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People vs. Malthus: Population Pressure, Environmental Degradation, and Armed Conflict Revisited*

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Demographic and environmental factors have claimed a dominant position in the post-Cold War security discourse. According to the neo-Malthusian conflict scenario, population pressure on natural renewable resources makes societies more prone to low-intensity civil war. On the contrary, resource-optimists concede that agricultural land scarcity caused by high population density may be a driving factor behind economic development, thus causing peace in a long-term perspective. These notions are tested in a quantitative cross-national time-series study covering the 1950–2000 period. The results do not provide strong support for either perspective. Countries experiencing high rates of population growth, high rates of urbanization, or large refugee populations do not face greater risks of internal armed conflict. There is some indication that scarcity of potential cropland may have a pacifying effect. However, where land scarcity combines with high rates of population growth, the risk of armed conflict increases somewhat. This trend is particularly marked for the 1970s, the decade that saw the great rise in neo-Malthusian concerns. Claims that the world has entered a 'new age of insecurity' after the end of the Cold War, where demographic and environmental factors threaten security and state stability, appear to be unfounded. Overall, the robustness of the empirical support for both paradigms is low. A strong emphasis on security as a macro rationale for reducing global population growth thus seems unwarranted.

Introduction

The social and human implications of armed conflict are enormous. The number of people dying from indirect causes of conflict such as under- and malnutrition, or diseases that could easily be treated if medicines were available, can be much higher than the number of battle-related deaths.[1] In the 1998–2001 civil war in the Democratic Republic of Congo, the ratio of indirect to direct casualties was roughly six to one (Roberts et al., 2003).[2] Armed conflict is further harmful to people's quality of life through negative effects on economic development and the environment. Collier (1999) has shown that conflict can tear down levels of economic development that took

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[1] See Lacina & Gleditsch (2005) for a discussion of different war mortality measurements.

[2] Of around 2.5 million deaths due to the conflict, 350,000 followed acts of violence (Roberts et al., 2003).

decades to achieve. He argues that spinoff effects continue to hamper economic growth for a long period following the termination of conflict.

Domestic armed conflicts and civil wars are now far more frequent than interstate conflicts. While there was a peak in conflict occurrence in the mid-1990s, the number of domestic conflicts has fallen slightly to equal approximately the level of the 1980s. In 2001, 33 internal armed conflicts with more than 25 battle-related casualties took place in 28 different countries. Eleven conflicts inflicted more than 1,000 battle casualties (Gleditsch et al., 2002).

This article addresses the *neo-Malthusian* concern that countries with rapidly growing populations will experience degradation and scarcity of natural resources such as cropland, fresh water, forests, and fisheries, increasing the risk of violent conflict over scarce resources. Although already rising as a security issue in the 1960s and 1970s, a renewed and more pronounced neo-Malthusian concern over security arrived in the 1990s. Explanations for this have been twofold. First, a general environmental awareness increased in Western popular opinion in this period, and environmental protagonists succeeded in 'securitizing' central environmental issues, thereby attracting the attention of policymakers (Levy, 1995: 44). In the United States, vice president Al Gore initiated the 'State Failure Task Force' project in 1994, aimed at revealing environmental, political, and social causes of state failure. Second, the end of the Cold War left a void in security policy, and Western national security establishments sought ways to legitimize their continued existence (Gleditsch, 2001: 259).[3]

Some argue that demographic and environmental factors have become *more important* as causes of conflict after the end of the Cold War. A widely cited article states that 'West Africa is becoming *the* symbol of worldwide demographic, environmental and societal stress', potentially leading to anarchy and dissolution of nation states in the future (Kaplan, 1994: 46, emphasis in original). According to de Soysa (2002a: 3), some of the environmental security literature argues that ecological and demographic pressures represent a 'new age of insecurity' after the end of the Cold War.

Much of the empirical literature on population, environment, and conflict is based on single-case studies, and these are frequently criticized for lack of methodological rigor. In this article, I have put neo-Malthusian notions to an empirical test in a large-N model covering all states and dependent areas in the international system for the past 50 years, using several different indicators of population pressure.

Population, Environment, and Conflict

Malthus (1803/1992) assessed that food production would grow arithmetically, while the human population would grow exponentially, at some point causing serious food shortages and human misery. History has to a considerable extent proven Malthus wrong. Food production has increased more than he foresaw, while population has grown more slowly. However, the idea survived that the human population cannot continue to grow indefinitely without at some point reaching and exceeding the carrying capacity of the earth. At the end of the 1960s and the beginning of the 1970s, a wave of alarmist 'neo-Malthusian' literature emerged, predicting that the rapidly growing world population would soon exceed the resource base and lead to serious environmental destruction, widespread hunger, and violent conflicts.[4]

Attempts to foresee future development

[3] See Hughes (1997: 11) for an excellent example.

[4] For a selection of alarmist literature, see Ehrlich (1968), Hardin (1968), and more recently Myers (1993), Renner (1996), and Ehrlich & Ehrlich (1996).

are a prominent feature of much of the neo-Malthusian literature. In 1968, Ehrlich stated that 'the battle to feed humanity is over. In the course of the 1970s the world will experience starvation of tragic proportions – hundreds of millions of people will starve to death' (Ehrlich, 1968: xi). Like many other alarmist predictions, Ehrlich's did not hold. The focus on potential future resource wars in much of the resource pessimist literature has been criticized for not being testable (Gleditsch, 2001). Since the argument that population-induced resource scarcity can cause violent conflict has such a long history, I assume that the argument does not apply only to future conflicts, but also to the past. The neo-Malthusian conflict scenario should be expected to stand up to empirical testing.

The view that population pressure and resource scarcity can cause conflict is met by counter-arguments on several grounds from a research tradition often referred to as cornucopians, resource optimists. Believing that the world is continuously improving by both human and environmental standards, cornucopians offer three main challenges to the neo-Malthusian paradigm. First, they claim that most debated natural resources are not really scarce, at least not in a global context, and that we are not going to experience a major resource crisis even in the face of continued population growth (e.g. Lomborg, 2001).

Second, if some resources are getting scarcer, humankind is able to adapt to these challenges. Market mechanisms are believed to reduce the demand for scarce resources through higher pricing. Furthermore, natural resource scarcity may even work as a catalyst to trigger technological innovation, making scarcity ever less likely in the future. Boserup argues that population pressure on natural resources is actually the key to development and implementation of new techniques in agricultural production (Boserup & Schultz, 1990). The higher population density is relative to the resource base, the more societies are forced to adopt new technologies. Boserup sees the relatively low agricultural effectiveness of many African states as a result of the continent's low population density (Boserup & Schultz, 1990). The third point made by cornucopians is that it is abundance of valuable natural resources, rather than scarcity, that leads to violent conflict. Income from rich natural resources such as gems, tropical timber, cash crops, and drugs may be regarded as an incentive for armed conflict ('greed') or as a means to finance warfare ('opportunity'). The empirical support for this argument is strong (e.g. Collier, 2000; Le Billon, 2001; de Soysa, 2002a).[5] While often portrayed as competing, the scarcity and abundance hypotheses are not theoretically mutually exclusive and may in fact coexist (Renner, 2002).

The Moderate Neo-Malthusian Position

Although some of the alarmist literature may have discredited the neo-Malthusian position, few scholars would argue that resource scarcities never occur or that they are irrelevant for conflict behavior. Natural resources that are essential to human life and welfare are unevenly distributed between and within states, and scarcities of certain natural resources may arise and persist locally, at least temporarily. The most influential scholar moderating the neo-Malthusian position has been Thomas Homer-Dixon and his 'Project on Environment, Population, and Security' at the University of Toronto.[6] Homer-Dixon and associates distinguish between different sources of resource scarcity.[7] Population

[5] Lujala, Gleditsch & Gilmore (2005) find that this relationship is not straightforward. While deposits of easily extractable secondary diamonds increase the risk of some forms of violence, primary diamonds do not have a similar effect.

[6] Gleditsch & Urdal (2002) provide a review of Homer-Dixon's work on population, environment, and conflict.

[7] I prefer the term 'resource scarcity' over Homer-Dixon's 'environmental scarcity'.

growth is an important source to *demand-induced scarcity* (Homer-Dixon, 1999: 48). If a resource base is constant, the availability of resources per person will diminish as an increasing number of persons have to share it. Such scarcity can also arise from an increase in demand per capita.

Most armed conflicts and wars are over objectives that can broadly be defined as resources (Gleditsch, 2001: 252). Neo-Malthusians are primarily concerned with resources that are essential to food production. Homer-Dixon & Blitt (1998) argue that large populations in many developing countries are highly dependent on four key resources: fresh water, cropland, forests, and fisheries. The availability of these resources determines people's day-to-day well-being, and scarcity of such resources can, under certain conditions, cause violent conflict (Homer-Dixon & Blitt, 1998: 2). It has been proposed that the resource scarcity and conflict scenario is more pertinent to developing countries, owing to generally lower capacity to deal with environmental issues and less ability to cope with and adapt to scarcity (Homer-Dixon, 1999: 4–5; Kahl, 2002: 258).

Homer-Dixon argues that increased environmental scarcity is likely to cause social effects that increase the risk of internal violent conflict. Environmental scarcities can lead to constrained agricultural and economic productivity, causing migration and widespread poverty. Grievances may result in violence provided two conditions exist. First, the aggrieved individuals need to participate in some sort of ethnic, religious, or class-based collective that is capable of violent action against the authorities. Second, the political structure must fail to give these groups the opportunity to peacefully express their grievances at the same time as it offers them the openings for violent action.

Some more recent contributions, particularly by Kahl and Matthew, further moderate the neo-Malthusian position. Kahl (2002: 266) refutes the critique that neo-Malthusian models are deterministic, and claims that they are rather underspecified. He criticizes much neo-Malthusian writing for failing to identify clearly which intervening variables are most important. Referring to the assumption of 'state weakness' as a necessary precondition for environmentally induced conflict in the works of Homer-Dixon and of Goldstone (e.g. 2002), he contends that such conflicts can also arise under conditions of 'state exploitation', when powerful elites exploit rising scarcities and corresponding grievances in order to consolidate power. Conflicts in Kenya and Rwanda are claimed to be examples of the latter (Kahl, 2002: 265).

Matthew (2002: 243) provides two important critiques of the simple neo-Malthusian thesis. First, it understates the capacity to adapt to scarcities that are manifest in many societies. Second, it does not adequately deal with historical and structural dimensions of violence, like globalization and colonial influence. Matthew's approach shifts the focus to why some states succeed while others fail to adapt to scarcities of renewable resources.

Among the more moderate neo-Malthusian contributions, there are few apocalyptical claims of large-scale warfare over scarce resources. Dalby (2002: 95) concedes that 'the likelihood of large-scale warfare over natural resources is small'. And while claims of future 'water wars' proliferate, Homer-Dixon (1999: 5) concludes that interstate scarcity wars are not very likely. He rather predicts that the most likely forms of violent conflict to erupt from resource scarcities are ethnic clashes and civil strife. In order to address the proposition that scarcity is more likely to produce low-level domestic violence, this study investigates whether population pressure may increase the risk of internal armed conflict with at least 25

battle-related deaths, a threshold well below the 1,000-deaths criterion conventionally set for civil war.

Neo-Malthusian Population Pressure and Armed Conflict

If there is something to the neo-Malthusian causal scheme, I would expect to find that countries experiencing a high population pressure would have an increased risk of armed conflict, all other factors being equal.[8] The concept of population pressure, however, contains several different aspects. The traditional Malthusian focus has been on *population growth*. The concern has been that high population growth would outstrip growth in revenues from natural resources. Population would then eventually exceed the productive capacity of natural resources, a situation often referred to as overpopulation. I thus assume the following:

H1: Countries with high population growth are more likely to experience domestic armed conflict than countries with low population growth.

Another measure that is often argued to be an indicator of population pressure is *population density*. However, the conventional density measure, the number of people per square kilometer, says very little about the ratio between population and the resource base. High density is more of a problem in arid areas than in fertile. Partly on these grounds, Ehrlich & Ehrlich (1996: 70) criticize the use of population density as a measure of population pressure, calling it the 'Netherlands fallacy'. If density instead is measured as population relative to the area that potentially could be used for food production, what I term *potential cropland*, one is able to measure the population pressure relative to what is perhaps the single most important renewable natural resource. Population density then resembles a measure of *cropland scarcity*. I expect the following:

H2: Countries with high population density relative to potential cropland are more likely to experience domestic armed conflict than countries with low density.

Population density is a static measure that tells us little about the current pressure on natural resources. Countries that have been densely populated for a longer period, and now experience moderate or low population growth, may have had sufficient time and opportunity to adapt to and overcome scarcities. By contrast, population growth in itself is a dynamic measure that is decoupled from actual resource availability. Population growth can also happen in countries with a plethora of natural resources, thus not causing scarcity. While one could question separately the validity of each of these indicators, I expect that the coexistence of the two factors, high population growth in a context of already scarce per capita cropland, would indicate an extraordinary strain on natural resources.

H3: The higher population density relative to potential cropland a country experiences, the stronger is the conflict-conducive effect of high population growth.

Urbanization is often added to the 'litany of emerging challenges' to state stability (Brennan-Galvin, 2002: 123). Rapid urbanization may be the result of rural resource scarcity (Homer-Dixon, 1999: 155), but urbanization may also produce severe scarcities of certain commodities, in particular fresh water (Klare, 2001: 140). While acknowledging that past studies have found 'surprisingly little correlation between urban growth and civil strife', Homer-Dixon

[8] Homer-Dixon and associates do not provide a stringent definition of 'civil violence' and do include cases of violence that would not qualify as 'organized armed conflict' as defined in this article.

(1999: 155–156) claims that 'in interaction with . . . other factors [including economic crisis and weakening of the state], it appears much more likely to contribute to violence'. According to Goldstone (2002: 14), urban growth that is not matched by increased economic growth and job creation is associated with an increased risk of political violence.

H4: The stronger the growth of the urban population, the more likely a country is to experience domestic armed conflict.

A final form of population pressure addressed by this study is *migration*. While Homer-Dixon is mainly concerned with how migration can be the outcome of resource scarcity, large groups of migrants can also be a source of serious environmental degradation in the receiving area. This is especially the case with large refugee camps (ECHO, 1995: 5). The impact that migrants have on the environment in the receiving area depends on their total number, the degree of concentration, and whether the movement of people is sudden or long term.[9] Refugee movements are likely to produce more acute and sudden social and environmental challenges than population growth, beyond the aspect of numbers. Refugees may have a short-term perspective, reducing incentives to handle resources in a sustainable manner; they may lack information about fragile ecological balances in the area of refuge, and may be regarded as competitors from the point of view of original inhabitants.

H5: Countries that host large refugee populations are more likely to experience domestic armed conflict than countries that do not.

[9] For data reasons, I focus on refugees crossing an international border and do not address the equally interesting aspect of internally displaced persons or migrants more generally.

Research Design

This study takes the form of a large-N quantitative survey. The unit of analysis is the country-year, and the dependent variable is armed conflict onset. With a dichotomous dependent variable, logistic regression is chosen as the statistical method. Included in the analysis are all sovereign states in the international system and all politically dependent areas (colonies, occupied territories, and dependencies) for the whole period 1950–2000.[10] The logit model is specified as

$$ln(p_{it}/(1 - p_{it})) = \alpha + \beta X_{it} + e_{it}$$

where α is the intercept, βX is a set of explanatory variables with corresponding coefficients, and e is the random error term, for country i at time t.

Previous Empirical Work

There has been little systematic comparative empirical research on the causal effects of population pressure on war and armed conflict. A few studies have addressed the population aspect briefly by including one or more measures of population pressure into more general models. Overall, they seem to find some support for neo-Malthusian concerns. Tir & Diehl (2001) find a significant and positive effect of population growth on the likelihood of interstate war, while there is no such effect of population density. Hauge & Ellingsen (2001) and de Soysa (2002b) find that high population density slightly increases the likelihood of domestic conflict. De Soysa further concludes that renewable resource scarcity, measured by the per capita stock of total renewable resources, does not condition the effect of density. Both studies apply the same low-intensity conflict data (at least 25 deaths per year) as this study

[10] I have also run analyses on a more restricted set of countries that qualify as members of the interstate system as defined by Small & Singer (1982).

does, covering mainly the 1980s and the 1990s, respectively. Collier & Hoeffler (1998) find no significant effects of population growth or density on civil war (more than 1,000 deaths).

Operationalizations

The conflict data are drawn from the PRIO–Uppsala dataset (Gleditsch et al., 2002). This dataset has been published annually in *Journal of Peace Research* since 1993 but has only recently been extended beyond the post-Cold War period. Shorter series, mostly for the post-Cold War era, have been analyzed in earlier studies (Hauge & Ellingsen, 2001; de Soysa, 2002b). Colonial wars are defined here as domestic conflicts.[11]

The PRIO–Uppsala 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). 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. If a conflict falls below the threshold of 25 deaths for at least two years and then resumes with the same parties and over the same incompatibility, this is coded as a separate conflict onset.[12]

A substantial number of the conflicts registered in the PRIO–Uppsala dataset broke out at a time when there was already at least one other conflict going on in the same country. Typically, large countries like India and Indonesia have experienced several local conflicts taking place at the same time. The number of such overlapping conflicts is greater for the PRIO–Uppsala data than for most other conflict datasets, owing to the low-intensity threshold. During the 1950–2000 period, a total of 192 conflict onsets from a state of peace were identified. Another 42 onsets happened when a country was already experiencing another armed conflict. For the alternatively coded dependent variable, all country-years experiencing a conflict onset are coded 1, irrespective of whether a previous conflict is active. Overlapping conflicts pose a methodological challenge, since studies of armed conflict usually focus on transitions from peace to war, omitting consecutive years of war. While this study follows the conventional approach, a separate model using the alternative dependent variable will be run for comparison.

Data on *population growth* are estimated from UN total population size estimates of the *World Population Prospects* (UN, 1999).[13] For states with populations under 150,000 in 1995 (in the following referred to as 'small states'), data were collected from the *Demographic Yearbook* (UN, annual) and the *Statistical Abstract of the World* (Reddy, 1994). The measure is lagged by five years to account for the presumably slow-moving process of population-induced resource scarcity.

A measure of *population density* relative to the total area of a country, as applied by Hauge & Ellingsen (2001), misses the

[11] I see no reason to treat armed conflicts between a liberation army and the representatives of a colonial power any differently than other forms of organized armed opposition against an autocratic regime.

[12] The choice of number of years in peace before coding resumed fighting between the same parties as a new onset is not guided by any theoretical justification. I follow Buhaug & Gates (2002), coding a new onset after at least two years of peace, but have also coded alternative dependent variables employing one and five years of peace. The slightly different results arising from alternative specifications are discussed below.

[13] For colonial powers, only the population of the territory proper, and not that of colonial territory, forms the basis for the population variables. All dependent areas, both historical and current, are treated as separate units of analysis.

important aspect that countries differ significantly with respect to the productive capacity of their land.[14] This study aims to establish a measure of per capita *cropland scarcity*: population density relating the number of people in a country to the area that is potentially suitable for food production, here termed *potential cropland*. I define potential cropland as all of a country's land that falls into the following land use categories: arable land, permanent crops, permanent pastures, and forests and woodland (CIA, annual). Land that is excluded from this definition includes, but is not limited to, urban areas, mountains, roads, and deserts. Owing to lack of reliable time-series estimates, the potential cropland measure is based on a single observation per country only, dating from the 1993–2001 period, ignoring the potential problem of changing land use over time. Data on total land area (in square kilometers) were collected from the *World Development Indicators* (World Bank, 2003), the *World Factbook* (CIA, annual), and the *Encyclopedia Britannica* (Britannica, annual). Data on total population size originate from UN (1999), and from the *Demographic Yearbook* (UN, annual) and the *Statistical Abstract of the World* (Reddy, 1994) for small states. The population density variable is log-transformed in order to reduce the huge variation.

The population data from the *World Population Prospects* are assumed to be the most reliable and comparable available. For more developed countries, the availability of reliable data on population size and dynamics is high, although data on international migration flows are generally inadequate (UN, 2000: 175). For many less developed countries and regions, data are less available and sometimes of inferior quality (ibid.). The UN Population Division uses a well of different sources to assess consistency between them and employs demographic estimation techniques to arrive at reasonable estimates. For some extreme cases where no or only outdated information exists, estimates are derived by inferring levels and trends from those experienced by countries in the same region that have a socio-economic profile similar to the country in question (UN, 2000: 176).

Data on *urbanization* covering the 1960–2000 period have been collected from the *World Development Indicators* (World Bank, 2003) and measure the annual increase in urban populations. *Refugee* data are drawn from statistics of the United Nations High Commissioner for Refugees (UNHCR, 1998, 1999, 2000). Refugee data are generally of low reliability. While the ideal would be to assess both total size and flows of refugees, building a more reliable dataset for refugees is beyond the scope of this article.[15] As a very crude first test of the refugee proposition, this study employs a dummy variable taking on the value 1 for countries that hosted more than 100,000 refugees in a given year, and 0 otherwise. Data on refugee populations are available for the years 1988–99 only. All estimates are as of 31 December, and the variable is lagged by one year.

Control Variables

Existing conflict literature suggests a broad variety of control variables that can explain the onset of domestic armed conflict. A number of previous empirical studies have found level of *development* to be strongly associated with conflict (Collier & Hoeffler, 1998; de Soysa, 2002a; Hauge & Ellingsen, 2001; Hegre et al., 2001; Henderson & Singer, 2000). This study applies the infant mortality rate (IMR) as a proxy for

[14] De Soysa (2002b) measures population density relative to arable land, which includes all land currently used for agricultural production.

[15] A better understanding of the dynamics between refugees and armed conflict will evolve as new work in this field moves forward.

development, as previously done by the State Failure Task Force group (Esty et al., 1998).[16] While conventional development proxies, like GDP or energy consumption per capita, focus heavily on economic aspects, IMR better captures the diverse aspects of development. The IMR is defined as the fraction of live-born children who die before the age of one year. Data are gathered from the *World Population Prospects* (UN, 1999), and the *Demographic Yearbook* (UN, annual) for small states.

Regime type is another variable assumed to be associated with conflict. While the democratic peace hypothesis argues that democracies never fight each other, democracy is also found to have a pacifying effect on the domestic arena (Hegre et al., 2001). The impact of regime type is generally believed to take an inverted U-shaped form, meaning that stark autocracies and fully developed democracies are both less likely to experience conflict than intermediate and unstable regimes. I use the Polity IV data (Marshall & Jaggers, 2000) to measure regime type, and the variable ranges from –10 (most autocratic) to 10 (most democratic).[17] I also include a squared term in order to measure the assumed inverted U-shaped effect of regime on armed conflict.

Regardless of the absolute level of wealth of a country, economic performance is assumed to influence the legitimacy of a government. If *economic growth* is low, leading to decreasing levels of wealth and rising unemployment, this is likely to cause grievances and anti-government sentiments. Economic growth is measured as average annual percentage change in GDP per capita over the five-year period prior to the year of observation. The estimates are based on PPP adjusted GDP per capita data from Heston, Summers & Aten (2002).[18]

To account for differences in conflict propensity potentially embedded in the size of a country, a variable measuring *total population* size is included.[19] The larger the size of a state's population, the greater the likelihood of a large geographical area, and the greater the chance of linguistic, religious, ethnic, or cultural fractionalization. Data are drawn from the *World Population Prospects* (UN, 1999), and from the *Demographic Yearbook* (UN, annual) for small states. The variable is log-transformed, as I expect the marginal effect of population size to be small for populous countries. I also include controls for political *dependency* status, a dummy variable coded 1 for political dependent areas and 0 for sovereign states. The data were gathered from Gleditsch & Befring (1986), the *Encyclopedia Britannica* (Britannica, annual), and the *World Factbook* (CIA, annual).

Controls for Statistical Dependency

A number of previous empirical studies applying country-years as the unit of observation have noted that such an approach, if uncorrected, leads to serially correlated errors (Beck, Katz & Tucker, 1998: 1263). Obviously, a country that experiences conflict over several years will find subsequent years of conflict to be heavily dependent on the first year. This problem of *time-dependence* is usually dealt with by omitting all observations of conflict, except for observations of the onset of conflict given that the country was at peace at $t - 1$. But omitting consecutive years of war does not solve the problem of time-dependence entirely, because the

[16] For the sake of comparison, I will also apply a development measure of log-transformed GDP per capita adjusted for purchasing power parities collected from Heston, Summers & Aten (2002).

[17] In order not to lose a lot of observations, I assign the value for the sample average for units with missing values. I add a dummy variable, *missing regime data,* controlling for imputed values.

[18] As for regime type, I have imputed the sample average for missing values.

[19] This is merely a control for state size, and is not a population pressure indicator.

same statistical dependence prevails for consecutive years of peace. To account for temporal dependence, this study applies a control variable measuring the number of years in peace since the previous conflict, termed *brevity of peace*. It is generally assumed that the risk of experiencing a new conflict is high in the period immediately after an armed conflict and that this risk diminishes as time goes by. I follow Hegre et al. (2001) and assume that the effect of a previous conflict is decaying over time according to the formula $exp\{(-years\ in\ peace)/X\}$.[20] In this formula, 'years in peace' is the number of years since a country experienced the end of armed conflict, while the value of X determines the rate of decay of the effect of a previous armed conflict. Here, the value chosen for X is 4, implying that the risk of conflict is halved approximately every three years.[21] The brevity of peace variable takes on values close to 1 immediately after the end of a conflict and converges towards 0 over time.

In the model allowing for simultaneous conflicts, the brevity of peace variable is substituted for a *brevity of conflict* variable. This variable decays according to the same formula as brevity of peace and counts the time since a country experienced the most recent conflict onset. If a country did not experience a conflict since 1950, the variable is coded 0. I expect this variable to be positive, assuming that the risk of a new conflict breaking out is decreasing as time passes since the previous conflict onset. Since, in this model, consecutive years of a conflict are not censored, and several conflicts in a country can occur simultaneously, I also apply a dummy variable, *ongoing conflict in country*, taking the value 1 if a country is currently experiencing conflict.[22] I expect small countries to be particularly likely to have 'space' for only one conflict at a time, and include an interaction term between *total population* and *ongoing conflict in country*.

Results

The empirical results from Table I provide only limited, and not very robust, support for both neo-Malthusian and cornucopian propositions. High population growth is by itself not associated with armed conflict. The estimated effect is in fact negative in most models, and it is consequently statistically insignificant. Land scarcity, measured by population density, is mostly negatively associated with armed conflict.[23] In a few models (1, 3, and 6), population density has a significant negative impact on conflict. [24] However, the robustness of this finding is low; the effects turn insignificant if only the restricted sample of sovereign states is considered.[25] Where land scarcity combines with high population growth, there is generally a positive association with conflict, and this relationship is statistically significant when longer periods of peace are required before coding a new onset (Model 6). But again, the relationship is not particularly robust and becomes statistically insignificant when only sovereign states are included.

Interaction effects between population pressure variables and IMR in Model 1 were

[20] This form of time-dependency control is very similar to that suggested by Beck, Katz & Tucker (1998). I prefer the Hegre et al. (2001) approach as it is directly interpretable.

[21] This value for a half-life of conflict is also used by Toset, Gleditsch & Hegre (2000). Three years after the end of conflict, the value is approximately halved: $exp(-3/4) = 0.47$. The analyses of this article are extremely robust over different specifications of this function. Assuming half-lives of 5, 10, or 16 years does not change the results.

[22] The variable is coded 0 for the first year of a conflict erupting from a state of peace.

[23] These results are virtually unchanged when using a conventional density measure.

[24] However, when running this model on the restricted sample only, population density turns insignificant.

[25] If the interaction term is excluded from Models 1–6, the only change in the main explanatory variables is that population density turns insignificant in Model 1.

Table I. Risk of Armed Conflict by Neo-Malthusian Population Pressure Variables

	Full sample	*Restricted sample*	*Full sample*			
	Model 1	*Model 2*	*Model 3*	*Model 4 all onsets*	*Model 5*	*Model 6 onset 2*
Explanatory variables	*β* *st. error*	*β* *st. error*	*β* *st. error*	*β* *st. error*	*β* *st. error*	*β* *st. error*
Population pressure variables						
Population growth[a]	–0.009	0.074	–0.020	0.003	–0.013	–0.019
	(0.062)	(0.071)	(0.062)	(0.058)	(0.071)	(0.063)
Population density[a]	–0.088*	0.002	–0.156***	–0.074	–0.068	–0.113**
	(0.053)	(0.061)	(0.052)	(0.049)	(0.060)	(0.055)
Growth * density[a]	0.042	–0.017	0.061	0.041	0.014	0.081**
	(0.039)	(0.050)	(0.041)	(0.036)	(0.045)	(0.037)
Urban growth					–0.025	
					(0.041)	
Control variables						
Total population[a]	0.269***	0.207***	0.266***	0.323***	0.289***	0.285***
	(0.047)	(0.055)	(0.047)	(0.043)	(0.055)	(0.050)
Dependency	–0.890**		–0.663	–1.167***	–0.855	–0.933**
	(0.381)		(0.716)	(0.354)	(0.538)	(0.394)
Infant mortality rate[a]	0.006***	0.006***		0.006***	0.010***	0.006***
	(0.001)	(0.002)		(0.001)	(0.002)	(0.002)
GDP per capita (Ln)			–0.663***			
			(0.102)			
Missing GDP data			0.408			
			(0.729)			
Regime	0.006	0.005	0.009	0.003	0.015	0.011
	(0.014)	(0.014)	(0.014)	(0.012)	(0.015)	(0.014)
Regime, squared	–0.014***	–0.013***	–0.013***	–0.014***	–0.014***	–0.015***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Missing regime data	–0.259	–0.009	–0.313	–0.114	–0.311	–0.235
	(0.314)	(0.331)	(0.317)	(0.274)	(0.346)	(0.332)
Economic growth					–0.054**	
					(0.024)	
Missing economic growth data					0.296	
					(0.245)	
Controls for statistical dependency						
Brevity of peace	1.819***	1.725***	1.763***		1.691***	1.124***
	(0.275)	(0.285)	(0.278)		(0.304)	(0.325)
Brevity of conflict				1.366***		
				(0.318)		
Ongoing conflict in country[a]				–1.218***		
				(0.351)		
Ongoing conflict * total population[a]				0.304**		
				(0.118)		
Constant	–6.078***	–5.385***	–2.273**	–3.845***	–6.302***	–6.157***
	(0.488)	(0.569)	(0.944)	(0.206)	(0.599)	(0.513)
N	7,752	5,490	8,065	8,691	5,851	7,730
Log likelihood	–793.33	–700.47	–795.95	–963.45	–631.85	–733.86
Pseudo R^2	0.107	0.080	0.112	0.096	0.113	0.089

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[a] Singular terms are centered to avoid multicollinearity when introducing interaction terms (Kleinbaum, Kupper & Muller, 1998: 206–212).

not significant, speaking against the proposition that developing countries are more susceptible to violence generated by population pressure and resource scarcity. Urbanization is not significantly related to armed conflict in any of the models. Furthermore, an interaction term between urbanization and economic growth[26] was not significant, running counter to the expectation that urbanization may cause violence when interacting with economic crises.

A Golden Age of Neo-Malthusianism?

The importance that neo-Malthusian factors have been ascribed in the security discourse has changed over time. In particular, the 1970s and the 1990s saw the emergence of such security concerns. Could it be that the impact of population pressure on conflict propensity has changed over time? In Table II, I investigate whether indicators of neo-Malthusian population pressure perform differently over the five decades covered by this study.

Stratifying the model on decades does not provide considerable support for the neo-Malthusian conflict scenario, but for the 1970s the interaction term between population growth and density is positive and significant (Model 8). Thus, in the decade in which neo-Malthusian literature exploded, countries that experienced high population growth and cropland scarcity combined did experience a higher risk of armed conflict, other factors being equal. This relationship is quite robust, but as in Model 5, it turns insignificant when the model is applied to a restricted sample of only sovereign states. For the period of the second wave of environmental security literature, the post-Cold War era, there is no support for neo-Malthusian claims. Population density is found to be negative and significantly associated with conflict in the 1960s and 1980s (Models 7 and 9).[27] Urbanization is associated with a significantly decreased risk of conflict for the 1990s, and is insignificant for all other periods. Data for refugee populations is available only for the post-Cold War period. The refugee term has the expected positive sign but is not statistically significant.

Control Variables

Among the control variables, countries with larger populations are clearly more exposed to the risk of armed conflict, while economic growth and political dependency act to reduce conflict propensity. High levels of development, as measured by either infant mortality or GDP per capita, strongly reduce the risk of armed conflict. This study also reconfirms the inverted U-curved relationship between regime type and conflict; intermediary regimes seem to be most conflict prone. The more recent the termination of a previous conflict, the higher is the risk of a new armed conflict onset. An ongoing conflict is associated with a reduction in conflict propensity (Model 5). This may be explained by several factors. First, since the army is already mobilized, a government is able to crack down on subsequent rebel attempts. Second, governments of countries that experience an ongoing conflict will probably be likely to increase surveillance of potential rebel elements. Third, observing the negative effects of the ongoing conflict may act as a deterrent to the initiation of another.

Conclusion

After the end of the Cold War, demographic and environmental factors have increasingly been regarded as security issues. According to neo-Malthusian theorizing, population

[26] The test was performed for both short- and long-term economic growth.

[27] However, when using the conventional density measure, the variable turns statistically insignificant.

Table II. Risk of Armed Conflict by Neo-Malthusian Population Pressure Variables and Decades, Full Sample

Explanatory variables	*Model 6 1950–59* β *st. error*	*Model 7 1960–69* β *st. error*	*Model 8 1970–79* β *st. error*	*Model 9 1980–89* β *st. error*	*Model 10 1990–2000* β *st. error*	*All decades* β *st. error*
Population pressure variables						
Population growth[a]	0.030	0.134	–0.024	0.150	–0.126	–0.009
	(0.250)	(0.193)	(0.099)	(0.184)	(0.086)	(0.062)
Population density[a]	0.009	–0.386***	–0.080	–0.246*	0.064	–0.088*
	(0.137)	(0.142)	(0.115)	(0.136)	(0.106)	(0.053)
Growth * density[a]	–0.017	0.094	0.129**	–0.065	0.040	0.042
	(0.096)	(0.099)	(0.057)	(0.096)	(0.075)	(0.039)
Urban growth					–0.112**	
					(0.046)	
Refugees[b]					0.424	
					(0.346)	
Control variables						
Total population	0.409***	0.431***	0.344***	0.272**	0.228**	0.269***
	(0.130)	(0.126)	(0.103)	(0.133)	(0.106)	(0.047)
Dependency[c]	–0.332	–1.005	–0.416			–0.890**
	(0.824)	(0.723)	(0.996)			(0.381)
Infant mortality rate	0.001	0.012***	0.011***	0.013**	0.021***	0.006***
	(0.004)	(0.004)	(0.003)	(0.005)	(0.005)	(0.001)
Regime	–0.018	0.006	0.028	0.060*	–0.0001	0.006
	(0.041)	(0.036)	(0.029)	(0.034)	(0.027)	(0.014)
Regime, squared	–0.016**	–0.006	–0.005	–0.015*	–0.022***	–0.014***
	(0.008)	(0.007)	(0.007)	(0.008)	(0.006)	(0.003)
Missing regime data	–0.069	1.254*	0.310	–0.127	–2.140***	–0.259
	(0.823)	(0.689)	(0.764)	(0.943)	(0.705)	(0.314)
Controls for statistical dependency						
Brevity of peace	2.376***	1.534**	1.101	0.058	1.716***	1.819***
	(0.726)	(0.681)	(0.714)	(1.046)	(0.467)	(0.275)
Constant	–7.265***	–9.160***	–7.433***	–6.304***	–5.691***	–6.078***
	(1.283)	(1.441)	(1.143)	(1.562)	(1.087)	(0.488)
N	1,483	1,578	1,519	1,423	1,680	7,752
Log likelihood	–118.26	–143.21	–165.94	–133.47	–194.43	–793.33
Pseudo R^2	0.149	0.147	0.103	0.083	0.197	0.107

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
[a] Centered variable.
[b] Data on refugees are available only for the 1990s.
[c] For the periods 1980–89 and 1990–2000, no dependent country-years that were analyzed experienced an armed conflict onset; thus, the dependency variable is omitted from the analysis for these periods.

growth is an important source of natural resource scarcity. Societies experiencing such scarcity are likely to perform worse in terms of food production and economic development and are assumed to have an increased risk of domestic armed conflict.

This study has not found strong empirical support for neo-Malthusian concerns. Countries experiencing high population growth are generally not experiencing a greater risk of conflict compared to countries with low levels of population pressure. There is some support for 'cornucopian' expectations that scarcity of potentially productive land is associated with a decreased risk of armed conflict. These results generally back up a development scheme proposing that densely populated areas are forced to develop in order to overcome resource scarcity, thereby eventually reducing the risk of conflict. However, as cornucopians concede, peace is likely to be a long-term effect of land scarcity. Some of the empirical evidence provided here suggests that countries experiencing the demographic transition, still facing high rates of population growth, may be under a somewhat greater risk of armed conflict if productive land is already scarce. Neither of these relationships are very robust, though, suggesting that high population pressure on natural resources is not a strong predictor of domestic armed conflict, nor of peace.

When assessing differences over time, it is interesting that the neo-Malthusian proposition is supported only for the 1970s. It could be that the great rise in environmental security concerns in this decade reflected a greater significance played by neo-Malthusian factors. In the 1965–80 period, the less developed regions of the world experienced the highest levels of population growth ever. This was particularly the case in many parts of Asia where population density was already high. In a period of strong superpower involvement in armed conflicts around the globe, the attention paid to demographic and environmental factors may have influenced the superpowers' perceptions of what would be fertile ground for military engagement. There is, on the contrary, no support for claims that the post-Cold War period represents a new era of insecurity, or an erupting state of anarchy due to demographic pressure and resource scarcity. Rather, the post-Cold War era is marked by the strong statistical significance of conventional explanations of conflict such as level of development, regime type, and geography. Although often portrayed as an emerging challenge to security, countries with high levels of urban growth are significantly less prone to armed conflict in this period. A very crude measure for refugee populations is not associated with conflict.

When controlling for trade, de Soysa (2002a,b) finds that population density is positively associated with armed conflict. One possible interpretation is that when a country is trading less, land scarcity becomes a more pertinent issue and may instigate armed conflict. The possibly conditioning effect of a bad macroeconomic environment on the relationship between land scarcity and armed conflict may be a promising avenue for further research. But a strong emphasis on security as a macro rationale for reducing global population growth seems unwarranted. Although the looting of cropland and cattle may be observable in violent conflicts in agrarian societies like Rwanda, natural resource scarcity is not necessarily a root cause of conflict. As Ferguson (1992: 61) notes, 'even when people do acquire land through war, they actually go to war for other reasons'.

The attempt to establish a measure of population density that would be more sensitive to the availability of cropland than the conventional measurement did not produce very different outcomes. GIS tools and more detailed information on land quality can improve the density measure further. While

a first assessment addressing refugee populations and conflict did not result in any significant relationship, future studies taking a more cautious approach will most certainly add to our understanding of this relationship. Such studies should also aim to take into account issues of migration and internal displacement. A third future avenue for testing neo-Malthusian claims are meso-level quantitative studies of selected countries, aimed at revealing possible conflict-conducive effects of neo-Malthusian population pressure at a local level.

Neo-Malthusians may well claim that the aggregated data used here to test population pressure hypotheses fail to reflect local population pressure causing local conflict. However, similar criticism should also then be directed to much neo-Malthusian literature. Four of the five cases investigated in Homer-Dixon & Blitt (1998) deal with whole countries, while only one case study is limited to a region within a country.[28] In all these cases, Homer-Dixon and associates argue that overall population growth in a country contributes to resource scarcity. My study indicates that the relationship between population-induced scarcity and conflict that was found for some of the cases presented in Homer-Dixon & Blitt (1998) does not seem to represent a strong general trend among countries over time.

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[28] The countries studied in Homer-Dixon & Blitt (1998) are Gaza (included in this study as a separate entity), South Africa, Pakistan, and Rwanda. The region is Chiapas, Mexico.

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Appendix A. Descriptive Statistics

	N	*Mean*	*St. dev.*	*Min.*	*Max.*	*Measurement unit*
Population pressure variables						
Population growth	9,183	2.07	1.71	–32.3	16.66	Annual growth rate (%), lagged by five years.
Population density, potential cropland (Ln)	9,004	4.29	1.89	0	13.98	Inhabitants per square km productive land. Log-transformed.
Population density, all land (Ln)	9,159	3.76	1.71	0	10.07	Inhabitants per square km total land. Log-transformed.
Growth * density (potential cropland, Ln)	9,004	8.61	9.49	–172	103	
Urban growth	6,776	3.67	2.75	–44.2	23.4	Annual percentage growth in urban population.
Refugees	2,340	0.14	0.35	0	1	1 if country hosts >100,000 refugees.
Control variables						
Total population (Ln)	9,183	8.01	2.20	1.79	14.06	Population in thousands.
Dependency	9,183	0.23	0.42	0	1	0 if sovereign.
Infant mortality rate	8,797	79.61	58.53	2	264	Deaths below age 1 per 1,000 live-born.
GDP per capita (Ln)	9,183	8.32	0.94	5.62	10.74	GDP per capita in PPP adjusted US$. Log-transformed.
Missing GDP data	9,183	0.20	0.40	0	1	1 if missing.
Regime type	9,183	–0.25	6.39	–10	10	Polity score, 10 if full democracy.
Regime type, squared	9,183	40.90	37.63	0	100	Squared polity score.
Missing regime data	9,183	0.31	0.46	0	1	1 if missing.
Economic growth	9,183	2.05	3.21	–23	50	Average percentage growth in PPP-adjusted GDP per capita over past five years.
Missing economic growth data	9,183	0.35	0.48	0	1	1 if missing.
Controls for statistical dependency						
Brevity of peace	9,183	0.15	0.33	0	1	Function of time since the end of previous conflict.
Brevity of conflict	9,183	0.07	0.17	0	0.78	Function of time since last conflict onset.
Ongoing conflict in country	9,183	0.10	0.30	0	1	1 if ongoing.
Ongoing conflict * total population (Ln)	9,183	0.95	2.87	0	13.83	

Number of country-years with originally missing values in parentheses: Regime type (2,866), Economic growth (3,169), Purchasing Power Parities adjusted GDP per capita (1,866).