nature climate change

Article

https://doi.org/10.1038/s41558-024-02091-2

Climate change engagement of scientists

Received: 19 December 2023

Accepted: 14 July 2024

Published online: 05 August 2024

Check for updates

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Climate change is one of the biggest threats to humanity. Scientists are well positioned to help address it beyond conducting academic research, yet little is known about their wider engagement with the topic. We investigate scientists' engagement with climate change using quantitative and qualitative analyses of a large-scale survey ($N = 9{,}220$) across 115 countries, all fields and all career stages. Many scientists already engage in individual lifestyle changes, but fewer engage in advocacy or activism. On the basis of our quantitative and qualitative results, we propose a two-step model of engagement to better understand why. Scientists must first overcome intellectual and practical barriers to be willing to engage, and then overcome additional barriers to actually engage. On the basis of this model, we provide concrete recommendations for increasing scientists' engagement with climate change.

Humanity is crossing multiple planetary boundaries, pushing the Earth system outside the safe operating space for humanity[1,2]. Climate change poses a particularly urgent threat, with impacts considerably worse than predicted by earlier research[3,4]. While some governments and corporations have made pledges to limit global heating to 'well below' 2 °C, strategies to meet these pledges are lacking[5]. This leaves the world at high risk[6], with projected global heating by the end of the century that may be beyond the capacity of human societies to adapt[7,8].

There is growing recognition that insufficient mitigation and adaptation is substantially due to resistance from actors who benefit from the status quo[9–12]. These obstructors include not only fossil fuel companies making record profits and influencing policy making[13–16], but also wealthy, high-emitting individuals who, consciously or not, seek to protect their carbon-intensive lifestyles[17–19].

Overcoming this resistance and compelling governments to take decisive action against climate change requires bottom-up pressure from large parts of society[20,21]. Scientists and academics (henceforth 'scientists') are uniquely positioned to help mobilize society, given that they are among the most trusted groups in society[22] and have broad access to important stakeholders, including media and government[23,24]. Scientists working on climate change may use their status and expertise to shape public opinion by informing the public about climate risks and solutions[25,26] and advocate for stronger policy[27]. In addition, some have highlighted the role the wider scientific community could play in supporting the climate movement, for instance, by sharing knowledge about social change[27,28], by joining protests, which may lend credibility to the wider climate movement[29,30], and by educating students about the many facets of the climate crisis[31–33].

Accordingly, there have been increasing calls for scientists to engage in advocacy[34–36] as well as activism, including protest and civil disobedience[29,30,37–40]. However, despite the fact that scientists are uniquely positioned to understand and communicate the risks of climate change, only a small fraction of scientists appears to actively engage in climate advocacy or activism. It is therefore crucial to understand scientists' beliefs about climate change and their perceived barriers to climate change engagement. Studies addressing these

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 https://doi.org/10.1038/s41558-024-02091-2

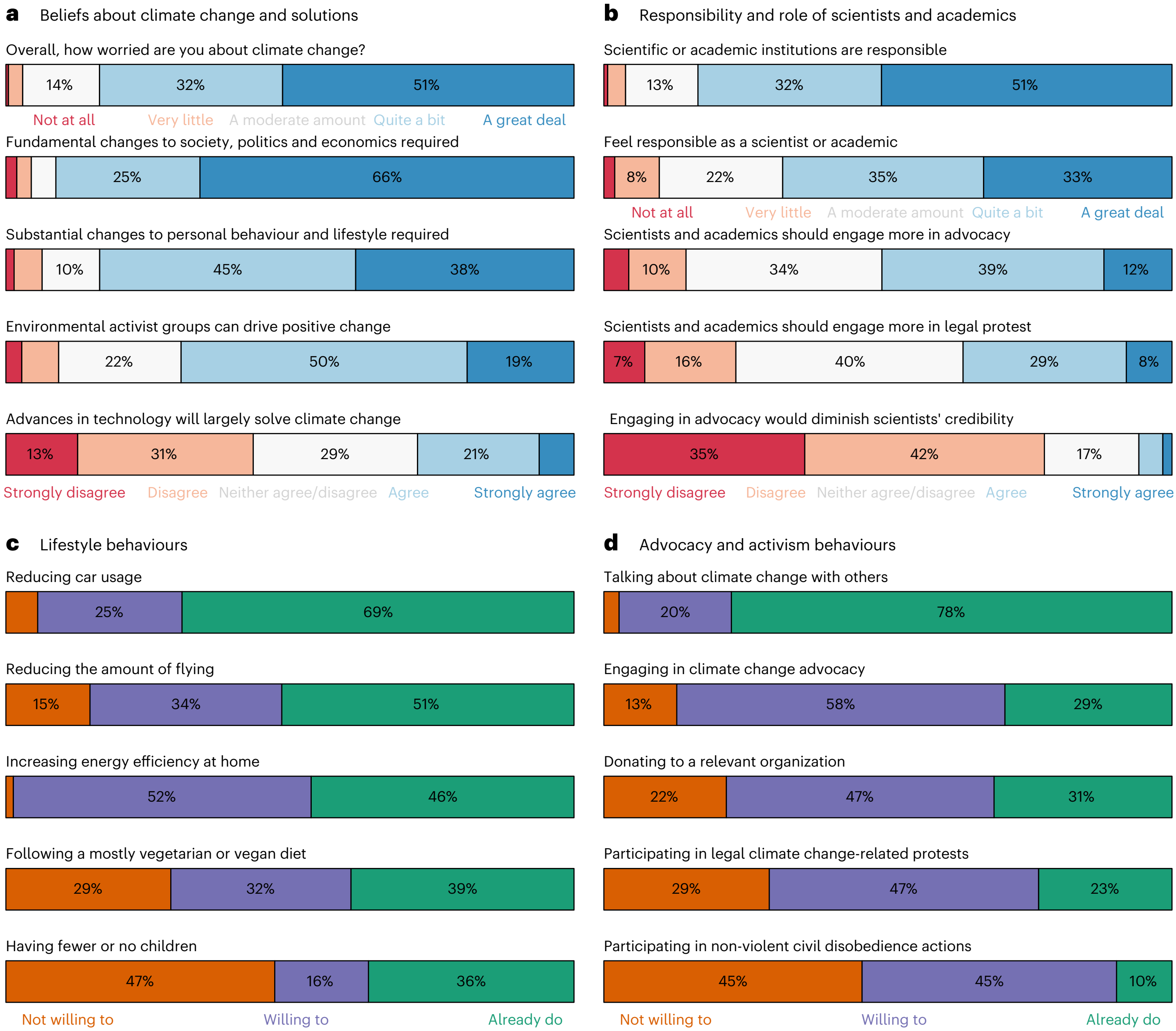

Fig. 1 | Descriptive statistics of key variables. a, Beliefs about climate change and solutions. **b**, Beliefs about responsibility and role of scientists. **c**, Lifestyle behaviours. **d**, Advocacy and activism behaviours. See Supplementary Table 2 for the exact formulations of the items. The maximum possible standard error of the percentages is 0.52% (for details, see Methods). Sample size, $N = 9{,}220$.

questions have primarily focused on scientists working on climate change[35,41–43], health professionals[44] or engagement not specific to climate change[45]. Given the scope of climate change, however, the engagement of scientists across disciplines and career stages is arguably highly valuable[28,46,47]. Here we report on a large-scale international survey ($N = 9{,}220$) investigating climate change engagement of scientists across all fields and career stages. We explore beliefs and behaviours related to climate change and what role scientists believe they should take and identify key predictors of whether scientists are engaged in advocacy or activism. We then propose a model for the engagement of scientists with climate change, suggesting concrete ways to increase their engagement.

Results

We first report descriptive statistics on scientists' climate change beliefs and actions, and then investigate which barriers are associated with engagement in advocacy and protest.

Scientists' climate change beliefs and actions

Respondents were invited to participate via personalized emails and came from 115 countries (Extended Data Fig. 1), all scientific disciplines and all career stages. Many were full professors (26%), from the natural sciences (42%), male (62%), between 35 and 54 years old (58%), from Europe (55%) and politically left leaning (46% indicated 1 or 2 on a 7-point Likert scale with 1 = left and 7 = right). The research of 17% of respondents was strongly related to climate change, but for 25%, climate change was not at all related to their research. Full demographics can be found in Supplementary Table 1. The sample matched the defined sample population reasonably well on all available measures (see Extended Data Table 1 and Extended Data Fig. 2).

Virtually all respondents believed that climate change is human caused (96%). Only these respondents completed the remaining questions. Most scientists surveyed said they were 'quite a bit' (42%) or 'a great deal' (30%) informed about climate change, with 32% of respondents expressing 'quite a bit' and 51% 'a great deal' of worry about climate change (Fig. 1a).

The overwhelming majority (91%) of all scientists (strongly) agreed that addressing climate change requires fundamental changes to social, political and economic systems, while most (84%) also (strongly) agreed that significant changes in personal and lifestyle behaviours are required. Almost twice as many scientists '(strongly) disagreed' that technology will largely solve the problems caused by climate change (44%) compared with those that (strongly) agreed (28%). A majority of scientists (69%) (strongly) agreed that environmental activist groups can drive positive change concerning climate change, with very few scientists (strongly) disagreeing (9%).

Concerning their perception of the role of scientists, most felt 'quite a bit' (35%) and 'a great deal' (33%) of responsibility as a scientist to reduce climate change. An even larger majority felt that scientific institutions have quite a bit (32%) or a great deal (51%) of responsibility to reduce climate change (Fig. 1b).

Many scientists (51%) (strongly) agreed that scientists should engage more in advocacy, and 35% neither agreed nor disagreed. Fewer scientists (36%) (strongly) agreed that scientists should engage more in legal climate change-related protests, and 40% neither agreed nor disagreed. Most scientists (65%) (strongly) disagreed that participating in legal climate change-related protests would diminish scientists' credibility, while even more (77%) (strongly) disagreed that participating in climate change advocacy would diminish their credibility.

Many of the scientists reported making high-impact lifestyle changes (Fig. 1c), including reducing car usage (69%), reducing flying (51%), increasing energy efficiency at home or shifting to renewable energy (46%), following a vegetarian or vegan diet (39%) and having fewer children (36%). Many also reported engaging in advocacy and activism behaviours (Fig. 1d), including talking to others about climate change (78%), engaging in advocacy (29%), donating to organizations addressing climate change (31%), participating in legal climate change-related protests (23%), and a meaningful fraction had engaged in civil disobedience (10%). For a full list of behaviours, see Supplementary Tables 2–5.

We also explored which characteristics and beliefs of scientists were associated with six lifestyle behaviours and seven advocacy and activism behaviours (see Supplementary Text and Supplementary Fig. 1).

Barriers to advocacy and protest

To better understand perceived barriers to action, we modelled the differences between scientists who (1) were willing to engage in advocacy (n = 5,329) or legal climate change-related protest (n = 4,371) compared to those who were not willing to (n = 1,184 and n = 2,686), and the differences between scientists who (2) already engaged in advocacy (n = 2,707) or protest (n = 2,163) compared with those who were willing to engage. To analyse which barriers are associated with advocacy and protest, we estimated individual Bayesian multilevel logistic regressions (Fig. 2) for each variable on advocacy (left) and protest (right) with the results for the contrast of not willing to vs willing to (orange) and the contrast of willing to vs already do (green). We included random intercepts and random slopes to model heterogeneity across countries (see Methods and Supplementary Fig. 2). Below we focus our discussion on variables other than background variables (for example, gender, tenure status), since those cannot be plausibly intervened on.

Not willing to vs willing to engage. We first compare those scientists who are not willing to engage with those who are willing to engage in advocacy and protest. For both behaviours, key groups of variables that were associated with more willingness to engage include (1) higher levels of worry and believed climate impacts on oneself, (2) increased personal/academic/institutional responsibility, (3) beliefs that academics should engage more in protest and advocacy, (4) that activists can drive change, (5) that both system and lifestyle changes are required and (6) having an activist in one's inner circle. Variables that were associated with less willingness to engage were (1) not being convinced of the behaviours' impact (particularly for protest), (2) believing that the behaviour would diminish the credibility of scientists (particularly for protest), (3) that there is not much we can do and that scientific institutions are doing enough and (4) fearing potential repercussions and believing that the behaviour would negatively affect one's reputation (particularly for protest). We consider the effect of not knowing any groups an artefact of the question design (see Supplementary Text). For correlations between all variables, see Supplementary Fig. 3. While the effects of the variables were similar for both advocacy and protest, the size of the effects was generally higher for protest.

A considerable number of scientists (n = 1,590 for advocacy; n = 2,848 for protest) provided open-text responses, which we coded qualitatively (see Supplementary Tables 6–8). Consistent with the quantitative results, key barriers to advocacy for those not willing to engage were: not being convinced about the efficacy of advocacy (mentioned by 8% of scientists who provided open-ended responses), having conceptions of the role of scientists that are in tension with advocacy (for example, mentioning neutrality, objectivity and the value-free ideal of science[48,49]; 9%), perceiving themselves as not having a suitable personality (12%) or believing that they did not have enough skills and knowledge about climate change (11%). Key barriers to engaging in protests for those not willing to engage included doubts about the efficacy of protests (15%), including believing that they could have more impact in a different role (for example, as educator; 11%) or in other routes to change (15%), as well as potential adverse effects of protests (10%). Disagreement with activist ideology and strategies (15%) and perceiving one does not have a suitable personality (14%) were also described as barriers to joining protests.

Willing to vs already engaged. We next compared those who were willing to engage in advocacy or protest to those who already did. For both behaviours, key groups of variables that were associated with more engagement were (1) higher levels of worry, (2) increased personal/academic/institutional responsibility (particularly for advocacy) and (3) having an advocate/activist in one's inner circle. Variables that were associated with less willingness to engage are (1) not knowing any groups, (2) lack of time, (3) not being convinced of the behaviours' impact, (4) perceiving one has a 'too carbon-intensive' lifestyle and (5) believing that the behaviour would diminish one's credibility (particularly for protest). For advocacy, being informed on climate change was associated with increased engagement, and feeling one does not know enough about climate change was associated with decreased engagement. These effects were smaller for protest. Believing that academics should protest more was associated with increased engagement in protest, while the same belief regarding advocacy was much less strongly related to increased engagement in advocacy. Whether one's research was related to climate change had a stronger effect for advocacy compared with protest. For more on this variable, see Supplementary Figs. 4 and 5 and ref. 50. We also ran multiple logistic regression models (see Supplementary Fig. 4), whose predictive power is shown in Supplementary Table 9.

The corresponding qualitative analysis of the open-ended responses on barriers corroborated these findings. The key barrier described for both advocacy and protest for those willing to engage was not having enough time (16% and 14%, respectively). Not having enough skills and knowledge about climate change was mentioned as a barrier to advocacy (13%). Doubts about the efficacy of protests (8%), having concerns about activist strategy or ideology (6%) and a lack of opportunity (29%) were mentioned as barriers to protest. For all qualitative results and the coding procedure, see Supplementary Text and Tables 6–8. For results on civil disobedience, see Supplementary Fig. 7. Our study is subject to a number of limitations that are standard for observational designs (see Methods for details).

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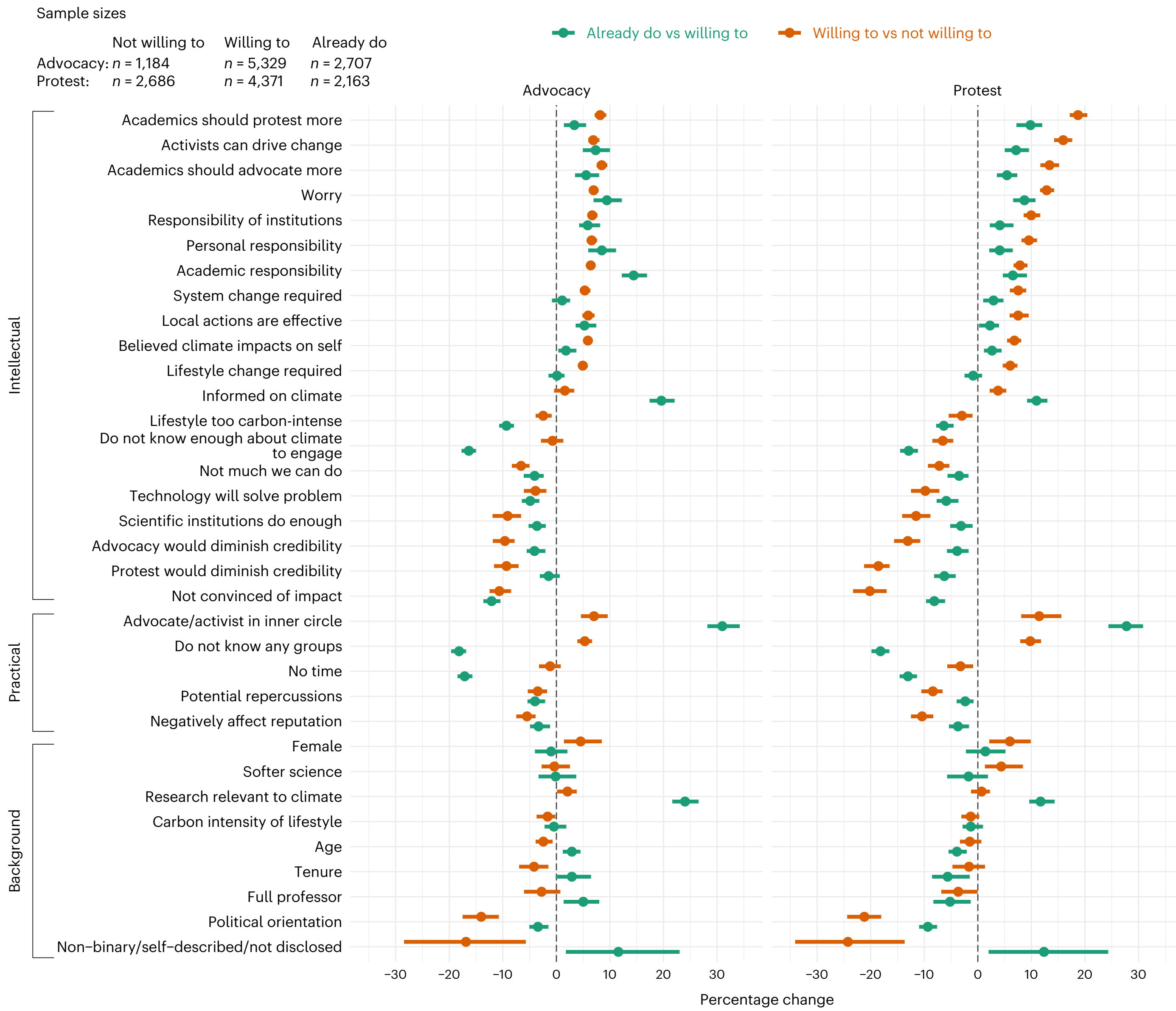

Fig. 2 | Results of individual multilevel logistic regressions predicting engagement. Posterior means and 95% credible intervals for the contrasts 'willing to vs not willing to' (orange) and 'already do versus willing to' (green) for both advocacy (left) and protest (right) from the individual Bayesian multilevel logistic regression models. We estimated one model for each variable. Correlations between all pairs of variables can be found in Supplementary Fig. 3. Heterogeneity across countries, effects from multiple regressions and moderating effect of research relevant to climate are visualized in Supplementary Figs. 2, 4 and 5/6, respectively. Non-binary predictors were z-standardized. Percentage change indicates the increase in percentage when going from 0 to 1 for a binary or a 1 s.d. increase for a non-binary predictor.

Discussion

Our large-scale investigation shows how scientists around the world view climate change, the extent to which they are engaged in climate action and what barriers keep them from engaging more. Nearly all scientists agree that climate change is caused by human activities and a large majority are worried about climate change and believe that addressing it requires fundamental changes to social, political and economic systems. A majority also believe that scientists and academic institutions have a responsibility to reduce climate change. Further, a sizable proportion reported having engaged in advocacy and activism behaviours, and a large proportion reported being willing to do so.

Barriers to climate change engagement

Despite serious concerns about climate change, most scientists did not report engaging in advocacy or protest. To better understand why, we synthesized our findings into a two-step model of barriers to engagement (Fig. 3). In this model, scientists are initially either undecided or unwilling to engage and first have to overcome a set of barriers to be willing to engage in principle, and then overcome additional barriers to actually engage. In both steps, we distinguish between 'intellectual' and 'practical' barriers and indicate whether they apply to engagement in advocacy (A) or protest (P).

In the first step, intellectual barriers of scientists' willingness to engage include low levels of worry about climate change, little knowledge about the subject, doubts about the efficacy of advocacy or protest, not feeling responsible as citizens or scientists and believing that it is not the role of scientists to engage in such behaviours. In addition, not identifying with activists and disagreeing with their ideology and strategy emerged as an intellectual barrier for willingness to join protests. Practical barriers to being willing to engage include the fear of losing credibility, perceiving oneself to have an unsuitable personality and not having an advocate/activist in one's inner circle. A perceived

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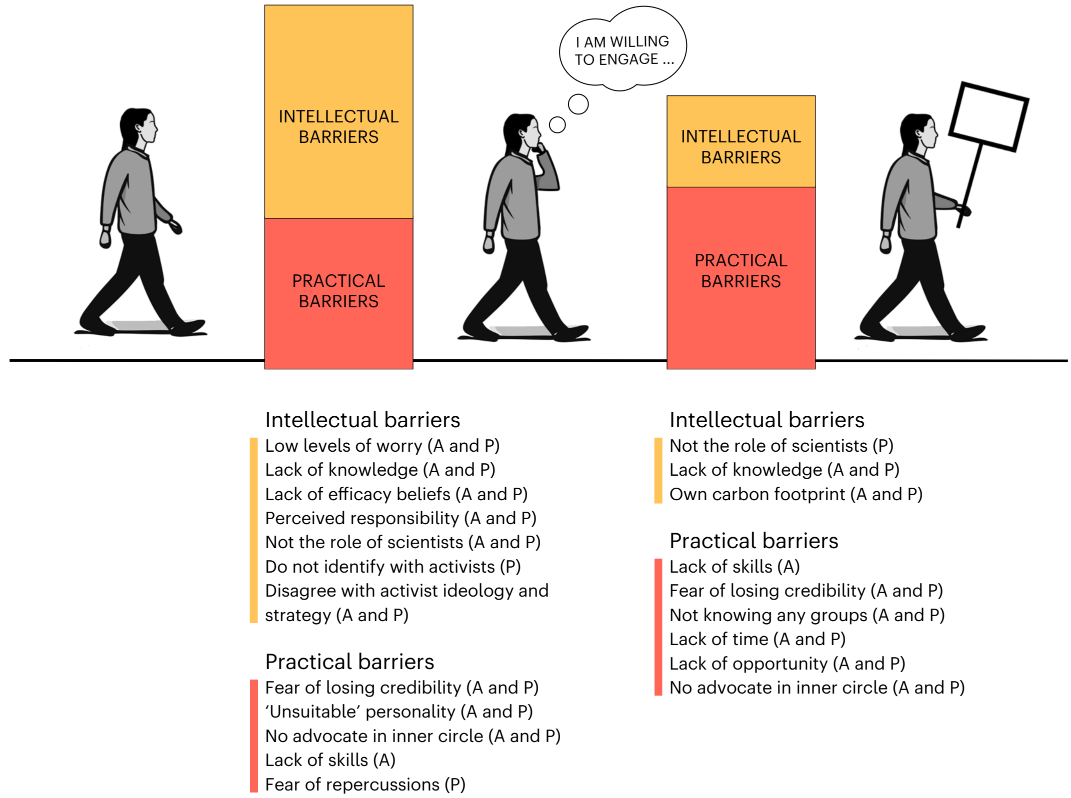

Fig. 3 | Model for barriers to climate change engagement of scientists. Key barriers of advocacy or protest, focusing on variables that could plausibly be intervened on. For example, academic discipline and political orientation are also important, but intervening on these variables is not desirable or feasible. A and P indicate whether a given barrier is a barrier only for advocacy (A), only for protest (P) or both (A and P).

lack of skill was especially pronounced for advocacy, while a particular barrier for protest was fear of repercussions.

Once scientists are willing to engage, practical barriers become more important than intellectual ones for actual engagement. Only three intellectual barriers emerged in the second step: beliefs about the role of scientists (for example, to stay 'objective') may reduce engagement in protests, lack of knowledge about climate change may reduce engagement in both protest and advocacy, and also the feeling that one's own carbon footprint is too high may reduce the willingness to engage in both protest and advocacy. Practical barriers for both advocacy and participating in protests include having no connections to advocates/activists, lack of time, lack of opportunities and the fear of losing credibility. In addition, lack of skills and expertise emerged as a barrier to engaging in advocacy behaviour. Key practical barriers such as lack of time, perceived lack of subject knowledge and skill, a perceived tension between science and advocacy/activism and lack of efficacy also emerged in previous studies on health professionals' and scientists' barriers to engagement[44–46,51,52]. Our findings suggest a number of routes to increase engagement of scientists.

Increasing engagement

Several intellectual barriers could be addressed through outreach and education. Facilitating interactions between scientists who are worried and engaged with those who are not, for example, at conferences[53–55], can lead to critical reflection on the role and responsibility of scientists, increased understanding and motivation to engage, and also show pathways to engagement. Connecting with scientists who engage in advocacy or activism could also resolve the barrier of not identifying with activists or disagreeing with specific types of activist ideology. Today's students are tomorrow's scientists, and teaching courses on the planetary emergency and adequate responses in every curriculum could be a powerful tool to equip them to be agents of change[56–58].

While research suggests that loss of credibility due to advocacy depends on the advocated policy[59], available research suggests that such fears are largely unfounded[35,60–62]. Existing work also suggests that protest and civil disobedience do not hurt credibility, but more research is needed[63]. Communicating these findings to scientists who are worrying about this issue may thus increase their engagement.

It is important to communicate that there is no simple solution for addressing climate change and that this type of engagement is subject to experimentation and adaptation to ecological, political and societal realities[64]. Scientists who have doubts about the efficacy of certain actions could be involved in this discussion to work towards creative solutions. There is a well-documented history of how advocacy and protest were instrumental in bringing about many of the rights enjoyed by large parts of the world today, including women's suffrage, the 8-hour work day, the end of apartheid in South Africa and environmental protections in the United States. Teaching the history of successful social movements may increase the perceived efficacy of collective action[16,20,65–67].

Practical barriers such as lack of time, lack of skills and fear of repercussions could partially be addressed by institutional reform, for example, by facilitating engagement through providing more time and funding, but also by providing practical support for scientists to engage with society and other stakeholders and by normalizing and rewarding climate action[58,68,69]. Institutional reform could also reduce the carbon footprint of scientists by changing norms around travel and conference organization[70,71], thereby removing the barrier of scientists feeling hypocritical because of their own footprint. Courses on science communication provided by universities could train staff in the skills needed for advocacy[41,51]. Similarly, climate advocacy groups could provide training for scientists to gain necessary skills.

A very practical barrier that emerged is that many scientists simply do not know how to get started with advocacy or activism and do not know a local network they can connect to. This suggests that academic advocacy and activist movements should set up local groups within institutions to minimize the thresholds for scientists to engage. Scientists who perceive they have an unsuitable personality for engaging in advocacy or protest can still provide critical support for climate advocacy groups in other ways[28,58]. We hope that our discussion of strategies for overcoming barriers can help to increase scientists' engagement with climate change.

Online content

Any methods, additional references, Nature Portfolio reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at https://doi.org/10.1038/s41558-024-02091-2.

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Methods

Data collection

We used the Scopus database[72] to identify scientists and academics who published a peer-reviewed article between 2020 and 2022. Specifically, we selected the top 1.2% of journals per broad subject area specified in Scopus (for example, Arts and Humanities, Earth and Planetary Sciences), which led to the inclusion of 545 journals. (We selected the top 1.2% because this yielded 100 journals in the social sciences.) The corresponding authors of publications in those journals were then invited to participate in our survey via personalized email. In the email, they were invited to participate in a global study on scientists' and academics' considerations when thinking about their professional role in times of climate change, which they could do by clicking on a personalized link to the survey. The survey was administered via Qualtrics (https://www.qualtrics.com)[73]. In total, 249,876 authors were sent invitations and two reminders (see 'Materials' in Supplementary Text). Email invites were distributed between 23 May 2023 and 3 July 2023, with reminders being sent out 1 and 2 weeks after the initial invitation.

A total of 11,430 participants participated in the survey, of which 2,210 were removed stepwise as they (1) used an anonymous distribution link (n = 259; 2.3%), (2) did not consent to participate in the study (n = 142; 1.3%) or (3) did not finish the survey (n = 1,447; 13.1%). Of the remaining 9,582 participants, 361 (3.7%) indicated that they did not agree that climate change is caused by human activity; for them the survey then ended. Lastly, one participant was excluded because they participated after 11 August 2023. The analyses were performed on the basis of the remaining 9,220 participants.

We chose to exclude participants who did not finish the survey for the following reasons: For the marginal descriptive statistics in Fig. 1, we could have indeed used all available data; however, we decided against it for two reasons: First, it would have led to a different sample size for every question and a different sample size than in the analysis in Fig. 2, which would have led to additional reporting that may be confusing to the reader. Second, the sample size we currently use (N = 9,220) already leads to extremely precise estimates of the proportions we report in Fig. 1 and adding another few thousand cases would not have improved this precision in any meaningful way. For the remaining statistical analyses, we required a complete dataset. To obtain such a dataset while including all participants who began the survey would require us to impute a lot of data. This imputation would be substantial for the large number of participants who aborted the survey in the very early stages. That is, we would impute a lot of responses that are critical to our analysis on the basis of only a few responses at the beginning of the survey. The imputations would be based on the responses of other participants we do have, which means that, for the subsequent analyses, we would pretend to have information we do not actually have. This is of course always the case for standard imputation approaches but is especially severe for cases in which much of the data is missing and has to be imputed. To avoid underestimating uncertainty in the Bayesian (multilevel) models behind Fig. 2 (and other analyses in the Supplement), we made the conservative choice to exclude the data of all individuals who did not finish the survey. The anonymized dataset and code used for all analyses can be accessed on Zenodo[74].

Survey participants were compared to all invited authors in terms of h-index (https://en.wikipedia.org/wiki/H-index), number of published articles, year of first publication, citations and citing authors. Survey respondents were reasonably similar in all characteristics compared to all invited researchers. A comparison of their current affiliations' continents shows that European-based scientists are overrepresented in our survey, whereas Asian-based scientists are underrepresented (see Extended Data Table 1 and Extended Data Fig. 2 for details).

We implemented best practices for observational designs and defined a clear population of authors across all scientific fields on the basis of the Scopus database, which we sampled from exclusively. However, as is common in observational designs, we had no control over who of the 249,876 invited scientists responded to our survey. If there are variables that have a causal effect on both whether one responds to the survey and the variables assessed in the survey, the estimates obtained from our sample could be biased with respect to the population we defined. For some variables about scientific publishing that we could obtain from Scopus, we were able to compare the obtained sample with the population. As we have shown in Extended Data Fig. 2, the characteristics were reasonably similar in all variables, which reduced the chances of biases stemming from these variables. For example, one could imagine the hypothetical situation where less senior scientists with high citation counts participate and senior scientists tend to be more conservative about climate change advocacy, which would lead to biased results. However, we did not observe this.

There can be a myriad of other variables that may cause both survey participation and some of the variables we assessed in the survey. There is also some evidence for this in our survey results. For example, we saw a relatively high level of engagement in advocacy, legal protest and civil disobedience. While there is no data similar to ours to compare these numbers to, they are too high to reflect what the authors know to be the case in each of their universities. This suggests that variables such as concern about climate change increased the probability of individuals to participate and also shaped the responses to our survey. That said, we also had responses from scientists who have a conservative political leaning and who are not very concerned about climate change. The only way we see to significantly improve our sampling methodology would be to obtain a random sample. However, obtaining such a sample from the international community of scientists is extremely difficult in principle and would require massive resources in practice.

Survey

The survey design had open and closed questions in four blocks: (1) assessing climate change beliefs, (2) beliefs about how to address climate change, (3) climate actions, barriers and role of scientists, and (4) demographics and background variables. Below is a brief summary. Exact wording and response options are in Supplementary Table 2.

First, participants reported their beliefs about climate change. Participants indicated whether they agree that climate change is being caused by human activities on a binary scale ('yes'/'no'), adapted from the Yale Climate Opinion Maps[75]. Only participants answering 'yes' continued with the remainder of the questionnaire. Those who answered 'no' were then presented with an open text field to explain, after which the survey ended. The screening question was included because all subsequent questions are based on the assumption that individuals believe in the fact that climate change is caused by human activity. Next, climate change risk perceptions were assessed using three items, including perceptions of personal harm, worry[75,76] and informedness[77]. Three items were used to assess the perceptions of perceived responsibility to mitigate climate change of different actors: of oneself (personal responsibility[76]), of oneself as a scientist or academic, and of scientific or academic institutions. Participants could use a text box to explain the reasons for their answers on the responsibility items. All multiple-choice items in this section were answered on a 5-point Likert scale from 'Not at all' (1) to 'A great deal' (5).

In the block on beliefs about how to address climate change, participants were asked to indicate to what extent different actors (governments, scientific and academic institutions) are doing enough to address climate change[75,76]; what they believe is necessary to address climate change (for example, technological advances, local actions; items inspired by refs. 78,79); and climate despair/denialism (that is, feeling that we cannot reduce climate change[80]).

Third, in the climate actions block, participants indicated (1) their lifestyle changes and civic actions, (2) their perceived barriers to two types of public engagement (advocacy and legal climate change-related protests) and (3) their perceptions of the role of (climate) scientists

https://doi.org/10.1038/s41558-024-02091-2

concerning climate change engagement. Six climate change-related lifestyle behaviours with high CO_2 mitigation potential were included[81,82], as well as seven items on civic actions, which were adapted from different sources[35,68,75,83] and included talking about climate change with others and advocating for institutional change. Two additional items related to including climate change in one's teaching or shifting one's research to work on topics related to climate change were included. Engagement was rated on a three-point scale (Already do/did, Would be willing to, Would not be willing to). Barriers were assessed for two additional items: engaging in legal climate change-related protests and in climate change advocacy (being defined as 'the promotion of actions and policies aimed at reducing the impacts of climate change through, for example, public education, awareness raising and political engagement'). We assessed seven barriers inspired by previous research on barriers to advocacy[35] and academic activism[68]. The barrier items were rephrased on the basis of the participant's answer on the engagement scale, such that they would fit with participant's indicated willingness. For instance, if a respondent indicated that they are willing to engage in advocacy, they were subsequently asked to indicate the reasons for not having engaged yet. Additional barriers and actions could be reported in open text fields. Finally, participants indicated the extent to which they agree that scientists (not) working on topics related to climate change should engage in advocacy and legal protests[35], and that such engagement would negatively affect scientists' credibility. They could report any additional thoughts on scientists' engagement in the context of climate change in an open text box.

Finally, in the background variables block, the following demographic variables were assessed: age, gender, country of residence and political orientation on a scale from 'Left' (1) to 'Right' (7)[76]. Variables concerning their work in science/academia were assessed, that is, the extent to which their research is related to climate change, their field of study (for example, Humanities, Formal Sciences, Other), their current position (for example, PhD student, Full professor), tenure status, h-index and whether their position includes research and/or teaching. Participants could specify their field of study in an open text field if none of the options fit; open answers were coded into the pre-specified answer options (for example, Physics into Natural Sciences) and a category was added for Medical Sciences (for example, Medicine, Health Sciences). Lastly, participants were asked to indicate the relative carbon intensity of their lifestyle and whether anyone in their inner circle engages in climate advocacy or activism.

Our survey was carefully developed, refined and piloted to ensure that scientists understood and answered each survey question as intended. While the focus of our manuscript was not on cross-cultural comparisons, a limitation of our study is that the piloting and refinement was conducted with scientists working at universities in Europe and North America. It is therefore possible that researchers with other backgrounds understood and answered questions in a systematically different way. In other words, we cannot exclude the possibility that we have cross-cultural measurement invariance for some items[84,85]. All authors agree that the focus of psychological research on populations that are Western, Educated, Industrialized, Rich and Democratic (WEIRD)[86] is highly problematic and we hope that future research can establish measurement invariance across cultures, especially when the focus of the work is on cross-cultural comparisons. Moreover, given the importance of potential heterogeneity across countries, we used random intercepts and random slopes in the analysis underlying Fig. 2. We quantified country heterogeneity (see Supplementary Text and Supplementary Fig. 2 for details).

Like any self-report measures, our results may be subject to social desirability biases. We are aware of such biases, in particular for assessments of political participation[87].

The study was approved by the local ethics committee of the Faculty of Social and Behavioural Sciences of the University of Amsterdam (protocol number FMG-925).

Statistical inference

Out of the 9,220 final responses, 509 (5.53%) had at least one missing value for any of the outcome or predictor variables. We imputed these missing values using random forests with 10,000 trees per forest via the missForest (v.1.5)[88] R package. Some variables in Fig. 1 were imputed (for example, political orientation, feelings of responsibility, advocacy and activism behaviours) for the subsequent analyses, while others were not (for example, field of research, country). We coded the 289 responses that were either missing for 'country' or that constituted countries with less than 10 observations as 'other' to still be able to use these data (sensibly) in the multilevel models. The differences in the percentages with or without imputation are negligible (less than 0.5%). For the analysis of overall climate actions, we counted the number of lifestyle (six in total) and civic actions (seven in total) each participant engages in. We standardized all non-binary predictor variables and used the brms (v.2.21.0)[89] R package to estimate a Bayesian binomial regression, using weakly informative Student's t-distributions as priors[90]. For the analysis of advocacy, legal protest and civil disobedience behaviours, we used a Bayesian logistic regression with a similar specification as above, including the (z-standardized) barriers for advocacy and legal protest as additional predictors. Note that each model used only one response per participant (that is, there were no multiple responses by one participant in any one model). We specified country as a random effect to account for potential heterogeneity. Note that running two logistic regressions rather than a single multinomial logistic regression yields the same inferences except that they might have slightly larger standard errors (see also ref. 91, p. 273). We tested this and found negligible differences, but used logistic regressions since they are considerably faster to estimate. Note that, since one respondent answered both the advocacy and protest (and civil disobedience) items, the analysis would ideally be a multinomial regression model that takes into account this potential dependency in the response. However, this is currently not possible with the brms R package and even if so, it may be computationally infeasible to estimate (especially when including random effects). Not modelling this dependency may slightly decrease the standard errors (which is probably negligible given our sample size), but would not result in bias of the point estimates. We report 'percentage change' as effect size in the main text, which is a more intuitive effect size measure than (log) odds ratios. We report (log) odds ratios in Supplementary Figs. 2 and 6, but none of our conclusions would change. These effect estimates are marginal effects at the mean (that is, the effect of a change in predictors assuming all others are at their mean or zero for binary variables), calculated using the marginaleffects (v.0.20.1)[92,93] R package. In the online code repository, we also show average marginal effects. For all effects calculations, we took the random effects into account, that is, calculated effects averaged across countries rather than effects for a 'typical' country[94]. For all Bayesian analyses, we ran eight chains with 1,000 burn-in samples and 4,000 final samples each. Convergence using the R-hat statistic was established[95]. The average relative change between the effect sizes across advocacy, protest and civil disobedience estimated on the imputed and non-imputed data was negligible, with 2% for percentage change and 1.8% for log odds ratios. A reviewer suggested assessing differences in effect size estimates between our model specification that included countries as random effects and a specification that included countries as fixed effects instead. We did this and found virtually indistinguishable effect size estimates. However, Bayesian leave-one-out cross-validation preferred the random effects specification in all cases.

We analysed observational data and therefore, without additional assumptions, our statistical analyses do not support causal claims. We use causal language in the discussion because the question about barriers to engagement are fundamentally causal questions. We do not claim that our statistical analyses identify clear causes of engagement; instead, we seek to develop causal hypotheses, for which our statistical analyses provide evidence. The barriers are such causal hypotheses, which could be further strengthened by employing causal inference techniques, using different study designs (for example, repeated observations), focusing measurement less on intentions and more on behaviour or using a more qualitative approach using interviews and perceived causal relations.

In Fig. 1, we report proportions on the basis of the total sample of $N = 9{,}220$. In the caption of Fig. 1, we provide the maximum possible standard error for those proportions. The standard error for the estimate of $p_i = P(X = i)$, the probability of variable X being in category i, is equal to $\mathrm{sqrt}((p_i\,(1 - p_i))/n)$. The term $p_i\,(1 - p_i)$ is maximized by $p_i = 0.5$ and gives the value 0.25. With our sample size, this gives us a maximum possible standard error of sqrt(0.25/9,220) = 0.0052, which in percentage terms is 0.52%—very small with respect to the range of 0–100%. This is the number we report in the caption of Fig. 1. Of course, for all p_i different from 0.5, the standard error becomes quadratically smaller away from $p_i = 0.5$.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

We used the Scopus database[72] to identify scientists and academics who were subsequently invited to participate in the survey. The anonymized data used for analysis are available on Zenodo at https://doi.org/10.5281/zenodo.12187345 (ref. 74).

Code availability

The code and all materials are available on Zenodo at https://doi.org/10.5281/zenodo.12187345 (ref. 74). Together with the data (see above), these allow the reader to reproduce all analyses, results and figures reported in the paper.

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Acknowledgements

This work was supported by NWO gravitation grant number 024.004.016 (to J.H.), Swiss National Science Foundation Postdoc Mobility Fellowship P500PS_202935 (to V.C.), the Harvard University Faculty Development Funds (to V.C.) and the Studienstiftung des deutschen Volkes (PhD scholarship) (to A.B.). We thank G. Gallo from New Environments and D. Mackey for help with Fig. 3, and T. Fossen, K. Nielsen, A. Urai and C. van Eck for their helpful comments on an earlier version of this paper.

Author contributions

F.D. conceived the initial idea of the study and F.D., M.S.M.S., J.M.B.H., V.C., N.-M.G., C.B., A.J.K.G. and A.R.A. contributed to its conceptualization. F.D., M.S.M.S., J.M.B.H., N.S., N.M.G., A.B. and A.R.A. contributed to the formal analysis of the quantitative and/or qualitative data. F.D., M.S.M.S., J.M.B.H. and N.S. contributed to the methodology of the study, the data collection strategy, software used for the study administration and/or analysis. F.D., N.S., M.S.M.S., A.R.A. and A.B. contributed to the validation of the study results. F.D. and J.M.B.H. performed data visualization. F.D., M.S.M.S. and J.M.B.H. curated the data, administered the project and wrote the original draft. F.D., M.S.M.S., J.M.B.H., V.C., C.B., A.J.K.G. and A.R.A. reviewed and edited the original draft.

Competing interests
The authors declare the existence of a non-financial competing interest. All authors have engaged in climate change advocacy or activism.

Additional information
Extended data is available for this paper at https://doi.org/10.1038/s41558-024-02091-2.

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41558-024-02091-2.

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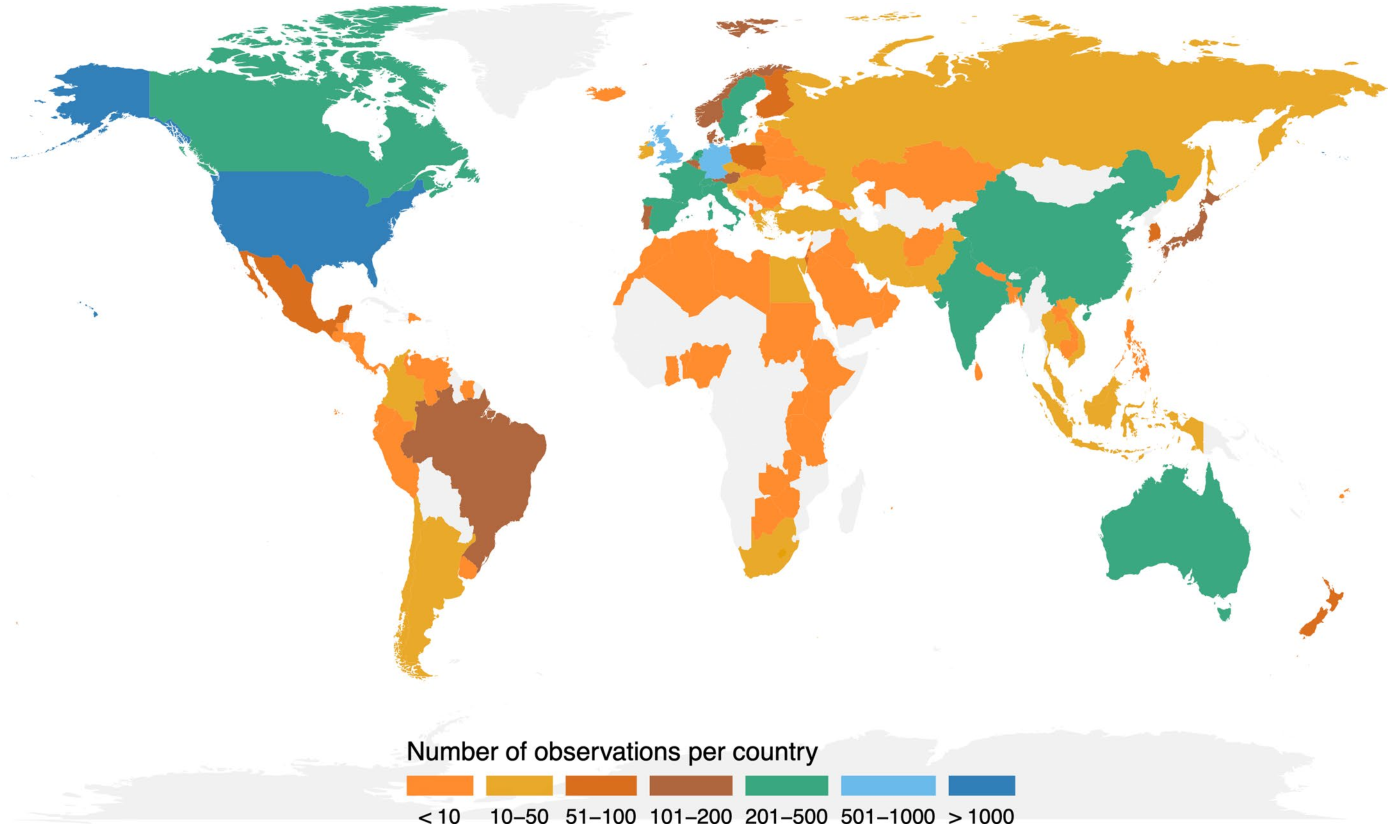
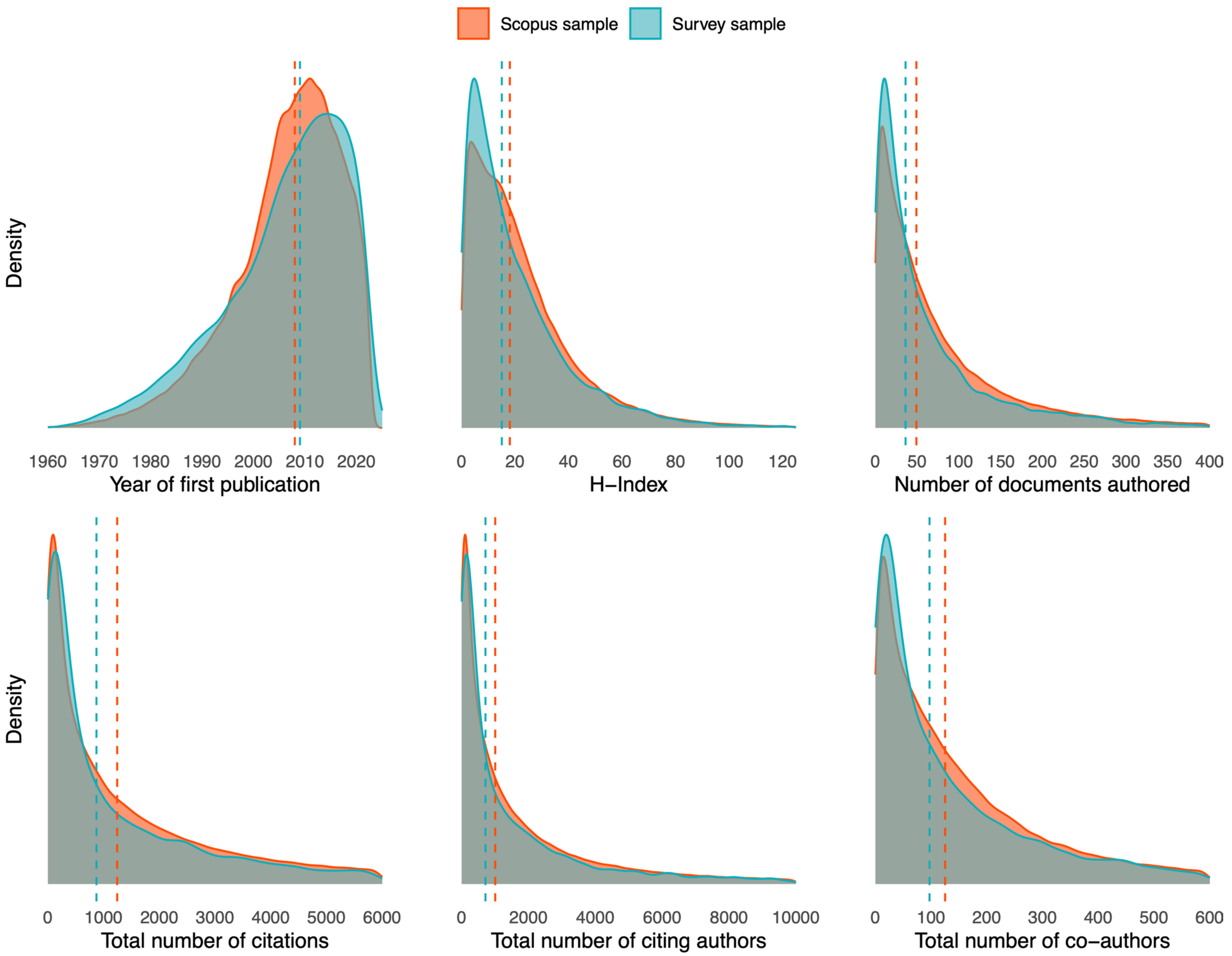
Peer review information *Nature Climate Change* thanks Matthew Ballew, Clara Vandeweerdt and the other, anonymous, reviewer(s) for their contribution to the peer review of this work.

https://doi.org/10.1038/s41558-024-02091-2



Extended Data Fig. 1 | Number of observations per country in our data set. Please note that Hong Kong (n = 32) is not included as a separate country on this map, but is modelled as a separate country in all other analyses that include country as a variable.



Extended Data Fig. 2 | Distribution of Scopus and our sample on key variables. The dashed lines indicate the median of the respective distributions.

https://doi.org/10.1038/s41558-024-02091-2

Extended Data Table 1 | Representativity of survey sample as compared to the Scopus sample based on characteristics provided within the Scopus database (top) and the authors continent (bottom)

Characteristic	Survey (*N* = 9,220) Median (SD)	Scopus sample (*N* = 249,876) Median (SD)
h-index	15 (20)	18 (21)
Number of documents	36 (117)	49 (124)
Cited by	710 (6,953)	1,002 (6,860)
Citation count	871 (10,315)	1,243 (10,065)
Co-author count	97 (1,136)	125 (967)
First publication	2,009 (12)	2,008 (11)
Continent	*N* (Percentage)	*N* (Percentage)
Asia	1,072 (12.0%)	93,958 (38.0%)
Europe	4,691 (51.0%)	77,916 (31.0%)
North America	2,559 (28.0%)	63,365 (25.0%)
Oceania	470 (5.1%)	8,189 (3.3%)
South America	287 (3.1%)	3,808 (1.5%)
Africa	110 (1.2%)	2,017 (0.8%)

Note. We do not have information on the continent of 31 participants through Scopus.

nature portfolio

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Last updated by author(s): Jun 18, 2024

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☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
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☐	☒	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
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☐	☒	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒	Estimates of effect sizes (e.g. Cohen's d, Pearson's r), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Qualtrics (06.2023)
Data analysis	We used the R-package missForest version 1.5 for imputation, and the R-package brms version 2.19.0 and the R-package marginaleffects version 0.20.1 for Bayesian analysis. Code availability The code and all materials are available on the Open Science Framework using this link: https://osf.io/nz27y/?view_only=bc5dd7d9a5f64edfb8bac652ee593337.

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Data availability
We used the Scopus database (www.scopus.com/standard/marketing.uri#basic) to identify scientists and academics who were subsequently invited to participate in the survey.
[UPDATE ONCE LINK IS UPDATED] The anonymized data are available on the Open Science Framework using this link: https://osf.io/nz27y/?view_only=bc5dd7d9a5f64edfb8bac652ee593337.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	We only use the term gender, which was derived via a self-reported item with the following answer options: Male, Female, Non-binary, Self-described, Non-disclosed. Findings therefore only apply to gender. Consent has been obtained for sharing of non-anonymous data; individual-level data is provided in the anonymized data set. Gender (female vs. male; other vs. male) was used as a predictor in the Bayesian analyses investigating predictors of different forms of climate change engagement.
Reporting on race, ethnicity, or other socially relevant groupings	No data was collected on respondents' race or ethnicity. Respondents did report the country they currently reside in; no inferences on their race or ethnicity were made based on their country of residence. To ensure anonymity, we derived the continent of residence for all respondents based on the country variable and only report the country variable of respondents residing in countries in which n > 10 in the present sample.
Population characteristics	Respondents were from 115 countries, all scientific disciplines, and all career stages. 61% were male, 36% female and 3% identified as non-binary, self-described their gender or did not disclose their gender. 18% of the respondents reported being between 25-34 years old, 35% between 35-44 years old, 23% being between 45-54 years old, 15% between 55-64 years old and 9% reported being above 65 years of age. Concerning their career stage, many respondents were full professors (27%), associate (18%) or assistant professors (15%), around 18% reported being scientists outside of academia, and fewer respondents reported being postdocs (12%) or PhD students (6%). Most respondents were residing in European countries (51%), followed by Northern American countries (28%), and Asian countries (11%), with fewer respondents residing in Oceania (5%), South America (3%) or Africa (1%).
Recruitment	We used the Scopus database to identify scientists and academics who published a peer-reviewed article between 2020 and 2022. Specifically, we selected the top 1.2% journals per broad subject area specified in Scopus (e.g., Arts and Humanities, Earth and Planetary Sciences), which led to the inclusion of 545 journals. The corresponding authors of publications in those journals were then invited to participate in our survey via personalized email. In total, 249,876 authors were sent invitations and two reminders. Survey participants were compared to all invited authors in terms of h-index, number of published articles, year of first publication, citations, and citing authors. Survey respondents were reasonably similar in all characteristics compared to all invited researchers. A comparison of their current affiliations' continents shows that European-based scientists are overrepresented in our survey, whereas Asian-based scientists are underrepresented (see Extended Data Table 1 and Extended Data Figure 2 for details).
Ethics oversight	The study was approved by the local ethics committee of the Faculty of Social and Behavioral Sciences of the University of Amsterdam (Protocol number FMG-925).

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☒ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	The study is a cross-sectional survey study with both quantitative (self-reported questionnaire items) and qualitative (open-text responses) data.
Research sample	The sample consists of 9,220 scientists and academics from 115 countries, all scientific disciplines, and all career stages. The sample is not representative, but represents the population it was drawn from reasonably well. The study focuses on scientists and academics given unique position in society to understand the risks of climate change, and to act as potential sources of information on climate change for the general public as well as policy makers. Respondents were from 115 countries, all scientific disciplines, and all career stages. 61% were male, 36% female and 3% identified as non-binary, self-described their gender or did not disclose their gender. 18% of the respondents reported being between 25-34 years old, 35% between 35-44 years old, 23% being between 45-54 years old, 15% between 55-64 years old and 9% reported being above 65 years of age. Concerning their career stage, many respondents were full professors (27%), associate (18%) or assistant professors (15%), around 18% reported being scientists outside of academia, and fewer respondents reported being postdocs (12%) or PhD students (6%). Most respondents were residing in European countries (51%), followed by Northern American countries (28%), and Asian countries (11%), with fewer respondents residing in Oceania (5%), South America (3%) or Africa (1%).
Sampling strategy	We used the Scopus database to identify scientists and academics who published a peer-reviewed article between 2020 and 2022. Specifically, we selected the top 1.2% journals per broad subject area specified in Scopus (e.g., Arts and Humanities, Earth and Planetary Sciences), which led to the inclusion of 545 journals. (We selected the top 1.2% because this yielded 100 journals in the social sciences.) The corresponding authors of publications in those journals were then invited to participate in our survey via personalized email. In total, 249,876 authors were sent invitations and two reminders. Email invites were distributed between 23.05.2023 and 03.07.2023, with reminders being sent out one and two weeks after the initial invitation. For the qualitative data, we did not consider data saturation given that (1) the sampling strategy was aimed at maximizing the sample size, (2) we were primarily interested in relatively common additional barriers to engagement that we had not included in the multiple choice questions, we therefore (3) quantified the qualitative data to derive relatively frequent barriers to engagement.
Data collection	Data collection was done online: The survey was administered via Qualtrics. Respondents were invited to participate via a personalized link to the Qualtrics survey, which they received via e-mail. The researcher was not present during respondents filling in the survey. No experimental conditions were used, so blinding of experimental condition of the researcher was not required.
Timing	Email invites were distributed between 23.05.2023 and 03.07.2023, with reminders being sent out one and two weeks after the initial invitation. Only responses up until 11.08.2023 were included in the analysis.
Data exclusions	11,430 participants participated in the survey, of which 2,210 were removed step-wise as they (1) used a different distribution link (n = 259; 2.3%), (2) did not consent to participate in the study (n = 142; 1.3%), or (3) did not finish the survey (n = 1,447; 13.1%). Of the remaining 9,582 participants, 361 (3.7%) indicated that they did not agree that climate change is caused by human activity; for them the survey then ended. Lastly, one participant was excluded because they participated after August 11, 2023. The analyses were performed based on the remaining 9,220 participants.
Non-participation	The response rate for starting the survey was 4.5% (n = 11,171) and for finishing the survey 3.7% (n = 9,220).
Randomization	Participants were not allocated into experimental groups.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Plants

Seed stocks	*Report on the source of all seed stocks or other plant material used. If applicable, state the seed stock centre and catalogue number. If plant specimens were collected from the field, describe the collection location, date and sampling procedures.*
Novel plant genotypes	*Describe the methods by which all novel plant genotypes were produced. This includes those generated by transgenic approaches, gene editing, chemical/radiation-based mutagenesis and hybridization. For transgenic lines, describe the transformation method, the number of independent lines analyzed and the generation upon which experiments were performed. For gene-edited lines, describe the editor used, the endogenous sequence targeted for editing, the targeting guide RNA sequence (if applicable) and how the editor was applied.*
Authentication	*Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosiacism, off-target gene editing) were examined.*