Regional Conflict and Climate Change

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Charge questions

Briefly review existing studies of the impacts of climate change on intra- or inter-regional conflicts, with special attention to any existing quantitative estimates of the effects of changes in temperature, precipitation patterns, or sea level on conflict. Which regions are likely to be the most vulnerable to these impacts?

Briefly review the models and data used to estimate these impacts. What factors are most important to capture in such models when thinking about the conflict impacts of climate change over a long time frame?

Characterize the uncertainty/robustness/level of confidence in these estimates, globally and by region. What are the most important gaps or uncertainties in our knowledge regarding the conflict impacts of climate change? What research in this area would be most useful in the near term?

Abstract

The world is generally becoming more peaceful, but the debate on climate change raises the specter of a new source of instability and conflict. In this field, the policy debate is running well ahead of its academic foundation – and sometimes even contrary to the best evidence. To date there is little published systematic research on the security implications of climate change. The few studies that do exist are inconclusive, most often finding no effect or only a low effect of climate variability and climate change. The scenarios summarized by the Inter-Governmental Panel on Climate Change (IPCC) are much less certain in terms of the social implications than the conclusions about the physical implications of climate change, and the few statements on the security implications found in the IPCC reports are largely based on outdated or irrelevant sources. This paper reviews briefly the models and the uncertainties and outlines some priorities for future research in this area.

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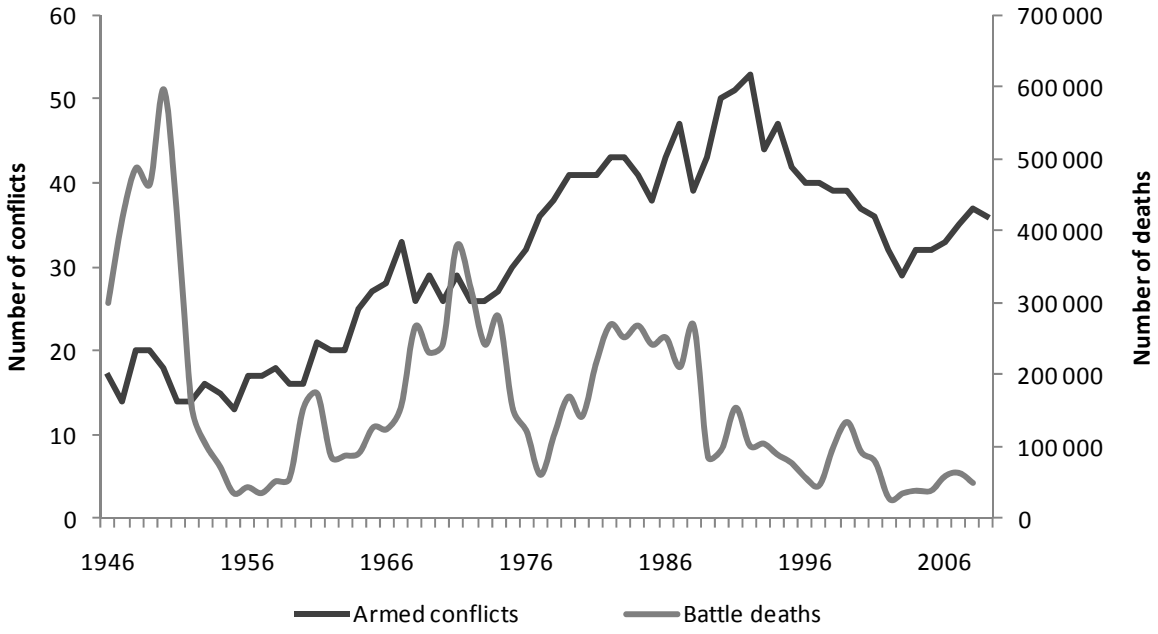
* This paper builds on various publications from the Centre for the Study of Civil War at PRIO including Buhaug (2010a), Buhaug, Gleditsch & Theisen (2008, 2010), Gleditsch & Nordås (2009), Gleditsch, Nordås & Salehyan (2007), and Nordås & Gleditsch (2007b). I am grateful to my colleagues Halvard Buhaug and Ole Magnus Theisen for comments and suggestions. Our research is principally funded by the Research Council of Norway. Author address: Centre for the Study of Civil War, PRIO, P. O. Box 9229, Grønland, 0134 Oslo, Norway; nilspg@prio.no.

Introduction

A liberal peace seems to be in the making (Gleditsch, 2008), with a decreasing number of armed conflicts (Gleditsch et al., 2002; Harbom & Wallensteen, 2010) and lower severity of war as measured by annual battle-related deaths (Lacina, Gleditsch & Russett, 2006; HSRP, 2010). At the same time, there has been a strong in democracy, trade, international economic integration, and memberships in international organizations, as well as in international peace-keeping and mediation efforts. Figure 1 illustrates the trends in the frequency and severity of armed conflict.

Figure 1. The frequency and severity of armed conflict, 1946–2009



Source: UCDP/PRIO Armed Conflict Dataset, v. 4–2006 (Gleditsch et al., 2002) and PRIO Battle Deaths Dataset, v. 2.0 (Lacina & Gleditsch, 2005). Figure created by Halvard Buhaug. Data available from www.prio.no/cscw/datasets and www.pcr.uu.se/research/UCDP/. The figure includes all state-based conflicts with more than 25 battle deaths in a calendar year.

The financial crisis, fundamentalist religion, and other factors are widely seen as obstacles on the road towards a more peaceful world. But the greatest challenge to the global liberal peace, according to an increasingly widespread view, is the threat of climate change. Fears on this score have been expressed by the Norwegian Nobel Committee (Mjøs, 2007), which awarded the Nobel Peace Prize for 2007 to Al Gore and the Inter-Governmental Panel for Climate

Change and by President Barack Obama (2009). The UN Security Council discussed the security implications of climate change for the first time in April 2007 (UN, 2007).

Despite the rhetoric, there is little systematic evidence to date that long-term climate change or short-term climate variability has had any observable effects on the pattern of conflict at any level. The Intergovernmental Panel on Climate Change (IPCC) is the main source of scientific information on the causes and consequences of climate change and has had a strong influence on the agenda of the public debate. However, so far the IPCC has not made the security implications a priority issue. The Third and Fourth Assessment Reports (IPCC, 2001, 2007) make scattered comments on climate change in the reports from Working Group II on 'Impacts, Adaptation, and Vulnerability', but these comments are very weakly founded in peer-reviewed research. There is no thematic chapter for security or conflict, so the scattered comments turn up in chapters on other topics such as freshwater management and in some of the regional chapters (notably in the Africa chapter of AR4).

Had the IPCC systematically reviewed the conflict literature, it would have discovered some relevant research relating to scarcity models of conflict. And since 2007, more systematic research on the security implications effects of climate change has emerged. In what follows, I will review this literature, assess the level of uncertainty of this area of research (which is high), and discuss priorities for future research. But first, a brief primer on conflict.

Defining conflict[2]

In our research, we distinguish between conflict, understood as an incompatibility between actors over interests or values, and conflict behavior. Although for convenience, the literature often refers just to 'conflict', we are interested in *armed conflict,* defined by the Uppsala Conflict Data Program (UCDP) as a contested incompatibility that concerns government or territory or both where the use of armed force between two parties results in at least 25 battle-related deaths in a calendar year. Of these two parties, at least one is the government of a state. A war is defined as an armed conflict with more than 1,000 battle-deaths in a calendar year. UCDP's Armed Conflict Dataset (ACD) has been compiled for the time-period 1946–2009 (Harbom & Wallensteen, 2010) and is updated annually. To distinguish them from other types of armed conflict, such conflicts are now frequently referred to as *state-based armed conflict.* They can be subdivided into *interstate conflict* (between two or more states), *extra-state*

[2] Detailed definitions from the Uppsala Conflict Data Program are found at www.pcr.uu.se/research/ucdp/definitions.

conflict (between a state and a non-state group outside its own territory, e.g. colonial war), *intrastate conflict* (between the government of a state and internal opposition groups), and *internationalized intrastate conflict* (where troops from another country supports one or both parties to the conflict). The term *civil war* is used for intrastate armed conflict with more than 1,000 battle deaths.

Two additional forms of conflict, both with the same lower threshold of 25 battle deaths in a calendar year and covering the period 1989–2008, are now regularly recorded by the UCDP, although not necessarily updated annually[3]: *One-sided violence* is the use of armed force by the government or an organized group against civilians. This dataset, which covers the period 1989–2009, includes genocide and politicide. *Non-state conflict* is the use of armed force between two organized armed groups, neither of which is the government. This includes communal violence. A final form of violence, not coded as a separate category by UCDP, is *Riots,* rural or urban, where the violence is not carried out by an organized group, and where the target is mostly the government but which can also be directed against private actors. A borderline case is *violent crime,* which often accompanies riots and even organized violence and sometimes can be hard to separate from violent conflict (Collier, 2000).

Of the different types of conflict, disregarding crime, interstate conflict and one-sided violence claimed the greatest numbers of lives in the twentieth century. Civil war follows next, while communal conflicts and riots are usually smaller. Given the small number of interstate wars after the end of the Cold War and the sparsity of major episodes of one-sided violence, civil war is now the main killer.

The political rhetoric is unclear about the kinds of conflict expected to result from climate change, but all these forms of violence have been mentioned at times. The academic work on the topic needs to be more specific, and many scholars expect climate change to have a greater impact on non-state violence than on state-based conflict.

The term 'regional conflict' in the assigned title for this talk is interpreted in the first charge question as 'intra- or inter-regional conflict'. The common meaning of regional conflict is probably conflict within certain regions.[4] In fact, a large share of the emerging research focuses on Sub-Saharan Africa as the most probable venue for climate-induced violence. The alternative interpretation, conflict between regions, would potentially involve violence at a higher

3 The data can be downloaded from www.pcr.uu.se/research/ucdp/datasets/.
4 See, for instance, an early discussion of environmental quality (including climate change) and regional conflict (Kennedy et al., 1996).

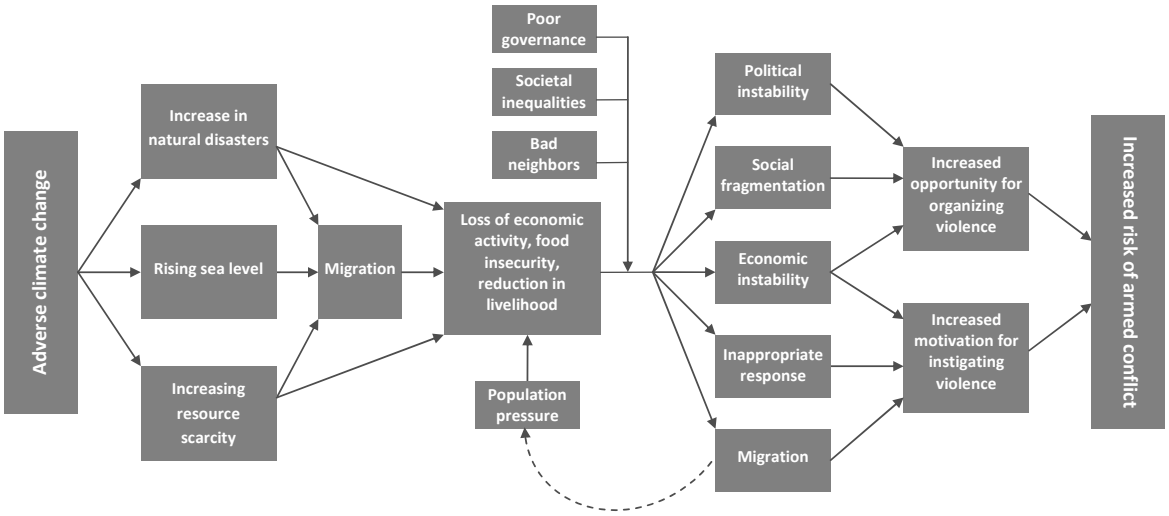
level, possibly even 'world war'. Most of the research discussed here is relevant to the first interpretation, but I will also pay brief visits to interregional conflict.

Linking climate change to conflict

Figure 2 is a theoretical model linking climate change to intrastate armed conflict. The model incorporates insights from case studies as well as statistical studies of conflict. Three effects of climate change (natural disasters, sea-level rise, and increasing resource scarcity) are posited to lead to loss of livelihood, economic decline, and increased insecurity either directly or through forced migration. Interacting with poor governance, societal inequalities, and a bad neighborhood, these factors in turn may promote political and economic instability, social fragmentation, migration, and inappropriate responses from governments. Eventually this produces increased motivation for instigating violence as well as improved opportunities for organizing it.

In the following we review the evidence for some of these links via the three mechanisms mentioned in Charge question 1 (precipitation, temperature, and rising sea level) as well as two others (natural disasters and arctic rivalry) that are frequently mentioned in the literature.

Figure 2. Possible pathways from climate change to conflict



The diagram gives a synthesized account of proposed causal linkages between climate change and armed conflict. For the sake of clarity, possible feedback loops, reciprocal effects, and contextual determinants are kept at a minimum. Source: Buhaug, Gleditsch & Theisen (2008: 21).

Evidence

Only a limited number of peer-reviewed studies deal with climate change/variability and conflict. In the following, I include a few unpublished papers in the discussion. These are generally papers that have been circulating in the academic community for some time, have been revised, and are currently under review at major journals or in press.

Precipitation

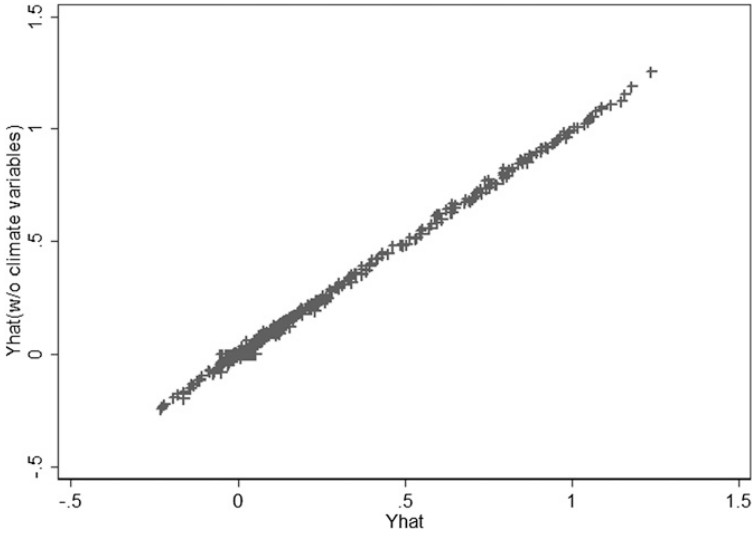
The scarcity (or neo-malthusian) model of conflict assumes that if climate change results in a reduction in essential resources for livelihood, such as food or water, those affected by the increasing scarcity may start fighting over the remaining resources. Alternatively, people may be forced to leave the area, and create new scarcities when they encroach on the territory of other people who may also be resource-constrained. Barnett & Adger (2007) review a broad range of studies of both of these effects, focusing particularly on countries where a large majority of the population is still dependent on employment in the primary sector. If climate change results in reduced rainfall and access to the natural capital that sustains livelihoods, poverty will be more widespread and the potential for conflict greater. Published statistical studies of conflicts globally (Raleigh & Urdal, 2007) or in Africa (Hendrix & Glaser, 2007; Meier, Bond & Bond, 2007) provide only limited support for these hypotheses. For instance, Raleigh & Urdal concluded (p. 674) on the basis of local-level data, that the effects of land degradation and water scarcity were 'weak, negligible, or insignificant'. Many of these early studies were inspired by a study by Miguel, Satyanath & Sergenti (2004), which found a relationship between negative rainfall deviation and increased risk of civil war in Africa. These authors were not primarily interested in climate change, but used rainfall deviation as an instrument for economic shocks. Jensen & Gleditsch (2009) have pointed out that Miguel et al. misinterpreted the UCDP data and included countries that intervene in civil war as countries at civil war. Correcting for this, their results are weaker. And as Ciccone (2010) has remarked, Miguel et al. look only at year-to-year rainfall deviations rather than deviations from a long-term mean. Using this indicator, which better reflects abnormality in rainfall and conforms more closely to the idea of climate change, their results evaporate. All of these studies are conducted at the national level. But rainfall variations do not follow national boundaries. Theisen, Holtermann & Buhaug (2010) used disaggregated data on conflict and climatic variations and found no relationship at the local level. Looking at a broader set of conflicts for the past two decades, Hendrix &

Salehyan (2010) found rainfall to be correlated with civil war and insurgency, but it is wetter years that are more likely to suffer from violent events. Extreme deviations in rainfall – particularly dry and wet years – are associated with all types of political conflict.

Temperature

Two of the authors behind Miguel et al. (2004) were also involved in a more recent study of temperature and conflict. In a widely publicized study, Burke et al. (2009, 2010) claimed to find a link between temperature and civil war in Sub-Saharan Africa for the period 1981–2002 and argued that over a 35-year period climate change would produce a major increase in the incidence and severity of civil war in the region, despite the expected conflict-dampening effect of economic growth and continued democratization during this period.[5] However, Buhaug (2010a,b) found that their results were not robust to standard control variables, to variations in the model specification, to different cut-offs for the severity of conflict, or to an extension of the time series to the most recent years. Buhaug concluded that climate variability is not a good predictor of civil war. Instead, civil war can be better accounted for by poverty, ethno-political exclusion, and the influence of the Cold War. Figure 3 from Buhaug's work indicates that using one of the models from Burke et al. (2009), the climate variables (temperature and precipitation) add virtually nothing to the explanatory power of the model.

Figure 3. Predicted values of civil war – does climate matter?



[5] They also suggest (Burke et al., 2009: 20672) that 'earlier findings of increased conflict during drier years' may have captured the effect of temperature and that 'the role of precipitation remains empirically ambiguous'

This figure plots predicted values of civil war for Model 2 of Burke et al. (2009) on the horizontal axis and a similar model without climate parameters on the vertical axis (r=.999). The linear models predict outside the range of possible values (0,1). The climate variables add 0.002 to a total explained variance of 0.657. Source: Buhaug (2010b: E186–187).

A study that looked at long-term trends (a millennium) in climate and war for China (Zhang et al., 2006) showed that China suffered more often from war, population decline, and dynastic changes during cold periods. A follow-up paper found more that cooling impeded agricultural production, in turn resulting in price inflation, war, famine, and population decline (Zhang et al., 2007) A study of Europe over the last millennium (Tol & Wagner, 2010) found that violent conflict (data from www.warscholar.com/) was more intense during colder periods, but that this relationship disappears in the past three centuries and is not robust to details of the climate reconstruction or to the sample period.[6] It makes sense that by and large a colder climate over some time would lead to a drop in agricultural production and thus in food scarcity and also makes sense that these Malthusian constraints are becoming less important over time with increasing industrialization and long-distance trade But the conflict data have not yet been frequently used in academic research and so far these findings have not been tested by other scholars.

A recent study of Central Europe by Büntgen et al. (2010), while not addressing armed conflict directly, links climate to the rise of fall of civilizations. It confirms the link between warmer summers and improved conditions for human settlements but also finds that climate variability has a major impact. However, the authors concede that modern societies may be less vulnerable to climatic fluctuations.

Several decades ago there was widespread concern in the scientific community that the world might be facing a period of global cooling, possibly even a new ice age. The CIA warned of an era of drought, famine, and political unrest, and even a potential for international conflict. The agency's analysis suggested that forecasting climate was vital to the planning and execution of US policy and would occupy a major portion of US intelligence assets (CIA, 1974).

A long line of research links hot temperatures to individual aggression, including violent crime and riots. Anderson (2001) suggests that therefore global warming may increase violence. But the causal mechanism proposed in

[6] The positive correlation between low temperature and conflict holds for most of Europe, but in the Balkans it is reversed. However, they note that the Balkans is largely excluded from the conflict database. They also report a positive correlation between precipitation and conflict for most of Europe in the earlier centuries (which they attribute to a decline in agricultural output due to waterlogging) and a negative correlation in the Balkans (which may be due to drought). Again, this correlation is not found for the most recent three centuries.

these studies (personal discomfort) is different from the scarcity thesis that is at the core of the relationship proposed by Burke et al. (2009) and the kind of violence is also different.

Sea-level change

IPCC (2007, WG II: 323) forecasts a global mean sea-level rise of between 0.28 and 0.43 meters within this century, depending on the scenario chosen.[7] Projections for the size of coastal populations (residing below 100 m elevation and less than 100 km from the coast) show that they may rise from 1.2 billion (1990 estimate) to between 1.8 and 5.2 billion (Nicholls & Small, 2002). Sea-level rise will threaten the livelihood of the populations on small island states in the Indian Ocean, the Caribbean, and the Pacific. However, a much larger number of people in low-lying areas, rural and urban, and particularly in South Asia and West Africa, may become more exposed to soil erosion, seasonal flooding, and extreme weather. Depending on the degree of protection that can be offered, this may lead to 'climate migration', and conflict with the host population is a possible consequence (Nicholls & Tol, 2006). However, this is going to be a slow process and urbanization and industrialization may well absorb a large fraction of the people who move.

In a global study covering the period 1951–2001, Salehyan & Gleditsch (2006) found that an influx of refugees increased the probability of civil war. However, since a large proportion of these people have fled from conflict, they are likely to bring with them the attitudes, the weapons, and the organization that fuel a continuation of the conflict in the host location. It is not obvious that economic migrants, including environmental migrants, will generate armed conflict in the same way (Gleditsch, Nordås & Salehyan, 2007). However, this has not been studied systematically, due to conceptual problems (what is the definition of an environmental migrant?) and lack of systematic data. Reuveny (2007) examined 38 cases of environmental migration since the 1930s and found that in half of them there was some kind of armed conflict, most frequently when the migration cross international boundaries. While suggestive, his study is unlikely to include all cases of environmental migration during this period and the conflicts are of different types. Moreover, he did not have any control variables.

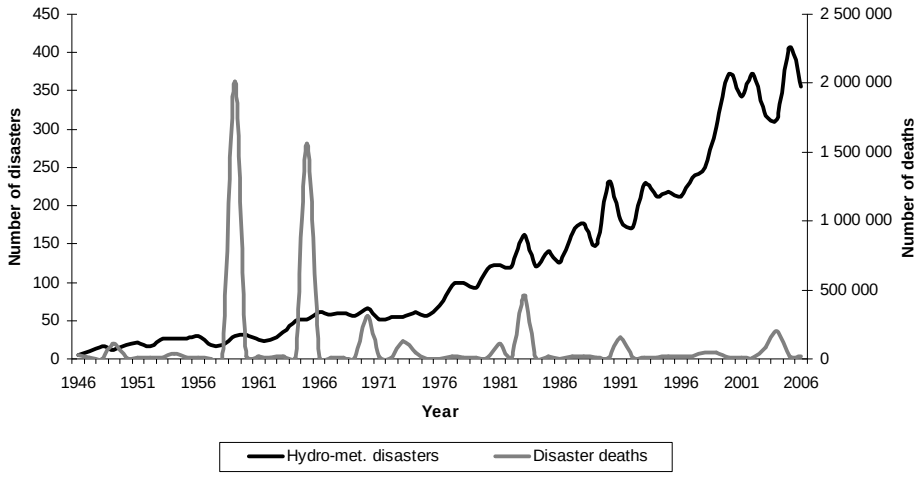
[7] Several more recent estimates are higher, cf. Grinsted, Moore & Jevrejeva (2009) who project sea-level rise to the end of the twenty-first century from 0.9 to 1.3 m for the A1B scenario.

Natural disasters

Global warming is predicted to increase the frequency and intensity of natural disasters such as tropical storms, flash floods, landslides, and wild fires, and substantially alter precipitation patterns in many parts of the world. There has been a sharp increase in the number of disasters over the last sixty years[8], although it is not certain how much of this can be accounted for by improved reporting, population growth, and shifting patterns of settlement. In 2009, 335 natural disasters were reported, killing more than 10,000 people (Vos et al., 2010: 1). Asia is the region most heavily affected. Geological disasters like volcanic eruptions, earthquakes, and tsunamis need not concern us here, since they are unlikely to be influenced by climate change. The temporal increase in disaster frequency is largely accounted for by hydrological and meteorological disasters, particularly by floods, as shown in Figure 4.

The severity of disasters, measured as the number of casualties, shows no evident time trend, presumably because of increasing coping capacity in many countries. Future economic development is likely to further increase the ability of many societies to absorb natural disasters without great loss of human life, so an increase in extreme weather events need not be accompanied by higher casualty figures. Geological events are slightly more deadly, but the more numerous climate-related generate the highest overall death toll.

Figure 4. Frequency and severity of hydro-meteorological disasters since 1946



[8] Vos et al. (2010: 5) define a disaster as 'a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering'.

Source of Figure: Buhaug, Gleditsch & Theisen (2008: 11). Data from EM-DAT, Centre for Research on the Epidemiology of Disasters (CRED). An update from CRED (Vos et al., 2010) does not show any time trend in the number of disasters for the most recent decade.

Natural disasters may exacerbate conflict risk primarily through economic loss and a weakening of government authority. Some statistical studies find the risk of conflict to be higher following natural disasters (Drury & Olson, 1998; Brancati, 2007; Nel & Righarts, 2008).[9] However, Slettebak & de Soysa (2010), drawing on a long tradition in disaster sociology, argue that disasters are just as likely to unite those who are adversely affected, at least in the short run, implying that various forms of anti-social behavior, including violence, should decline. Using a global sample from 1950 until today and a set of standard control variables they find that countries affected by climate disasters face a lower risk of civil war. Similarly, Bergholt & Lujala (2010) find that climatic natural disasters such as floods and storms have a negative impact on economic growth but have no effect on the onset of conflict, either directly or as an instrument for economic shocks.

Arctic rivalry

The melting of the Arctic icecap has been predicted to lead to a scramble for shipping lanes and natural resources in previously inaccessible territories (Borgerson, 2008; Paskal, 2010). Since there is no established legal regime for the region, some observers feel that this could lead to armed conflict. Several major powers have interests in the region, so potentially this could lead to some serious conflicts. On the other hand, the vast extension (from the early 1970s) of national sovereignty through the establishment of Exclusive Economic Zones (EEZs) points in a different direction. Despite legal action, unresolved boundaries, and occasional confrontations, particularly over fisheries, the establishment of EEZs to 200 miles off the coastline has proceeded in overwhelmingly peaceful fashion. Although several countries (including the US) have not ratified the UN Convention on the Law of the Sea (concluded in 1982, entered into force in 1994), its provisions are generally respected. Most observers seem to agree with Haftendorn (2010) that a mad race to the Pole is not very likely, nor is a military conflict among the contenders. Historically, the role of disputed territory is one the central issues of war (Holsti, 1991; Huth, 1996) but interstate war, regardless of issue, has declined to the point where it is now very rare (Harbom & Wallensteen, 2010).

[9] Brancati (2007) studied only earthquakes and Nel & Righarts (2008) also found stronger results for geological than for climatic disasters.

Vulnerable regions

Which are the most vulnerable regions? Empirical studies of rainfall and temperature (such as Miguel et al., 2004; Burke et al., 2009, Buhaug, 2010) have largely focused on Africa South of Sahara. In part, this is because Africa is more dependent on rain-fed agriculture and thus more severely affected by major climate change or variability. But it is also because climate change is expected to be associated with conflict in interaction with other conflict-inducing factors, such as poverty, economic decline, ethnic exclusion etc. (Buhaug, Gleditsch & Theisen, 2010), all of which also have been frequent in Africa. Of the 58 countries included in the 'bottom billion' (the countries that are both poor and stagnating) close to two-thirds are found in Africa (Collier, 2009).

Africa is also one of the more conflict-prone regions, along with South Asia and the Middle East. In the late 1990s, Africa accounted for more battle-related deaths than all other regions together. However, since then, all regions – and Africa in particular – have experienced a decline in battle deaths. Since 2005 most battle deaths have occurred in Central and South Asia, driven in particular by the wars in Sri Lanka, Afghanistan, and Pakistan.

In the second half of the twentieth century, East Asia experienced the three largest wars anywhere, the Chinese Civil War, the Korea War, and the Vietnam War, However, since the Vietnamese invasion of Cambodia in 1978 and the Sino-Vietnamese War in 1979 (followed by some minor skirmishes in the 1980s), this region has been largely free of war.[10]

Since the physical effects of climate change are so varied, it is hard to compare regions in terms of the overall effects of climate change. IPCC (2007, WG II: 435) characterizes Africa as 'one of the most vulnerable continents to climate change and climate variability', but this judgment is made as much because of Africa's low adaptive capacity as much as the absolute size of the climate changes.

Unfortunately, the climate change projections for Africa are highly uncertain (IPCC, 2007, WG I: 266ff.). Paradoxically, where accurate measurement of historical climate variables is the most needed, the information is also the most limited.

[10] Cf. www.prio.no/cscw/cross/battledeaths. The major exception is provided by the two insurrections in the Philippines, which have claimed some than 20,000 battle deaths over this thirty-year period. By contrast, each of the three major East Asian wars claimed more than one million battle deaths each over much shorter time periods.

Major climate change challenges in Asia include possible increased seasonal flooding and drought in the areas downstream from the shrinking Himalayan glaciers, environmental refugees following sea-level rise, and threats to major coastal cities such as Dhaka, Mumbai, and Hong Kong as a result of increased tropical storms as well s sea-level rise (IPCC, 2007; Wischnath, 2010). These challenges are particularly serious since the population of Asia makes up more than half of the world total. On the other hand, economic growth has been particularly rapid in large parts of Asia in the past two decades, so the adaptive capacity is clearly larger than in Africa.

Models

The climate models used in studies of the effects on conflict are generally derived from standard sources, such as those used by the IPCC. For instance, Burke et al. (2009) use time series on precipitation and temperature from the Climatic Research Unit at the University of East Anglia and climate projections from general circulation models from the World Climate Research Program's Coupled Model Intercomparison Project under the IPCC's A1B emissions scenarios, with some alternative calculations under the A2 and B1 scenarios. Although different scenarios yield somewhat different results, current controversies about the effects of climate change on conflict do not seem to depend on the choice of historical data or emissions scenarios.

There is no standard model of conflict which is universally accepted, but the two most frequently used models of civil war are those used in Fearon & Laitin (2003) and Collier & Hoeffler (2004), and Hegre & Sambanis (2006) have conducted a sensitivity analysis to identify the most robust variables from a large number of common explanatory schemes. Buhaug (2010a) employs some of the variables from these studies as controls and alternative explanations. Burke et al. (2010), however, insist that controlling for endogenous variables, i.e. independent variables that can be influenced by conflict (or the anticipation of it) will bias the analysis. In the early work of Miguel et al. (2004) the endogeneity problem was tackled by using rainfall deviation as an instrument for economic shocks, but it is not always possible to find suitable instruments and in Burke et al. (2009) there are none.

As already shown in Figure 3 above, the climate variables add very little to the explanatory power of the model used by Burke et al. (2009). The relatively high explanatory power, with R^2 as high as 0.66 in their Model 1, is driven by the fixed country effects and the time trends. Standard opportunity models of civil war, such as Fearon & Laitin (2003) and Collier & Hoeffler (2004) as well as studies that place more emphasis on ethnic grievances, such as Cederman &

Girardin (2007), explain more of the variance with explanatory variables and control variables. However, as Ward, Greenhill & Bakke (2010) point out, such models nevertheless do a very poor job of prediction. The Fearon & Laitin (2003) model does not correctly predict a single onset of civil war, while the Collier & Hoeffler (2004) model correctly predicts 3, at the expense of predicting 5 false positives.[11] At the moment, social scientists are poorly equipped to predict rare events like conflict but climate change is just one of many areas where policy prescriptions are dependent on more successful efforts at prediction (Schneider, Gleditsch & Carey, 2010).

Uncertainty

The IPCC assessment reports employ quantitative as well as qualitative assessments of uncertainty. In the Fourth Assessment Report, each Working Group used a different variation. Working Group I, which assessed the physical science, relied primarily on a quantitative likelihood scale, with 'virtually certain' (>99% probability of occurrence) at the top.[12] For instance, WG I estimated it to be 'very likely' (i.e. > 90%) that the frequency of heavy precipitation events would increase in the future for most areas.[13] WG2 relied mostly on a quantitative confidence scale, where e.g. 'high confidence' indicates an 80% or higher chance of being correct.[14] WG III relied exclusively on a qualitative level-of-understanding scale.

The uncertainties in the IPCC assessments are exacerbated by the inclusion of non-peer reviewed material. The basic principle is that material used by IPCC and included in the assessment reports should be peer-reviewed. In WG I on the physical consequences of climate change, this provides the bulk of the evidence. However, the IPCC has concluded that 'it is increasingly apparent that materials relevant to IPCC Reports, in particular, information about the experience and practice of the private sector in mitigation and adaptation activities, are found in sources that have not been published or peer-reviewed' (IPCC, 1999/2008: Annex 2). Each such source is to be critically assessed by the authors of the IPCC assessment and will be archived and made available to IPCC review authors who request them. An outsider cannot know exactly how these guidelines have been used in the preparation of the Third and Fourth Assessment Report, but it is obvious to a reader who knows the

[11] When the threshold is set at p (onset) > 0.5. With a lower threshold, both models predict more conflicts correctly, but they yield an even larger number of false positives (from two to four as many as the correct predictions).
[12] IPCC (2007, WG I: 23), IAC (2010: 29).
[13] IPCC (2007, WG I: 8).
[14] IPCC (2007, WG I: 22), IAC (2010: 28).

literature that a number of sources have in fact been used quite uncritically in references to conflict.[15]

Following the discovery of an error in the Fourth Assessment Report[16] that had cited a non-peer reviewed source to back up a an alarmist statement that the Himalayan glaciers were likely to disappear within 35 years, the UN and the IPCC itself asked the InterAcademy Council, an umbrella group of national academies of science in fifteen countries, to review the IPCC's organization and procedures. Although the evaluation report (IAC, 2010) was generally favorable, there were critical comments that the review editors had insufficient authority to ensure that the authors followed up their comments, that Working Group II (which deals with the social consequences of climate change) had overemphasized the negative aspects of climate change, that it had reported high confidence in some statements for which there was little evidence (p. 4), and that the selection of authors for regional chapters often excludes some of the best experts because they don't live in the region (p. 18). The report also noted that peer-reviewed journal articles comprised 84% of the references in Working Group I, but only 59% in WG II and 36% in WG III (p. 19). An implication, not stated explicitly by the IAC, is that the IPCC's statements on the social implications of climate change are less reliable than assessments of the physical basis.

In the Fifth Assessment Report (AR5), scheduled for 2013, there will be a chapter on human security, which it is expected will also include a discussion of violent conflict.[17] This is a promising development. However, the expertise of the group of authors responsible for this chapter leans heavily towards broader aspects of human security rather than conflict. It seems likely that they will produce a more balanced assessment of the literature on climate change and conflict, as the authors have signaled a stronger emphasis on peer-reviewed literature. But it remains to be seen whether this will prevent more extravagant and empirically unsupported statements being made in other chapters of the report and restrain the more dramatic interpretations by NGOs and politicians.[18]

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[15] For a detailed examination, see Nordås & Gleditsch (2009).
[16] And, at about the same time, the leaking of thousands of documents and e-mails from the Climate Research Unit at the University of East Anglia. For a balanced account of the 'Climategate' affair, see Pearce (2010).
[17] However, the scoping document of the AR5, approved in October 2010, does not reveal the contents at this level of detail, cf. www.ipcc.ch/meetings/session32/syr_final_scoping_document.pdf),
[18] The IPCC November 2010 announcement about the Table of Contents and the authors is found at www.ipcc.ch/meetings/session32/inf07_p32_ipcc_ar5_authors_review_editors.pdf, cf. Chapter 12.

Research priorities

Research on the security effects of climate change should focus on interactions between climatic variables and other conflict-inducing factors, to test the notion that climate change can act as a 'threat multiplier' (CNA, 2007: 1).

Secondly, although data and models may be more readily available for rich countries, research on conflict as a possible effect of climate change needs to focus on the poorer parts of the world, where the adaptive capacity is lower today. Of course, some countries in the third world now have high economic growth and are likely to be in a position to absorb greater changes fifty years from now. Therefore, particular attention needs to be paid to countries that are not only poor but also stagnating.

Third, we need to go beyond the state-based violence considered in most statistical studies to date. Much of the case study literature refers to non-state or one-sided violence, but this has hardly been tested in large-n studies. Unfortunately, the time series for these types of conflict data are still quite short, so improved data collection will be a priority.

More work needs to be put into the geographical disaggregation of the effects of climate change since these effects will not follow national boundaries.

Further, the study of climate change and conflict needs to balance the negative and positive effects of climate change. While food production is likely to decrease in some areas, it may increase in others. Although the global net effect of climate change seems likely to be negative, the effects would vary considerably both geographically and by sector.

Finally, if we are to go beyond the simple projection of past changes into the future, we will need a tighter coupling of climate change models and the conflict models. The development of more fine-grained data for the physical effects of climate change, incorporating geographic variation, rates of change, and adaptive measures, will facilitate the scientific interface. But for the moment, it may be more realistic to concentrate on the past impact of climate change. If such research indicates that the link to conflict is weak, efforts to establish projections into the future probably should have lower priority.

Conclusions

Given the potential range and scope of consequences of climate change, it is not surprising that there is widespread concern about its security implications. In part, this concern has been directed at raising awareness about 'environmental security' in a broad sense. Climate change will have many serious effects, particularly transition effects, on peoples and societies worldwide. The hardships of climate change are particularly likely to add to the burden of poverty and

human insecurity of already vulnerable societies and weak governments.[19] However, the use of such wider concepts of security must not stand in the way of a focused effort to analyze empirically the possible link between environmental change and violent conflict. Assuming such a link without the necessary evidence may lead peacemaking astray and can eventually also undermine the credibility of the IPCC and the efforts to reach a consensus of knowledge about human-made climate change and a concerted global effort at mitigation and adaptation. The climate-conflict discourse is easily exploited by cynical governments and ruthless rebels who would like to evade any direct responsibility for atrocities and violence and prefer to put the blame on developed countries and their greenhouse gas emissions (Salehyan, 2008).

Finally, what if the academic community were to conclude that climate change has very little impact on armed conflict. Does it matter? It matters a great deal for the credibility of climate change research. Extremely low-probability hazards should not be promoted to major threats under the precautionary principle. For adaptation to climate change, clarifying the conflict effects may also be important. Preventing armed conflict is likely to require countermeasures that are different than preventing biodiversity loss. For the need to mitigate the effects of climate change, however, the effects of climate probably matter very little. There are many other reasons to reduce the human impact on the climate and to prevent global warming from getting out of hand.

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[19] However, Buhaug, Falch, Gleditsch & Wischnath (2010) found that climate change so far has had no greater absolute impact on temperature and precipitation in 'bottom billion' countries in Africa than in other African countries.

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