https://doi.org/10.1038/s41586-019-1300-6

Climate as a risk factor for armed conflict

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Research findings on the relationship between climate and conflict are diverse and contested. Here we assess the current understanding of the relationship between climate and conflict, based on the structured judgments of experts from diverse disciplines. These experts agree that climate has affected organized armed conflict within countries. However, other drivers, such as low socioeconomic development and low capabilities of the state, are judged to be substantially more influential, and the mechanisms of climate–conflict linkages remain a key uncertainty. Intensifying climate change is estimated to increase future risks of conflict.

Research over the past decade has established that climate variability and climate change may influence the risk of violent conflict, including organized armed conflict[1,2]. However, use of different research designs, datasets and methods has resulted in divergent findings and stark questions about legitimate approaches to scientific inference[1,3–9]. Previous analyses, many from authors of this paper, have both asserted and refuted a substantial role for climate in conflicts to date and have repeatedly triggered dissenting perspectives[1,3–6,9–22]. Even syntheses have failed to clarify areas of agreement and reasons for disagreement[2,4,5,8,9,12,13,23–26]. There are important uncertainties about when and how climate has caused conflict to date, and under future scenarios[8,23,27,28]. The lack of clarity on current knowledge limits informed management of the risks of conflict to states and human security, and of the risks of continuing greenhouse gas emissions.

Expert elicitation is a well-vetted method for documenting the judgments of experts about available evidence[29] (Methods). For societally relevant topics with divergent evidence, experimental comparisons of structured elicitation and group-panel assessment have suggested that individual elicitation paired with collective assessment can better reveal the state of knowledge than either approach in isolation[30–32]. Here, we develop a synoptic assessment of the relationship between climate and conflict.

The assessment approach and expert group

Our focus is organized armed conflict within countries (Extended Data Fig. 1). Previous crosscutting analyses of climate and conflict have combined individual-level violence (for example, suicide or domestic violence) through to war between countries[2,4,9]. However, drivers of suicide fundamentally differ from drivers of world wars. To enable a focused evaluation, the social scale of violence is constrained to organized armed conflict within countries (that is, state-based armed conflict, non-state armed conflict and one-sided violence against civilians)[33]. These forms of violent conflict may affect or be affected by conflict in neighbouring areas or external intervention. In evaluating the effects of climate, climate-related variability, hazards, trends and change are all included (for example, related to temperature, precipitation, modes of variability, such as the El Niño Southern Oscillation, and extreme events, such as droughts and floods).

The authors of this manuscript consist of 3 assessment facilitators and a group of 11 climate and conflict experts. The group of 11 experts is a sample of the most experienced and highly cited scholars on the topic, spanning relevant social science disciplines (especially political science, economics, geography and environmental sciences), epistemological approaches and diverse previous conclusions about climate and conflict (Methods). The selection of the expert group was done based on expertise necessary to resolve scientific disagreement about the contribution of climate to conflict risks globally and in conflict-prone regions, which requires consideration of comparative and crosscutting analyses and replicable empirical research. For climate and conflict overall, however, the scope of relevant expertise in scholarship, practice and policy is vast. Semi-structured interviews with purposively sampled stakeholders were used to inform the project.

The expert group participated in 6–8-h individual expert-elicitation interviews and a subsequent 2-day group deliberation (Methods). The interview and deliberation protocols were collectively developed by the authors and then administered by the assessment facilitators. In total, 950 transcript pages from the interviews and deliberation were iteratively analysed and distilled. The results presented here include subjective probabilistic judgments documented individually (Extended Data Figs. 2–4) and the origins of these judgments in the scientific literature (Supplementary Information). The approach establishes a foundation for assessing—across the full academic field—the strengths and limitations of our current understanding and the reasons for disagreement.

This assessment approach complements existing crosscutting reviews, meta-analyses and perspectives on climate and conflict[2,8,9,17,23,25–27]. The methods here go beyond previous syntheses by (1) systematically characterizing judgments not only about

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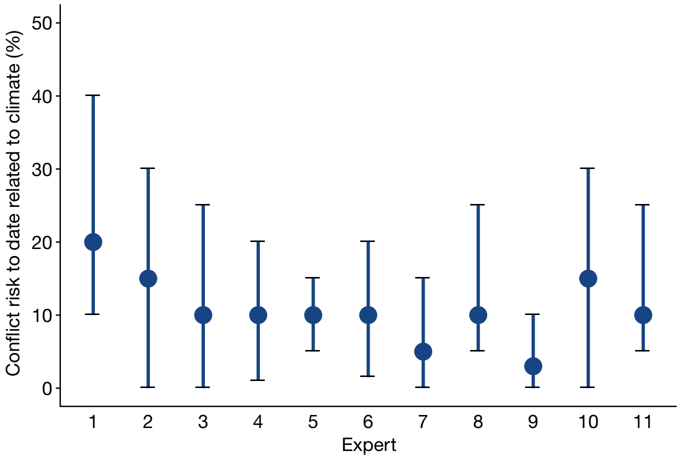

Fig. 1 | The estimated relationship between climate and conflict risk to date. Each expert provided subjective probabilistic judgments of the percentage of total conflict risk related to climate across experiences over the past century. The estimated 1st, 50th and 99th percentiles are shown for each expert.

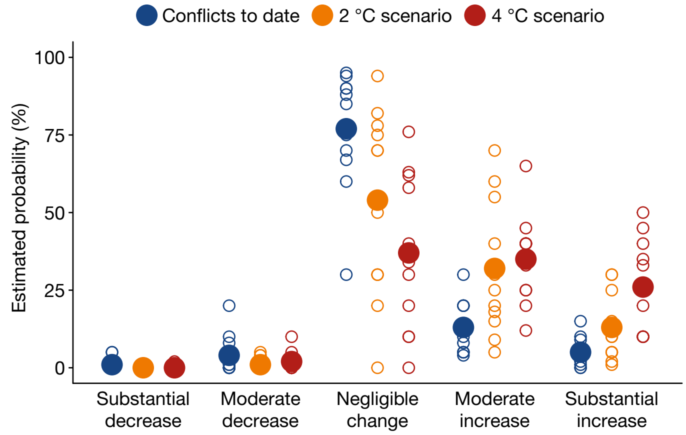

Fig. 2 | Estimated changes in the relationship between climate and conflict risk under increasing climate change. For three scenarios, each expert estimated the likelihood that climate leads to negligible, moderate or substantial changes in conflict risk. For violent conflicts to date (blue), probability estimates indicate how frequently climate variability and change have led to the specified changes in conflict risk. For the approximately 2 °C (orange) and approximately 4 °C (red) warming scenarios, probability estimates indicate potential changes in conflict risk compared to the current climate. For these hypothetical 2 °C and 4 °C scenarios, each expert considered associated effects of climate change for current societies, assuming current levels of (for example) socioeconomic development, population and government capacity. Open circles, individual estimates; filled circles, mean across experts.

well-quantified risks, but also more uncertain outcomes that may carry large consequences; (2) thoroughly exploring how these judgments are underpinned by present-day knowledge; and (3) rigorously combining individual and collective deliberations to minimize biases.

The climate–conflict relationship

The experts agree that, over the past century, climate variability, hazards and trends have affected organized armed conflict within countries (Figs. 1, 2). They also agree that other conflict drivers are much more influential for conflict risk across experiences to date, as compared to climate variability and change (Fig. 3).

Estimates of conflict risk related to climate to date overlap across experts (Fig. 1). Across the experts, best estimates are that 3–20% of conflict risk over the past century has been influenced by climate variability or change, and none of their individual estimated ranges excludes a role of climate in 10% of conflict risk to date. Throughout this assessment, risk is defined as the potential for consequences in cases in which something of value is at stake, which can be represented as probability multiplied by consequences[34]. Under this definition, an influence of climate on conflict risk can involve a change in the likelihood of conflict occurring (for example, the frequency of conflict outbreaks or the duration of a conflict) or altered magnitudes of the resulting harmful consequences (for example, number of deaths, destruction of assets or legacies of violence). The definition allows for consideration of the initial outbreak and continuing incidences of violent conflict, and the consequences of these conflicts[34].

When evaluating conflict drivers to date, each expert individually ranked causal factors that have most influenced the risk of conflict over the past century, drawing from a list of 16 factors that were collectively generated by the expert group (Fig. 3a). Each expert also ranked factors on the basis of how much uncertainty there was about their influence[35] (Fig. 3a).

Across experts, four drivers were ranked as particularly influential for conflict risk to date: low socioeconomic development, low capabilities of the state, intergroup inequality (for example, ethnic differences across groups) and recent history of violent conflict (Fig. 3a). The experts indicate that there is more uncertainty about the influence of low socioeconomic development and recent history of conflict, compared to low capabilities of the state and intergroup inequality. There is high agreement that low socioeconomic development is one of the strongest predictors of the onset of intrastate conflict and its continuing incidence[36]. However, there is uncertainty about whether it is a proxy for other mechanisms or whether it is directly related to conflict risk, especially because fewer livelihood opportunities can increase the ease of mobilizing rebels (Supplementary Table 1). Similarly, recent history of violent conflict is a strong predictor of subsequent conflicts[36]. However, there is uncertainty that stems from the many possible causal mechanisms, including more individuals with knowledge and weapons to fight, persistent factors that contribute to instability or the continuation of grievances from previous violence.

Climate variability and/or change is low on the ranked list of the most influential conflict drivers across experiences to date, and the experts rank it as the most uncertain in its influence (Fig. 3a, Extended Data Tables 1, 2 and Supplementary Table 2). This judgment of uncertainty is perhaps unsurprising given the divergent research findings to date, which have motivated this expert assessment[1,3–7,9]. Within a risk framing, such uncertainty is important to assess when outcomes have low or difficult-to-quantify probabilities, but may carry large consequences that are relevant to ongoing decision-making processes[31,34,37].

The experts agree that additional climate change will amplify conflict risk, along with the associated uncertainties (Fig. 2). Climate variability and change are estimated to have substantially increased risk across 5% of conflicts to date (mean estimate across experts). By contrast, an approximately 2 °C increase in the global mean temperature above pre-industrial levels is estimated to substantially increase conflict risk with 13% probability, rising to 26% probability under an approximately 4 °C warming scenario. A 'substantial' increase in conflict risk was defined in the elicitation as involving severe and widespread effects, based on criteria for key risks that have been developed and applied in assessments by the Intergovernmental Panel on Climate Change (IPCC)[34].

The judgments about increasing conflict risk in the 2 °C and 4 °C warming scenarios incorporate a hypothetical constraint that assumes societies with the current levels of socioeconomic development experience additional climate change. Even with this constraint, uncertainties increase notably. The range of estimates from individual experts for a substantial increase in conflict risk due to climate increases from a probability of 0–15% for conflicts to date to a probability of 10–50% in the 4 °C scenario (Fig. 2).

Climate–conflict linkages

Across experts, there is low confidence in the mechanisms through which climate affects the risk of conflict (Fig. 3 and Extended Data

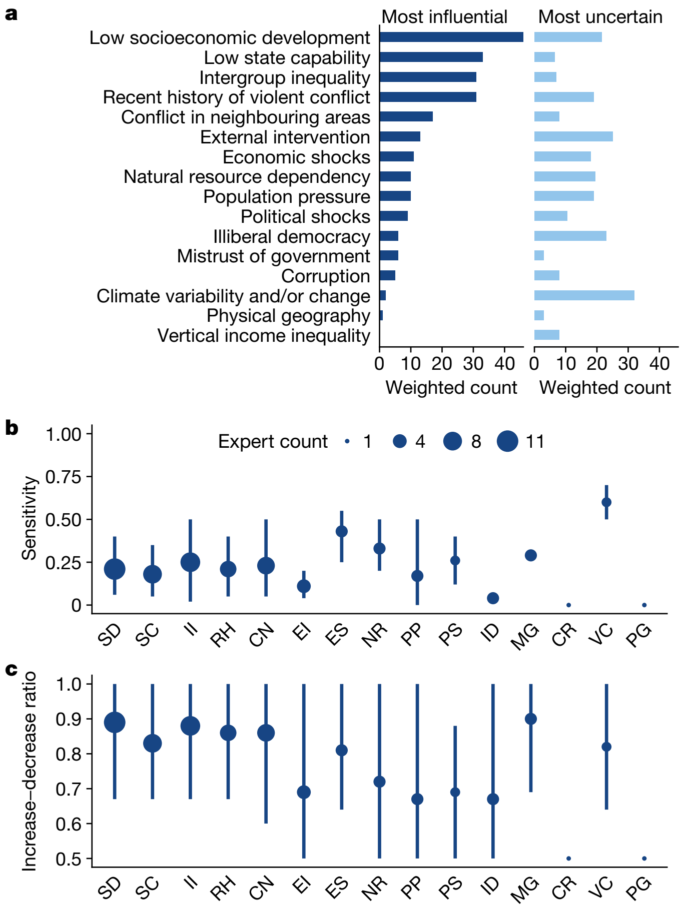

Fig. 3 | Factors that drive conflict risk and their relationship to climate in experiences to date. a, Rankings of causal factors that influence conflict risk the most. Each expert individually ranked six causal factors that have influenced violent conflict the most to date and then ranked six causal factors for which there is the most uncertainty about their influence. Aggregated weighted rankings of the causal factors are indicated: a factor ranked first in the listing of an expert is assigned a value of 6, through to a value of 1 for a factor ranked sixth. **b**, **c**, The relationship between factors that drive conflict risk (from **a**) and climate in experiences to date. Two measures are shown: climate sensitivity (**b**) and the increase/decrease ratio (**c**). For conflicts to date in which each causal factor is relevant, climate sensitivity is the estimated fraction of these conflicts for which climate has affected conflict risk, increasing or decreasing it. Of this, the increase/decrease ratio is the fraction allocated to increased conflict risk. For climate sensitivity, a higher value indicates that climate variability and change have more frequently modulated conflict risk through the factor. For the increase/decrease ratio, a value of 1 indicates climate sensitivity was estimated to only increase conflict risk, whereas a value of 0.5 indicates climate sensitivity equally increases and decreases conflict risk. Filled circle, mean across experts, with circle size indicating the number of experts who ranked the factor in their top-six list; range for each factor, minimum and maximum values across the 11 experts. CN, conflict in neighbouring areas; CR, corruption; ES, economic shocks; EI, external intervention; ID, illiberal democracy; II, intergroup inequality; MG, mistrust of government; NR, natural resource dependency; PG, physical geography; PP, population pressure; PS, political shocks; RH, recent history of violent conflict; SC, low state capability; SD, low socioeconomic development; VC, climate variability and/or change.

Tables 1, 2). For each conflict driver across experiences to date, each expert estimated the frequency with which climate variability and change increased or decreased conflict risk through the driver or had negligible effect (Fig. 3 and Extended Data Figs. 5, 6). For the four conflict drivers that were ranked to be the most influential overall, the experts estimate that the climatic sensitivity of these drivers is relatively low (low socioeconomic development, low capabilities of the state, intergroup inequality and recent history of conflict) (Fig. 3b). Notably, non-climate factors and historical processes shape these conflict drivers (Extended Data Table 1). However, where climate has affected conflict risk through these top-four conflict drivers, the experts estimate that climate has most often increased, rather than decreased, the risk of conflict (Fig. 3c).

By contrast, the causal factors that are judged to be most sensitive to climate are ranked as much less influential to the risk of conflict overall. In particular, economic shocks and dependency on natural resources are judged to be likely climate–conflict linkages across experiences to date (Fig. 3b); however, their overall influence on conflict risk is much lower (Fig. 3a). Furthermore, the experts estimate that climate has had more variable and uncertain effects in both increasing and decreasing the risk of conflict through these linkages (Fig. 3c).

Climate-related hazards, variability and change can cause economic shocks through effects on agricultural productivity or food prices, or through the direct and indirect consequences of disasters such as floods, droughts, heat waves or cyclones (Extended Data Table 2). Such shocks could heighten conflict risks through several potential mechanisms, including reduced opportunity costs for violence (in which adverse effects on livelihoods make participation in violence relatively more attractive), uneven economic effects precipitating the collapse of intergroup bargains or deleterious effects on long-term socioeconomic development. The consequences of climate-related economic shocks are highly variable and depend on the affected areas and timing (for example, growing-season drought in rain-fed versus irrigated croplands), affected sectors and groups (for example, exports that affect state capability and/or employment), and political will and response capacity (for example, availability of cash transfers or alternative livelihoods).

Linkages through dependency on natural resources also underscore uncertainty due to context-specific and multifaceted interactions (Extended Data Table 2). Climate-related resource scarcity can increase conflict risk; however, it can also stimulate cooperation to ensure the fair distribution of resources, or decrease conflict risk if more time is spent on procuring food or because conditions are unfavourable for sustaining an armed group[38,39]. Climate-related resource abundance can also have conditional and complex effects if there are higher opportunity costs for violence or improved conditions for mounting and sustaining conflict.

In the future, climate change could increase the risk of conflict through channels beyond the climate-variability effects that have been important to date (Extended Data Table 2). Because such linkages exceed historical experiences, uncertainties increase especially under large magnitudes of climate change, such as an increase in global mean temperature of 4 °C (Fig. 2). Extrapolation from historical relationships has high levels of uncertainty because complex climate–conflict linkages partly depend on future socioeconomic development pathways, macroeconomic patterns (for example, global recession), shifts in state capability, ideological fluctuations and the state of global order and cooperation (for example, through the UN (United Nations) Security Council).

Future climate–conflict linkages could involve exacerbation of climate–conflict connections that are present in experiences to date, climate change effects that are fundamentally beyond previous experiences or circumstances in which existing response capacities reach their limits. Across these categories, relevant climate change risks include substantial economic effects, climatic extremes and associated disasters, effects on agricultural production or differential climate change effects that increase intergroup inequalities (Extended Data Table 2). Such influences could also reveal 'missing' institutions, for which governance mechanisms do not yet exist to address emergent climate change risks (for example, the potential for substantial increases in migration).

The potential for risk reduction

The experts agree that conflict risk related to climate can be reduced with substantial investments in the reduction of the risk of conflict (Extended Data Fig. 7 and Extended Data Table 3). For conflicts to date, the experts estimate with a 67% probability that climate-related conflict risk could be reduced through investments that address known drivers (mean estimates across experts). For a 4 °C scenario, however, the estimated potential for reducing climate-related conflict risk drops to a 57% probability, given more severe climate change effects.

The potential for synergies exists between the reduction in conflict risk and adaptation to climate change (Extended Data Table 3). Similar factors determine vulnerability to both climate change and armed conflict. Specific measures that address these factors can ameliorate climate–conflict linkages and advance sustainable development and human security, interlinked with the quality of governance, the persistence of structural inequities and capacity across levels of government. Relevant adaptation options (for example, crop insurance, training services, cash transfers, improved storage after harvest or more-secure land tenure) can support food and livelihood security and economic diversification beyond agricultural livelihoods. Furthermore, consideration of climate could be incorporated into standard assessments for the reduction of conflict risk through conflict mediation, peacekeeping operations and post-conflict aid and reconstruction efforts. Climate–conflict linkages could be reduced by addressing environmental challenges in building cooperation and peace or by preventing relapse into conflict in societies with especially high vulnerability and exposure to climatic hazards[40].

However, there is a need to increase our understanding of both the effectiveness and the potential adverse side effects of different actions (Supplementary Table 3). Trade-offs include the ways in which climate responses can create new problems or unintended consequences, which can potentially affect conflict risk[2]. For example, actions that are adaptive from one perspective—such as food export bans following climate-related crop failures—can increase instability elsewhere. Adaptation policies that favour some groups over others or that displace climatic hazards to more vulnerable groups could also affect conflict risk. Limitations in reducing conflict in general will also apply to climate–conflict linkages, such as challenges in predicting the onset and severity of conflict or in addressing the root causes of exclusion and unequal access to services and markets. Effective management of the risks will benefit from improved evidence and approaches that are suitable for deeper, difficult-to-quantify uncertainties.

Analytical challenges

Challenges in analysis strongly contribute to the key uncertainties that were identified in this assessment, especially the relative importance of climate as a driver of conflict, the mechanisms through which climate affects conflict, the conditions under which they materialize and the implications of future climate change for conflict risk (Supplementary Table 4).

Tight causal inferences remain unclear for many fundamental questions of interest for our understanding of why conflict occurs, including what distinguishes countries with conflict onset versus its most-common absence, and how particular cases can be understood in the context of broader patterns (Supplementary Table 4). Model design and interpretation of reported results are limited accordingly (for example, see the sections on model design, the garden of forking paths and the file drawer in Supplementary Table 4). Causal inference is more feasible for temperature variability compared to slow-trending variables such as levels of socioeconomic development, state capability or intergroup inequality. This limits our understanding of the relative importance of climate for conflict, the mechanisms and mediators of the effects of climate on conflict and the interactions of climate with other conflict drivers (for example, the degree to which climate modulates the timing of conflict versus increasing the overall number of conflicts that occur). Compared to studies on the outbreak of war, the climate and conflict literature has been less focused on theory and mechanisms of effects (such as through process tracing and the examination of case studies) for the generation of hypotheses for subsequent systematic testing.

Relationships between conflict drivers and outcomes tend to be temporally bounded and place-dependent[41] (Supplementary Table 4). As is also the case for general conflict studies, most of the empirical evaluations to date have examined climate–conflict linkages since 1945, a period in which organized armed conflict has predominantly occurred in unique conditions that have resulted from the breakdown of colonial empires and the rise of independent states. Most previous empirical analyses have focused on contexts in which climate variability has led to conflict, rather than resilient, cooperative and peaceful outcomes that are evident in ethnographic studies.

Analysing the effects of climate variability through such approaches leads to multiple uncertainties about implications for the future. Future climate–conflict linkages will involve climate variability, mean climate change and diverse effects resulting from climate change, even though empirical investigations have focused largely on climate variability (for example, temperature or precipitation variability). Open questions pertain to the ways in which climate affects distinct phases of conflict—ranging from its onset and escalation through to termination. The future will entail societal adjustments to new climate baselines, potential limits to such adaptation and thresholds in the effects of climate change for which historical precedents do not currently exist. The implications for conflict will be modulated by state systems and the policies of major powers, which will also be influenced in uncertain ways by climate change.

Conclusion

The aim of this Analysis has been to generate a comprehensive and balanced assessment of the relationship between climate and conflict risks, reconciling contradictory findings in comparative and empirical research. On the basis of the methods that were applied here, we conclude that there is agreement that climate variability and change shape the risk of organized armed conflict within countries. In conflicts to date, however, the role of climate is judged to be small compared to other drivers of conflict, and the mechanisms by which climate affects conflict are uncertain. As risks grow under future climate change, many more potential climate–conflict linkages become relevant and extend beyond historical experiences.

One could ask what the usefulness of resolving the scientific disagreement and identifying areas of agreement is. For those scholars and policy-makers who are focused on climate, a synoptic understanding of the climate–conflict relationship is important, even if the role of climate is relatively minor compared to other drivers of conflict. Given that conflict has pervasive detrimental human, economic and environmental consequences, climate–conflict linkages—even if small—would markedly influence the social costs of carbon and decisions to limit future climate change. For those scholars and policy-makers focused on conflict, the assessment has pointed to the different ways in which climate may interact with the major drivers of conflict risk. Effectively managing such interactions will require mainstream and holistic, rather than myopic, considerations of the role of the climate across diverse settings and attention to uncertainties that will persist. And finally, appreciation of the future role of climate change and its security effects can help to prioritize societal responses, which could include enhanced global aid and cooperation.

Online content

Any methods, additional references, Nature Research reporting summaries, source data, statements of data availability and associated accession codes are available at https://doi.org/10.1038/s41586-019-1300-6.

Received: 26 November 2018; Accepted: 14 May 2019;
Published online 12 June 2019.

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Acknowledgements We acknowledge the substantial contributions of researchers whose work was the basis of this expert assessment. G. Albistegui Adler and T. Carleton participated in trials of the elicitation protocol. This research was supported by the Alexander von Humboldt Foundation, the Stanford Woods Institute for the Environment, European Research Council grant no. 648291, the German Science Foundation Clusters of Excellence CliSAP and CliCCS, the National Science Foundation Interdisciplinary Behavioral Social Science Initiative and the Swedish Foundation for Strategic Environmental Research Mistra Geopolitics program.

Reviewer information *Nature* thanks Geoff Dabelko, Vally Koubi and the other anonymous reviewer(s) for their contribution to the peer review of this work.

Author contributions K.J.M. and C.B.F. conceptualized the research goals. The author team of this manuscript consists of the climate and conflict expert group (W.N.A., H.B., M.B., J.D.F., C.S.H., J.-F.M., J.O., P.R., J.S., K.A.S. and N.v.U.) and the assessment facilitators (K.J.M., C.M.K. and C.B.F.). K.J.M., C.B.F. and C.M.K. developed the methodology with review and revision by the expert group (W.N.A., H.B., M.B., J.D.F., C.S.H., J.-F.M., J.O., P.R., J.S., K.A.S. and N.v.U.). K.J.M. and C.M.K. conducted the individual expert elicitation and group deliberation with the expert group and analysed the data. K.J.M. drafted the manuscript with review and revision by all authors.

Competing interests The authors declare no competing interests.

Additional information
Extended data is available for this paper at https://doi.org/10.1038/s41586-019-1300-6.
Supplementary information is available for this paper at https://doi.org/10.1038/s41586-019-1300-6.
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METHODS

The structure of the expert assessment. The expert assessment combined 3 primary phases: (1) in-depth, full-day expert-elicitation interviews, conducted individually with each member of an 11-person climate and conflict expert group; (2) an in-person, 2-day deliberation of the expert group on the interview results and associated extensions; and (3) development of a synthesis manuscript co-authored by everyone in the expert group. The author team of this manuscript consists of the climate and conflict expert group (W.N.A., H.B., M.B., J.D.F., C.S.H., J.-F.M., J.O., P.R., J.S., K.A.S. and N.v.U.) and the assessment facilitators (K.J.M., C.M.K. and C.B.F.). Stanford University IRB reviewed and approved the involvement of human subjects in this research project, including associated procedures for informed consent.

Each of the expert-assessment phases has substantial precedence in the applied-decision-sciences and assessment literature[29,37]. For decades, combination of the three phases has been recommended[30–32], but not yet attempted, to reduce biases that arise in expert-panel assessment (second and third phases) without sufficient attention to the range of individual perspectives on the literature and its uncertainties (first phase).

The assessment facilitators identified the expert group through extensive literature searches for publications on climate and conflict and additional suggestions from H.B., M.B., J.D.F. and K.A.S. for general conflict scholars. For each potential expert (around 65 in total), the facilitators determined disciplinary background, affiliation, published work and associated metrics, collaborators, relative emphasis on comparative and crosscutting analyses, including replicable quantitative empirical research, previous conclusions about climate and conflict, and relative focus on climate versus conflict. From this evaluation, 12 experts were identified based on a goal of spanning a wide range of relevant perspectives, consistent with expert-elicitation best practices. In particular, the experts were selected to encompass a wide range of relevant disciplines (especially political science, economics, geography and environmental sciences), career stages and institutions, beliefs about the strengths of connections between climate and conflict, and relative focus on climate versus conflict. Of the identified experts, 11 accepted the invitation to participate in the project, forming the expert group.

Expert elicitation. Expert elicitation is a well-vetted interview method from the applied decision and policy-analysis sciences[29]. The interview approach documents the subjective probabilistic judgments of experts, using question formats that minimize cognitive biases and overconfidence. Associated practices include exploring thinking first about more extreme possibilities compared to anchoring on initial best guesses; applying backwards analysis in which an expert considers and explains how he or she could be incorrect; and specifically challenging experts to evaluate the literature and interpretations of other experts in cases in which there are disagreements.

The interview approach also involves extended exploration of the bases of expert judgments in available evidence, along with the strengths and limitations of that evidence. For this expert assessment of climate and conflict, relevant forms of evidence include empirical observations and datasets, case-based analyses, statistical analyses, theory and its testing, simulation and descriptive models and experimental results. These forms of evidence, published in peer-reviewed literature, draw from different disciplinary approaches and methods of research.

To develop a wide-ranging understanding of societal questions relevant to evidence on climate and conflict, the assessment facilitators also conducted short, semi-structured interviews with a range of purposively sampled stakeholders who work on conflict risk reduction or climate change adaptation across professional and geographical contexts (project data 1)[42]. Perspectives from these stakeholder interviews informed, in particular, the semi-structured question follow-ups during the individual expert-elicitation interviews.

The individual expert-elicitation protocol for this assessment characterized expert judgments on the evidence across four progressive themes: (1) the relative importance of causal factors increasing conflict risk; (2) the relationship between climate and conflict risk to date; (3) the relationship between climate and conflict risk in the future; and (4) the implications for climate change adaptation and conflict risk reduction.

The assessment facilitators drafted the individual expert-elicitation interview protocol. Each member of the expert group individually reviewed the clarity and effectiveness of the draft protocol. These reviews especially considered questions that are most important for evaluating the state of knowledge of the topic and reasons for disagreement across lines of evidence. The assessment facilitators, in turn, revised the expert-elicitation interview protocol, the expert group reviewed it a second time, and on that basis, the assessment facilitators prepared a final version of the interview protocol, along with implementation notes. In parallel, the assessment facilitators tested the interview protocol with two advanced graduate students who were researching climate and conflict. See methods files 1 and 2 of the project[42] for the final individual expert-elicitation interview protocol and associated response sheet.

To support the expert-elicitation interviews, the assessment facilitators developed a briefing book of relevant literature, including suggestions from the expert group (methods file 3)[42]. The goal of the briefing book was to ensure that expert judgments about the state of knowledge, as documented in the interviews, were thoroughly built from a full range of available evidence. The experts individually reviewed the briefing book in advance of the expert-elicitation interviews.

Each expert-elicitation interview was administered over 6–8 h by K.J.M., assisted by C.M.K., at the home institution of the expert. On the basis of audio recordings, transcripts were prepared by C.M.K. for each interview (constituting 787 pages in total) and then summarized anonymously by K.J.M. with each expert randomly assigned an identifying number (project data 2)[42]. Per the Stanford University IRB approval for this project and associated informed consent of the participating experts, the anonymized transcript summary is provided in project data 2[42], however, the raw transcripts themselves are not included.

Group deliberation. The second stage of the assessment was the in-person, two-day deliberation of the full expert group. Its design was based on best practices for strategically exploring perspectives[37,43]. In particular, the deliberation combined full-group discussions, small-group discussions and individual reflections preceding those discussions. The biggest areas of disagreement and most wide-open questions were considered through different modes of interaction, in addition to the discussions: short stage-setting perspectives expanding thinking on the full range of possibilities; construction of conceptual graphics to reveal understanding of the experts' mental models; and development of the summary text. The deliberation was moderated by K.J.M.

The assessment facilitators drafted the group-deliberation agenda in advance of the meeting, with revision following the individual review of the agenda by the expert group (for the final agenda and associated individual workbook, see methods files 4 and 5[42]). On the basis of audio recordings of the group deliberation, transcripts were again prepared (constituting 163 pages in total), with points raised then combined anonymously with the analysis of the individual expert-elicitation interviews (project data 2[42]).

After the group deliberation, each expert revisited his or her judgments from the individual expert elicitation, updating them in some cases.

Synthesis manuscript. The summarized transcripts from the individual expert-elicitation interviews and group deliberation were analysed by K.J.M. through qualitative content analysis. Unique points raised were coded across the assessment themes. Commonalities and differences in expert perspectives were identified iteratively and inductively through multiple rounds of synthesis. Throughout the resulting summary, each expert is consistently identified with his or her randomly assigned number, and group deliberation inputs are referenced as 'GD'.

The nature of the corresponding traceable accounts—the linkages from expert judgments to their basis in the underlying evidence—was evaluated. Degree-of-certainty descriptors[37] were applied accordingly to characterize existing evidence (limited to robust) and agreement about the evidence (low to high). This approach draws from guidance developed for and applied by lead authors in assessments by the IPCC, as well as from analysis of the IPCC reports[35].

Data were analysed in Microsoft Excel and RStudio. In plots of subjective probabilistic judgments elicited, the randomly assigned identifying number of each expert is used. For questions about historical and future conflict risk, as well as most influential causal factors, measures of sensitivity and the increase/decrease ratio, related to climate, are defined in the analysis of judgments made. Sensitivity is $(I + D)/T$. Here, I is the sum of probabilities assigned to the moderate and substantial increase categories for relevant elicitation questions. D is the sum of probabilities assigned to the moderate and substantial decrease categories. T is the total probability assigned across the substantial, moderate and negligible change categories. The increase/decrease ratio is $I/(D + I)$. An increase–decrease value of 1 indicates weighting of the moderate and substantial increase categories, but not the decrease categories. An increase–decrease value of 0.5 indicates equal weighting of the increase and decrease categories.

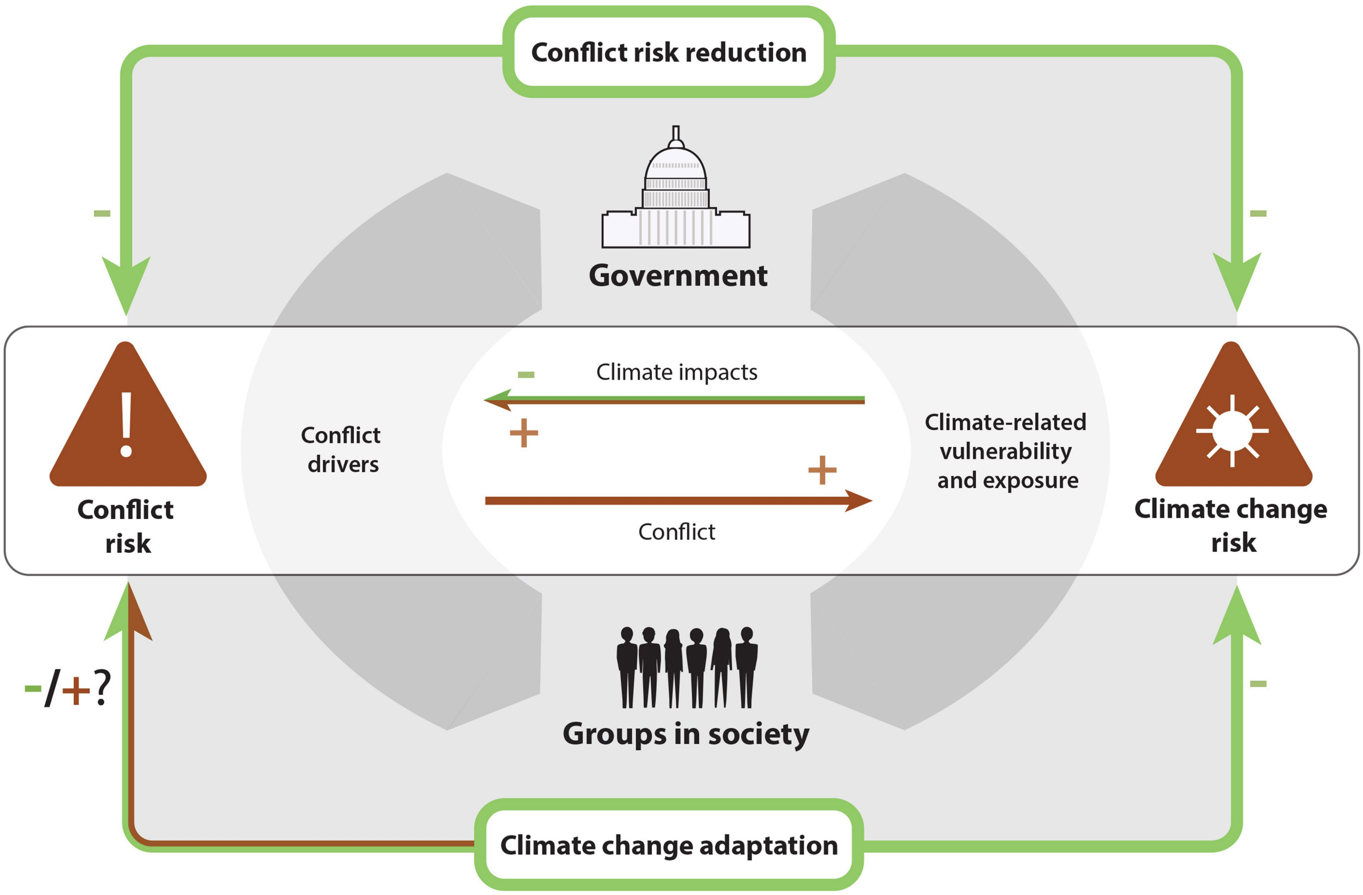
This analysis synthesized the 950 pages of interview and group-deliberation transcripts, along with the subjective probabilistic judgments documented, into a first draft of this manuscript. The full expert group then commented heavily on the draft through multiple rounds of revision.

Reporting summary. Further information on research design is available in the Nature Research Reporting Summary linked to this paper.

Data availability

All data generated or analysed during this study are included in this published article (and its Supplementary Information) or are available in the Stanford Digital Repository (https://purl.stanford.edu/sy632nx6578)[42]. The Stanford University IRB approved involvement of the human subjects in this research project. Per that approval and associated informed consent, anonymized transcript summaries are provided, but not the raw transcripts themselves.

42. Mach, K. J. et al. *Climate as a risk factor for armed conflict data sets*. https://purl.stanford.edu/sy632nx6578 (Stanford Digital Repository, 2019).
43. Straus, S. G., Parker, A. M., Bruces, J. B. & Dembosky, J. W. *The group matters: a review of the effects of group interaction on processes and outcomes in analytic teams*. Working Paper No. WR-580-USG https://www.rand.org/content/dam/rand/pubs/working_papers/2009/RAND_WR580.pdf (RAND, 2009).



Extended Data Fig. 1 | Scope of the expert assessment. The risk of organized armed conflict within countries is shaped by interactions between the government and societal claimants (grey rounded arrows). Conflict and climate change are interconnected through climate effects on drivers of conflict (centre green/brown arrow pointing to the left). They also are interconnected through the consequences of conflict for climate-related vulnerability and exposure (centre brown arrow pointing to the right). These interactions depend on their geographical and temporal context. Against this backdrop, the assessment successively documented expert judgments across several themes: (1) drivers of conflict risk in experiences to date (grey rounded arrow on the left); (2) the relationship between climate and conflict risk to date and in the future (centre of figure); and (3) implications for adaptation to climate change and reduction in the risk of conflict (top and bottom). Throughout this figure, green arrows indicate interactions that decrease risk, whereas brown arrows indicate interactions that increase risk. Participating experts were selected to encompass a wide range of expertise on conflict, climate or their combination. Figure illustration by K. Marx.

Expert 1

ES	0	10	50	30	10	m
SD	0	0	90	10	0	l
SC	0	0	70	20	10	l
II	0	10	70	20	0	l
NR	0	10	70	20	0	l
RH	0	10	70	20	0	l
Past	0	0	70	20	10	l
2°C	0	0	30	60	10	m
4°C	0	0	10	45	45	m

Expert 2

SD	0	5	70	20	5	h
II	5	10	50	25	10	m
PS	0	5	60	30	5	m
EI	0	5	80	15	0	h
SC	0	10	65	20	5	m
PG	0	0	100	0	0	vh
Past	5	10	60	20	5	m
2°C	0	0	70	25	5	m
4°C	0	0	40	40	20	l

Expert 3

SC	1	1	94	2	2	m
PS	3	3	88	3	3	l
EI	1	1	96	1	1	m
SD	1	1	94	2	2	l
ID	1	1	96	1	1	m
CN	1	1	95	2	1	m
Past	2	3	85	5	5	l
2°C	1	4	75	18	2	l
4°C	1	1	63	25	10	vl

Expert 4

RH	0	1	95	4	0	l
SD	1	1	86	10	2	m
SC	1	1	90	7	1	l
ID	1	1	96	1	1	l
CN	1	1	93	4	1	l
II	1	1	94	3	1	l
Past	1	1	88	8	2	l
2°C	1	1	78	15	5	l
4°C	1	2	62	25	10	l

Expert 5

RH	0	0	83	10	7	m
CN	0	0	85	9	6	m
SC	0	5	82	8	5	m
II	0	1	88	7	4	l
MG	0	8	74	10	8	l
SD	0	5	77	12	6	l
Past	2	8	67	14	9	l
2°C	0	4	82	9	5	l
4°C	0	2	76	12	10	vl

Expert 6

SC	0	0	95	5	0	m
II	0	0	95	5	0	m
PP	0	0	100	0	0	m
SD	0	0	85	15	0	m
ES	0	0	75	20	5	l
CN	0	0	95	5	0	m
Past	0	0	90	10	0	l
2°C	0	0	70	20	10	l
4°C	0	0	34	33	33	vl

Expert 7

RH	0	0	70	20	10	m
SD	0	0	60	30	10	h
SC	0	0	70	20	10	m
CN	0	0	60	30	10	m
II	0	0	50	40	10	h
MG	0	0	70	25	5	m
Past	0	0	95	5	0	h
2°C	0	0	20	55	25	m
4°C	0	0	20	40	40	h

Expert 8

RH	2	10	60	20	8	l
SD	0	5	80	15	0	l
NR	0	10	80	10	0	m
ES	5	15	45	25	10	m
CN	2	10	60	20	8	l
VC	5	20	30	30	15	m
Past	5	20	30	30	15	l
2°C	0	0	30	40	30	m
4°C	0	0	10	40	50	m

Expert 9

RH	0	0	95	5	0	l
SD	0	1	92	6	1	l
PP	0	1	98	1	0	m
SC	0	2	93	4	1	m
EI	2	5	86	5	2	l
II	0	0	98	2	0	l
Past	0	1	94	4	1	m
2°C	0	0	94	5	1	l
4°C	2	10	58	20	10	vl

Expert 10

SD	0	0	70	20	10	vl
II	0	0	60	30	10	vl
NR	0	0	50	35	15	vl
CN	0	0	50	35	15	vl
PP	0	0	50	30	20	vl
VC	0	0	50	25	25	vl
Past	0	0	90	5	5	m
2°C	0	5	50	30	15	m
4°C	0	5	30	40	25	l

Expert 11

II	0	0	70	15	15	m
CR	0	0	100	0	0	h
EI	0	0	95	5	0	h
MG	0	0	70	20	10	m
SD	0	0	70	20	10	h
ID	0	0	95	5	0	h
Past	0	0	75	20	5	l
2°C	0	0	0	70	30	h
4°C	0	0	0	65	35	m

Estimated probabilities (%)

Substantial decrease ← Negligible change → Substantial increase

Most influential causal factors	F1	0	0	70	15	15	m
	F2	0	0	100	0	0	h
	F3	0	0	95	5	0	h
	F4	0	0	70	20	10	m
	F5	0	0	70	20	10	h
	F6	0	0	95	5	0	h
Past examples of conflict	Past	0	0	75	20	5	l
Future climate scenarios	2°C	0	0	0	70	30	h
	4°C	0	0	0	65	35	m

Confidence level

Extended Data Fig. 2 | See next page for caption.

Extended Data Fig. 2 | Individual expert judgments about the relationship between climate and conflict risk. Raw numbers of the subjective probabilistic estimates of each expert that are documented in the elicitation. For each expert, the first 6 rows correspond to the 6 causal factors that the expert ranked as most influencing conflict risk to date, drawing from a list of 16 factors collectively generated by the full expert group. The last 3 rows correspond to past examples of organized armed conflict overall (labelled as 'past') and to conflict risk under approximately 2 °C and approximately 4 °C warming scenarios (labelled as 2 °C and 4 °C). Numbers within each row are estimated probabilities. For each causal factor (the first six rows), the probabilities reflect judgments of how frequently climate variability and change have led to substantial, moderate or negligible changes in conflict risk for violent conflicts to date involving that factor (probabilities ordered as: substantial decrease, moderate decrease, negligible change, moderate increase and substantial increase). For total risk of violent conflict to date (past), the probabilities reflect judgments across past examples of conflict overall. For the approximately 2 °C and approximately 4 °C warming scenarios, specified probabilities reflect judgments of potential changes in conflict risk compared to the current climate; these hypothetical scenarios consider effects for current societies, assuming current levels of (for example) socioeconomic development, population and government capacity. Shading categories visualize patterns. CN, conflict in neighbouring areas; CR, corruption; ES, economic shocks; EI, external intervention; ID, illiberal democracy; II, intergroup inequality; MG, mistrust of government; NR, natural resource dependency; PG, physical geography; PP, population pressure; PS, political shocks; RH, recent history of violent conflict; SC, low state capability; SD, low socioeconomic development; VC, climate variability and/or change; VI, vertical income inequality. Confidence levels[37] are indicated in the rightmost column: vl, very low; l, low; m, medium; h, high; vh, very high.

Expert 1

ES	0	0	30	50	20	m
SD	0	0	90	10	0	l
SC	0	0	70	20	10	l
II	0	10	70	20	0	l
NR	0	10	60	30	0	l
RH	0	0	70	30	0	l
Past	0	0	70	20	10	l
2°C	0	0	30	60	10	m
4°C	0	0	10	45	45	m

Expert 2

SD	0	5	70	20	5	h
II	5	10	50	25	10	m
PS	0	5	60	30	5	m
EI	0	5	80	15	0	h
SC	0	10	65	20	5	m
PG	0	0	100	0	0	vh
Past	5	10	60	20	5	m
2°C	0	0	70	25	5	m
4°C	0	0	40	40	20	l

Expert 3

SC	1	1	94	2	2	m
PS	3	3	88	3	3	l
EI	1	1	96	1	1	m
SD	1	1	94	2	2	l
ID	1	1	96	1	1	m
CN	1	1	95	2	1	m
Past	2	3	85	5	5	l
2°C	1	4	75	18	2	l
4°C	1	1	63	25	10	vl

Expert 4

RH	0	1	95	4	0	l
SD	0	0	95	5	0	l
SC	0	0	97	3	0	vl
ID	0	0	99	1	0	l
CN	0	1	95	4	0	l
II	0	0	97	3	0	l
Past	0	1	95	4	0	l
2°C	0	1	93	6	0	vl
4°C	0	2	86	10	2	vl

Expert 5

RH	0	0	83	10	7	m
CN	0	0	85	9	6	m
SC	0	5	82	8	5	m
II	0	1	88	7	4	l
MG	0	8	74	10	8	l
SD	0	5	77	12	6	l
Past	2	8	67	14	9	l
2°C	0	4	82	9	5	l
4°C	0	2	76	12	10	vl

Expert 6

SC	0	0	95	5	0	m
II	0	0	95	5	0	m
PP	0	0	100	0	0	m
SD	0	0	85	15	0	m
ES	0	0	75	20	5	l
CN	0	0	95	5	0	m
Past	0	0	90	10	0	l
2°C	0	0	70	20	10	l
4°C	0	0	25	25	50	vl

Expert 7

RH	0	0	70	20	10	m
SD	0	0	60	30	10	h
SC	0	0	70	20	10	m
CN	0	0	60	30	10	m
II	0	0	50	40	10	h
MG	0	0	70	25	5	m
Past	0	0	95	5	0	h
2°C	0	0	50	45	5	m
4°C	0	0	30	60	10	h

Expert 8

RH	2	10	60	20	8	l
SD	0	5	80	15	0	l
NR	0	10	80	10	0	m
ES	5	15	45	25	10	m
CN	2	10	60	20	8	l
VC	5	20	30	30	15	m
Past	5	20	30	30	15	l
2°C	0	0	30	40	30	m
4°C	0	0	10	40	50	m

Expert 9

RH	0	0	95	5	0	m
SD	0	1	92	6	1	m
PP	0	0	100	0	0	vh
SC	0	2	93	4	1	m
EI	2	8	80	8	2	l
II	0	0	98	2	0	h
Past	0	1	94	4	1	m
2°C	0	0	94	5	1	m
4°C	1	5	44	40	10	l

Expert 10

SD	0	0	70	20	10	vl
II	0	0	60	30	10	vl
NR	0	0	50	35	15	vl
CN	0	0	50	35	15	vl
PP	0	0	50	30	20	vl
VC	0	0	50	25	25	vl
Past	0	0	90	5	5	m
2°C	0	5	50	30	15	m
4°C	0	5	30	40	25	l

Expert 11

II	0	0	70	15	15	m
CR	0	0	100	0	0	h
EI	0	0	95	5	0	h
MG	0	0	70	20	10	m
SD	0	0	70	20	10	h
ID	0	0	95	5	0	h
Past	0	0	75	20	5	l
2°C	0	0	0	70	30	h
4°C	0	0	0	65	35	m

Estimated probabilities (%)

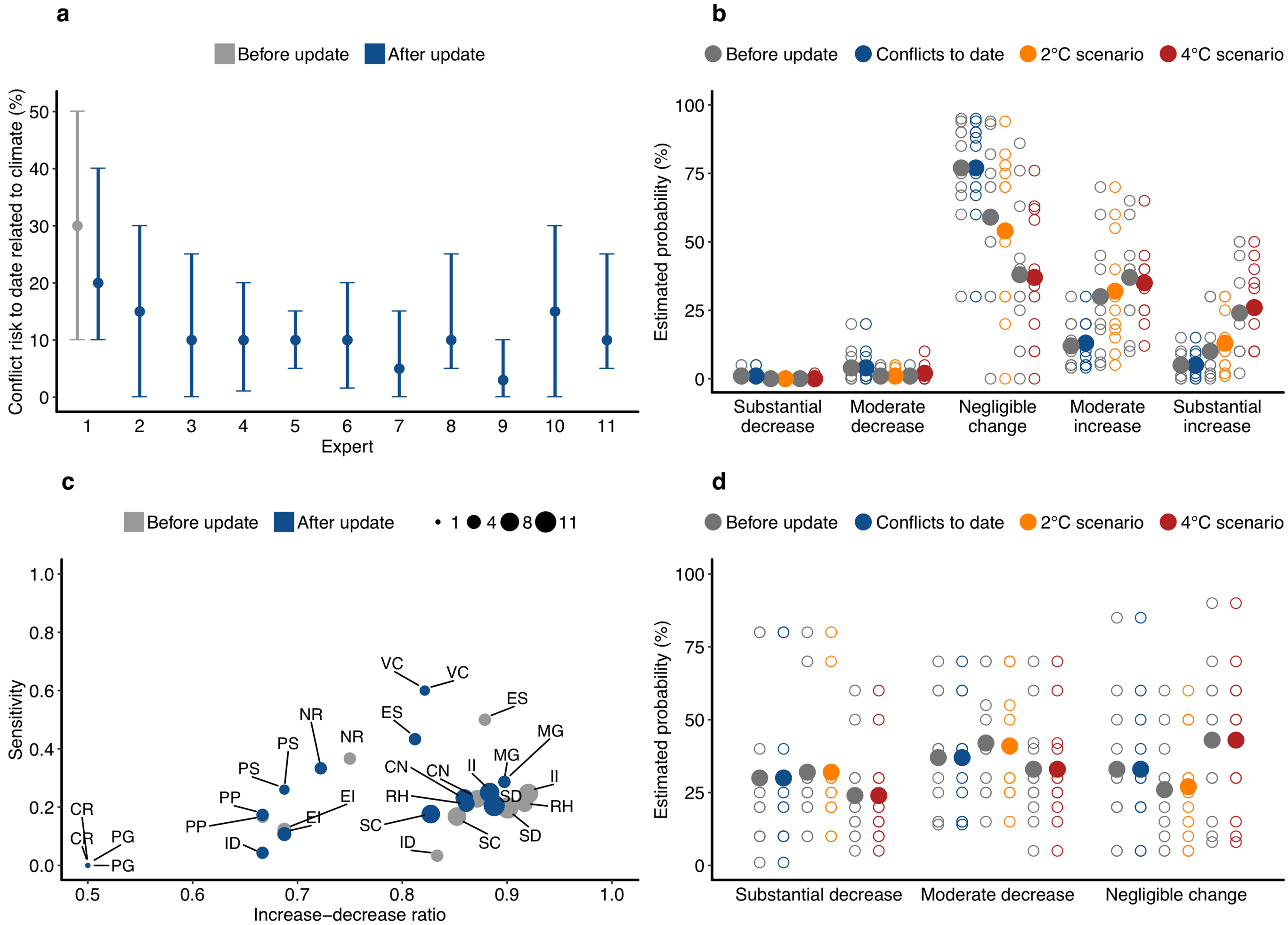
Substantial decrease ← Negligible change → Substantial increase

Most influential causal factors	F1	0	0	70	15	15	m
	F2	0	0	100	0	0	h
	F3	0	0	95	5	0	h
	F4	0	0	70	20	10	m
	F5	0	0	70	20	10	h
	F6	0	0	95	5	0	h
Past examples of conflict	Past	0	0	75	20	5	l
Future climate scenarios	2°C	0	0	0	70	30	h
	4°C	0	0	0	65	35	m

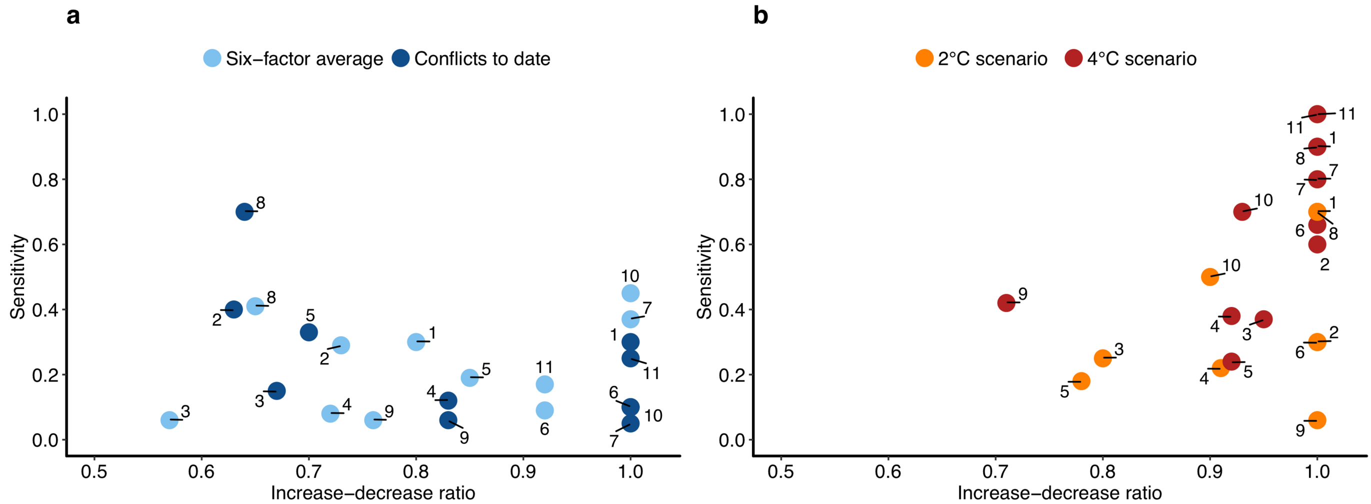
Adjusted values in red

Confidence level

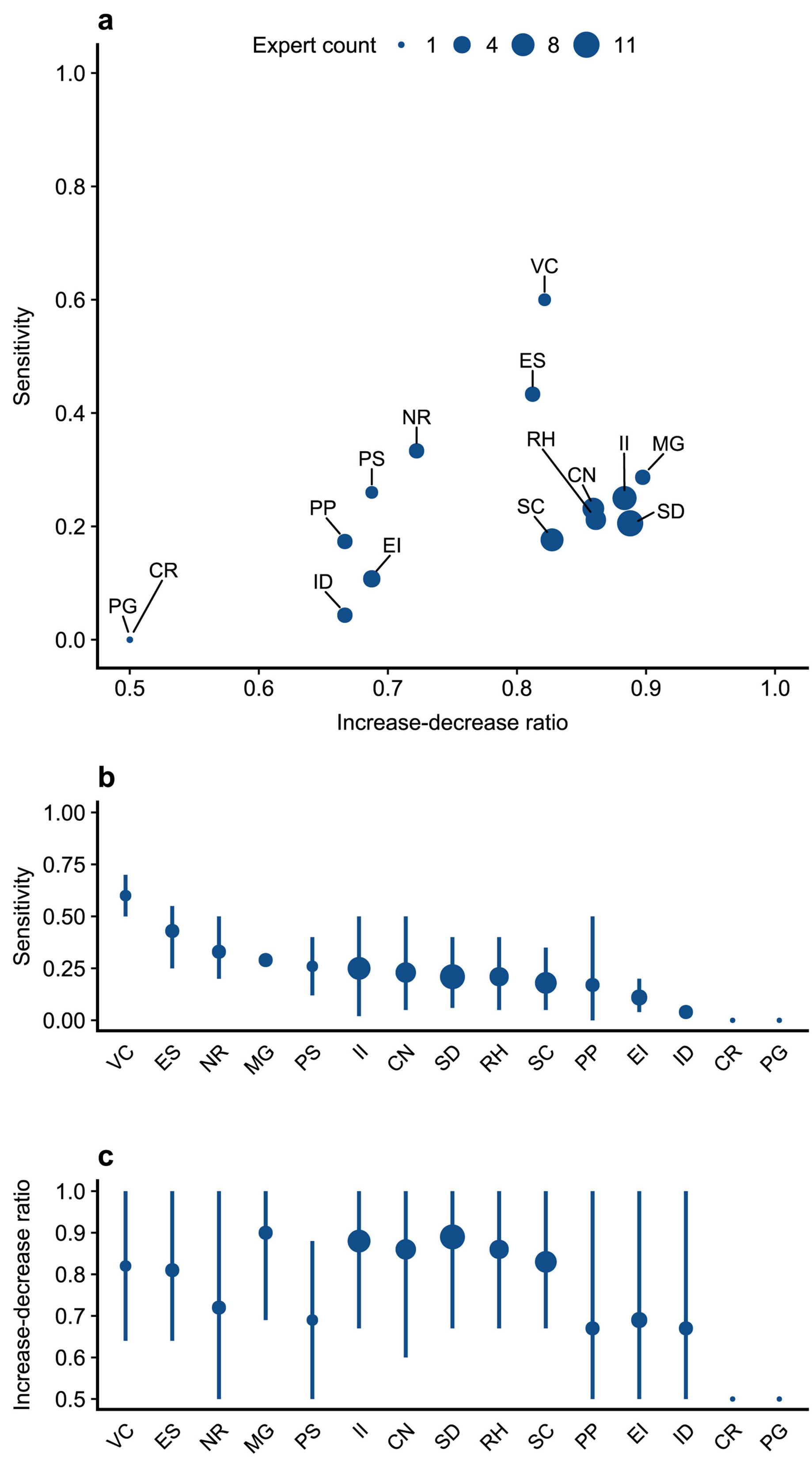
Extended Data Fig. 3 | Before–after comparisons of elicited expert judgments. After the group deliberation, each expert individually revisited his or her judgments from the individual expert elicitation, updating them in some cases. All adjustments made are depicted here and in Extended Data Fig. 4. Across expert-elicitation interview questions, individual updates following the group deliberation are modest. This figure indicates individual expert judgments about the relationship between climate and conflict risk for the 6 most influential factors ranked by each expert, for conflicts to date overall, and for the 2 °C and 4 °C warming scenarios for current societies overall. Data are the initial judgments of each expert during the individual expert-elicitation interviews. Estimates updated after the group deliberation (see Extended Data Fig. 2 for final estimates) are shown in red.



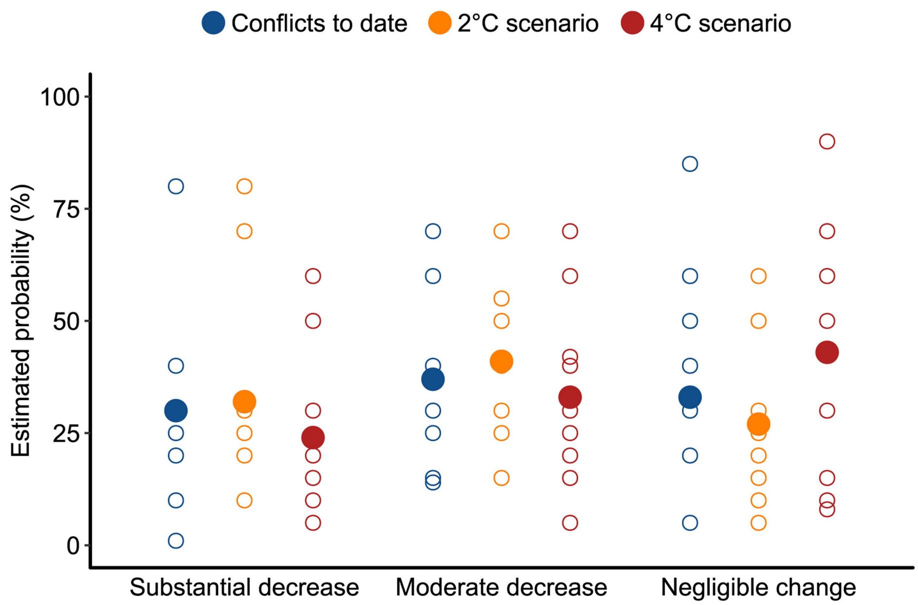
Extended Data Fig. 4 | Before–after comparisons of elicited expert judgments. After the group deliberation, each expert individually revisited his or her judgments from the individual expert-elicitation interviews, updating them in some cases. All adjustments made are depicted here and in Extended Data Fig. 3. Across expert-elicitation interview questions, individual updates following the group deliberation are modest. **a**–**d**, In these plots, initial judgments during the individual expert-elicitation interviews are compared to the revisited judgments that were updated in some cases. In cases in which judgments are updated, figure panels are repeated, showing the initial estimates in grey (**a** repeats Fig. 1, **b** repeats Fig. 2, **c** repeats Extended Data Fig. 6a and **d** repeats Extended Data Fig. 7). Detailed descriptions of each panel and the symbols used are provided in the legends of Figs. 1, 2 and Extended Data Figs. 6a, 7.



Extended Data Fig. 5 | Individual expert judgments regarding the climate sensitivity and increase/decrease ratio for the relationship between climate and conflict risk. For each expert, two measures were used to characterize elicited judgments about the relationship between climate and conflict risk: climate sensitivity and increase/decrease ratio. **a**, Sensitivity and increase/decrease ratio are shown for the six most influential conflict drivers that were considered by an expert (light blue; mean across causal factors) and for past examples of violent conflict overall (dark blue). **b**, Sensitivity and increase/decrease ratio are shown for conflict risk overall under the 2 °C (orange) and 4 °C (red) scenarios. Numbers indicate the expert identifier for each data point. A comparison of blue to orange to red data points indicates that they shift to the right and upwards. This shift illustrates the overall judgment that, with intensifying climate change, climate is expected to increasingly affect conflict risk (illustrated by greater sensitivity—that is, the upward shift). Additionally, this effect will increasingly serve to intensify rather than diminish conflict risk (illustrated by the greater increase/decrease ratio—that is, the shift to the right). For full definitions of the climate sensitivity and increase/decrease ratio measures, see Methods.



Extended Data Fig. 6 | Expert judgments regarding the climate sensitivity and increase/decrease ratio of the most influential conflict drivers. Two measures are used to characterize elicited judgments about the relationship between factors that drive conflict risk and climate in experiences to date: climate sensitivity and increase/decrease ratio. **a**, Sensitivity and increase/decrease ratio are shown for each causal factor (mean across experts; causal factor abbreviations as in Extended Data Fig. 2). The size of each data point indicates the number of experts who ranked the causal factor in their top-six-factor list. **b**, **c**, Mean sensitivity and increase/decrease ratio are repeated for each factor from **a**, shown as circles. For each factor, the range indicates the maximum and minimum sensitivity (**b**) and increase/decrease ratio (**c**) across the 11 experts. **a**, **c**, For causal factors with 100% estimated for negligible change (sensitivity = 0), the increase/decrease ratio is assigned a value of 0.5. **b** and **c** are repeated from Fig. 3, but with different sorting of factors, to enable comparison with **a**. For full definitions of the climate sensitivity and increase–decrease measures, see the legend of Fig. 3 and Methods.



Extended Data Fig. 7 | Estimated potential to reduce climate-related conflict risk. For three scenarios (experiences to date and the 2 °C and 4 °C warming scenarios), each expert estimated the reduction in climate-related conflict risk that could occur with substantial investments in conflict risk reduction. Probability estimates are indicated for substantial decrease in conflict risk, moderate decrease in conflict risk or negligible change. Substantial investments include measures and policies that address known conflict drivers, which are expected to contribute to risk reduction. For past examples of organized armed conflict overall (blue), probability estimates indicate a risk reduction deficit[34]. For the 2 °C and 4 °C warming scenarios presented here, probability estimates assume that the global mean warming levels are reached in the second half of the twenty-first century. Probability estimates encompass the range of socioeconomic development pathways that could occur over that timeframe. Open circles, individual estimates; filled circles, means across experts.

Extended Data Table 1 | The climatic sensitivity of most influential conflict drivers to date

Low socioeconomic development
Climate to some degree affects long-term socioeconomic development. There is greater uncertainty about resulting consequences for conflict risk. Climate–conflict linkages through low socioeconomic development could result from reduced opportunity costs for participating in violence, increased grievances, or increased vulnerability to climate-related risks and lower capacity to respond. [Evidence: *medium*, Agreement: *low*/*medium*]
Low state capability
Low state capability has persistent, difficult-to-change features. Some climate sensitivity increasing conflict risk could arise from climate-related shocks that decrease state capability. For instance, climate-related reductions in the taxable resource base could decrease the state's ability to project power across its territory or provide services supporting societal resilience. Climate-related shocks can also overly increase demands on the state, e.g., exacerbating intergroup inequalities when the state inadequately or unfairly distributes disaster assistance. [Evidence: *limited*, Agreement: *low*/*medium*]
Intergroup inequality
Intergroup inequalities and associated political exclusion, linked to non-climate factors and historical processes, may increase climate-related vulnerability of marginalized groups. Resulting differential impacts and exacerbated inequality could have potential consequences for conflict risk, e.g., via perceptions of unfairness, violent expression of grievances, or, by contrast, reduced ability to mobilize rebel groups. [Evidence: *limited*, Agreement: *low*]
Recent history of violent conflict
To the degree that previous episodes of conflict are triggered by climate, persistent legacies of violence could be carried forward through many intermediaries that create conflict traps. Recent conflict also increases climate-related vulnerability and decreases adaptive capacity, magnifying the impacts of climate-related hazards. [Evidence: *limited*/*medium*, Agreement: *medium*/*high*]
Conflict in neighboring areas
To the degree that episodes of conflict are triggered or exacerbated by climate, spillover of conflict could occur for multiple reasons, many of which are unrelated to climate. [Evidence: *limited*, Agreement: *medium*]
External intervention
The main and most potent forms of external intervention are political, unrelated to climate. Potential climatic sensitivity could arise through international involvement following climate-related shocks or perceived risks to shared natural resources, reducing or increasing conflict risk. [Evidence: *limited*, Agreement: *low*]

Expert judgments about the state of knowledge on climate–conflict linkages are characterized for the most-influential factors driving conflict risk in experiences to date (see Fig. 3a). The available knowledge basis for each climate–conflict linkage is described through the level of evidence and the degree of agreement[37]. This approach linking expert judgments to their basis in the underlying scientific literature draws from guidance iteratively developed for and applied in assessments by the IPCC[35]. Summary terms for the type, amount, quality and consistency of available evidence include limited, medium and robust. The degree of agreement is characterized as low, medium or high; the degree of agreement goes beyond consistency of evidence to consider the extent of established, competing or speculative explanations across the full scholarly community. The assessment input relevant to the summarized entries draws from both the individual expert-elicitation interviews and the group deliberation (see Supplementary Tables 1, 2 for the extended judgments about current knowledge).

Extended Data Table 2 | Climate–conflict linkages to date and in the future

Most likely linkages to date
• **Economic shocks:** Economic shocks are robustly correlated with conflict, and they can be a linkage between climate and conflict, e.g., via climate-related agricultural shocks, price shocks, or disasters, especially in low-income countries. The linkage can be mediated by reduced opportunity costs for participating in violence, by collapse of intergroup bargains, or by consequences for long-run socioeconomic development. Consequences for conflict depend on affected regions, sectors, or groups, along with timing and response capacity. [Evidence: *limited*/*medium*, Agreement: *medium*]
• **Natural resource dependency:** Climate-related resource scarcity and abundance have variable effects dependent on contexts, e.g., differential implications for rural producers versus urban consumers. Scarcity or abundance can, in some cases, increase conflict risk, whereas in others they can stimulate cooperation or otherwise decrease conflict risk. Centrality of agricultural livelihoods, issues of food access, and food prices can create linkages between climate and conflict risk, particularly in low-income countries. [Evidence: *medium*, Agreement: *low*]
Potential additional linkages in the future
• **Direct and indirect future economic impacts:** Especially under large magnitudes of climate change (e.g., ~4°C global mean warming), impacts triggering economic shocks or limiting economic development could particularly affect poor, conflict-prone regions or undermine democratic institutions and global cooperation. The degree to which globalization and economic integration will cushion versus amplify risk is uncertain. [Evidence: *limited*/*medium*, Agreement: *low*]
• **Global cooperation and international systems:** With increasing climate change, global cooperation could increase or decrease, affecting conflict risk. For example, concerted development assistance or, by contrast, securitization of climate responses and military engagement would differentially affect conflict risk. Climate impacts exceeding historical experiences may reveal “missing” institutions where global governance mechanisms do not yet exist, potentially challenging global cooperation and increasing conflict risk. Changes in world order, related to climate change or not, will modulate potential linkages between climate and conflict risk. Additionally, improved state capability and socioeconomic development could compensate for increased conflict risk due to climate change. [Evidence: *limited*, Agreement: *medium*]
• **Extreme events and disasters:** Extremes and associated disasters exacerbated by climate change could challenge state capability, authority, and legitimacy with competing claims around government responses. Climate-related impacts could, for example, trigger political shocks through government’s inability to adequately respond to climate-related risks. [Evidence: *limited*, Agreement: *low*]
• **Differential climate change impacts:** Poor, peripheral, or excluded regions may experience disproportionate climate change impacts, increasing conflict risk through exacerbated inequalities. Such populations may have, however, more limited mobilization capacity. Inadequate or unfair government assistance to marginalized groups could also increase conflict risk following climate-related impacts or disasters, e.g., again through exacerbated intergroup inequality. It could also decrease conflict risk, e.g., through increased self-reliant adaptation. [Evidence: *limited*, Agreement: *low*]
• **Food security:** Low-income countries dependent on agricultural production have high climate change vulnerability, given livelihoods and state capability shaped by agricultural income susceptible to climate change impacts. Implications for conflict risk can arise through economic impacts or price shocks creating political instability. Structural transformation of economies away from agriculture could reduce such climate–conflict linkages. [Evidence: *limited*, Agreement: *low*]
• **Migration:** Under large magnitudes of climate change, migration could occur at greater rates and scales (e.g., in response to desertification, extreme events, land loss, or livelihood impacts), as compared to adaptive and often beneficial environmentally related migration to date. The implications for conflict risk are uncertain given potential changes in migration dynamics, processes, and distances as well as host-community and country responses. There is also potential for increases in trapped populations unable to migrate, which may face greater climate-related risk and associated consequences for conflict risk. [Evidence: *limited*, Agreement: *low*]
• **Water:** Under large magnitudes of climate change, uncertainties increase regarding the persistence of historical cooperation around water. [Evidence: *limited*, Agreement: *low*]
• **Nonlinearities and tail risk:** Under large magnitudes of climate change, potential nonlinearities and tail risk (e.g., related to substantial sea level rise, increasingly inhospitable or uninhabitable regions, mass migration, or interconnected global economic impacts) limit the relevance of current relationships between climate and conflict for understanding possible future outcomes, with difficult-to-reduce uncertainties about societal responses, adaptation limits, and implications for conflict risk. [Evidence: *limited*, Agreement: *high*]

Expert judgments about the state of knowledge on climate–conflict linkages are characterized for linkages judged to be most salient to date (see Fig. 3b) and emergent in the future. The available knowledge basis for each climate–conflict linkage is described through the level of evidence and the degree of agreement[37], as in Extended Data Table 1. The assessment input relevant to these summarized entries draws from both the individual expert-elicitation interviews and the group deliberation (see Supplementary Table 2 for the extended judgments about current knowledge).

Extended Data Table 3 | Entry points for reducing climate–conflict risks

Risk reduction
• **Adaptation opportunities and constraints:** Even without an explicit conflict focus, adaptation can decrease conflict risk because similar factors contribute to climate change vulnerability and elevated conflict risk, for example for marginalized groups. Adaptive responses can also create new problems or unintended consequences, potentially increasing conflict risk. Violent conflict increases climate change vulnerability, decreases adaptive capacity, and reduces the feasibility of implementing adaptation. [Evidence: *medium*, Agreement: *medium*]
• **International peacekeeping:** The international standard treatment model (e.g., mediation, peacekeeping operations, post-conflict aid and reconstruction) is largely effective and relevant to climate-related organized violence. Embedding climate into standard conflict risk reduction could involve focusing on regions with climate-related vulnerability and exposure and recognizing that peacekeeping increases adaptive capacity. Predicting and preventing organized violent conflict is hard for both conflict onset and severity, including where climate might be relevant. There are associated challenges for resource allocation. In particular, identifying areas prone to conflict is much simpler than understanding how to address fundamental drivers of conflict, and the relative importance of climate compared to other drivers is hard to evaluate. [Evidence: *medium*, Agreement: *medium*]
• **International development assistance:** International development assistance can help countries reduce climate-related conflict risk, for example, through strengthening state capabilities to buffer climate-related shocks or through decreasing the sensitivity of livelihoods to climatic variability. However, there are uncertainties about the effectiveness of different actions and the potential for adverse side-effects. [Evidence: *medium*, Agreement: *low*]
• **State capability building:** Improved local-level government institutions and conflict resolution mechanisms, along with national and subnational adaptation policies, could reduce climate–conflict linkages. State capability building can, in principle, reduce disproportionate climate-related impacts for marginalized groups, but with challenges in implementation. [Evidence: *medium*, Agreement: *low*]
• **Economic diversification and resilience:** Adaptations buffering income to climate-related shocks, such as access to credit or irrigation, could reduce implications for conflict risk. Improved food production and security, including economic diversification beyond agricultural livelihoods, could also reduce climate–conflict linkages. [Evidence: *medium*, Agreement: *low*]
• **International governance:** Incorporation of climate change adaptation into global governance, treaties, and fora related to both climate and security could reduce climate-related conflict risk. Actions adaptive at one scale can have negative externalities increasing conflict risk, which is important to consider in policy design. [Evidence: *limited*, Agreement: *low*]
• **Migration:** Enabling adaptive migration could reduce potential climate–conflict linkages. With increasing magnitudes of climate change, new institutions for managing migration and relocation may be needed. [Evidence: *limited*, Agreement: *low*]

Expert judgments are provided for different entry points and approaches for the reduction in the risk of conflict and adaptation to climate change. The available knowledge basis for each potential response is described through the level of evidence and the degree of agreement[37], as in Extended Data Table 1. The assessment input relevant to these summarized entries draws from both the individual expert-elicitation interviews and the group deliberation (see Supplementary Table 3 for the extended judgments about current knowledge).

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Last updated by author(s): 3/19/2019

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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

Expert elicitation: Each expert-elicitation interview was administered over 6-8 hours by KJM, assisted by CMK, at the home institution of the expert. Based on audio recordings, transcripts were prepared by CMK for each interview (constituting 787 pages in total) and then summarized anonymously by KJM with each expert randomly assigned an identifying number (Project Data 2).

Group deliberation: The assessment facilitators drafted the group-deliberation agenda in advance of the meeting, with revision following the expert group's individual review of it (for the final agenda and associated individual workbook, see Methods Files 4 and 5). Based on audio recordings of the group deliberation, transcripts were again prepared (constituting 163 pages in total), with points raised then combined anonymously with the analysis of the individual expert-elicitation interviews (Project Data 2). After the group deliberation, each expert revisited his or her judgments from the individual expert elicitation, updating them in some cases (Extended Data Figures 3 and 4).

Data analysis

The summarized transcripts from the individual expert-elicitation interviews and group deliberation were analyzed by KJM through qualitative content analysis. Unique points raised were coded across the assessment themes. Commonalities and differences in expert perspectives were identified iteratively and inductively through multiple rounds of synthesis. Throughout the resulting summary, each expert is consistently identified with his or her randomly assigned number, and group deliberation inputs are referenced as GD.

The nature of the corresponding traceable accounts—the linkages from expert judgments to their basis in the underlying evidence—was evaluated. Degree-of-certainty descriptors were applied accordingly to characterize existing evidence (limited to robust) and agreement about the evidence (low to high). This approach draws from guidance developed for and applied by lead authors in assessments by the Intergovernmental Panel on Climate Change, as well as from analysis of it.

In plots of subjective probabilistic judgments elicited, each expert's randomly assigned identifying number is used. For questions about historical and future conflict risk, as well as most influential causal factors, measures of sensitivity and increase–decrease ratio, related to climate, are defined in the analysis of judgments made. Sensitivity is (I + D) / T. Here, I is the sum of probabilities assigned to the moderate and substantial increase categories for relevant elicitation questions. D is the sum of probabilities assigned to the moderate and substantial decrease categories. T is the total probability assigned across the substantial, moderate, and negligible change categories. The increase–decrease ratio is I / (D + I). An increase–decrease value of 1 indicates weighting of the moderate and substantial increase categories, but not the decrease categories. An increase–decrease value of 0.5 indicates equal weighting of the increase and decrease categories.

This analysis synthesized the 950 pages of interview and group-deliberation transcript, along with the subjective probabilistic judgments documented, into a first draft of this manuscript. The full expert group then commented heavily on the draft through multiple rounds of revision.

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All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

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Behavioural & social sciences study design

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

Study description

The expert assessment combined three primary phases: (A) in-depth, full-day expert-elicitation interviews, conducted individually with each member of an 11-person climate and conflict expert group; (B) an in-person, two-day deliberation of the expert group on the interview results and associated extensions; and (C) development of a synthesis manuscript co-authored by everyone in the expert group. The author team of this manuscript consists of the climate and conflict expert group (WNA, HB, MB, JDF, CSH, JFM, JO, PR, JS, KAS, NU) and the assessment facilitators (KJM, CMK, CBF).

Each of these expert-assessment phases has substantial precedence in the applied-decision-sciences and assessment literature. For decades, combination of the three phases has been recommended, but not yet attempted, to reduce biases that arise in expert-panel assessment (phases B and C) without sufficient attention to the range of individual perspectives on the literature and its uncertainties (phase A).

Research sample

12 experts were identified based on a goal of spanning a wide range of relevant perspectives, in line with expert-elicitation best practices. In particular, the experts were selected to encompass a wide range of relevant disciplines (e.g., political science, economics, geography, environmental science), career stages and institutions, beliefs about the strengths of connections between climate and conflict, and relative focus on climate versus conflict.

Sampling strategy

The assessment facilitators identified the expert group through extensive literature searches for publications on climate and conflict and additional suggestions from HB, MB, JDF, and KAS for general conflict scholars. For each potential expert (~65 in total), the facilitators determined disciplinary background, affiliation, published work and associated metrics, collaborators, relative emphasis on comparative and crosscutting analyses including replicable quantitative empirical research, previous conclusions about climate and conflict, and relative focus on climate versus conflict.

Data collection

Expert elicitation: Each expert-elicitation interview was administered over 6-8 hours by KJM, assisted by CMK, at the home institution of the expert. Based on audio recordings, transcripts were prepared by CMK for each interview (constituting 787 pages in total) and then summarized anonymously by KJM with each expert randomly assigned an identifying number (Project Data 2).

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Timing

Individual expert interviews September-October 2017, group deliberation December 3 and 4, 2017.

Data exclusions	No data exclusions.
Non-participation	Out of 12 invited experts, one (general conflict) scholar declined participation due to existing workload. The informed consent process allowed experts to terminate participation at any time; all experts who began the study remained in it through to the end.
Randomization	Not relevant.

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☒	☐	Animals and other organisms
☐	☒	Human research participants
☒	☐	Clinical data

Methods

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

Human research participants

Policy information about studies involving human research participants

Population characteristics	See above.
Recruitment	See above.
Ethics oversight	Stanford University IRB reviewed and approved the research protocol for this study (protocol number 41909) and research continues to be under the oversight of this panel.

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