Climate Change, Demography, Environmental Degradation, and Armed Conflict

CLIONADH RALEIGH and HENRIK URDAL

Climate change is expected to alter the availability of freshwater, the productive capacity of soils, and patterns of human settlement. But we do not know the extent and geographical distribution of these changes, nor can we know how climate-related environmental change may influence human societies and political systems. The most dire predictions warn that climate change may greatly increase the risk of violent conflict over increasingly scarce resources, such as freshwater and arable land. We argue that such forecasts would be more accurate and less sensational if they were based on the relationships between demography, environment, and violent conflict found in the recent past.

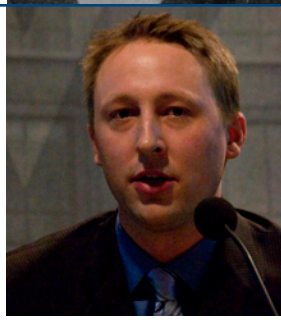
Land degradation, freshwater availability, and population density and change are important factors that many scholars argue have both influenced the risk of conflict in the past and will be strongly influenced by climate change. As previous quantitative studies have found mixed evidence for the resource scarcity and conflict nexus, we sought to reconcile these diverse findings by looking below national aggregates at local-level data. In our study, we found that local-level demographic and environmental factors do have some effect on conflict risk, but are generally outweighed by political and economic factors.[1]

Building on propositions from the literature on environmental security, we have identified potential links between natural resource scarcity and violent conflict. Combining these propositions with environmental change scenarios from the Intergovernmental Panel on Climate Change (IPCC), we tested hypotheses about the expected relationships in a statistical model with global coverage. While previous studies have mostly focused on national-level aggregates, we used a new approach to assess the impact of environmental change on internal armed conflict by using geo-referenced (GIS) data and geographical, rather than political, units of analysis.

Obviously, climate change may bring about more severe and more abrupt forms of environmental change than we have experienced in the past. While this argument is frequently invoked to support dire claims about climate change and conflict, major changes are likely to be the result of smaller changes compounding over a considerable period of time. Also, while environmental change may be more severe in the future than the past, we are unable to assess the extent to which increased technological and institutional capacity will enhance our adaptability to the effects of climate change.

Societal Consequences of Climate Change: Literature Review

As the focus on environmental consequences of climate change increases, greater attention has



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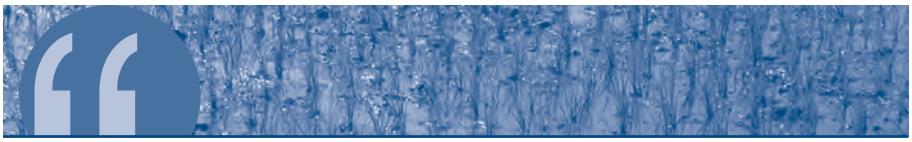


While abrupt displacements may happen, we primarily expect to see climate change causing a gradual migration by people searching for more fertile land—or for other economic opportunities to replace lost livelihoods.

been paid to climate change's potential influence on patterns of war and peace (e.g., Renner, 1996; Homer-Dixon & Blitt, 1998; Rahman, 1999; Klare, 2001; Brauch, 2002; Purvis & Busby, 2004; CNA, 2007; Buhaug et al., 2008; Burke & Parthemore, 2008; Raleigh et al., 2008; Salehyan, 2008). The literature on climate change and security focuses on two interrelated processes expected to result in resource scarcity. First, increasing temperatures, precipitation anomalies, and extreme weather are expected to aggravate the ongoing degradation of environmental resources (Renner, 1996; Homer-Dixon & Blitt, 1998; Klare, 2001; Purvis & Busby, 2004; Buhaug et al., 2008).

Second, scholars warn that rising sea levels, as well as more extreme weather conditions, will force millions of people to migrate, potentially leading to higher pressures on resources in the destination areas and subsequently fostering competition over resources (Renner, 1996; Rahman, 1999; Barnett, 2001; Oxfam, 2007; Renaud et al., 2007; Raleigh et al., 2008). Although climate change is usually viewed as a potential future threat, some argue that global climate change has already been a contributing factor in current conflicts such as the Darfur crisis (Byers & Dragojlovic, 2004; Ki-moon, 2007).

Although they warn against overstating the relationship between climate change and armed conflict, Jon Barnett (2001), as well as Nigel Purvis and Joshua Busby (2004), accept that the depletion and altered distribution of natural resources likely to result from climate change could, under certain circumstances, increase the risk of some forms of violent conflict. It is not likely to be a major or sufficient cause of conflict, but may form a mounting environmental challenge that could play a contributing role (Brauch, 2002; Tänzler & Carius, 2002).

Climate change is likely to influence the capacity of many areas to produce food. Some areas may experience a reduction in crop yields, but others are likely to benefit. While an increase in temperature of a few degrees could generally increase crop yields in temperate areas, greater warming may reduce agricultural output. In tropical areas, where dryland agriculture dominates, even minimal increases in temperature may be detrimental to food production (IPCC, 2001). Adverse changes in temperature and precipitation are likely to intensify the degradation of soil and water resources, although adaptive behavior could mitigate these impacts, since land use and management have been shown to have a greater impact on soil conditions than the indirect effect of climate change.

According to the IPCC (2001), 1.7 billion people currently live in countries that are water-stressed, meaning that they use more than 20 percent of their renewable water supply. This number is projected to increase as population grows and industries intensify; climate change may aggravate this trend by decreasing streamflow and groundwater recharge. Non-climatic factors may influence freshwater availability and quality more than climate change, so good water management may significantly reduce vulnerability. However, in areas where vulnerability increases and water management fails, increased freshwater scarcity is likely.

Due to rising sea levels and increased risk of flooding, climate change is expected to contribute to migration from coastal and riverine settlements (IPCC, 2001). Extreme weather events and flooding may cause substantial, sudden, and acute displacement of people. However, the most dramatic form of change—sea-level rise—is likely to happen gradually. Improved forecasting skills

Table 1: Summary Results of Empirical Analysis

	ALL COUNTRIES	HIGH-INCOME COUNTRIES	LOW-INCOME COUNTRIES
Low land degradation	Not significant	Higher risk	Lower risk
Medium land degradation	Higher risk	Higher risk	Not significant
Very high land degradation	Higher risk	Higher risk	Not significant
Water scarcity	Higher risk	Higher risk	Higher risk (weak)
Population density	Higher risk	Higher risk	Higher risk
Population growth	Higher risk	Higher risk	Higher risk
Population growth *density	Higher risk	Not significant	Higher risk
Population growth *water scarcity	Higher risk	Not significant	Higher risk (weak)
Population growth *medium degradation	Not significant	Lower risk (weak)	Not significant
Population growth *high degradation	Not significant	Not significant	Not significant
Instability interactions	Negative or not significant	Not significant	Not significant

Note: For actual values, see full results in Raleigh & Urdal (2007).

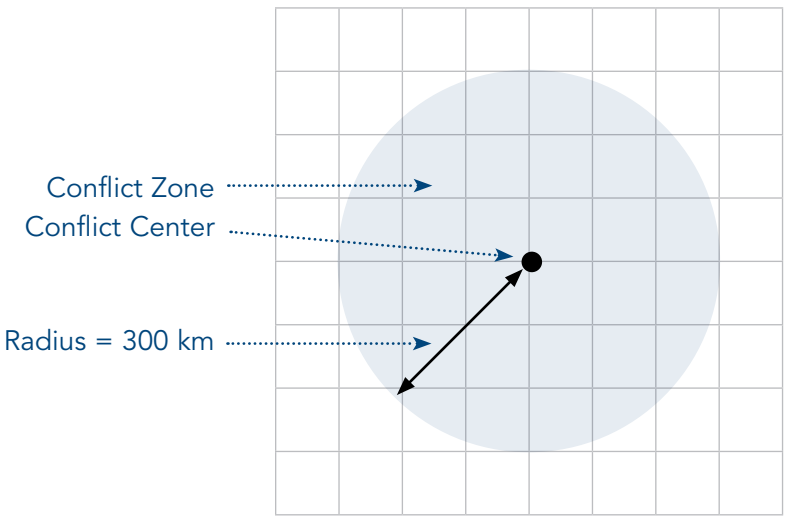
will make adaptation easier and reduce the problem of population displacements (Chimeli et al., 2002). While abrupt displacements may happen, we primarily expect to see climate change causing a gradual migration by people searching for more fertile land—or for other economic opportunities to replace lost livelihoods.

Kahl (2006) identifies two distinct "state-centric" causal pathways from resource scarcity to conflict: the "state failure" and the "state exploitation" hypotheses. Both start from the premise that resource scarcity may put severe pressure on both society at large and on state institutions. Lower agricultural wages and economic marginalization can lead to rural-to-rural migration, potentially causing inter-ethnic conflicts over land, and migration from rural to urban areas, leading to urban "hotspots." The state failure hypothesis posits that resource scarcity will weaken state institutions and provide opportunities for potential rebels to challenge state authority. The state exploitation hypothesis suggests that resource scarcity may be an opportunity for weakened states to bolster their support base by mobilizing ethnic groups to capture scarce resources. However, quantitative studies (Esty et al., 1998; Hauge & Ellingsen, 1998; Urdal, 2005; Theisen, 2008) have found mixed evidence for the resource scarcity and conflict nexus.

Testing the Climate Change and Conflict Scenario: Methodology

In our model, we tested whether areas with high levels of resource scarcity—which is likely to become more prevalent as a result of climate change—have been more susceptible to conflict in the past. We assumed that population density, freshwater scarcity, and environmental degradation would be associated with a higher risk of conflict if they occurred in areas with high population growth. We further assumed that

Figure 1: Conflict Zones Upon Grid Squares



Globally, medium to high levels of land degradation are related to increased conflict, as are very high levels of water scarcity, but the relative increases in risk are quite small.

the effects of demographic and environmental factors are stronger in poor countries than in wealthy ones, and stronger in periods of regime collapse and political transition.

For this sub-national study, we created a geospatial dataset by dividing the globe into 100 km by 100 km squares. Using the PRIO/Uppsala dataset, we identified the location of armed conflicts from 1990-2004 (Buhaug & Gates, 2002; Gleditsch et al., 2002), coding all grids within a 300-km radius as part of the conflict zone (see Figure 1). We used geographical data on human-induced soil degradation from the International Soil Reference and Information Centre (ISRIC), data on easily available freshwater from TERRASTAT, and population data from the Center for International Earth Science Information Network (CIESIN). We also controlled for state-level factors like GDP per capita and national regime type.

Results

We assessed the risk of conflict for a global sample, and then for richer and poorer states separately. Our disaggregated analysis shows that demographic and environmental variables have a very moderate effect on the risk of civil conflict (see Table 1 for a summary).

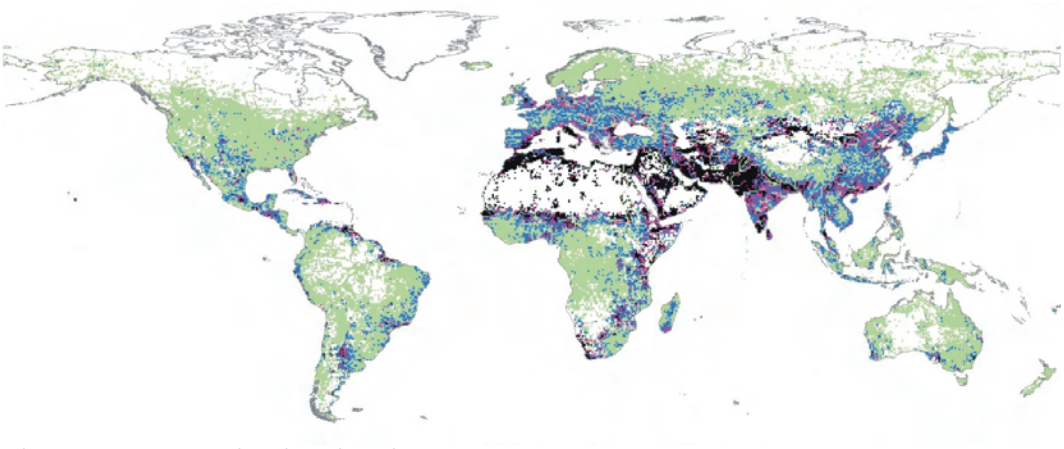
Globally, medium to high levels of land degradation are related to increased conflict, as are very high levels of water scarcity, but the relative increases in risk are quite small. Increasing levels of land degradation increase the risk of conflict from a baseline of 1 percent to between 2-4 percent. Freshwater scarcity appears to exert a somewhat stronger effect, increasing the risk of conflict to 6 percent for areas with very high levels of scarcity.

High population density, measured locally, is a consistently strong predictor of armed conflict. However, population density and conflict are presumably correlated, as densely populated areas and large cities are attractive locations for conflict because not only do they provide better opportunities for organizing and financing conflict, they also represent strategic targets (Hegre & Raleigh, 2007).

Based on our literature review, we expected that the interactions between demand-induced scarcity (measured by population growth) and supply-induced scarcity (represented by land degradation, water scarcity, and population density) were likely to produce multiple stresses that could trigger resource scarcity conflicts. In the global model, only the interaction between population growth and water scarcity, as well as that between population growth and density, were statistically significant.

Separating the group by income confirms the well-established importance of wealth and political systems. Lower levels of GDP are the most important predictor of armed conflict. States with low GDP depend more on their environment for individual and state income than states with higher GDP, and also have a lower capacity to attenuate tensions arising from degradation. However, our results show that resource scarcity affects the risk of conflict less in low-income states than in wealthier states. And while political instability is a strong driver of internal conflict in poor states, it does not seem to interact with demographic and environmental factors to increase the risk of conflict.

Figure 2: Water Scarcity Index for Contemporary Conditions



The water scarcity index describes the relationship between water availability and the number of people that can be supported by that water supply. The scarcity index is expressed in terms of the number of people per flow unit where a flow unit of water is equal to 1 million cubic meters per year.

Source: Levy et al. (2008).

WATER SCARCITY INDEX

- Water Barrier (>2000 people/flow unit)
- Water Scarcity/Stress (600–2000 people/flow unit)
- Populations Vulnerable to Water Stress (100–600 people/flow unit)
- Adequate Supply (<100 people/flow unit)
- Low Density Population

Recommendations for Future Research

Our models are more explanatory than many comparable cross-national studies, partly due to the inclusion of geo-referenced environmental and demographic data. Since conflict often does not occur throughout entire countries, additional localized data on conflict needs to be incorporated into future models to develop a comprehensive understanding of the links between conflict and demographic and environmental changes.

Moreover, we believe a clearer link between the physical changes associated with environmental variables and the political process of rebellion must be established. The use of local measures of income, state capacity, and ethnic relationships will significantly clarify the environment-conflict nexus and help analyze the role of state policies and market fluctuations in mediating it.

Our results caution against a disproportionate focus on environmental factors—including climate change—in causing conflict and instability in the developing world. By paying greater attention to how resources are distributed and how political institutions create vulnerability to climate change, we can better assess where, and under what circumstances, environmental factors contribute to or catalyze conflict. However, as future climate changes occur with greater frequency and intensity, any assumptions about the future must consider that the thresholds for both environmental change and political instability will undoubtedly fluctuate.

Note

1. This article is based on a study published in *Political Geography* (Raleigh & Urdal, 2007).

REPORT ONLINE

The full article on which this commentary is based, "Climate change, environmental degradation and armed conflict," was published in a special issue of *Political Geography* on climate change and conflict (Volume 26, Issue 6, August 2007): http://linkinghub.elsevier.com/retrieve/pii/S0962629807000856

The Uppsala Conflict Database is a free resource on armed conflicts; currently, it includes information on 124 conflicts for the period 1989-2007: http://www.pcr.uu.se/gpdatabase/search.php

Armed Conflict Location and Event Data (ACLED) is an event-based dataset based on the Uppsala Conflict Database, which records the location and date of conflict occurrences in Africa. Version 1.2 is available online: http://www.prio.no/CSCW/Datasets/Armed-Conflict/Armed-Conflict-Location-and-Event-Data/

The World Bank's Social Development Division convened a workshop and commissioned overview papers on the "Social Dimensions of Climate Change" on March 5, 2008: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALDEVELOPMENT/0,,contentMDK:21659919~pagePK:210058~piPK:210062~theSitePK:244363,00.html

For a balanced report on climate change and migration, see *Future Floods of Refugees: A Comment on Climate Change, Conflict and Forced Migration,* by Vikram Odedra Kolmannskog (Norwegian Refugee Council, 2008): http://www.nrc.no/arch/_img/9268480.pdf

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