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Climate as a risk factor for armed conflict

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Summary:
Research findings on the relationship between climate and conflict are diverse and contested. Based on the judgments of experts representing a broad range of disciplines and analytical approaches, we assess current understanding. The focus is on the importance of climate as a driver of organized armed conflict within countries, changes in conflict risk across climate futures, and implications for conflict risk reduction and climate change adaptation. Across experts, best estimates are that 3–20% of conflict risk over the last century has been influenced by climate, and none of their individual ranges excludes a role of climate in 10% of conflict risk to date. However, other drivers are judged substantially more influential for conflict overall, and the mechanisms of climate–conflict linkages are a key uncertainty. Intensifying climate change is estimated to increase future conflict risk as additional linkages become relevant, although uncertainties also expand.

Main Text:
Research over the past decade has established that climate variability and change may influence the risk of violent conflict, including organized armed conflict[1,2]. But use of different research designs, data sets, and methods has resulted in divergent findings and stark questions about legitimate approaches to scientific inference[1,3-9]. Past analyses, many from authors of this article, 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 causes 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 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 long suggested that individual elicitation paired with collective assessment could better reveal the state of knowledge than either approach in isolation[30-32]. Here, we develop a first such synoptic assessment of the relationship between climate and conflict.

The assessment approach and expert group
The focus here is organized armed conflict within countries (Extended Data Fig. 1). Previous crosscutting analyses of climate and conflict have combined individual-level violence (e.g., suicide, 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 (i.e., 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 neighboring areas or external intervention. In evaluating climate's effects, climate-related variability, hazards, trends, and change are all included (e.g., related to temperature, precipitation, modes of variability such as El Niño Southern Oscillation, and extreme events such as droughts and floods).

The author team of this manuscript consists of 3 assessment facilitators and a climate and conflict expert group. The 11-person expert group is a sample of the most experienced and highly cited scholars on the topic, spanning relevant social science disciplines (e.g., political science, economics, geography, environmental science), epistemological approaches, and diverse previous conclusions about climate and conflict (Methods). Selection of the expert group targeted 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 hour individual expert-elicitation interviews and a subsequent 2-day group deliberation (Methods). The interview and deliberation protocols were collectively developed by the author team and then administered by the assessment facilitators. 950 transcript pages from the interviews and deliberation were iteratively analyzed and distilled. 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 current understanding and the reasons for disagreement.

This assessment approach complements existing crosscutting reviews, meta-analyses, and perspectives on climate and conflict (e.g., [2,8,9,17,23,25-27]). The methods here go beyond previous syntheses by (1) systematically characterizing judgments about well-quantified risks and 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 last century, climate variability, hazards, and trends have affected organized armed conflict within countries (Figs 1 and 2). They also agree that other conflict drivers are much more influential for conflict risk across experiences to date, 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 last 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 where 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 changed likelihood of conflict occurring (e.g., the frequency of conflict outbreak or duration of conflict) or altered magnitudes of the resulting harmful consequences (e.g., number of deaths, destruction of assets, or legacies of violence). The definition allows for consideration of the initial outbreak and continuing incidence of violent conflict and its consequences[34].

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

Across experts, four drivers are ranked as particularly influential for conflict risk to date: low socioeconomic development, low state capability, intergroup inequality (e.g., ethnic differences across groups), and recent history of violent conflict (Fig. 3a). The experts indicate more uncertainty about the influence of low socioeconomic development and recent conflict history, as compared to low state capability and intergroup inequality. There is high agreement that low socioeconomic development is one of the best predictors of intrastate conflict onset and continuing incidence[36]. Yet there is uncertainty about whether it is proxying for other mechanisms or is directly related to conflict risk, especially through fewer livelihood opportunities increasing the ease of mobilizing rebels (Supplementary Table 1). Similarly, recent conflict history is a strong predictor of subsequent conflict[36]. But there is uncertainty stemming from the many causal mechanisms possible, including more individuals with knowledge and weapons to fight, persistent factors contributing to instability, or continuation of grievances from previous violence.

Climate variability and/or change is low on the ranked list of most influential conflict drivers across experiences to date, and the experts rank it as most uncertain in its influence (Fig. 3a, Extended Data Tables 1 and 2, 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 yet may carry large consequences relevant to ongoing decision-making[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, ~2°C global mean temperature increase above preindustrial levels is estimated to substantially increase conflict risk with 13% probability, rising to 26% probability under a ~4°C scenario. A "substantial" increase in conflict risk was defined in the elicitation as involving severe and widespread impacts, based on criteria for key risks developed and applied in assessment by the Intergovernmental Panel on Climate Change[34].

The judgments about increasing conflict risk in the ~2°C and ~4°C scenarios incorporate a hypothetical *current societies* constraint, i.e., assuming societies with current levels of socioeconomic development experience additional climate change. Even with this constraint, uncertainties increase notably. The range of individual expert estimates for a substantial increase in conflict risk due to climate grows from 0–15% of conflicts to date to 10–50% probability 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, Extended Data Tables 1 and 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, by contrast, had negligible effect (Fig. 3, Extended Data Figs 5 and 6). For the four conflict drivers ranked as most influential overall, the experts estimate their climatic sensitivity to be relatively low (low socioeconomic development, low state capability, intergroup inequality, and recent conflict history in Fig. 3b). Non-climate factors and historical processes importantly shape these conflict drivers (Extended Data Table 1). However, where climate has affected conflict risk via these top-four conflict drivers, the experts estimate that climate has most often increased risk rather than decreased it (Fig. 3c).

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

Climate-related hazards, variability, and change can cause economic shocks through impacts 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, where adverse impacts on livelihoods make participation in violence relatively more attractive; uneven economic impacts precipitating the collapse of intergroup bargains; or deleterious effects on long-run socioeconomic development. The consequences of climate-related economic shocks are highly variable and depend on the affected areas and timing (e.g., growing-season drought in rain fed versus irrigated croplands), affected sectors and groups (e.g., exports impacting state capability and/or employment), and political will and response capacity (e.g., availability of cash transfers or alternative livelihoods).

Linkages via natural resource dependency also underscore uncertainty due to context-specific and multifaceted interactions (Extended Data Table 2). Climate-related resource scarcity can increase conflict risk, yet it can also stimulate cooperation to ensure fair distribution of resources, or decrease conflict risk if more time is spent on procuring food or conditions are unfavorable 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, instead, improved conditions for mounting and sustaining conflict.

Into the future, climate change could increase the risk of conflict through channels beyond climate-variability effects to date (Extended Data Table 2). Because such linkages exceed historical experiences, uncertainties increase especially under large magnitudes of climate change, e.g., ~4°C global mean warming (Fig. 2). Extrapolation from historical relationships is fraught with uncertainty because complex climate–conflict linkages partly depend on future socioeconomic development pathways, macroeconomic patterns (e.g., global recession), shifts in state capability, ideological fluctuations, and the state of global order and cooperation (e.g., via the UN Security Council).

Future climate–conflict linkages could involve exacerbation of climate–conflict connections present in experiences to date, climate change impacts fundamentally beyond previous experiences, or circumstances where existing response capacities reach limits. Across these categories, relevant climate change risks include substantial economic impacts, climatic extremes and associated disasters, impacts on agricultural production, or differential climate change impacts increasing intergroup inequalities (Extended Data Table 2). Such impacts could also reveal "missing" institutions, where governance mechanisms do not yet exist to address emergent climate change risks (e.g., 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 conflict risk reduction (Extended Data Fig. 7 and Table 3). For conflicts to date, the experts estimate a 67% probability that climate-related conflict risk could be reduced through investments addressing known drivers (mean estimates across experts). For a ~4°C scenario, however, the estimated potential for reducing climate-related conflict risk drops to 57% probability, given more severe climate change impacts.

The potential for synergies exists between conflict risk reduction and climate change adaptation (Extended Data Table 3). Similar factors determine vulnerability to both climate change and armed conflict. Specific measures addressing 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 (e.g., crop insurance, training services, cash transfers, postharvest storage, improved land tenure) can support food and livelihood security and economic diversification beyond agricultural livelihoods. Further, consideration of climate could be incorporated into standard conflict risk reduction via conflict mediation, peacekeeping operations, and post-conflict aid and reconstruction. 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 understanding of both the effectiveness and the potential adverse side-effects of different actions (Supplementary Table 3). Trade-offs include the ways climate responses can create new problems or unintended consequences, potentially affecting 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 favoring some groups over others or displacing 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 also approaches appropriate for deeper, difficult-to-quantify uncertainties.

Analytical challenges

Challenges in analysis strongly contribute to key uncertainties identified in this assessment, especially (1) the relative importance of climate as a driver of conflict, (2) the mechanisms through which climate affects conflict, (3) the conditions under which they materialize, and (4) the implications of future climate change for conflict risk (Supplementary Table 4).

In understanding why conflict occurs, tight causal inference is elusive for many fundamental questions of interest, including what most distinguishes countries with conflict onset versus not, 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 (e.g., 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 as compared to slow-trending variables such as levels of socioeconomic development, state capability, or intergroup inequality. This limits understanding of climate's relative importance for conflict, the mechanisms and mediators of climate's effect on conflict, and its interactions with other conflict drivers (e.g., the degree to which climate modulates the timing of conflict versus increasing the overall number of conflicts that occur). Compared to studies of 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 examination of case studies to generate 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, much empirical evaluation to date has examined climate–conflict linkages since 1945, a period in which organized armed conflict has predominantly occurred in unique conditions resulting from the breakdown of colonial empires and the rise of weak independent states. Analysis has focused on contexts where climate variability has led to conflict, rather than resilient, cooperative, and peaceful outcomes evident in ethnographic works.

Analyzing 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 resulting climate change impacts, even though empirical investigation has focused largely on climate variability (e.g., temperature or precipitation variability). Open questions pertain to the ways climate affects distinct phases in 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 climate change impacts for which historical precedents do not exist. The implications for conflict will be importantly modulated by state systems and the policies of major powers, which will also be impacted in uncertain ways by climate change.

Conclusion

The aim of this analysis has been a comprehensive and balanced assessment of the relationship between climate and conflict risks, reconciling contradictory findings in comparative and empirical research. Based on the methods applied here, 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 conflict drivers, and the mechanisms of climate's effect on conflict are uncertain. As risks grow under additional climate change, many more potential climate–conflict linkages become relevant and extend beyond historical experiences.

What is the usefulness of resolving the scientific disagreement and identifying areas of agreement? For those focused on climate, synoptic understanding of the climate–conflict relationship is important even if climate's role is relatively minor among the drivers of conflict. Given that conflict has pervasive detrimental human, economic, and environmental consequences, climate–conflict linkages, even if minor, would significantly influence the social costs of carbon and decisions to limit future climate change. For those focused on conflict, the assessment has pointed to the different ways climate may interact with the major drivers of conflict risk. Effectively managing such interactions will require mainstream and holistic, rather than myopic, consideration of climate's role across diverse settings and attention to uncertainties that will persist. And finally, appreciation of the future role of climate change and its security impacts can help prioritize societal responses, which could include enhanced global aid and cooperation.

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End Notes:
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Main Text Figure Captions:

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

Figure 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 a ~2°C (orange) and a ~4°C (red) scenario, probability estimates indicate potential changes in conflict risk compared to today's climate. For these hypothetical ~2°C and ~4°C scenarios, each expert considered associated effects of climate change for current societies, assuming, for example, current levels of socioeconomic development, population, and government capacity. Open circle: individual estimate; filled circle: mean across experts.

Figure 3. Factors driving conflict risk and their relationship to climate in experiences to date. (**a**) Rankings of causal factors most influencing conflict risk. Each expert individually ranked six causal factors most influencing violent conflict 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** and **c**) The relationship between factors driving conflict risk (from **a**) and climate in experiences to date. Two measures are shown: (**b**) climate sensitivity and (**c**) increase–decrease ratio. 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 estimated only to increase conflict risk, whereas a value of 0.5 indicates climate sensitivity equally increasing and decreasing 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.

Methods:

The structure of the expert assessment

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). Stanford University IRB reviewed and approved the human subjects involvement 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 (phases B and C) without sufficient attention to the range of individual perspectives on the literature and its uncertainties (phase A).

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. From this evaluation, 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. 11 of these experts accepted invitation to participate in the project, forming the expert group.

Phase A: 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 as 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 where 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 the peer-reviewed literature, draw from different disciplinary approaches and methods of research.

To develop 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 most important for evaluating the state of knowledge on 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 researching climate and conflict. See Methods Files 1 and 2 for the final individual expert-elicitation interview protocol and associated response sheet[42].

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, 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 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[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], but not the raw transcripts themselves.

Phase B: 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 summary text. The deliberation was moderated by KJM.

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[42]). 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[42]).

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

Phase C: synthesis manuscript

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[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 Intergovernmental Panel on Climate Change, as well as from analysis of it[35].

Data were analyzed in Microsoft Excel and RStudio. 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.

Data Availability Statement:

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

Extended Data Figure and Table Captions:

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

Extended Data Figure 2. Individual expert judgments about the relationship between climate and conflict risk. This figure provides raw numbers for each expert's subjective probabilistic estimates documented in the elicitation. For each expert, the first six rows correspond to the six causal factors 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 next three rows correspond to past examples of organized armed conflict overall (labeled as Past) and to conflict risk under ~2°C and ~4°C scenarios (labeled 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 the factor (probabilities ordered as: substantial decrease, moderate decrease, negligible change, moderate increase, substantial increase). For total risk of violent conflict to date (Past), the probabilities reflect judgments across past examples of conflict overall. For the ~2°C and ~4°C scenarios, specified probabilities reflect judgments of potential changes in conflict risk compared to today's climate; these hypothetical scenarios consider effects for current societies, assuming, for example, current levels of socioeconomic development, population, and government capacity. Shading categories visualize patterns. Causal factor abbreviations: recent history of violent conflict (RH), conflict in neighboring areas (CN), low socioeconomic development (SD), economic shocks (ES), vertical income inequality (VI), intergroup inequality (II), low state capability (SC), corruption (CR), illiberal democracy (ID), mistrust of government (MG), political shocks (PS), external intervention (EI), population pressure (PP), physical geography (PG), natural resource dependency (NR), climate variability and/or change (VC). Confidence levels[37] are indicated in the rightmost column: very low (vl), low (l), medium (m), high (h), and very high confidence (vh).

Extended Data Figure 3. 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 in this figure and in Extended Data Figure 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 six most influential factors ranked by each expert, for conflicts to date overall, and for ~2°C and ~4°C scenarios for current societies overall. Data shown 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 Figure 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, updating them in some cases. All adjustments made are depicted in this figure. 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 are compared to the revisited judgments updated in some cases. Where judgments are updated, figure panels are repeated, showing the initial estimates in gray (**a** repeats Fig. 1, **b** repeats Fig. 2, **c** repeats Extended Data Fig. 6a, **d** repeats Extended Data Fig. 7). Detailed description of each panel and the symbols used is provided in the legends for Figs 1 and 2 and Extended Data Figs 6a and 7.

Extended Data Figure 5. Sensitivity and increase–decrease ratio for the relationship between climate and conflict risk: the judgments of each expert. For each expert, two measures are 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 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 ~2°C (orange) and ~4°C (red) scenarios. Expert number is specified 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, the upward shift). Additionally, this impact will increasingly serve to intensify rather than diminish conflict risk (illustrated by greater increase–decrease ratio, the shift to the right). For full definitions of the climate sensitivity and increase–decrease measures, see Methods.

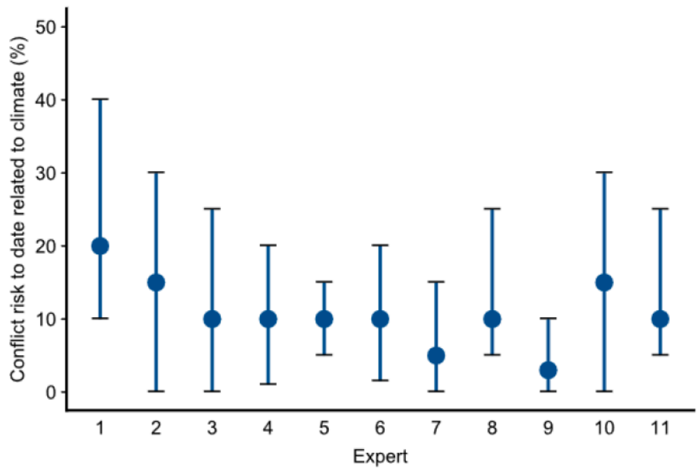
Extended Data Figure 6. Sensitivity and increase–decrease ratio for the relationship between climate and conflict risk: judgments for most influential conflict drivers. Two measures are used to characterize elicited judgments about the relationship between factors driving conflict risk and climate in 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** and **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. In **a** and **c**, for causal factors with 100% estimated for negligible change (sensitivity=0), the increase–decrease ratio is assigned a value of 0.5. Panels (**b**) and (**c**) are repeated from Fig. 3, but with different sorting of factors, to enable comparison with panel (**a**) here. For full definitions of the climate sensitivity and increase–decrease measures, see the Fig. 3 caption and Methods.

Extended Data Figure 7. Estimated potential to reduce climate-related conflict risk. For three scenarios (experiences to date, a ~2°C scenario, and a ~4°C scenario), 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 to 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 scenarios here, probability estimates assume the global mean warming levels are reached in the second half the 21st century. Probability estimates encompass the range of socioeconomic development pathways that could occur over that timeframe. Symbols used: open circle – individual estimate; filled circle – mean across experts.

Extended Data Table 1. The climatic sensitivity of most influential conflict drivers to date. 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 Intergovernmental Panel on Climate Change[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 this table's summarized entries draws from both the individual expert-elicitation interviews and the group deliberation (see Supplementary Tables 1 and 2 for the extended judgments about current knowledge).

Extended Data Table 2. Climate–conflict linkages to date and in the future. 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, as in Extended Data Table 1[37]. 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. Expert judgments are provided for different entry points and approaches for conflict risk reduction and climate change adaptation. The available knowledge basis for each potential response is described through the level of evidence and the degree of agreement, as in Extended Data Table 1[37]. 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).



Conflict risk to date related to climate (%)
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
Expert

Figure 1.

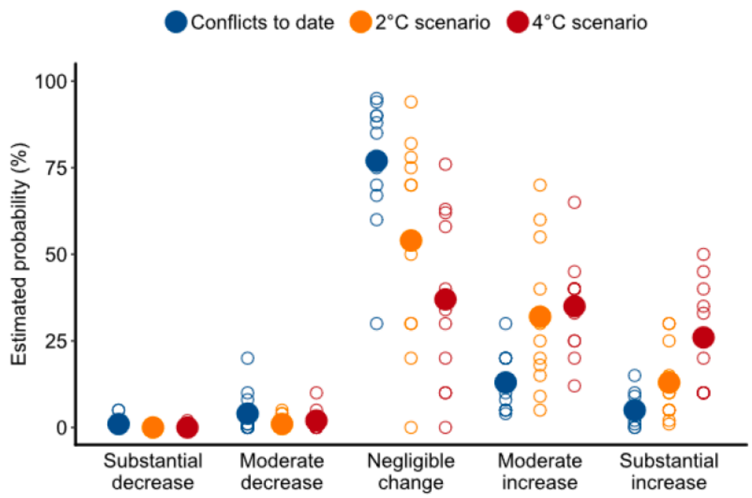

Conflicts to date
2°C scenario
4°C scenario
Estimated probability (%)
100
75
50
25
0
Substantial decrease
Moderate decrease
Negligible change
Moderate increase
Substantial increase

Figure 2.

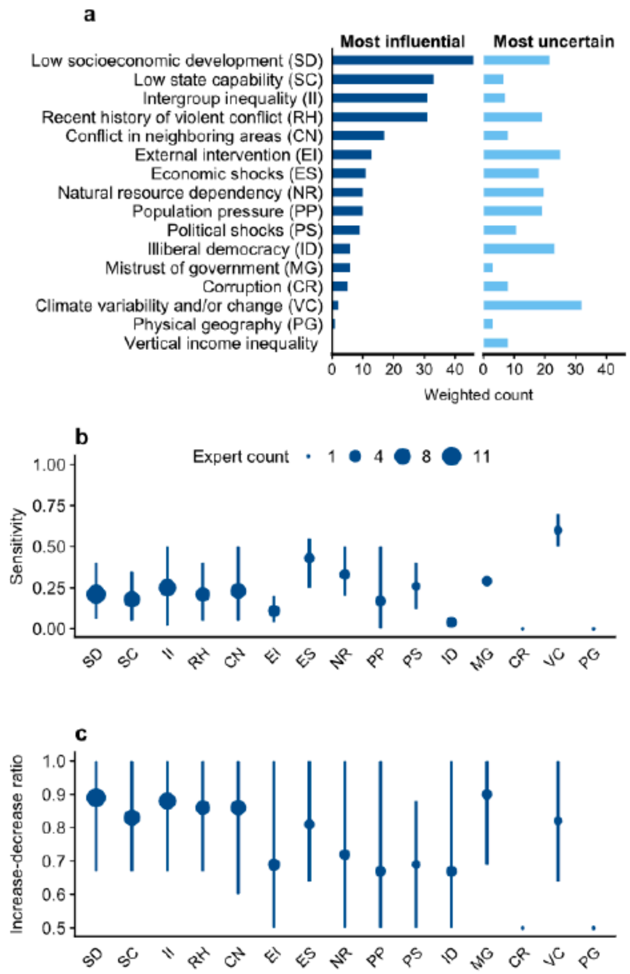
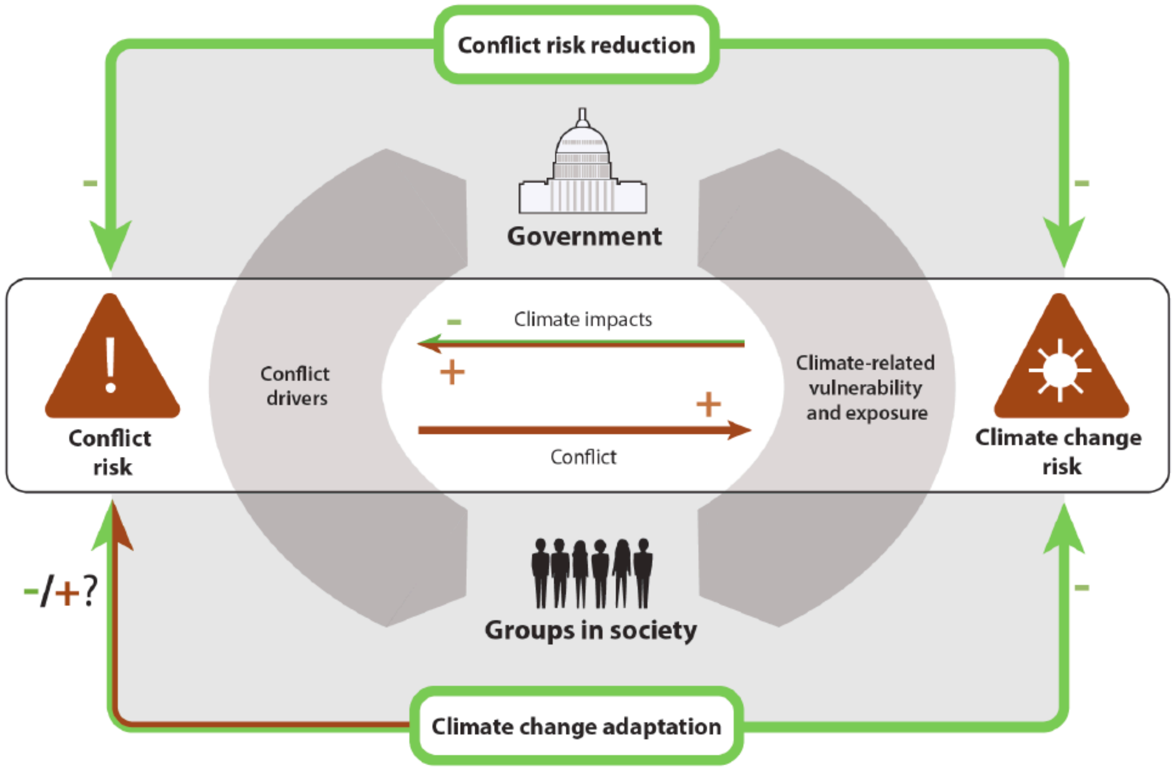

a
Most influential
Most uncertain
Low socioeconomic development (SD)
Low state capability (SC)
Intergroup inequality (II)
Recent history of violent conflict (RH)
Conflict in neighboring areas (CN)
External intervention (EI)
Economic shocks (ES)
Natural resource dependency (NR)
Population pressure (PP)
Political shocks (PS)
Illiberal democracy (ID)
Mistrust of government (MG)
Corruption (CR)
Climate variability and/or change (VC)
Physical geography (PG)
Vertical income inequality
Weighted count
b
Expert count 1 4 8 11
Sensitivity
c
Increase-decrease ratio
SD SC II RH CN EI ES NR PP PS ID MG CR VC PG

Figure 3.



Extended Data Figure 1.

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 Figure 2.

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

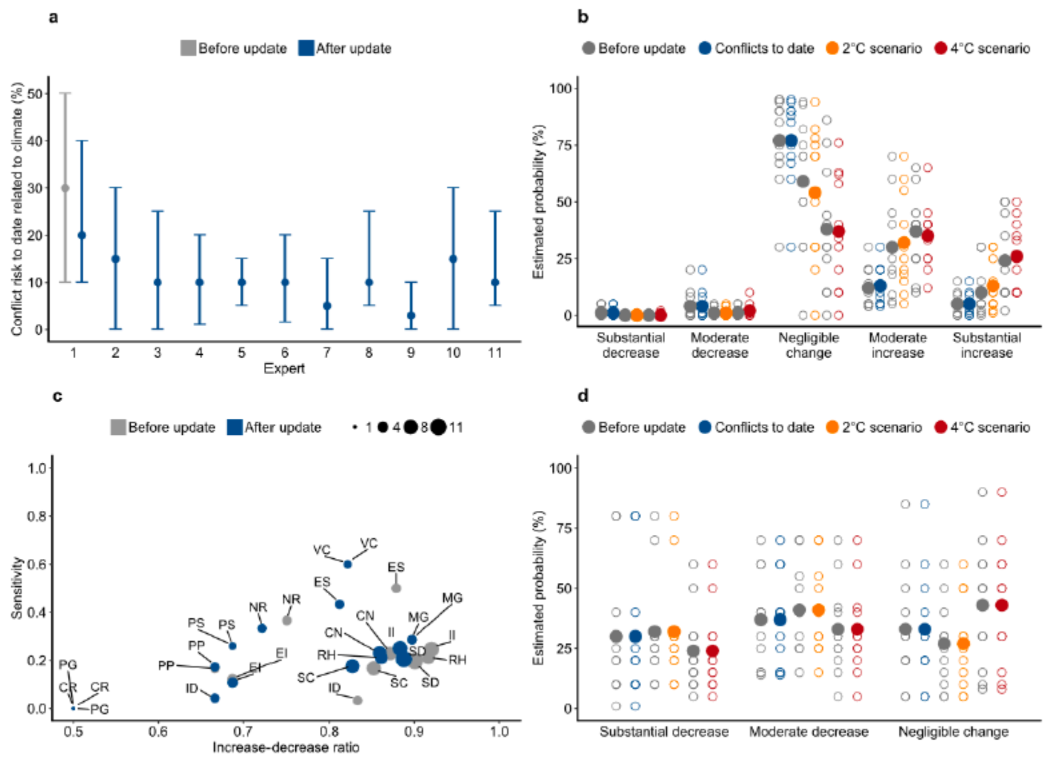
II	0	0	70	15	15	m
CR	0	0	100	0	0	h
EI	0	0	95	5	0	h
MG	0	0	70	20	10	m
SD	0	0	70	20	10	h
ID	0	0	95	5	0	h
Past	0	0	75	20	5	l
2°C	0	0	0	70	30	h
4°C	0	0	0	65	35	m

Estimated probabilities (%)

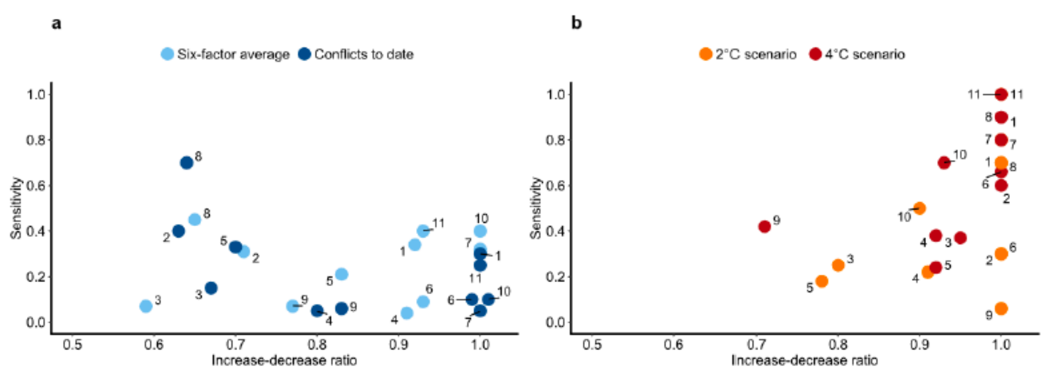
		Substantial decrease		Negligible change		Substantial increase	Confidence level
Most influential causal factors	F1	0	0	70	15	15	m
	F2	0	0	100	0	0	h
	F3	0	0	95	5	0	h
	F4	0	0	70	20	10	m
	F5	0	0	70	20	10	h
	F6	0	0	95	5	0	h
Past examples of conflict	Past	0	0	75	20	5	l
Future climate scenarios	2°C	0	0	0	70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

Adjusted values in red

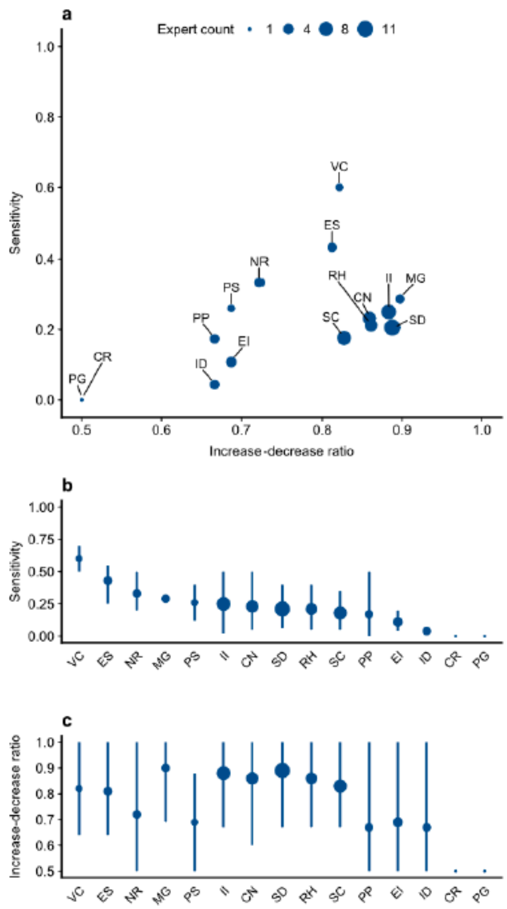
Extended Data Figure 3.



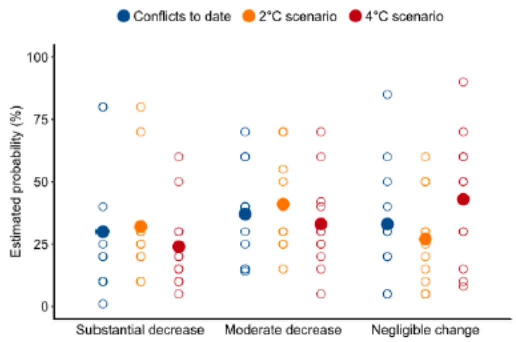
Extended Data Figure 4.



Extended Data Figure 5.



Extended Data Figure 6.



Extended Data Figure 7.