COMMENT

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An African Union peacekeeper patrols after a rebel attack in drought-ridden Darfur, Sudan, in 2006.

A call for peace on climate and conflict

Researchers trying to work out whether global warming will cause more wars need to stop fighting and work together, urges **Andrew R. Solow**.

Among the most worrying of the mooted impacts of climate change is an increase in civil conflict as people compete for diminishing resources, such as arable land and water[1]. Recent statistical studies[2–4] reporting a connection between climate and civil violence have attracted attention from the press and policy-makers, including US President Barack Obama. Doubts about such a connection have not been as widely aired[5–7], but a fierce battle has broken out within the research community.

The battle lines are not always clear, but on one side are the 'quants', who use quantitative methods to identify correlations between conflict and climate in global or regional data sets. On the other side are the 'quals', who study individual conflicts in depth. They argue that the factors that underlie civil conflict are more complex than the quants allow and that the reported correlations are statistical artefacts. In my view, although the concern that climate change could increase conflict is valid, the link remains unproven.

The way forward is for the two factions to work together to make the quants' statistical models reflect the quals' understanding of the factors that affect civil conflict and to strengthen inferences about the impact of climate on human behaviour. The stakes are too high not to try: civil conflict keeps poor countries poor and, if climate change turns out to be an important contributor to such conflict, it would be costly indeed.

QUANTS AND QUALS

Quants use regression models to identify relationships between measures of civil conflict, such as the number of countries in which deaths exceed some threshold, and climate variables, such as rainfall and temperature. The data sets used typically cover a few decades and tens of countries. Attempts are made to control for non-climate-related factors such as national income and the ▶

strength of civil institutions. A climate effect is identified if the inclusion of climate variables significantly improves the model's fit to the data.

For example, economist Marshall Burke at the University of California, Berkeley, and his colleagues linked the annual incidence of civil conflict resulting in at least 1,000 deaths in sub-Saharan Africa over the period 1981–2002 to warmer temperatures in the same and preceding years[3]. They found that a 1 °C increase in temperature increased the incidence of civil conflict by 4.5% in the same year and 0.9% in the following year. On the basis of climate-model projections of future warming, the authors predicted an alarming 54% increase in the incidence of civil conflict in this region by 2030, with additional deaths in the hundreds of thousands.

But political scientist Halvard Buhaug of the Peace Research Institute in Oslo argued that this finding was fragile[5]. It could be quashed by using a different threshold for the number of deaths or a different observation period. Burke and his colleagues defended their work[8] and deserve credit for tackling an important problem. But, in my view, such disagreements indicate that a deeper look behind the statistics is warranted.

Most of these statistical studies, including Burke's, relate the incidence of civil conflict to year-to-year variations in climate variables. In fact, short-term variability corresponds to weather and not to climate, which is average weather over the long run. The overall incidence of civil conflict has actually been declining since the late 1990s, while the signature of climate change has grown stronger[5].

But the quals' fundamental complaint is that the quants' statistical models are black boxes, reflecting little understanding of the social, economic and political pressures that underlie civil conflict. For example, Buhaug and colleagues pointed out that the six cases that contributed most to the findings of Burke *et al.* involved foreign intervention[7].

The most influential case was the outbreak of civil conflict in Guinea-Bissau in 1998, when Senegal demanded that the Guinea-Bissau military stop supporting Senegalese rebels. When President João Bernardo Viera of Guinea-Bissau moved to comply, he was ousted in a coup, and Senegal intervened on his behalf. Quants might respond that these interventions too were associated with high temperatures, and include a variable for foreign intervention in their next model. But this throws up a problem. The quants are not basing their models on an underlying theory of civil conflict, but rather are going where the data take them.

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Quants looking for relationships in the data might ask: is conflict correlated with temperature? No? How about temperature last year? Better, but what about precipitation? Of course, this is a caricature of a more thoughtful process. But using the same data to choose a model and to assess its fit is notorious for producing impressive, but spurious, results. As Buhaug showed, models can be so customized that even modest changes can overturn their results.

This is where quals could help, by drawing on individual cases. As political scientist Stathis Kalyvas of Yale University in New Haven, Connecticut, has argued, the dynamics of particular civil conflicts can provide a basis for statistical models[9]. For example, the role of asset inequality in civil conflict has been underscored by economist Klaus Deininger at the World Bank[10] in Washington DC and others.

Studies of single conflicts have their limits. Those that rely on interviews and the judgements of experts are highly subjective. Most cannot be easily generalized. To paraphrase Leo Tolstoy, every unhappy country is, to some extent, unhappy in its own way. Nevertheless, bringing together all sources of information will be progress.

A WAY FORWARD

I urge quants and quals to talk more to — and less about — each other. The goal of both should be to develop statistical models that better reflect the real drivers of civil conflict. Publishing in each other's journals and participating in each other's conferences, both of which behaviours are sadly rare, would be a start.

It is hard to predict where such a joint effort would go. My guess is that the statistical models would become more complicated — for example, separate ones for the effects of climate on resources and the effects of resources on conflict. Even if it is not possible to translate a qualitative understanding of civil conflict into a quantitative model that can readily be fitted and tested, the effort would still deepen our understanding of the effect of climate on violence.

In the meantime, what should policy-makers do? The argument that, in some parts of the world, a nexus exists between climate, resources and civil conflict has too much force to dismiss. However, the relationship is complex and it is too soon to make confident predictions. There is broad agreement on one matter: social, economic and institutional factors are at least as important for driving civil conflict as climate change. The promotion of social justice, balanced economic development and civil society generally must be a priority for policy-makers. ■

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The role of climate change in driving the 1998 Guinea-Bissau conflict is open to debate.

1. Homer-Dixon, T. *Environment, Scarcity, and Violence* (Princeton Press, 1999).
2. Miguel, E., Satyanath, S. & Sergenti, E. *J. Polit. Econ.* **112**, 725–753 (2004).
3. Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A. & Lobell, D. B. *Proc. Natl Acad. Sci. USA* **106**, 20670–20674 (2009).
4. Hsiang, S. M., Meng, K. C. & Cane, M. A. *Nature* **476**, 438–441 (2011).
5. Buhaug, H. *Proc. Natl Acad. Sci. USA* **107**, 16477–16482 (2010).
6. Theisen, O. M., Holtermann, H. & Buhaug, H. *Internatl Secur.* **36**, 79–106 (2011).
7. Buhaug, H., Hegre, H. & Strand, H. *Sensitivity Analysis of Climate Variability and Civil War* (Peace Research Institute of Oslo, 2010).
8. Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A. & Lobell, D. B. *Proc. Natl Acad. Sci. USA* **107**, E185 (2010).
9. Kalyvas, S. N. in *Order, Conflict and Violence* (eds Kalyvas, S. N., Shapiro, I. & Masoud, T.) 1–14 (Cambridge Univ. Press, 2008).
10. Deininger, K. *Oxf. Econ. Pap.* **55**, 579–606 (2003).