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DEMOGRAPHIC ASPECTS OF CLIMATE CHANGE, ENVIRONMENTAL DEGRADATION AND ARMED CONFLICT*

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A. INTRODUCTION

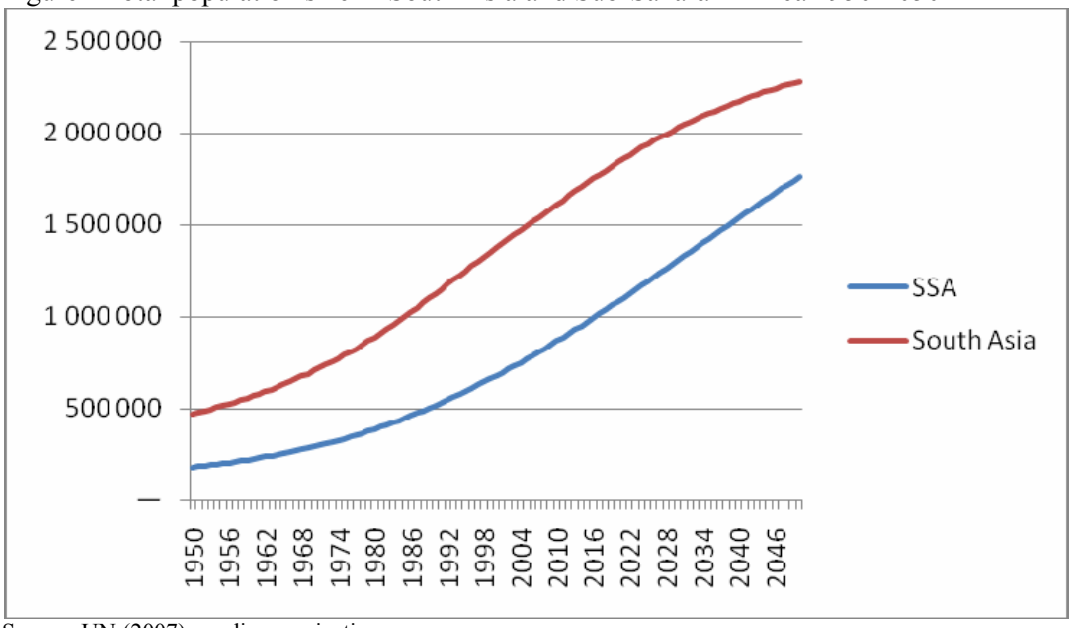
Demographic and environmental pressures have featured prominently in the debate over the new security challenges in the aftermath of the Cold War. In the *resource scarcity* literature, high population growth and density are seen as major causes of scarcity of renewable resources like arable land, fresh water, forests, and fisheries. Arguably, such scarcities may trigger armed conflict over resource access. The claim of a relationship between population growth, resource scarcity and conflict emerged with the increasing environmental awareness of the late 1960s (e.g. Ehrlich, 1968). After the end of the Cold War, population growth and resource scarcity became subjects of both popular accounts of violence (Kaplan, 1994), as well as of large academic research programs (e.g. Homer-Dixon and Blitt, 1998; Baechler, 1999). This article summarises the findings of a doctoral project aimed at systematically investigating the relationships between population pressure, resource scarcity and armed conflict. The project encompasses a set of cross-sectional time series analyses conducted both at the state and sub-state levels (Urdal, 2005; Raleigh and Urdal, 2007; Urdal, 2008).

Population-induced resource scarcity has particularly been argued to pose a security threat in developing countries with low capacity to prevent and adapt to scarcities (e.g., Homer-Dixon, 1999). Generally, one of the most robust findings in the quantitative conflict literature is that impoverished and institutionally weak countries, usually measure by low GDP per capita, have an exceptionally high risk of armed conflict and civil war (Collier and Hoeffler, 2004; Fearon and Laitin, 2003: Hegre and Sambanis, 2006). Two key trends arguably contribute to extend the relevance of population pressure and resource scarcity into the coming decades. First, despite declining population growth rates globally, low-income countries particularly in parts of Asia and sub-Saharan Africa will continue to experience very significant population growth rates in the near future. Second, these areas are also the ones expected to face the most severe consequences of global climate change (Stern et al., 2006).

1. Population trends

The total world population has increased from 1.6 billion to 6.1 billion over the course of the 20th century. Population growth accelerated after World War II when many developing countries entered into the early phase of the demographic transition with decreasing mortality and continued high fertility. The rapid population growth in most developing countries spurred concerns in the 1960s and 1970s that food production would not keep up, and that burgeoning populations would seriously deplete natural resources. The gloomiest scenarios proved unfounded as food production has kept pace with population increases in most parts of the world, and fertility is now declining in all world regions. The latest medium projection of the United Nations Population Division (UN, 2007) suggests a total world population of almost 9.2 billion by year 2050 (Figure 1.1). The UN projection does not go beyond 2050, but predicts some level of population growth also in the following period. Another projection expects world population growth to level off during the coming decade, with the most likely predictions suggesting a global population peak between 8 and 9 billion around year 2070 (Lutz et al., 2004: 40). While world population growth is losing momentum, there are substantial regional differences. Lutz et al. (2004: 45) expects population growth to be highest in sub-Saharan Africa, even with the toll claimed by HIV/AIDS. Here, the total population is expected to peak around year 2080 at about 1.5 billion, almost two and a half times the population in year 2000. The combined population of South Asia and sub-Saharan Africa has grown from 649 million in 1950 to 2.3 billion today (2008), and will continue to grow up to around 4 billion in 2050 (Figure I, UN medium projection). In relative terms, the population of South Asia and sub-Saharan Africa has grown from 26 per cent of the total world population in 1950 to 35 per cent today (2008), projected to reach 44 per cent in 2050 (UN medium projection).

Figure I Total population size in South Asia and Sub-Saharan Africa 1950-2050



Source: UN (2007), medium projection.

2. Climate change, forced migration, and conflict

Global climate change represents the ultimate resource scarcity perspective, and is argued to be a future source of conflict (e.g., Renner, 1996; Homer-Dixon and Blitt, 1998; Rahman, 1999; Klare, 2001; Brauch, 2002; Pervis and Busby, 2004). Population issues are at the heart of this concern. First, increasing temperatures, precipitation anomalies and extreme weather is expected to aggravate situations in areas already experiencing high population pressure and resource scarcity. Second, increasing sea levels, more extreme weather, and local resource depletion could force millions of people to migrate, arguably leading to increased risks of inter-ethnic tensions and higher pressures on resources in destination areas.

Some of the most alarming accounts grossly exaggerate the security implications of climate change. In a report for the Pentagon, Schwartz and Randall (2003) foresee a worst-case scenario where a collapse in carrying capacity "could make humanity revert to its ancient norm of constant battles for diminishing resources" (p. 16). Although warning against overstating the relationship between climate change and armed conflict, Barnett (2001: 6) and Pervis and Busby (2004: 68) 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. Climate change is generally not seen as a likely major or sufficient cause of conflict, but is argued to contribute to a mounting environmental challenge (Brauch 2002: 23; Tänzler and Carius 2002: 8). Although climate change is usually regarded as a potential future threat, some argue that global climate change has already been a contributing factor in recent conflicts such as Darfur (Byers and Dragojlovic, 2004: 2).

The issue of "climate refugees" as a source of conflict is one of the more contentious issues. Because of rising sea levels and increased risks of flooding, climate change is expected to contribute to migration from coastal and riverine settlements (IPCC 2001: 36). Extreme weather events and general resource degradation is argued to add to what is generally referred to as "environmental refugees." There are estimates putting the current stock of "environmental refugees" at around 20-25 million, but the term is highly contentious (e.g., Suhrke 1997; Castles, 2002). The Stern Review on economic consequences of climate change (Stern et al., 2006) states that by 2050, "200 million more people may become permanently displaced due to rising sea levels, heavier floods, and more intense droughts, according to one estimate" (p. 56). The review received considerable attention, and the claim about the 200 million climate refugees has been widely cited. The estimate is often attributed to the IPCC, but the IPCC Fourth Assessment Report is very cautious, and does not provide any migration estimates. The original source is a 1995 report by a British ecologist, Norman Myers (Myers and Kent, 1995). Stern et al. (2006: 77) acknowledge that "this estimate has not been rigorously tested" but claim that it is a conservative estimate that "remains in line with the evidence presented throughout this chapter that climate change will lead to hundreds of millions more people without sufficient water or food to survive or threatened by dangerous floods and increased disease." A recent report from the NGO "Christian Aid" drew considerable attention to its dramatic number of 1 billion displaced by 2050 due to war, disasters, development schemes, and climate change (Christian Aid, 2007). Although the vast majority (645 million) are thought to become displaced due to "development projects such as dams and mines," the report also provided a revised estimate by Norman Myers, who in an interview with Christian Aid, reveals that he "now believes that the true figure will be closer to 250 million" (Christian Aid, 2007: 5-6; 48).

The potential for and challenges related to migration spurred by climate change should be acknowledged, but not overemphasised. Some forms of environmental change associated with climate change like extreme weather and flooding may cause substantial and acute, but mostly temporal, displacement of people. However, the most dramatic form of change expected to affect human settlements, sea-level rise, is likely to happen gradually, as are processes of soil and freshwater degradation. Improved forecasting skills will make adaptation easier and reduce the problem of population displacements (Chimeli et al., 2002: 213). So, while abrupt displacements may happen, climate change is primarily expected to result in gradual migration. Furthermore, capable governments may in some cases be able to prevent or at least drastically reduce large-scale migration in the first place, and government capability is also crucial in determining the pace and conditions for the return of temporarily displaced populations. Finally, individuals respond differently to changes in their environment, and coping and adaptation mechanisms involve a range of options short of permanent migration.

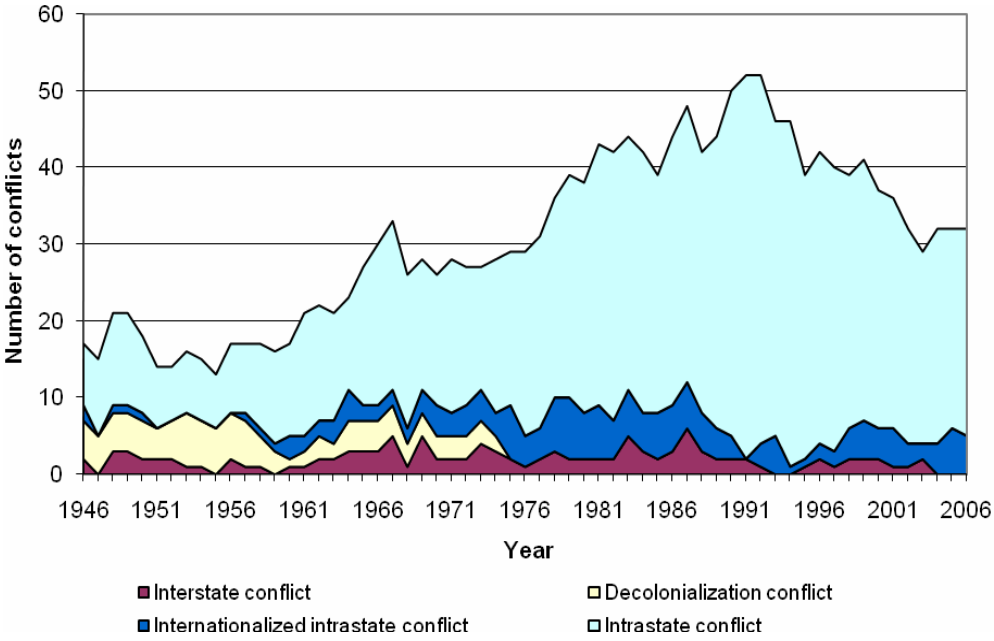
Crucial to understanding potential security implications of climate-related migration relates to where the migrants are moving to. Very few of these migrants are likely to move across international borders, and many will presumably become part of the historically unprecedented migration current from rural to urban areas that is taking place globally. According to the 2005 World Urbanization Prospects, only between 2005 and 2015 "a total of 250 million to 310 million people in developing countries would be expected to become urban dwellers [...] either because they would migrate from rural to urban areas or because their rural settlements would become urban" (UN, 2006).

3. Global conflict trends

The PRIO–Uppsala dataset (Gleditsch et al., 2002) is published annually in the *Journal of Peace Research*, and contains information on the start date, actors, and intensity levels of all armed conflicts since 1946. The dataset defines a relatively low threshold for conflict, a minimum of 25 battle-related deaths per year. According to the PRIO–Uppsala criteria, an armed conflict is further defined as a contested incompatibility concerning government and/or territory, between at least two parties, of which one is the government of a state, using armed force (Gleditsch et al., 2002: 619). The dataset distinguishes

between (low intensity) conflicts (at least 25 battle-related deaths per year, but fewer than 1,000) and wars (at least 1,000 battle-related deaths per year). In this paper, the terms internal armed conflict and civil war are used interchangeably. Figure II provides an overview of global conflict trends. The number of ongoing conflicts reached a peak of 53 in 1992-1993, and has declined to a level of just above 30 in the past few years.

Figure II Global conflict incidence by type, 1946-2006



Source: Gleditsch et al. (2002). Map produced by Halvard Buhaug.

B. THEORETICAL FRAMEWORK

Resource scarcity is seen as a product of three different factors interacting: population growth, resource degradation, and the distribution of resources between individuals and groups. Homer-Dixon has called this *demand-induced*, *supply-induced* and *structural scarcity* respectively (Homer-Dixon and Blitt 1998; Homer-Dixon 1999). The distributional aspect is central in all the most influential frameworks of the resource scarcity tradition (Baechler 1999: Homer-Dixon 1999; Kahl 2006). The three sources of scarcity may exert different impacts from case to case, and frequently interact. Homer-Dixon (1999) argues that two types of interactions are particularly common. *Resource capture* occurs in a situation of resource degradation and population growth, providing incentives for powerful groups to take control over scarce resources on the expense of weaker and poorer groups. *Ecological marginalization* denotes a situation where great land inequality and population growth leads people to move into more ecologically fragile areas. While many countries have the ability to adapt to environmental change, some countries, particularly poor and institutionally weak states, are likely to be more vulnerable to environmentally related violence (Baechler 1999: xvi; Homer-Dixon 1999: 181). Resource scarcity arguably also has the potential to aggravate social segmentation (Homer-Dixon 1999: 96). While demographic and environmental pressures are seen as unlikely causes of international wars, it is claimed that such factors may spur local violent low-intensity disputes (Baechler 1999: Homer-Dixon 1999; Kahl 2006).

While it is generally agreed in the environmental security literature that the effects of resource scarcity is modified through political, economic and social structures, the resource scarcity and conflict scenario has been theoretically underspecified. Attempting to rectify this problem, Kahl (2006) has identified two alternative causal pathways from demography and environment to violent conflict. Kahl (2006) identifies two distinct "state-centric" causal pathways from resource scarcity to internal violent conflict; the *state failure* and the *state exploitation* hypotheses. Both start from the premise that resource scarcity, or what he terms *demographic and environmental stress* (DES), may put severe pressure on both society at large and on state institutions. When the interaction between resource degradation, population growth and unequal resource distribution leads to lower per capita availability of land resources and expansions into more marginal land, this is assumed to put a greater pressure on agricultural wages and contribute to economic marginalization as a first-order effect. Such hardship can, as a second-order effect, lead both to rural-to-rural migration, potentially causing inter-ethnic conflicts over land, and to rural-to-urban migration. While urban populations generally enjoy material standards above those in rural areas, urbanization often puts a pressure on a state's ability to provide vital services such as housing, clean water and health services. Further, the social consequences of DES may produce absolute deprivation, meaning that people do not get what they need in order to survive, as well as relative deprivation, a situation in which they do not get what they feel they are entitled to. Both forms of deprivation may produce grievances among rural and urban populations.

The novelty in Kahl's (2006) approach lies in the way he differentiates between the potential roles of the state. Like Homer-Dixon (1999), he sees DES as a factor that can produce severe strains on a state. DES is argued to potentially weaken a state's *functional capacity* by placing costly demands on the state for development projects in the agricultural sector or social improvements for burgeoning urban populations, but also by generally undermining overall economic productivity and potentially also the ability to finance a coercive capacity (Kahl 2006: 40-42). The other aspect of state strength, *social cohesion*, may also be weakened by DES. Alternative elites within the state may compete over how to use strained resources either geographical or sectoral, and they may disagree over the best way to respond to the challenges posed by DES (Kahl 2006: 43).

The weakening of the state is seen as an intermediate factor between resource scarcity and violent conflict. While the resource scarcity literature is often seen as belonging to the "motive" tradition, the state-centric perspective identifies important opportunity factors in both the possible causal trajectories. The state weakness hypothesis posits that the impact of resource scarcity will weaken state institutions and provide opportunities for potential rebels to challenge the state authority. Conflict may arise when the potential gains from a rebellion are higher than the costs that a state can inflict on the rebels. Waning state authority produces a "security dilemma" where social groups are "left to fend for themselves" (Kahl 2006: 47). Episodes of regime collapse and regime transitions may thus provide particularly great opportunities for DES-generated violent conflict. However, even when demographic and environmental factors are *not* the primary drivers of state failure, relatively weaker states are presumably more likely to experience resource scarcity conflicts firstly because they are less capable of mitigating the effects of resource scarcity, and secondly because they are generally more likely to be militarily challenged by opposition groups. If the state failure hypothesis is an important pathway to armed conflict, we should expect to see that statistical controls for low state capacity and state failure should capture some of the explanatory power of the demographic and environmental variables.

The state exploitation hypothesis suggests another important opportunity aspect, namely the opportunity for weakened states to bolster their support base through mobilising ethnic groups to capture scarce resources. When regimes experience increased grievances and opposition due to resource scarcity, they may be likely to instigate interethnic violence as a means to divert attention from their inability to meet these demands at the same time as they consolidate support among groups that may capture resources on the expense of contending groups. While theoretically appealing, the state exploitation

hypothesis is difficult to empirically test in a statistical model. Kahl (2006: 50) posits that state exploitation "can occur at levels of state weakness far short of total collapse," but he does not offer suggestions for what characteristics we may expect to see among regimes that would engage in state exploitation. So while we may be able to test whether domestic armed conflicts are overrepresented in resource scarce areas of poor countries, we will not be able to conclude whether a possible statistical relationship between resource scarcity and conflict that is not well captured by the context of failed or very weak states may be due to a "state exploitation" explanation.

1. Critiques of the resource scarcity perspective

The major challenges of the resource scarcity perspective come from the three different traditions of neoclassical economy, political ecology, and institutionalism. Neoclassical economists, often also referred to as cornucopians or resource optimists, have posed three different sets of arguments that challenge the view that resource scarcities are likely to cause armed conflict. First, they argue that the situation is not as bleak as portrayed in some of the environmental scarcity literature. Most renewable resources are not scarce at the global level, and markets, technological developments, and resource substitution are factors that are likely to help us adapt to situations of local scarcity (Maddox, 1972; Lomborg, 2001). Furthermore, in virtually all areas of the world, people are responding to lower mortality by reducing their fertility, albeit at different speeds. Within the next 60 to 70 years, we are likely to see the end of world population growth (Lutz et al., 2004).

A second argument is that high population pressure and resource scarcity may be a vehicle for development. High population growth and increasing scarcity of resources provide incentives for people to search for ways to mitigate scarcity by means of technological development and resource substitution (e.g., Boserup and Schultz, 1990; Simon, 1989). Hence, a high population pressure will eventually lead to less resource dependence and decreasing problems of scarcity. Boserup holds that the historically low level of population pressure in sub-Saharan Africa is one important factor behind the continent's low agricultural effectiveness and underdevelopment (Boserup and Schultz, 1990). Further, countries with high population densities are likely to have more effective production systems due to lower per capita investments in infrastructure and generally greater availability of human resources in any location.

The third neoclassical argument is that it is resource abundance that causes conflict, not scarcity. This claim has two different bases. First, the honey-pot hypothesis contend that the availability of rich natural resources like diamonds, gemstones, oil, other valuable minerals or tropical timber may motivate rebels to capture the resources either as a way to enrich themselves or as a means to finance conflict activities. Second, resource abundance may work indirectly by weakening state institutions. Resource rents may lead to the crowding out of other forms of economic production, to economic stagnation and to corruption, known as the "Dutch disease." "Rentier states" may also use resource rents to quell dissatisfactions and hence avoid demands for structural reforms and democratisation.

While there is much empirical research pointing to a relationship between resource abundance and conflict (e.g., Collier, 2000; LeBillon, 2001; de Soysa, 2002; Lujala et al., 2005), the scarcity and abundance perspectives are by no means theoretically exclusive, although often portrayed as competing hypothesis. Renner (2002) argues that they may sometimes be complimentary, as resource extraction can lead to the degradation of renewable resources. The other two perspectives challenge the assumptions of the resource scarcity perspective more directly. The argument that renewable resources are not globally scarce and that markets, technological innovations and demographic adaptation may mute local scarcities is not entirely rejected by scholars associated with the resource scarcity perspective. In fact, Homer-Dixon (1999: 108) acknowledges that what he terms "technical and social ingenuity" is likely to help many societies overcome resource scarcities. However, in many developing countries, markets, property rights, government structures, infrastructure and human capital "are imperfect, absent altogether, or distorted in

ways that actually compound resource problems" (Kahl, 2006: 17), increasing the "ingenuity gap" (Homer-Dixon, 1999: 108; Homer-Dixon, 2000). Hence, resource scarcity is more likely to cause conflict where adaptation mechanisms are particularly weak, and may in particular pertain to regions within countries to where state penetration does not extend. Similarly, the argument posed by Boserup and Simon does not necessarily contradict the resource scarcity perspective, it may primarily speak to different temporal effects. The long-term consequences of population pressure in the form of high population densities may very well be greater adaptive capacity and peace. But scarcities of renewable resources, which both Boserup and Simon see as a consequence of population growth, can still be a source of conflict in the short run.

The second tradition challenging the resource scarcity perspective, political ecology, sees resource distribution as the primary issue of the relationship between the environment and conflict. Political economy has its root in Marxian political economy and sees scarcity primarily as a product of local and international structures of power and wealth, and downplays "natural" sources of scarcity like population growth and degradation. Political ecology "provides tools for thinking about the conflicts and struggles engendered by the forms of access to and control over resources" (Peluso and Watts, 2001: 25). While political ecologists argue that local cases of "scarcity" may very well happen in the context of local abundance, they also argue that the resource scarcity perspective mostly ignores what they see as the most important sources of resource degradation, namely resource extraction like mining and logging, dam construction and other forms of industrial activity (Peluso and Watts, 2001: 26).

Implicit in the critique from political ecologists is a claim that proponents of the resource scarcity perspective are blaming the poor for causing scarcity and violence. Under the heading "localising blame," Hartmann (2001: 50) criticises Homer-Dixon for failing to acknowledge the role of economic and political factors that create structures of exploitation. Arguing that Homer-Dixon is primarily focusing on internal stresses that create outward pressures, she claims that "the outside is rarely seen to be pressing in" (ibid.). Commenting on scarcity and violence in Ogoniland, Nigeria, Hartmann (2001: 60) asks why Homer-Dixon focuses "on the violence of local acts of resistance and not on the much larger violence of state and corporate enforcers?" Also claimed to be missing from the picture are "the consumers of the extracted products" for instance consumers of paper in developing countries playing a major role in the deforestation of developing countries (Hartmann, 2001: 61).

While it is true that Homer-Dixon's case studies mainly address local violent responses, it is not the case that external factors and resource distribution is absent from the analysis. The expansion of the ranching industry and neo-liberal economic reform plays an important role in the analysis of the Chiapas conflict (Howard and Homer-Dixon, 1998), the Israeli occupation is seen as an important cause of water scarcity and economic stagnation in Gaza (Kelly and Homer-Dixon, 1998), and the political economy of apartheid is considered the main driver behind resource scarcity in South African "homelands" (Percival and Homer-Dixon, 1998b). Resource distribution plays a major role in many of Homer-Dixon's cases, and for this reason he has been criticized for diluting the concept of resource scarcity (e.g. Gleditsch and Urdal, 2002). In Chiapas, Gaza and South Africa the major problem appears to be resource distribution, not lack of renewable resources per se. But population growth and resource degradation may play an aggravating role, a fact often overlooked by political ecologists.

Finally, the resource scarcity perspective has been challenged by "institutionalists," claiming that scarcity is more likely to lead to cooperation over resource management than conflict (e.g., Wolf, 1999; Wolf et al., 2005). Armed conflicts are costly, and fighting over renewable resources rarely pays. Rivalry over access to resources may instead provide opportunities for neighboring groups or states to enter into a dialogue over institutional arrangements for resource sharing. Cooperation over resource management may further lead to cooperation in non-resource related area through trust-building and development of institutional capital. Cooperation over resources can exist even in the context of violent conflict, such as

water sharing agreements between Palestinians and Israelis, and it can follow cyclical trends, with cooperation happening primarily during periods of scarcity. While much of the focus has been on water agreements, for which there were twice as many cooperative events as conflictual in the 1945-99 period (Wolf et al., 2005: 81), the concept of "environmental peacemaking" extends much further, including for instance establishment of "peace parks" (Conca et al., 2005). Meier et al. (2007) have found some local-level support for cyclical patterns of conflict and cooperation linked to rainfall.

2. Previous studies

Previous quantitative studies have found mixed evidence for the resource scarcity and conflict nexus. The two first larger studies in the field, the State Failure Task Force Report (Esty et al., 1998) and Hauge and Ellingsen (1998) reported slightly different results. Esty et al. (1998) found no effects of soil degradation, deforestation and freshwater supply on the risk of state failure. Hauge and Ellingsen (1998) on the contrary concluded that the same factors as well as high population density were indeed positively associated with civil war, but that the magnitude of the effects were secondary to political and economic factors. Theisen (2006) was unable to replicate their results using the same dataset, and found very limited support for the resource scarcity perspective in his own data. Assessing the issue of land scarcity, de Soysa (2002) found a significant effect of population density on domestic armed conflict. For an overview of quantitative studies on population and internal armed conflict, see Appendix A.

C. THREE EMPIRICAL STUDIES ON POPULATION AND ARMED CONFLICT

1. Global cross-national effects of population pressure 1950-2000

Do countries differ in their conflict propensities as a result of their overall population pressure on renewable resources? In an article published in the *Journal of Peace Research* (Urdal, 2005), I study the relationship between national-level demographic factors – population growth, per capita availability of potentially productive land, and their interaction – and the onset of internal armed conflict. While some case studies linking environmental factors and political violence address local environmental issues and disputes, many also focus on the country level. Arguably, the state is a highly relevant political unit in the study of the environment-conflict nexus, as local resource scarcity within a country may be ameliorated by better resource management, resource transfers or population movements. Hence, local resource scarcity in an overall resource abundant country may be seen as governance failure. If so, local conflict over scarce resources is a product of government actions or inactions, rather than of scarcity *per se*.

The unit of analysis is the country-year, and the dependent variable is internal armed conflict onset using conflict data from the PRIO–Uppsala dataset (Gleditsch et al., 2002). The study includes all sovereign states and all politically dependent areas (colonies, occupied territories, and dependencies) for the whole 1950–2000 period, applying a standard logistic regression design. An armed conflict onset is consequently coded 1 for the first year of a domestic conflict. Subsequent years in conflict (including new conflict onsets when a previous conflict is still active) as well as years in peace are coded 0.

Population data are primarily collected from the *World Population Prospects, The 1998 Revision* (UN, 1999). *Population density,* or *potential cropland,* is defined as total population relative to all of a country's land that fall into the following land use categories: arable land, permanent crops, permanent pastures, and forests and woodland. Land that is excluded from this definition includes, but is not limited to, urban areas, mountains, roads, and deserts. The population density variable is log-transformed in order to reduce the huge variation. Control variables include level of development, proxied by the infant mortality rate (IMR), regime type, economic growth, total population size and previous conflict. For exact references and operationalisations, see Urdal (2005).

The results of the study (see Table 1 for the two basic models) indicate that national-level aggregate demographic pressures do not seem to be strongly related to armed conflict. The interaction between population growth and density is not robustly associated with armed conflict onset. In fact, in countries with negligible population growth, high population densities seem to lower risk of conflict somewhat. But also this result is vulnerable to different model specifications. Nor is urban growth rates statistically associated with conflict onset. When considering the relationships between population pressure and conflict in temporal sequences I find the interaction of population growth and density to be clearly associated with an increased risk of conflict in the 1970s (not shown here, for all models see Urdal (2005)). Also, the frequent claim that resource scarcity has become more pertinent as a driver of armed conflict in the post-Cold War era receives no support. In fact, urban growth is statistically associated with lower risk of conflict onset in this period.

Table 1. Risk of armed conflict by population pressure variables

	Model 1	Model 5
Population growth	-0.009	-0.013
	(0.062)	(0.071)
Population density	-0.088*	-0.068
	(0.053)	(0.060)
Growth * density	0.042	0.014
	(0.039)	(0.045)
Urban growth		-0.025
		(0.041)
Total population	0.269***	0.289***
	(0.047)	(0.055)
Dependency	-0.890**	-0.855
	(0.381)	(0.538)
Infant mortality rate	0.006***	0.010***
	(0.001)	(0.002)
Regime	0.006	0.015
	(0.014)	(0.015)
Regime, squared	-0.014***	-0.014***
	(0.003)	(0.003)
Missing regime data	-0.259	-0.311
	(0.314)	(0.346)
Economic growth		-0.054**
		(0.024)
Missing economic Growth data		0.296
		(0.245)
Brevity of peace	1.819***	1.691***
	(0.275)	(0.304)
Constant	-6.078***	-6.302***
	(0.488)	(0.599)
N	7,752	5,851
Log likelihood	-793.33	-631.85
Pseudo R^2	0.107	0.113

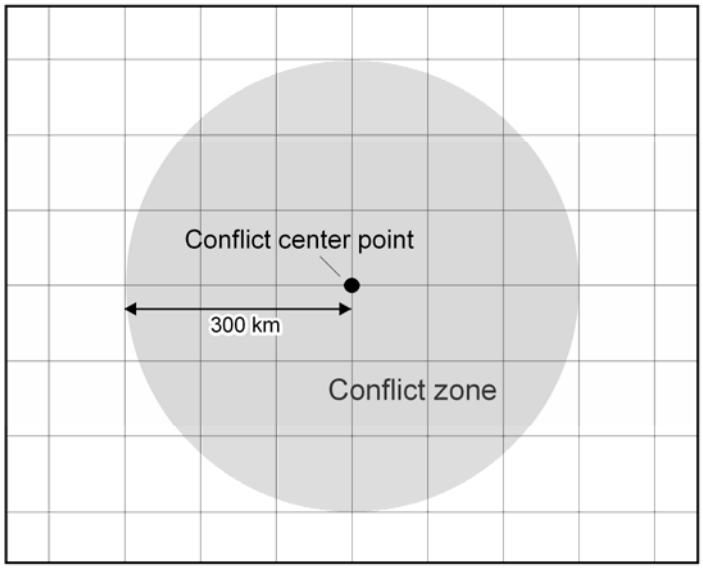
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. For all results, see Urdal (2005).

2. A global sub-national study of population and environmental pressures

Going below the state level, Raleigh and Urdal (2007) investigate whether demographic and environmental factors determine the location of armed conflict. The coverage is global, but the units of analysis are geographical squares of 100x100 km at the equator. In particular, we are investigating stressors that are assumed to become more common as a consequence of global warming. The study addresses three different demographic and environmental concerns, population pressure, land degradation and water scarcity and departs from the assumption that high population density, degradation and water scarcity should be more strongly associated with conflict in areas with increasing population pressure. For this sub-national study, data are created from geospatial information. The dataset has three main differences from typical county-year analyses: the unit of observation is considerably smaller; the dependent variable is positioned to have occurred at a particular location and associated with values from that location; and independent variables are derived from a geospatial dataset, including shape and raster files. A shapefile stores and map and attributes of a point, line or polygon unit. Raster graphics are digital images created or captured (for example, by scanning in a photo) as a set of samples of a given space. For a description of the creation of the dataset, see Buhaug and Rød (2006) and Raleigh and Urdal (2007).

The data covers all countries with populations over 100,000, and the full dataset is comprised of 13,199 polygon squares. The study is limited to the civil conflicts observed from 1990 to 2004 as the geospatial explanatory variables used were collected during or after 1990. The Uppsala/PRIO location information is an aggregate measure of the center of the larger conflict, so the actual location of the fighting is not directly represented (see Buhaug and Gates 2002). We chose a radius of 300 km from the conflict point, assuming that this would properly denote a "conflict zone" and therefore account for the majority of definite fighting locations. All 585 conflict point coordinates are automatically assigned a radius of 300 km, resulting in 1,907 conflict squares. Figure III displays a hypothetical conflict zone set upon grid square.

Figure III: Conflict zones upon grid squares



a. Explanatory variables

Human Induced Soil Degradation: the measure of soil degradation throughout the world was commissioned by The International Soil Reference and Information Centre (ISRIC) for the United Nations Environment Programme in 1990. The information of soil degradation is based on questionnaire answers from numerous soil experts throughout the world. Each measure combines type, degree, extent, cause and rate of soil degradation, recoded into a set of four dummy variables indicating no or very low, low, medium to high, or very high level of degradation. *Easily Available Fresh Water* measures the amount of stored soil moisture easily available to crops, and the variable is coded into five different categories of very high, high, medium, and low access to available water, and finally dry land. Geo-referenced data on *population density* from The Center for International Earth Science Information Network (CIESIN) provides population measures from two points in time (1990 and 1995) at a 1 km level. Population count of people per square kilometer is represented as an increasing density score (see Appendix 1 in Raleigh and Urdal 2007). Differences between 1995 and 1990 estimates determine population growth during this time. All three variables are also interacted with population growth to assess whether areas of high population or environmental pressures are particularly susceptible to conflict when population growth is high. We further control for country level GDP per capita and regime type, political instability and direction of political change. The analysis method is ordinal logistic regression, where the dependent variable is conflict and the unit of observation is the grid square.

b. Results

Table 2 shows the three base models from the article, for all results see Raleigh and Urdal (2007). For the full global sample, we find robust effects on conflict for the interactions of population growth and density, as well as population growth and water scarcity. We do not find empirical support for any mediating effects of the proxies we use to measure state capacity or governance. When looking exclusively at the poorer half of the globe, which presumably should be more susceptible to conflict generated by demographic and environmental factors, we only find consistent and robust effect of the interaction between population growth and density. Again, the assumed mediating effect of state capacity and governance is not captured by the empirical model. The positive effects of degradation seem to be driven by a handful of conflictual states in the higher income sample. The results are extremely sensitive to country omissions. If Russia is omitted from the high income models, low and medium degradation as well as water scarcity become clearly insignificant, and interaction terms retain their insignificance. The positive influence of high degradation is driven by twenty-nine high degradation squares in Iraq, Serbia and Mexico. Further, if either Spain or Mexico is omitted, the water scarcity variable becomes insignificant.

Table 2 Demographic and environmental stress factors and internal armed conflict

	Model 1 Full Sample	Model 5 Political and Economic Factors (High Income Sample)	Model 6 Political and Economic Factors (Low Income Sample)
Low Level Degradation	.108 (.084)	1.12(.245)***	-.477(.103)***
Medium Level Degradation	.217(.067)***	1.17(.212)***	.050(.081)
Very High Level Degradation	.568 (.100)***	1.74(.281)***	-.060(.118)
Local Water Scarcity	.274 (.028)***	.162(.071)**	.095(.038)**
Pop Density (1990)	.273(.011)***	.336(.030)***	.239(.017)***
Population Growth	.016 (.064)	.167(.152)	-.136(.094)
Logged GDP (1990)		-.285(.250)	-.723(.058)***
Polity		-.097(.012)***	.025(.005)***
Polity squared		.026(.004)***	-.013(.001)***
Instability 1990s		n/a	.784(.084)***
Movement to Autocracy		3.20(.335)***	.588(.104)***
Movement to Democracy		2.80(.415)***	.109(.076)
Population Growth*Pop Density	.019(.007)**	.010(.017)	.031(.013)**
Population Growth* Water Scarcity	.067 (.020)***	.038(.038)	.058(.031)*
Population Growth* Medium Degradation	-.056 (.052)	-.202(.117) *	.033(.082)
Population Growth* High Degradation	-.108 (.109)	-.116(.237)	-.061(.146)
Constant	-3.84(.099)***	-7.88 (.762)***	-2.06 (.168)***
N/ -2ll / R^2	13,199/-5,019/8%	6,239/-832/24%	2,515/-3,335/12%

* Sign at 0.1 ** Sign at 0.05 *** Sign at 0.001. For all results, see Raleigh and Urdal (2007).

It is clear that the impact of population growth is mediated via other variables, most notably population density. At the highest levels of both, the risk of conflict more than doubles. The interaction between population growth and high levels of water scarcity also significantly increases the risk of conflict. This result, along with other demographic and environmental results for this model, should be considered with two caveats. Grid squares in Niger are driving the result between water scarcity and population growth; its omission from the model renders this interaction clearly statistically insignificant. Furthermore, although the additional risk from population growth interacting with environmental variables varies from insignificant to pronounced, squares with the combination of high population growth and the highest levels of degradation, scarcity and density are unlikely or rare occurrences, calling for considerable caution when interpreting the results.

It remains that all low-income sample models show very consistent results despite the gradual inclusion of interaction terms and control variables. Growth interacted with water availability and population pressures increase the risk of conflict, while the traditional national-level explanations of GDP, political institutions and the sub national population density account for a considerable amount of conflict across states. The inclusion of economic and political control variables do not alter the impact of any of the demographic and environmental variables. This runs counter to the expectation that state weakness variables would capture some of the variance explained by resource scarcity variables. For all intents and purposes, models on the low-income sub-sample speak to the relative insignificance of demographic and

environmental pressures for conflict behavior in those areas that should, according to the resource scarcity perspective, experience the most pronounced effects.

3. A sub-national study of India

An alternative disaggregated approach is to study whether variations in demographic and environmental factors are associated with variations in levels of political violence within one state, implicitly controlling for aspects of type and strength of government. A study of regions in India (Urdal, 2008) addresses the relationships between demography, environment and political violence among 27 Indian states for the 1956 to 2002 period. A great advantage of such design is the availability of relevant data that are comparable over time and space. Compared to cross-national analyses where data reliability varies significantly between units of observation, within-country sub-national statistical studies have the great advantage that data are collected and disseminated by highly similar procedures for different regions and local communities. While acknowledging that Indian census data reliability also varies between states and over time, discrepancies due to variation in data collection procedures are likely to be small compared to that between countries over time. In particular, data from Indian censuses and other regular national surveys allow for cross-sectional time-series comparison due to highly similar methods and procedures for the collection and dissemination of information. The generally good data availability on a variety of demographic, environmental and socioeconomic factors also provides better opportunities for testing more specific hypotheses derived from the literature on demography and conflict.

There are three different and independently collected measures for political violence analyzed in this study. Data on *internal armed conflict* is based on the PRIO/Uppsala dataset (Gleditsch et al., 2002). These data are analyzed using logistic regression with controls for previous conflict and neighboring conflict. The second data source is a count measure of *political violence events* collected from news sources covering the 1960-2000 period (Marshall, 2001), and covers a total of 793 events, most of which involved at least one death. The third dependent variable is a count measure of *Hindu-Muslim riots* (Varshney and Wilkinson, 2004). I use negative binomial regression to analyze both sets of event count data, controlling for previous violent events, and violence in neighboring states.

Demographic explanatory variables are based on data from the Indian censuses of 1951, 1961, 1971, 1981, 1991 and 2001. Rural population density is measured as the number of rural inhabitants per hectare of productive land, defined as the state's total reporting area for land utilization statistics less area classified as "forests" and "not available for cultivation." Data on *agricultural yield* is defined as the total production of food grains (cereals and pulses) divided by the total area reported to be under the relevant crops. Data on rural and urban inequality and poverty, as well as agricultural wages originate from a World Bank project on poverty in India (Özler et al., 1996). *Inequality* is measured by income distribution (the GINI coefficient, where a higher value indicates greater inequality), while *poverty* is measured as the percentage of people below the poverty line set by India's government. Based on the World Bank data on agricultural sector real wage, I have calculated short-term (annual) and long-term (average of annual fluctuations over five years) changes in *agricultural wages*. I further control for total population size and level of development, proxied by literacy rates.

a. Results

The results generally provide more support for the resource scarcity and conflict scenario than cross-national studies (the most illustrating models are provided in Table 3, for all results see Urdal (2008)). Scarcity of productive rural land is associated with higher risks of political violence, particularly when interacting with high rural population growth and low agricultural yield. High growth in agricultural wages is associated with a lower risk of armed conflict. But other central aspects of the resource scarcity

scenario are not supported. Structural scarcity (measured by rural inequality) and high urbanization rates do not increase the risk of political violence. Hindu-Muslim riots, a predominantly urban phenomenon, do not seem to be related to population pressure, not even to high urbanization rates.

Table 3 Population, resources and armed conflict in India, 1956-2002

Explanatory Variables	**Model 1**	**Model 3**	**Model 4**	**Model 6**	**Model 7**	**Model 12**
	Armed Conflict			**Violent political events**		**Riots**
Rural population growth β z	-0.006 (-0.42)	-0.075 (-1.50)	0.046 (0.69)	0.014 (1.31)	0.014 (1.32)	-0.0001 (-0.01)
Rural population Density	0.166** (1.99)	-0.169 (-0.38)	0.222 (0.57)	0.020 (0.38)	0.066 (1.12)	-0.021 (-0.22)
Rural population growth * Rural population density	-0.008 (-1.47)	0.011 (0.51)	0.044 (0.74)	0.010*** (2.60)	0.009** (2.30)	-0.003 (-0.38)
Rural share	0.020 (0.60)	0.004 (0.10)	0.126 (1.54)	0.035* (1.75)	0.031 (1.51)	
Urban share						0.053*** (2.68)
Urban growth	-0.020*** (-4.27)	-0.014* (-1.94)	-0.018 (-1.14)	0.004 (0.95)	0.0004 (0.11)	-0.003 (-0.54)
Agricultural yield (inverted)					0.007 (0.40)	-0.038 (-1.28)
Rural density * Agri-cultural yield (inverted)					0.016** (2.23)	0.008 (0.77)
Growth agricultural wages (5 yr avg)		-0.202*** (-2.75)				
Rural inequality			0.011 (0.06)			
Rural population density * Rural inequality			0.031 (0.56)			
Rural poverty			-0.066** (-2.11)			
Urban poverty			0.001 (0.02)			
Urban inequality			0.081* (1.88)			
Total population (ln)	-0.340** (-1.98)	-2.403*** (-2.96)	-0.247 (-0.65)	0.164 (1.50)	0.127 (1.14)	0.622*** (3.83)
Literacy	-0.002 (-1.26)	0.001 (0.31)	0.0001 (0.04)	0.002** (1.96)	0.002* (1.69)	-0.002* (-1.68)
Conflict previous year	5.67*** (12.22)	5.61*** (5.85)	5.65*** (5.80)	0.104*** (5.39)	0.106*** (5.51)	0.034*** (3.14)
Conflict in neighboring state	0.617 (0.99)	2.30*** (5.74)	0.959 (1.15)	0.077 (0.44)	0.085 (0.49)	0.435*** (3.26)
Constant	-0.997 (-0.31)	18.79** (2.29)	-11.06** (-2.27)	-5.71** (-2.51)	-4.67 (-2.03)	-7.73*** (-4.49)
N Log Likelihood Pseudo R^2	945 -109.62 0.66	475 -33.88 0.70	559 -46.43 0.67	817 22 -788.89	817 22 -786.26	660 18 -767.09

* Sign at 0.1 ** Sign at 0.05 ***Sign at 0.001. Robust z statistics in parentheses. For all results, see Urdal (2008).

D. SUMMARY

The motivation behind this larger project was to provide more systematic research on the relationship between demographic factors and internal armed conflict in order to supplement and transcend the broad case-study literature in the field. The principal research question has been whether countries that experience demographic pressures are generally at a higher risk of experiencing armed conflict and other forms of political violence. In order to try to answer this question, a set of statistical studies, both global cross-national studies as well as disaggregated studies, were conducted (see Appendix A for a summary of these and previous studies).

A main conclusion from the project is that high levels of population growth and high population to productive land ratios do *not* make countries more susceptible to armed conflict. Furthermore, there is no indication that the conflict proneness of poor countries results from greater population pressure on natural resources. These findings resonate well with previous cross-national studies that have found little support for the resource scarcity perspective. It further appears to be little reason to fear that the rapid and massive urbanization that we currently witness in many developing countries is something that generally will lead to destabilisation and armed conflict. Hence, security does not appear to be a valid rationale for reducing global population growth.

A second main conclusion is that the disaggregated studies provide greater support for the relationship between population pressure on natural resources and conflict than the cross-national study, albeit with some important qualifications described above. These findings suggest that environmental scarcity and conflict relationships should be studied at the local level. The combined findings of cross-national and disaggregated studies indicate that while overall demographic pressures and resource scarcity does not seem to make a state conflict prone, the internal resource distribution and resource management seem to contribute to explain the geographical distribution of political violence. In other words, relative regional differences in access to natural resources seem to impact conflict risk, even in the absence of any "absolute" scarcity in the country as a whole. While it may be argued that this result is in accordance with the distributional aspect of the resource scarcity argument, it is notable that structural inequalities among rural people and groups internal to Indian states do not appear to affect the risk of political violence. This observation may be compatible with a centre-periphery motive perspective, assuming that groups in relative resource scarce regions may be more likely to challenge state governments. But it may also be compatible with the opportunity perspective if resource scarcity leads to lower alternative costs for potential rebel recruits through lower wages or higher unemployment rates. Furthermore, the relationship between regional resource scarcity and conflict may be seen as originating from either the lack of ability or willingness by central governments to address relative resource scarcity between regions, from inability by regional and local governments to adopt measures to reduce resource scarcity, or from low adaptability and mobility of people.

Two caveats should be added to the conclusions about the impact of population pressure as a source of resource scarcity and conflict. The first is that the detailed test for Indian states of propositions derived from the resource scarcity perspective cannot be reproduced for a global sample of states. Comparable data on rural land availability, rural and urban inequalities, agricultural productivity and growth in agricultural wages are not available across countries and over time periods. Hence, there is a possibility that the discrepancies in results may be a consequence of the inability to test more detailed aspects of the resource scarcity hypothesis globally. The other caveat relates to the data availability in the global disaggregated study of geographical squares. There is no established standard methodology in this field, and data are not available for very long time-series. Hence, we have to be cautious when interpreting the results. Our most robust finding in support of the resource scarcity perspective is the interaction between high population growth and density. But we are not yet able to empirically assess whether the result is driven by urbanization, growth in populous agrarian areas, or inter-rural and possibly

cross-border migration. Ongoing efforts to collect comparable time-series data on population and environment will eventually provide opportunities for better tests of the resource scarcity perspective. Future studies of regional or local population pressure and political violence will show whether the results obtained in the India study can be replicated for other political contexts. As more data becomes available, more detailed studies using geographical units of analysis could shed more light on the regional and local population-conflict nexus. In particular, longer time-series of demographic and environmental data, as well as geo-referenced data on ethnicity, poverty and state penetration may provide more detailed insights. Substantively, the issue of migration should be prioritised. A recent global study suggests that conflict-related refugee movements play a role in the diffusion of conflict (e.g., Salehyan and Gleditsch, 2006), but migrants responding to environmental change may not necessarily pose a similar threat (Gleditsch et al., 2007). The development of better data may provide opportunities to test more specific hypotheses on the relationship between migration and political violence at the sub-national level. Finally, the discrepancy in findings between scarcity at the state and sub-state levels calls for more detailed case studies of sub-national areas that have peacefully succeeded in addressing high levels of population pressure and resource scarcity. Such studies will enable us to answer to what extent adaptation and coping is facilitated by the state, by local and regional governments, or by the local population itself.

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Appendix A: Summary of quantitative studies on population and internal armed conflict

Variables	Cross-national studies	Sub-national studies
Population density, growth, and their interaction	Hauge and Ellingsen (1998), de Soysa (2002): positive effect of population density. Collier and Hoeffler (1998; 2004), Esty et al. (1998), Hegre and Sambanis (2006), Theisen (2006), Urdal (2005): no effect of population density. Urdal (2005): no effect of the interaction of high population density and growth, except positive for the 1970-79 period.	Buhaug and Rød (2006): no effect of population density for sub-Saharan Africa. Raleigh and Urdal (2007): a positive effect of density and growth combined, for low-income countries only. Urdal (2008): High rural population density is associated with a higher risk of armed conflict, and high rural density and population growth combined with increasing levels of violent political events. Rural population pressure is unrelated to Hindu-Muslim riots
Secondary Effects: Rural inequality, agricultural productivity and growth rates of agricultural wages	Not previously tested in cross-national studies	Urdal (2008): No effect of rural inequality, some effect of low agricultural yield and declining agricultural wages
High urban population growth	Urdal (2005): no effect, except negative for the post-Cold War period.	Urdal (2008): Urban growth negatively affects the risk of armed conflict, unrelated to other forms of political violence