caring for the well-being of people who they are close to is important to them.
Australia (n=598)
46%
44%
9%
2%
Japan (n=597)
20%
58%
18%
4%
India (n=583)
58%
32%
9%
1%
Philippines (n=596)
64%
32%
4%
1%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar


Q17_5. They want people to do what they say.
Australia (n=598)
20%
35%
30%
15%
Japan (n=597)
5%
30%
46%
19%
India (n=583)
40%
39%
15%
6%
Philippines (n=596)
28%
39%
22%
11%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar


Q17_6. Being wealthy is important to them.
Australia (n=598)
15%
34%
34%
17%
Japan (n=597)
7%
47%
38%
8%
India (n=583)
41%
39%
14%
6%
Philippines (n=596)
24%
39%
26%
12%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar



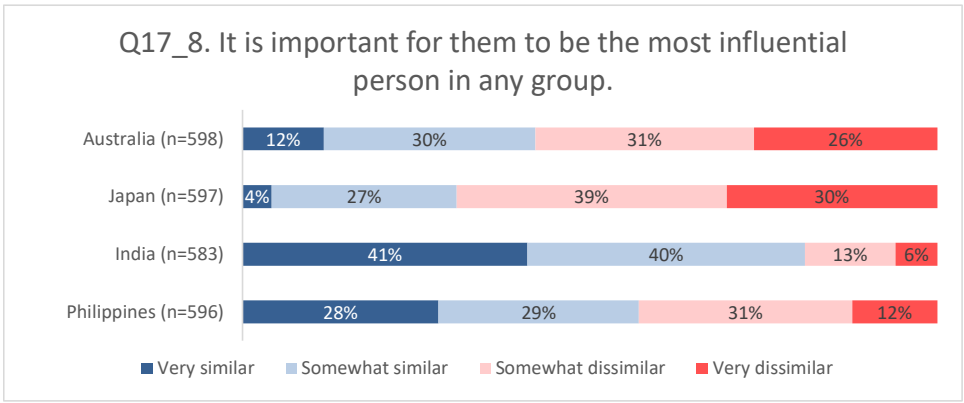
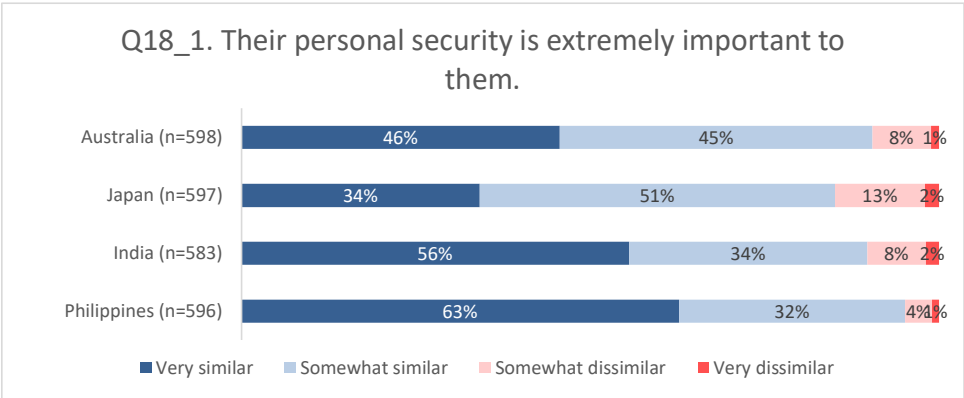
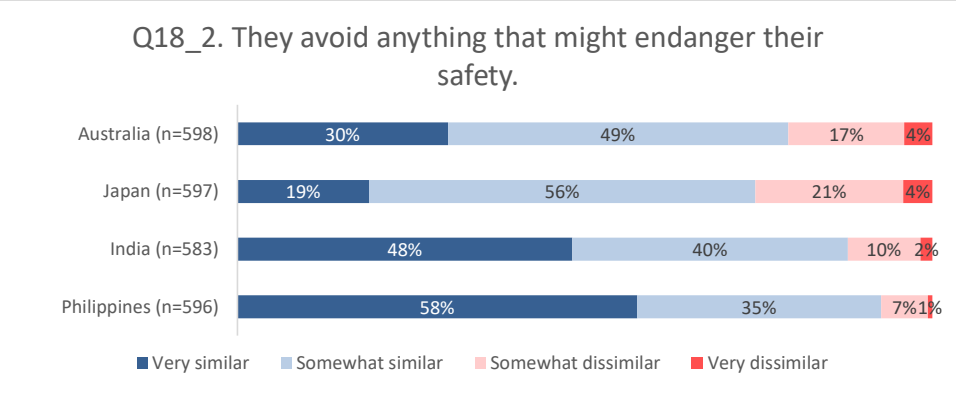
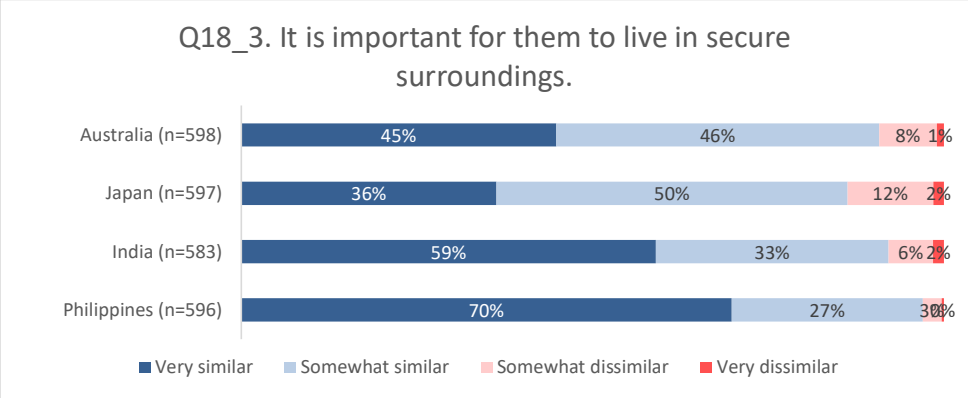


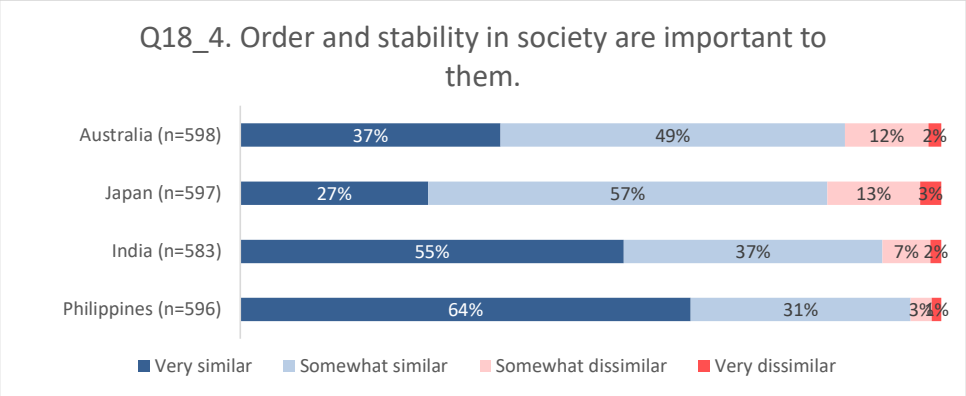
Figure 17. Responses to Q17. The following gives descriptions of various people. To what extent do you think you are similar or dissimilar to the people described below?

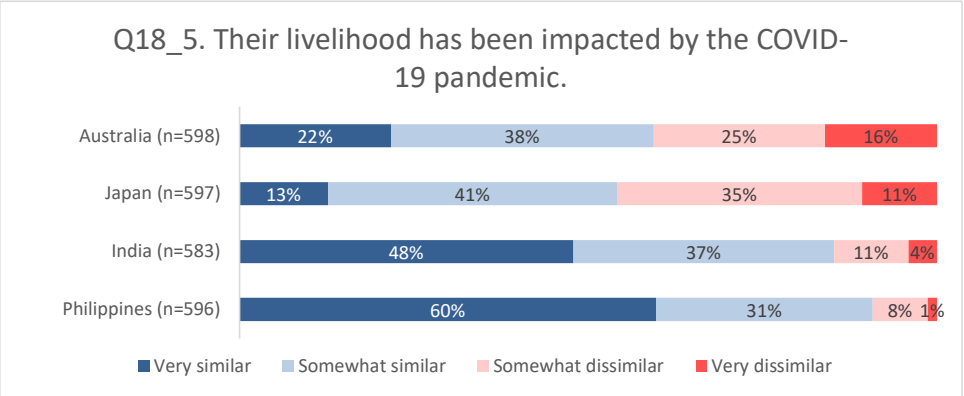
COVID-19 has the largest impact in the Philippines, followed by India, Australia, and Japan.

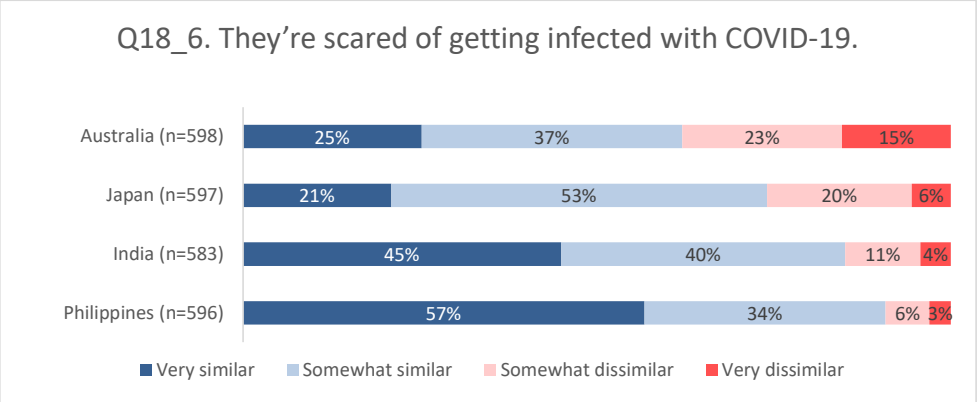



Q18_2. They avoid anything that might endanger their safety.
Australia (n=598)
30%
49%
17%
4%
Japan (n=597)
19%
56%
21%
4%
India (n=583)
48%
40%
10%
2%
Philippines (n=596)
58%
35%
7%
1%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar


Q18_3. It is important for them to live in secure surroundings.
Australia (n=598)
45%
46%
8%
1%
Japan (n=597)
36%
50%
12%
2%
India (n=583)
59%
33%
6%
2%
Philippines (n=596)
70%
27%
3%
0%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar


Q18_4. Order and stability in society are important to them.
Australia (n=598)
37%
49%
12%
2%
Japan (n=597)
27%
57%
13%
3%
India (n=583)
55%
37%
7%
2%
Philippines (n=596)
64%
31%
3%
1%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar


Q18_5. Their livelihood has been impacted by the COVID-19 pandemic.
Australia (n=598)
22%
38%
25%
16%
Japan (n=597)
13%
41%
35%
11%
India (n=583)
48%
37%
11%
4%
Philippines (n=596)
60%
31%
8%
1%
Very similar
Somewhat similar
Somewhat dissimilar
Very dissimilar



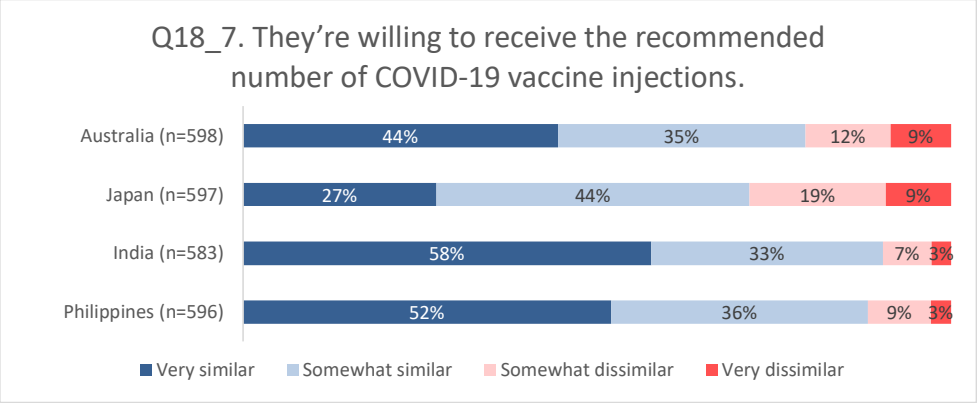


Figure 18. Responses to Q18. Please read the following descriptions of various people. To what extent are you similar or dissimilar to each of the people described below?

More than 60% of respondents in all countries indicated that they very or somewhat trust "Friends and family" as a source of information. Similarly, India and the Philippines have high levels of trust in "Researchers at universities," "Environmental organizations," and "United Nations," India also has high levels of trust in "National Government". Japan has a high percentage of "Neither trust nor distrust" responses.

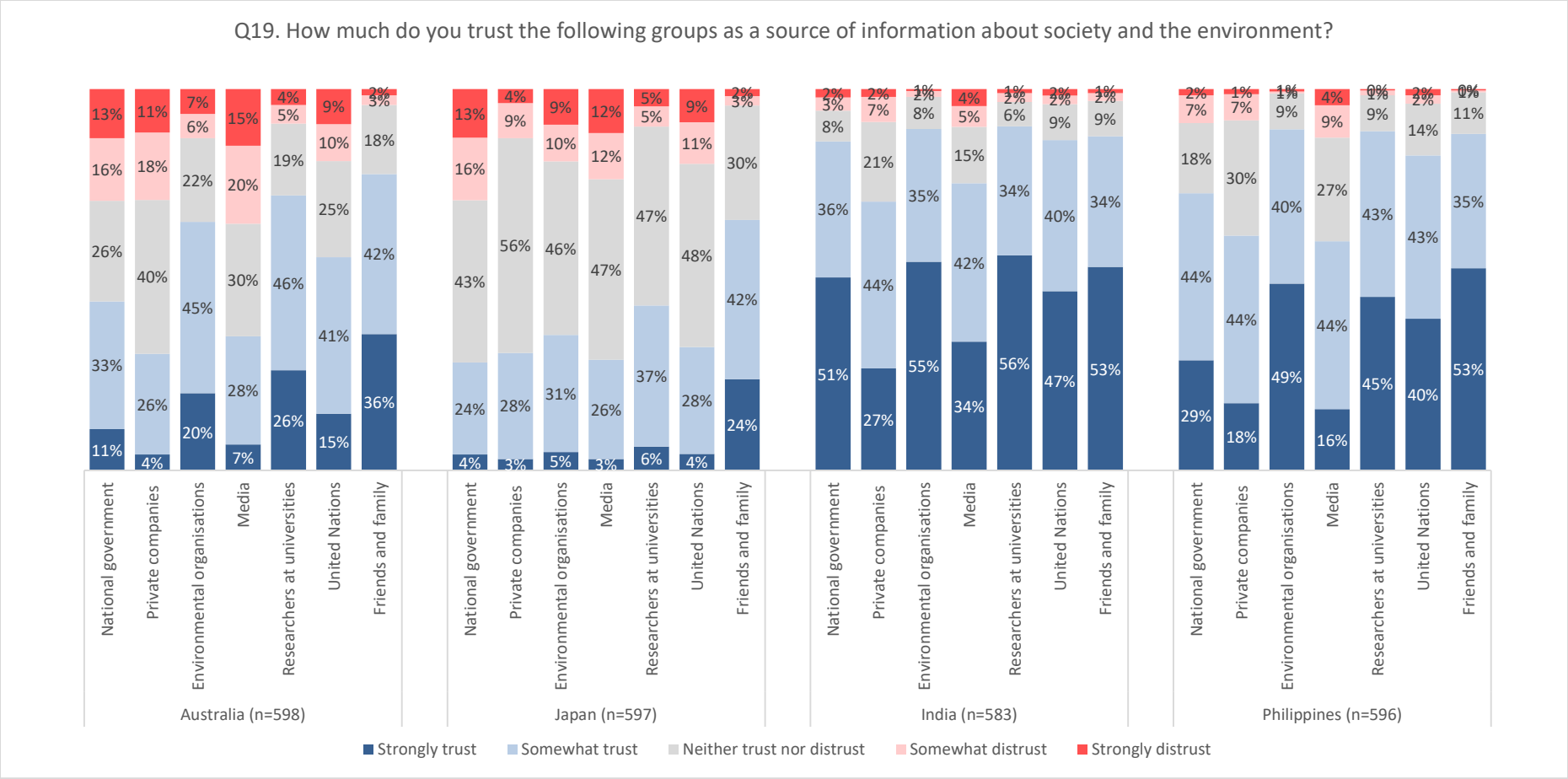


Figure 19. Responses to Q19. How much do you trust the following groups as a source of information about society and the environment?

All countries have a high percentage of "Bachelor's degree" respondents. India shows a high educational bias with 51% of respondents selecting "Graduate degree".

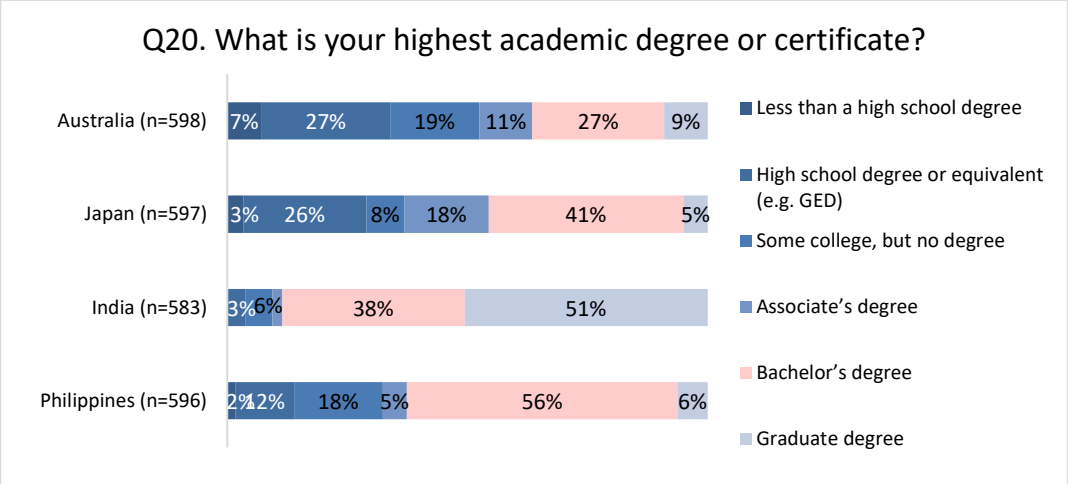


Figure 20. Responses to Q20. What is your highest academic degree or certificate?

Respondents were equally distributed by gender and age by the survey firm. Company employee (full-time)" was the most common occupation in all four countries.

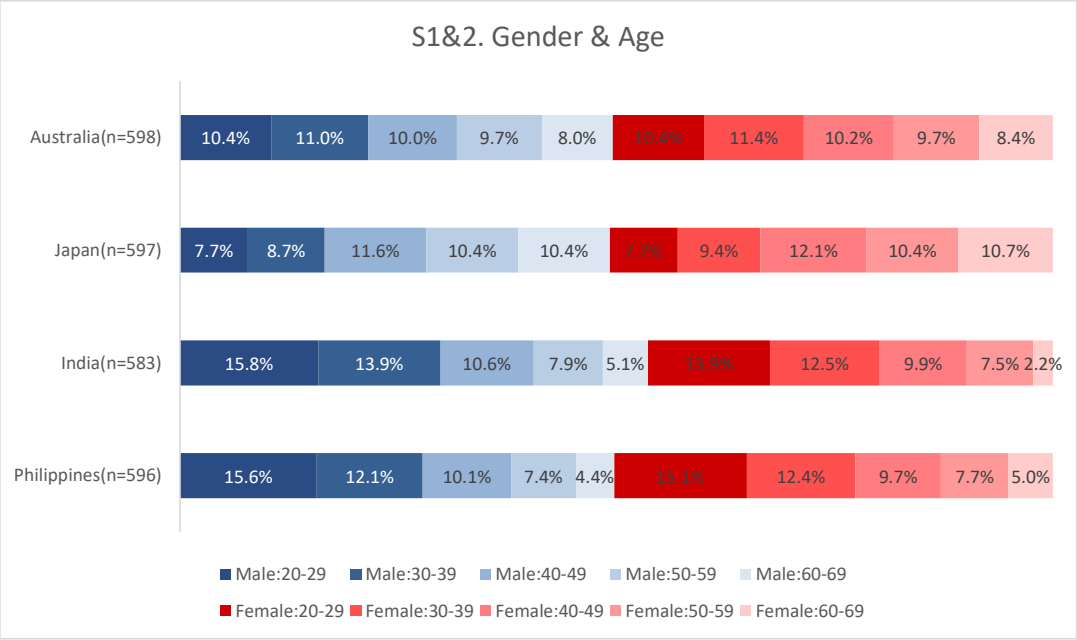


Figure 21. Responses to Gender and Age

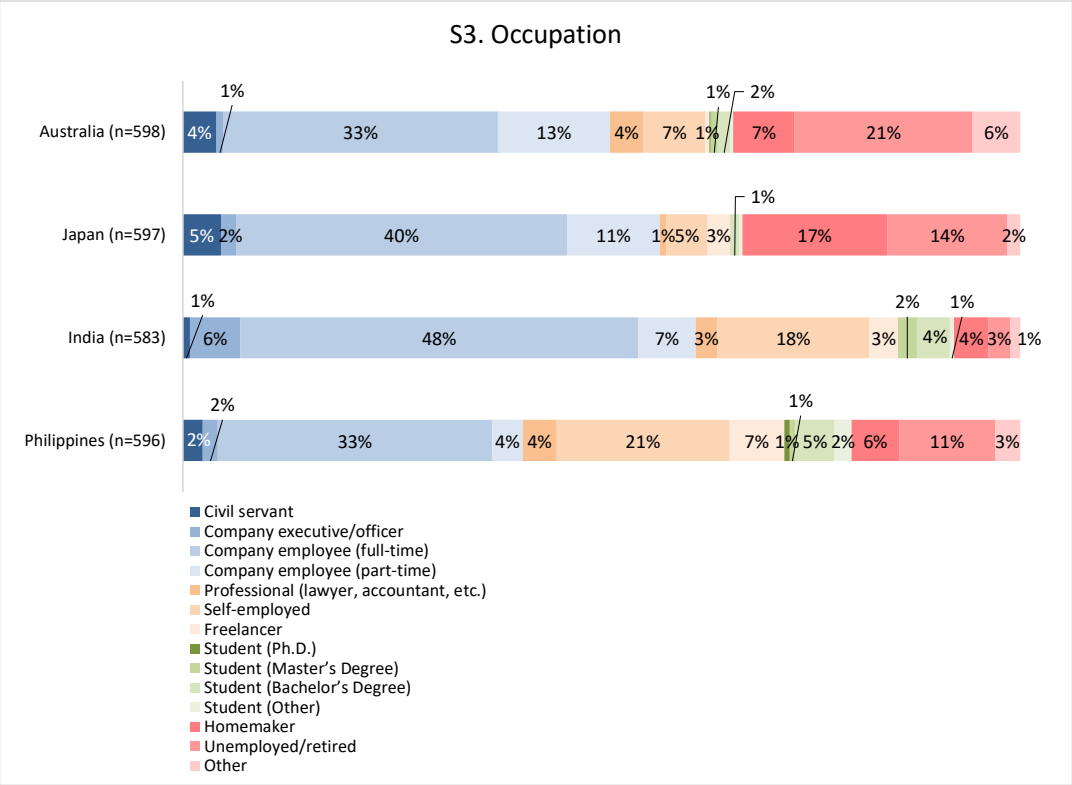


Figure 22. Responses to Occupation

Appendix 3. Information materials in Japanese

Information material in Japanese.

Scenario1

2030年の未来シナリオ

主に石炭や石油、天然ガスなどの化石燃料を燃やして出る二酸化炭素(CO2)が大気中で増えて、よりたくさんの熱が地球にこもることで地球温暖化が生じ、異常気象(熱波・山火事・洪水・干ばつなど)を増加させつつあります。
研究によれば産業革命前からの世界平均気温上昇を1.5℃に抑えることで異常気象の災害リスクを減らし、これまでの生活をなんとか維持できます。
2021年に国際社会は、気温上昇を1.5℃に抑える努力を行うことに合意し、化石燃料の使用を抑えてCO2の排出量を大幅に減らし、今世紀半ば頃には実質ゼロにすることを目標としました。
2030年現在、国際社会の一致した努力によって削減が進んできた結果、気温上昇を1.5℃に抑えられる可能性が高まりました。
しかし、気温上昇を1.5℃に抑えても、南極やグリーンランドの大規模な氷床が溶けて海面上昇が加速したり、北極域の永久凍土が溶けて強力な温室効果ガスのメタンが大量に放出されて温暖化が加速したりする可能性があることが最新の科学で分かってきました。
こうした中、新しい地球温暖化対策として、「気候工学」と呼ばれる人工的に地球を冷やす方法の検討が始まっており、2035年頃からの実施開始を視野に入れて、国際的な地球冷却計画が動き出しました。
飛行機などを使い、太陽光を反射する微粒子を大気上空にまく技術が検討されています。
過去20年以上の研究の蓄積から冷却効果が確認された一方、一部の地域での降水の変化やオゾン層も破壊される恐れがあるなど環境への副作用も懸念されています。
国際地球冷却計画は、CO2を減らしつつも、氷床や永久凍土の溶解の可能性に備えて、小規模な気候工学を安全に使うことを目的としています。

Scenario 2

2030年の未来シナリオ

主に石炭や石油、天然ガスなどの化石燃料を燃やして出る二酸化炭素(CO2)が大気中で増えて、よりたくさんの熱が地球にこもることで地球温暖化が生じ、異常気象(熱波・山火事・洪水・干ばつなど)を増加させつつあります。
研究によれば産業革命前からの世界平均気温上昇を1.5℃に抑えることで異常気象の災害リスクを減らし、これまでの生活をなんとか維持できます。
2021年に国際社会は、気温上昇を1.5℃に抑える努力を行うことに合意し、化石燃料の使用を抑えてCO2の排出量を大幅に減らし、今世紀半ば頃には実質ゼロにすることを目標としました。
2030年現在、大排出国や、急激な経済発展や人口の増加をとげた途上国などでは削減が進まず、気温上昇は近いうちに1.5℃を超える見通しです。
このままでは近い将来、南極やグリーンランドの大規模な氷床が溶けて海面上昇が加速したり、北極域の永久凍土が溶けて強力な温室効果ガスのメタンが大量に放出されて温暖化が加速したりする恐れが生じています。
こうした中、新しい地球温暖化対策として、「気候工学」と呼ばれる人工的に地球を冷やす方法の検討が始まっており、2035年頃からの実施開始を視野に入れて、国際的な地球冷却計画が動き出しました。
飛行機などを使い、太陽光を反射する微粒子を大気上空にまく技術が検討されています。
過去20年以上の研究の蓄積から冷却効果が確認された一方、一部の地域での降水の変化やオゾン層も破壊される恐れがあるなど環境への副作用も懸念されています。
国際地球冷却計画は、国際社会の一致した削減努力が期待できない中、氷床や永久凍土の溶解を予防するため、大規模な気候工学を安全に使うことを目的としています。