

## Does warming increase the risk of civil war in Africa?

The potential relationship between climate change and conflict is intriguing and warrants rigorous study. However, the proposition by Burke et al. (1) that warming may be a directly causative factor in the risk of civil war in Sub-Saharan Africa seems unlikely. The analysis of Burke et al. (1) suggests instead a tenuous historical association between warming and increased conflict. Regrettably, the authors did not elucidate further with either (i) specific case studies that demonstrate warming as a causative factor above economic, political, and sociocultural precipitants of conflict or (ii) a more thorough investigation of how climate-induced problems in agricultural sectors may result in increased conflict.

Our greatest concern with the analysis is the characterization of the link between warming and large-scale conflict (>1,000 battle deaths). The title of the paper, "Warming Increases the Risk of Civil War in Africa," suggests causation, but the evidence presented is not substantive enough to warrant such a conclusion. Although warming may serve as a proxy for correlated variables such as decreased soil moisture and reduced agricultural production, identifying warming, or even agricultural production, as primary factors in civil war oversimplifies systems affected by many geopolitical and social factors.

Although Burke et al. (1) do explore the role of per capita income and political regime type in their models, they found no additional explanatory power in these variables. In discussing this paper, we asked whether the temperature–conflict correlation might actually reflect unrelated processes that happen to share a temporal trend: global temperatures increased during the past 50–60 y, whereas unrelated geopolitical trends (notably decolonization and the rise and fall of the Cold War) perturbed the political and social landscape of the African continent in ways not well represented by either income or regime type. Add the prerequisite of conflict finance (in Africa from local,

usually mineral, resources or external players), and the causal chain between temperature and conflict may be even more illusory. Earlier analyses of conflict in Africa have discussed these issues (2, 3).

A secondary concern is the possible fragility of the presented models. Models 1 and 2 have a shared  $R^2$  of 0.657, a substantial correlation. However, when complexity increases further in model 3, and just 74 (8%) observations are removed, the  $R^2$  decreases to just 0.389. This raises concerns about model sensitivity to sample size and outlier effects.

The conclusions of this study represent a simplification of conflict history in Africa and potential impacts of warming. Studies exploring how climate change will affect human well-being and sociopolitical trends in Africa are important. However, the analysis of Burke et al. (1) invites the incautious reader to conclude that civil war in Africa will necessarily increase with future climate change. Such a conclusion could have perverse consequences: if international political and commercial communities conclude, based on the results of Burke et al. (1), that Africa is predestined to additional strife related to global warming, it might discourage the kind of meaningful engagement that is so important for political and economic stability, economic development, and peace in Africa.

**Alexandra E. Sutton<sup>a</sup>, Justin Dohn<sup>a</sup>, Kara Loyd<sup>b</sup>, Andrew Tredennick<sup>a</sup>, Gabriela Bucini<sup>a</sup>, Alexandro Solórzano<sup>c</sup>, Lara Prihodko<sup>a</sup>, and Niall P. Hanan<sup>a,1</sup>**

<sup>a</sup>Natural Resource Ecology Laboratory and <sup>b</sup>Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, CO 80523; and <sup>c</sup>Department of Ecology, University of Brasilia, 70910-900 Brasilia, Brazil

1. Burke MB, Miguel E, Satyanath S, Dykema JA, Lobell DB (2009) Warming increases the risk of civil war in Africa. *Proc Natl Acad Sci USA* 106:20670–20674.
2. Humphreys M (2005) Natural resources, conflict, and conflict resolution. *J Confl Resolut* 49:508–537.
3. Benjaminsen TA (2008) Does supply-induced scarcity drive violent conflicts in the African Sahel? The case of the Tuareg rebellion in northern Mali. *J Peace Res* 45:819–836.

Author contributions: A.E.S., J.D., K.L., A.T., G.B., A.S., L.P., and N.P.H. wrote the paper. The authors declare no conflict of interest.

<sup>1</sup>To whom correspondence should be addressed. E-mail: niall@nrel.colostate.edu.