One effect to rule them all? A comment on climate and conflict

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Abstract: A recent meta-analysis and review reports a remarkable convergence of evidence linking climatic events to violent conflict. This conclusion departs markedly from other contemporary assessments of the empirical literature. This commentary revisits the meta-analysis in order to understand the origins for the discrepancy. We believe the analysis suffers from important shortcomings with respect to sample selection and analytical coherence. A modified assessment that addresses some of these problems suggests that scientific research on climate and conflict to date has produced mixed and inconclusive results.

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Hsiang and Burke (2013) and a companion paper by Hsiang et al. (2013), henceforth jointly referred to as HBM, find a "remarkable convergence in findings" and "strong causal evidence" that climatic events are linked to social conflict at all scales and across all major regions of the world. The average effect from the meta-analysis underlying their review indicates that a 1 standard deviation (σ) increase in temperature or rainfall anomaly is associated with an 11.1% change in the risk of "intergroup conflict". Assuming that future societies respond similarly to climate variability as past populations, they warn that increased rates of human conflict might represent a "large and critical impact" of climate change.

What HBM set out to do – to synthesize scientific evidence on climate and conflict – is a timely and important task, even though their study is only one more contribution to a long list of scientific reviews published in the past couple of years (Bernauer et al. 2012; Gleditsch 2012; Meierding 2013; Scheffran et al. 2012a,b; Theisen et al. 2013). However, HBM depart from these other reviews in two important ways. First, their conclusion about a consistent and robust climate effect contrasts dominant observations, such as "there is, to date, no scientific consensus on the impact of environmental changes on violent conflict" (Bernauer et al. 2012), "researchers have failed to uncover consistent linkages between environmental shifts and intrastate contention" (Meierding 2013), and there is a "lack of consensus for a climate-conflict link" (Theisen et al. 2013). Second, HBM's review stands out by attempting to quantify the "true" average climate effect on conflict. This is done through a meta-analysis of replication data from selected statistical articles and unpublished papers on climate and human conflict.

We believe the origin for the notable discrepancy in views between HBM and the larger scholarly community can be traced back to problems related to HBM's meta-analysis. This commentary identifies three limitations and shows that well-justified modifications to the original setup result in a different conclusion. The problems that we consider here relate to three underlying assumptions of the meta-analysis: (i) cross-study independence, (ii) causal homogeneity, and (iii) sample representativeness.

First, HBM's main analysis rests on the assumption that sample studies are fully independent, although it is clear that there is considerable overlap between them. Every civil conflict study considered by Hsiang and Burke (2013) and 19 of the 22 studies of modern climate–intergroup conflict link in Hsiang et al. (2013) include African countries and more than half of these are limited to post-1980 Sub-Saharan Africa or a subset of country years. In one case, the cross-study correlation is estimated at r=0.6 (see supplementary information). Accordingly, the precision-weighted calculation of climate effects conducted by HBM returns unrealistically precise estimates and the true uncertainty around the average climate effect is much larger than reported.

Second, HBM's sample of candidate studies covers a wide range of phenomena from horn honking to imperial war, involves temporal scales from hours to millennia, concerns actors that range from individuals to ancient civilizations, and assumes climate effects that sometimes are linear, at other times parabolic; sometimes instant and at other times materialize after a distinct temporal lag. Claiming the same underlying climate effect across these heterogeneous studies is certainly a bold exercise, but this assumption is essential for the meta-analysis to be meaningful. A careful reading of the literature, or inspection of Figure 1, reveals a variation in findings that is inconsistent with the assumption of causal homogeneity.

Third, aggregating and generalizing results from selected studies serves no larger purpose unless the sample constitutes a representative subset of all relevant scientific research. Yet, HBM's sample inclusion strategy favors form over function by using strictly methodological selection criteria. The result is a meta-analysis that disregards modern studies that revisit previously investigated climate-conflict associations, regardless of whether they complement, contrast or correct earlier findings. For example, the country-level relationship between rainfall and civil conflict is represented by a single peer-reviewed article (Miguel et al. 2004), ignoring several more recent investigations that reach different conclusions (e.g., Buhaug 2010; Burke et al. 2009; Ciccone 2011; Couttenier and Soubeyran 2013; Koubi et al. 2012). Moreover, HBM's meta-analysis considers just one climate indicator from each study, in many cases the one that indicated the strongest effect, despite most of the original studies exploring multiple alternative and complementary climate measures that sometimes produce contrasting results.

These are not trivial concerns. In an effort to address these issues, we replicated HBM after implementing three changes. More specifically, we first limited the sample to studies of contemporary civil conflict. These are the forms of conflict with the gravest social and political implications, and narrowing the scope of the dependent variable increases the plausibility of the assumed common causal effect. Next, to obtain a more representative sample and avoid the temptation to selectively pick indicators that produce a desired result, we included all main climate variables from the relevant studies. For the same reason, and to ensure analytical consistency and the correct sequence of events, we also applied a consistent lag of one time period (t–1) to all climate parameters across all models.

The updated meta-analysis with all three modifications implemented is visualized in Figure 1. The result is striking. In contrast to HBM, we find no evidence of a convergence of findings on climate variability and civil conflict. Recent studies disagree not only on the magnitude of the impact of climate variability but also on the direction of the effect. The aggregate median effect from these studies suggests that a one-standard deviation increase in temperature or loss of rainfall is associated with a 3.5% increase in conflict risk, although the 95% precision interval cannot exclude the possibility of large negative or positive effects. With all contemporaneous effects, the aggregate point estimate increases somewhat but remains statistically indistinguishable from zero (see supplementary information for further details).

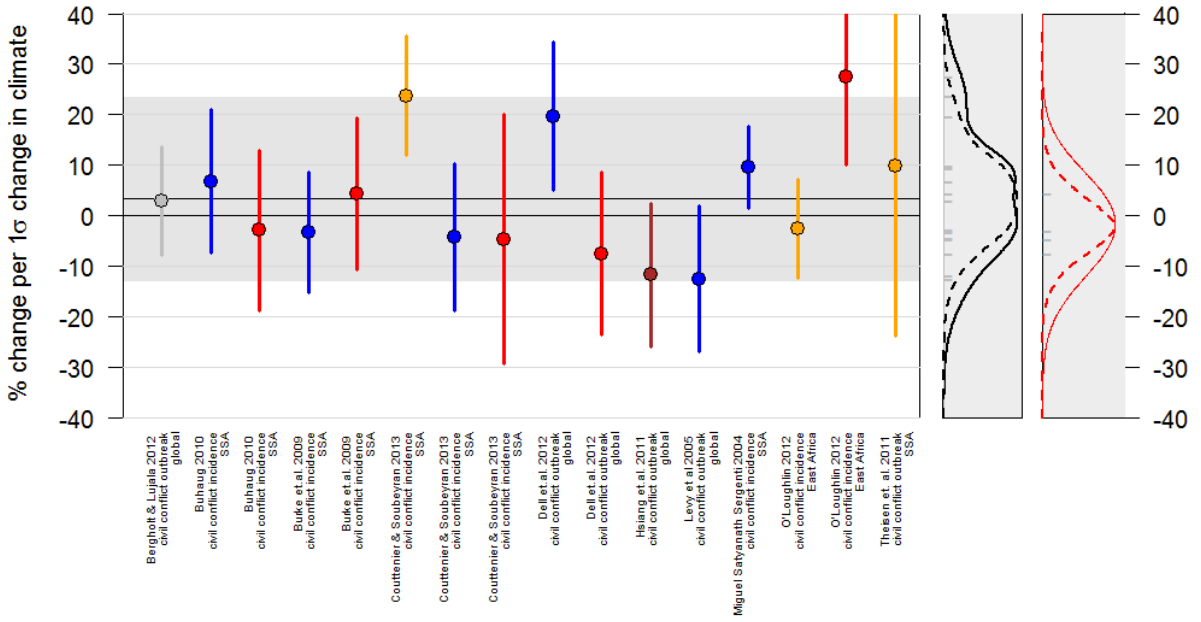

Fig. 1. Modern empirical estimates for the effect of climate variability on civil conflict. The markers illustrate the estimated percentage change in conflict with a 1σ increase in temperature (red), loss of rainfall (blue), increase in drought (orange), El Niño-like conditions (brown) or increase in severity of climatic natural disasters (gray). Whiskers denote the 95% confidence interval. The solid horizontal line indicates the median climate effect with 95% precision interval in grey, based on a Bayesian hierarchical model. The panels at the right show the distribution of results from all candidate studies (black) or those focusing squarely on temperature effects (red). Studies listed alphabetically.

Does our updated meta-analysis provide the true quantification of the average effect of climate on violent conflict? We daresay no. While the modifications we have implemented increase analytical consistency and representativeness and offer meaningful alternative specifications, a fundamental problem of this analysis remains largely unaddressed. Unlike meta-analyses of medical treatment studies, which are based on similar individual-level investigations from independent sample populations, this assessment bundles together partly overlapping observations at different spatial and temporal scales in an inconsistent and atheoretical fashion. Quantifying the "average" effect across this heterogeneous sample, weighting results by statistical precision but ignoring variations in substantive relevance and potential for generalization, makes little sense. It is a bit like averaging the price of apples and oranges, sampled in different locations and time periods, at different scales, using different metrics. The exercise is mathematically feasible but the outcome has no relevant meaning. Remedying this problem can only be done by taking into account the substantive content of candidate studies, ensuring similar units of analysis across studies based on unique samples, and parameterizing empirical indicators in a theoretically consistent manner.

Let us be clear: This commentary should not be taken to imply that climate has no influence on armed conflict. Rather, we argue – in line with recent scientific reviews (Bernauer et al. 2012; Gleditsch 2012; Meierding 2013; Scheffran et al. 2012a,b; Theisen et al. 2013) – that research to date has failed to converge on a specific and direct association between climate and violent conflict. In order to uncover more subtle and complex conditions under which climatic events plausibly may have a measurable impact on conflict dynamics, future research should continue the recent trend toward spatial and temporal disaggregation, focus

on political violence beyond civil war, and investigate possible indirect mechanisms and intervening factors (for inspiration, see Fjelde and von Uexkull 2012; O'Loughlin et al. 2012; Theisen 2012; Wischnath and Buhaug forthcoming). This is an important challenge and one where HBM and we are in complete agreement.

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