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Past and future research on climate change and violent conflict

University of Hamburg
Research Group Climate Change and Security

Working Paper
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1. Introduction

While recent research has provided new insights into the relationship between climate change and violent conflict *(Gleditsch, 2012a, Scheffran et al., 2012a)* there is yet no consensus in the literature about its nature and extent. Those who claim a strong causal connection are facing serious doubts by scholars who find no or only weak empirical evidence for such claims. In this review we compare the results, methodologies, and data applied in the peer-reviewed literature to summarize the current state of the debate. While long-term historical studies suggest a coincidence between climate variability and armed conflict, empirical findings are less conclusive for recent periods. Understanding the different views provides a foundation for the prediction of future impacts on violent conflict. However, it is argued here that more comprehensive approaches are needed to disentangle the complex climate-conflict nexus. We briefly discuss the key intervening variables and causal pathways between precipitation changes, freshwater scarcity, and food insecurity as well as weather extremes and environmental migration. Pathways may differ in their relevance for distinguishable types of violence and regional contexts. Theoretical insights suggest that low-level violence is more likely to be linked to the effects of climate change than full scale wars. Empirical findings indicate that climate-conflict linkages vary significantly between the world's regions. For illustration, we provide a broad-brush geographic differentiation by countries to show that countries with low human development are particularly vulnerable to the double exposure of natural disasters and armed conflict.

This highlights the point that climate change is not the only important parameter of future violence. Other factors, such as human development, effective institutions, and governance also affect the likelihood of violent conflict. Economic, political, and social factors on local, regional and global levels are interlinked with broader effects of climate change. As a promising basis for future research, we suggest an integrative framework of the pathways between climate change and violent conflict that can be applied to model and empirically calibrate linkages between climate change, natural resources, human security, and societal stability.

This review summarizes key lessons from the scientific literature, identifies research needs, and draws conclusions for future research and policy. First, we systematically assess the current state of empirical research on the link between climate change and violent conflict. Going beyond global data sets we consider selected intermediate pathways and address regional differences in how climate change and violent conflict affect human security. In this context, the role of human development and institutional processes in multiplying or minimizing potential conflicts is discussed. Finally, we identify shortcomings, challenges and questions for future research within the integrated framework of human-environment interaction.

2 Empirical Findings

Until now, research on this subject has largely relied on quantitative methodologies based on statistical analyses of climate and conflict data, and on qualitative assessments of causal mechanisms in case studies. In contrast to the extensive modeling in climate science, models of climate-conflict linkages are rare *(example in Devitt and Tol, 2012, see review in Scheffran et al., 2012c)*. Using different concepts of climate change and conflict, most studies in this field are based on a selected set of climatic or weather-related variables (temperature, precipitation, and extreme weather events) that are correlated with specific aspects of violent conflict (particularly the onset or number of armed conflicts).

Quantitative empirical studies that analyze various regions and time periods reach differing conclusions about the influence of climate variables on armed conflict (Tab. 1). Studies that use quantitative data over long historical periods generally tend to find a correlation between climate variability and armed conflict. One study showing such a link for pre-industrial Europe concludes that cooler periods in pre-industrial Europe were more likely related to periods of violence than warmer phases *(Tol and Wagner, 2010)*. Similar results were found for the Northern Hemisphere *(Zhang et al., 2011)* and Eastern China (*Zhang et al., 2007* and Table 1).

As shown in Table 1, studies for more recent periods come to differing and sometimes opposing results. In an important study, Miguel and others *(Miguel et al., 2004)* found that an increase of armed conflicts was correlated with economic shocks, for which rainfall variation was used as an instrumental variable in agriculturally-dependent regions in Africa that can be influenced by climate change. However, the specification of rainfall measures has been criticized because of its counterintuitive formalism *(Ciccone, 2011)*. In another major study, a significant linkage between civil war and temperature has been found for the period 1981 to 2002 in Africa *(Burke et al., 2009)*. This study in turn has been challenged on the basis that the results were not robust to alternative model specifications and the application of more recent data *(Buhaug, 2010)*. In what is probably the strongest but also most puzzling statement of a statistical correlation between weather-related data and armed conflict, Hsiang and others *(2011)* find a strong effect of the El Nino Southern Oscillation (ENSO) on armed conflict for the period 1950–2004. The "probability of new civil conflicts arising throughout the tropics doubles during El Niño years relative to La Niña years" *(Hsiang et al., 2011:438)*. Yet, key questions remain on the connection between climate change and the El Niño phenomenon (*Gergis and Fowler, 2009*), even more on the link to conflict. Is El Niño an adequate indicator for the impact of climate change on violent conflict? Is it possible that El Niño redirects civil conflict away from El Niña years without raising the overall number of conflict incidences? What are the main pathways of the effects of El Niño years on civil conflict? For low-income countries the study leaves open "if (1) they respond strongly because they are low-income, (2) they are low income because they are sensitive to ENSO, or (3) they are sensitive to ENSO and low income for some third unobservable reason" *(Hsiang et al., 2011:440)* .

Table 1: Results of key peer reviewed quantitative studies since 2004 on the link between climate change and violent conflict

Link	Specified Link	Conflict type	Region	Analyzed period	Reference
Y	+T ∣ -P ∣ +D →+C	s	Global	1950–2004	*(Hsiang et al., 2011)*
Y	-L→+C	s	Global	1980–92	*(Theisen, 2008)*
Y	-L→+C	s, ns	Global	1990–2004	*(Raleigh and Urdal, 2007)*
Y	+D→+C	s	Global	1950–2000	*(Nel and Righarts, 2008)*
Y	+D→-C	s	Global	1950–2008	*(Slettebak, 2012)*
Y	ΔP→+C	s	Africa	1981–1999	*(Miguel et al., 2004)*
Y	+P→+C	s	Africa	1990–2008	*(Hendrix and Salehyan, 2012)*
Y	+P→+C	ns	East Africa	1950–1994/1971–2010	*(Adano et al., 2012)*
Y	+P→+C	ns	East Africa	1989–2004	*(Theisen, 2012)*
Y	ΔP→+C	s, ns	East Africa	1997–2009	*(Raleigh and Kniveton, 2012)*
Y	+V→+C	s	East Africa	2000–2006	*(Rowhani et al., 2011)*
Y	+T→+C	s	SSA	1981–2002	*(Burke et al., 2009)*
Y	-P→+C	s, ns	East Asia	220BC–1839AD	*(Bai and Kung, 2011)*
Y	-T→+C	s	East Asia	AD10–1900	*(Zhang et al., 2010)*
Y	-T→+C	s	East Asia	800BC–AD1911	*(Zhang et al., 2007)*
Y	-T→+C	s	Europe	1500–1800	*(Zhang et al., 2011)*
N	+T☒C	s	Global	1816–2000	*(Gartzke, 2012)*
N	ΔT ∣ ΔP☒C	s	Global	1980–2004	*(Koubi et al., 2012)*
N	+D☒C	s	Global	1980–2007	*(Bergholt and Lujala, 2012)*
N	ΔP☒C	s	Africa	1960–2004	*(Buhaug and Theisen, 2012)*
N	+T ∣ ΔP☒C	s	SSA	1981–2002	*(Buhaug, 2010)*
N	-W☒C	s, ns	Sahel	1960–2006	*(Benjaminsen et al., 2012)*
A	W→+C W☒C	s	Global	1880–2001	*(Gleditsch et al., 2006)*
A	-W→+C +W→+C	s	Global	1981–2000	*(Gizelis and Wooden, 2010)*)
A	-L→-C -L→+C	s	Global	1950–2000	*(Urdal, 2005)*
A	ΔP→+C -L ∣ -W☒C	s	SSA	1981–2002	*(Hendrix and Glaser, 2007)*
A	-T~+C	s, ns	Central Europe	1500–1900	*(Tol and Wagner, 2010)*

The column "Link" denotes whether there is a significant link between the variables (y) or not (n) or whether the link is ambivalent (a).
P = precipitation, T = temperature, D = disaster, W = freshwater, L = land, V = vegetation, C = conflict, → = leads to, + = increase, - = decrease, Δ = change (increase or decrease), ☒ = no link, ~ = weak link (for details see supplement), Example: +P→+C = increase in precipitation leads to increase in conflict, ∣ = and/or,
s = state involved, ns = no state involved, SSA = Sub-Sahara Africa, *projection.

Based on the mixed evidence, earlier reviews conclude that there is "only limited support for viewing climate change as an important influence on armed conflict" *(Gleditsch, 2012b:3)*, but that "environmental changes may, under specific circumstances, increase the risk of violent conflict" *(Bernauer et al., 2012:1)*. We find it important to understand these conditions to move beyond the limitations in current approaches towards more systematic assessments.

As shown in Table 1, quantitative empirical studies are suited to identify significant correlations between climate variables and violent conflict, but they have limited explanatory power with respect to characterizing the causal pathways and their dynamics. Qualitative studies on the other hand are able to disentangle the complex conflict factors, but they have difficulties to support their claims beyond case-specific data and to establish causality. Both approaches may not be robust against variation of model variables and assumptions, for instance regarding conflict type, involved parties, regional samples, and time periods. They extend past data into a future world with unprecedented rates of temperature rise and its associated consequences. They also lack experience in human and societal responses to such changes. Conflict and cooperation, which are of core interest for the relationship between climate change and violence, may cancel each other out at the global scale.

The studies listed in Table 1 predominantly but not exclusively use the UCDP/PRIO Armed Conflict Dataset, primarily due to its availability and quality. However, PRIO's definition of conflict limits the studies to conflicts with governmental involvement and an intensity of at least 25 battle deaths per year (*PRIO, 2011a*). Hence low-level events such as protests, riots and inter-group violence are disregarded in those datasets. Recent projects like the Armed Conflict Location and Events Dataset (ACLED), the Social, Political and Economic Event Database (SPEED) and the Social Conflict in Africa Database (SCAD) attempt to fill the gap by including non-state conflicts, low-level violence, social instability events, and geo-referenced spatio-temporal patterns *(see Busby et al., 2012, Nardulli and Leetaru, 2012, Raleigh and Kniveton, 2012, and the supplement in Scheffran et al., 2012b)*. Due to the huge amount of data, it will take time until the upcoming databases cover longer periods and major parts of the world.

3 Intermediate Factors and Indirect Pathways

We suggest that one of the reasons for the different findings in the empirical literature on the effects of climate change and violent conflict is the theoretical basis used for quantitative work, which does not sufficiently consider the complexities of the issue. As suggested earlier *(Scheffran et al., 2012b, Scheffran et al., 2012c)*, a complex model of the direct and indirect causal relationships between climate change and conflict is needed. Figure 1 shows connections between the climate system, natural resources, human security and societal stability. Climate change in itself has various dimensions, with multiple relevant effects on the environment, economics, society and politics. Most important in this context is the frequency and intensity of extreme weather events, the variability of weather parameters such as temperature and precipitation, and long-term changes in such parameters. These variables may have direct impacts on social systems or indirect implications through other pathways affecting natural resources and human security, which together can lead to ambiguous results.

For each pathway, the consequences of climate change depend on how vulnerable affected natural and social systems are and how sensitive they respond to the stress. At each level, human intervention can influence the systems, e.g. through mitigation and adaptation strategies to reduce risks, strengthen resilience, and improve sustainability. The main focus here is the impact of climate change on conflict which generally refers to social or political incompatibilities over interests, values, or methods. The definitions of conflict vary with respect to the number of actors, casualties and the degree of violence. In the context of climate change most studies refer to armed conflict in which actors use force to achieve their aims.

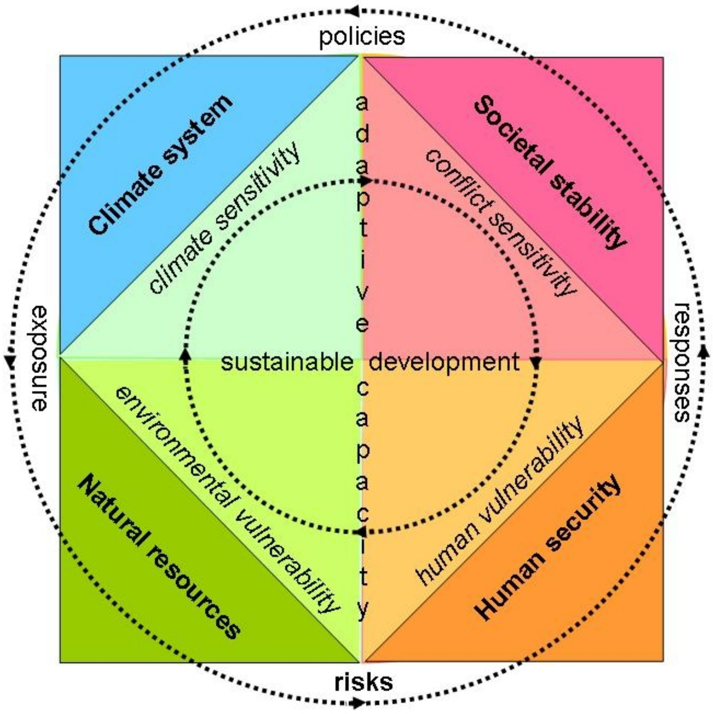

Figure 1: Analytical framework of linkages between the climate system, natural resources, human security, and societal stability *(based on Scheffran et al., 2012b,c)*

There is a wealth of literature on each of the intermediate phenomena. Therefore, we focus only on key messages and references in the subsequent aggregation. Since the 1990s, there has been an extensive scientific debate on how the scarcity of natural resources such as minerals, water, energy, fish, and land affects violence and armed conflict *(Bächler, 1999, Homer-Dixon, 1994)*. While many case studies suggest that environmental degradation and resource scarcity undermine human well-being, the effect on violent conflict "appears to be contingent on a set of intervening economic and political factors that determine adaptation capacity" *(Bernauer et al., 2012:1)*. Particular attention has been placed on the following intermediate factors *(Scheffran and Battaglini, 2011, WBGU, 2008)*.

Precipitation changes and variability: While lack of precipitation and drought may increase resource conflicts in some cases (*Opiyo et al., 2012*), other assessments support the proposition that the occurrence of conflict, caused by issues on rainfed agriculture or pastoralism, is more likely in rainy than in dry seasons (Tab. 1). For instance, some studies find that in Kenya the conflict likelihood, in the form of livestock raiding, is greater in years with rainfall abundance than in drought years *(Theisen, 2012).* People "reconcile their differences and cooperate" *(Adano et al., 2012:77)* in dry seasons of relative scarcity. Others argue that strong deviations from average precipitation in both directions are related to the onset of violent conflict *(Hendrix and Salehyan, 2012, Raleigh and Kniveton, 2012)*. Generally, political and economic marginalization of ethnic groups is a more significant factor influencing violence than drought *(Eriksen and Lind, 2009, Theisen, 2012)*. Other studies *(e.g. Koubi et al., 2012)* do not directly test for a relationship between climate variability and conflict but rather proceed in two stages: they first estimate the effect of temperature on economic growth and then assess the relationship between growth and conflict.

Freshwater resources and scarcity: Systematic empirical assessments demonstrate that international river systems are more associated with low-level conflicts and diplomatic tensions than with full-scale wars *(e.g. Bernauer and Siegfried, 2012, Brochmann and Hensel, 2009)*. According to the Transboundary Freshwater Dispute Database the evidence for war between countries over water is low. The number of international water agreements has been rising over the past decades, which indicates growing cooperation *(De Stefano et al., 2012, Wolf, 2007)*.

Land and food: Climate change is likely to contribute to food insecurity in parts of the world *(Gahukar, 2009)*, while food insecurity can contribute to violence *(Messer, 2009)*. This has been highlighted by the "food riots" that occurred in several countries between 2007 and 2011, which correlated with rising food prices *(Bush, 2010, Sternberg, 2012)*. So far there is little explicit evidence of climate change as a contributing factor in this context *(Johnstone and Mazo, 2011)*. Also, the role of climate change in conflicts among pastoral and farming communities over land and pasture in Sub-Sahara Africa is ambivalent *(Adano et al., 2012, Benjaminsen et al., 2012)*. One study indicates that rainfall-related economic shocks increase land invasions and hence the potential for conflict, as shown for regions with highly unequal land distribution in Brazil *(Hidalgo et al., 2010)*.

Weather extremes: In addition to the study on the ENSO phenomenon *(Hsiang et al., 2011)*, additional publications have found relevant evidence of links between extreme weather events and armed conflict. This includes studies of natural disasters *(Nel and Righarts, 2008)*, which arguably have similar effects as those predicted by extreme weather events, such as floods and storms. However, other assessments do not support this result and find no increased likelihood of civil armed conflict in natural disasters. Among those, Slettebak *(2012)* argues that in crisis situations cooperation prevails over conflict. Future studies using broader sets of data, including low-level violence should take into account both conflict and cooperation as consequences of weather-related extreme events.

Environmental migration: There is a wide range of estimates on the number of future migrants who are driven by environmental and climatic changes *(Jakobeit and Methmann, 2012)*. Empirical findings reach no consensus whether environmental migration can act as a precursor for violence *(Barnett and Adger, 2007, Reuveny, 2007)*. Recent studies rather suggest to treat migration as an important adaptation measure to climate change *(Black et al., 2011)*, which could strengthen the resilience of affected communities, e.g. through remittances *(Scheffran et al., 2012d)*.

4 Geographical Distribution of Vulnerabilities

A large body of literature suggests that the impact of climate change on human beings and societies is shaped by the vulnerabilities specific to each region (e.g. Füssel, 2011, IPCC, 2007b, Samson et al., 2011). The vulnerability to climate impacts can be broken down into three factors: i) exposure to climate change, ii) sensitivity to climate change, and iii) adaptive capacity *(IPCC, 2007a)*. While exposure can be considered to be independent from conflict, the other two cannot, suggesting that the climate-conflict link is not a one-way road. In Figure 2 we identify countries that have been sensitive to violent conflict (using the number of armed conflicts in recent decades) and countries that are vulnerable to future climate change (using an established indicator for climate vulnerability). This provides a geographical representation of countries that are facing the double exposure to both climate change and violent conflict, only one of these phenomena, or none of them. Several questions arise: Will regions that are prone to violent conflict also become more affected by climate change? Could increased climate impacts undermine adaptive capacity and add to conflict? How do climate vulnerability and violent conflict interact in "hot spots" that suffer from this double exposure?

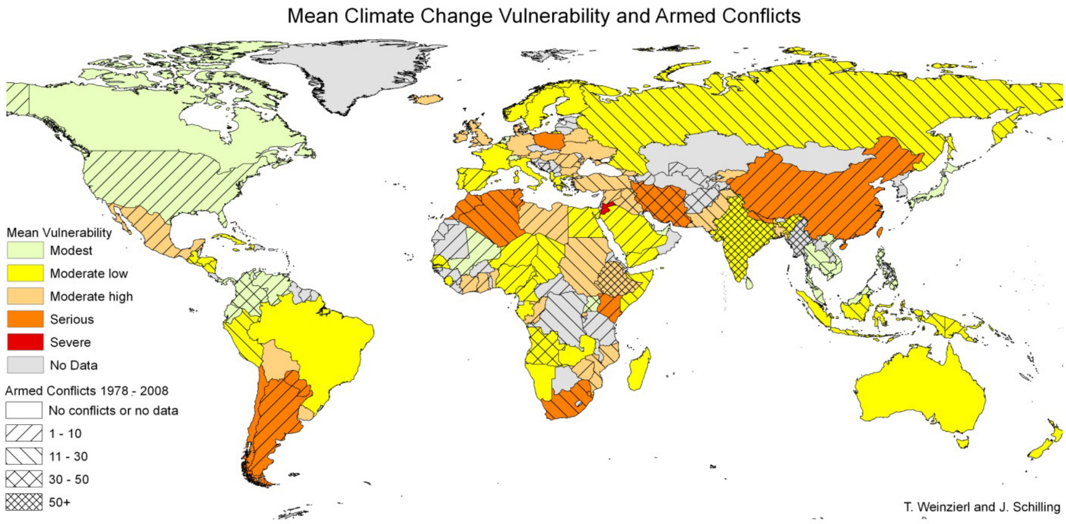

Figure 2: Mean vulnerability to future climate change and the number of recent armed conflicts. The vulnerability shown is the mean between the vulnerability index for climate sensitivities of 1.5°C and 5.5°C, both calculated for the IPCC A2 emission scenario until 2050 (Yohe et al., 2006b). The vulnerability index is a measure of climate change exposure, sensitivity, and adaptive capacity *(for details see Yohe et al., 2006a, 2006b)*. The conflict data are from UCDP/PRIO Armed Conflict Dataset v.4-2011 (PRIO, 2011b)

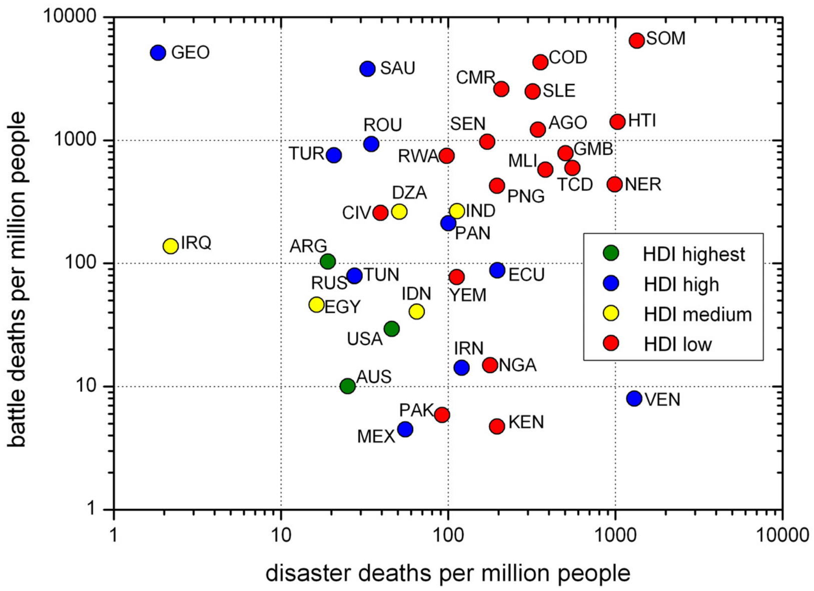

Figure 3: Battle deaths vs. disaster deaths in countries that experienced casualties in both categories between 1978 and 2008 (UCDP/PRIO and EM-DAT for the time period 1978-2008). Disasters considered are drought, epidemic, extreme temperature, flood, insect infestation, wet mass movement, storm, and wildfire. Categorization of development is based on the 2011 Human Development Index.

Country codes: AGO Angola, ARG Argentina, AUS Australia, CIV Cote d'Ivoire, CMR Cameroon, COD Congo, DZA Algeria, ECU Ecuador, EGY Egypt, GEO Georgia, GMB Gambia, HTI Haiti, IDN Indonesia, IND India, IRN Iran, IRQ Iraq, KEN Kenya, MEX Mexico, MLI Mali, NER Niger, NGA Nigeria, PAK Pakistan, PAN Panama, PNG Papua New Guinea, ROU Romania, RUS Russia, RWA Rwanda, SAU Saudi Arabia, SEN Senegal, SLE Sierra Leone, SOM Somalia, TCD Chad, TUN Tunisia, TUR Turkey, USA United States of America, VEN Venezuela, YEM Yemen

Although definite answers cannot be given yet, it is worthwhile to examine the factors that shape this interaction. A comparison of the number of deaths from natural disasters and battle-related deaths in the past reveals that both are highest in countries with a low human development index (see Fig. 3). Many of these countries are home to the world's poorest people who already experience increased threats to their lives and health that undermine human development. If climate change adds to these risks and vulnerabilities, it can increase humanitarian crises and aggravate existing conflicts without directly causing them.

5 Governmental Responses, Governance and Institutional Frameworks

Human development and adaptive capacity are fundamental ingredients to contain the double exposure of conflict and climate risks. Their interaction is related to the concept of human security, which refers to the reduction and elimination of vital anthropogenic threats to the life and health of individuals and communities *(Commission on Human Security, 2003)*. The potential effects of climate change on human security are decisively influenced by the responses of local, national, and international actors, which may both reduce or increase the likelihood of climate-induced violence.

While global temperature has been rising in the past decades, the number of armed conflicts declined since the end of the Cold War (Fig. 4). The growing wealth per capita and the spread of democracies increase the chance of an expansion of adaptive capacity in many parts of the world, which counters climate exposure and sensitivity. Until the global financial crisis of 2008, humanitarian aid and development assistance have increased *(OECD, 2012)*. In most parts of the world this contributed to important improvements in the living conditions of people potentially most vulnerable to the effects of climate change. With the global financial crisis, however, the situation has become more severe again.

International efforts to prevent and manage conflicts have been strengthened, which considerably reduced the number of armed conflicts and battle deaths (Fig. 4). In recent years, however, this trend seems to have come to a standstill, and it is not clear how conflict prevention and management will evolve in the future. A particular problem is the capacity of conflict management institutions at various levels from the local to the global to deal with sub-national conflicts and multiple crises simultaneously. Effective institutional frameworks, governance mechanisms and democratisation are often seen as an important precondition for peaceful management of conflict. Democracies have rarely fought each other in the past, and democratic states also have seen fewer incidences of civil wars in the past decades *(Gleditsch et al., 2009)*. The number of democratic states has generally grown in waves over the past half century, which concurred with a decline in armed conflict. At the same time, low-level violence and the number of fragile states with weak institutions has also increased in the last few decades, albeit slowly in the last few years *(Marshall and Cole, 2011, Stewart and Brown, 2010)*. Still, there is a risk that institutions could be overwhelmed by climate change related crises *(WBGU, 2008)*.

While the United States and the United Kingdom consider climate change as a major future problem for national and global security, other states such as Russia and China have so far paid minor attention to this issue. The divergent views have been expressed in the two controversial debates in the UN Security Council in 2007 (initiated by the UK) and in 2011 (initiated by Germany). Main areas of military concern are interventions in fragile states, the securing of borders, and access to resources, e.g. in the Mediterranean or in the Arctic region *(see Brzoska, 2012)*. The debate on the securitization of climate change has enhanced the focus on its risks but this discourse also entails the danger of the militarization of climate change which may have unintended consequences. For instance, it may instigate policy makers to choose violent means when facing crisis situations with links to climate change, which may raise the likelihood of armed conflict. Furthermore, it may undermine the conditions for cooperation and reduce the financial means available for mitigation and adaptation measures. Some of these responses to climate change could become causes of conflict themselves *(Webersik, 2010)*, such as the competition of bioenergy and food production for land, or the potential quarrel between states over climate engineering. Some of the technical fixes to reduce climate change or its effects could be introduced in unilateral action by some states at the expense of other states. In general, it is important to consider the implications of mitigation and adaptation measures for the interests of the many groups of stakeholders involved and to aim at avoiding the creation or further aggravation of conflicts.

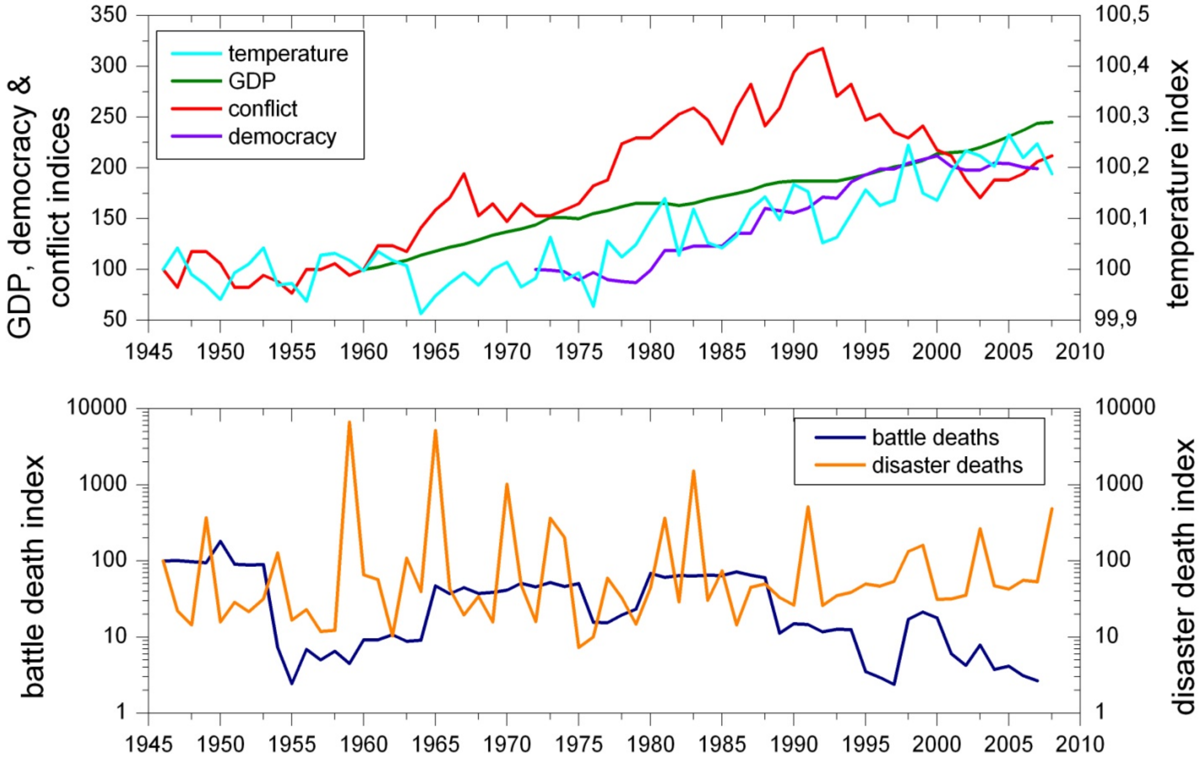

Figure 4: Development of indices of global sea surface temperature (top right scale, based on Kelvin), per capita gross domestic product, number of violent conflicts, democratic countries (top left scale), and casualties from battle and disasters (bottom logarithmic scales) (NOAA, World Bank Online Database, UDCP/PRIO, Freedom House Index, Correlates of War Interstate Wars, EM-DAT). For all indices 100% is set for a reference year.

6 Conclusions and Future Research Challenges

A significant part of the current literature supports the argument that climate change has an influence on violent conflict in at least some regions of the world. While quantitative studies tend to provide evidence for a link between climate change and violent conflict over longer historical periods, results for recent periods are more ambiguous. Other trends and events may have had a larger influence on violent conflict than climate change. Two examples from the recent past are the end of the Cold War and the increase in international activity to stop armed conflict in many parts of the world. However, without strong mitigation efforts future climate change may by far exceed levels that have been reached in human history. If major ‘tipping points’ of societal stability are reached, climate change may become a major driver of armed conflict in the future.

At present, such predictions are based on presumptions and not on evidence. Assessments of the links between climate change and violent conflict are still unclear about many important elements. A relevant restraint is the lack of understanding of the escalation from non-violent to violent conflict. Further important limitations of current research are inadequate data (e.g. on rainfall), insufficient indicators (e.g. of drought or conflict independent of violence), and the lack of comparability and generalization for different regional contexts and intermediate pathways. More micro level data on violent conflict would help to understand feedback effects between climate change and conflict at subnational levels. In addition, data on social and political processes that can lead to violence are needed. Causality is hard to measure as numerous variables, complex interactions, and long chains are involved.

Future analysis may more specifically look at the various pathways of interaction between the climate system, natural resources, human security, and societal stability that have been indicated in Figure 1. Besides the direct effects of climate change on society, e.g. through extreme weather events, the more indirect causal chains need further investigation. This includes large-scale impacts on ecosystems, food and water supply, health problems, income shocks, human migration, and ultimately violent conflict. It is key to improve the understanding of vulnerability and sensitivity of the affected systems with regard to a changing climate. It is important to determine whether these systems are able to maintain resilience, and how the factors and processes shape adaptive capacities, strategies, and their successful implementation. A related question is how these systems respond and interact if the climate stress exceeds critical thresholds of adaptive capacity. Will such development trigger tipping elements, cascading events, and ultimately violent conflict, or will it rather lead to coordinated responses and cooperation to jointly address the future global challenges, e.g. by a transformation towards low-carbon societies?

As explained before, it is necessary to use a comprehensive approach to study the links between climate change and violent conflict. The various linkages indicated in Figure 1 open up a multitude of possibilities of how climate change may be linked, via intermediate factors, to violent conflict – or not, if the pathway does not materialize. A lot of research has been done and is on the way to investigate those linkages, however, it needs to be better related and integrated into a framework such as the one suggested here. The prime objective of the framework is to combine quantitative empirical analyses, qualitative case studies, and modeling of the complex human-environment interactions. To further address the ambiguities, uncertainties, and limitations of current quantitative research, data are needed on low-level conflicts and their geographical and temporal distribution. Models could build on a rich set of modeling tools from complexity science, multi-agent systems, social network analysis, and conflict assessment that extend previous data and experiences into future scenarios, covering different social, economic, and political contexts. Developing an integrative framework would help to overcome the current deficits in research and identify under which conditions climate change would lead to violent conflict or its prevention.

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