Will Climate Change Lead to More Urban Violence? Urbanization, Urban Environmental Problems, and Social Disorder in Cities

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'Security Implications of Climate Change'

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Abstract
For the first time in history, the majority of the world population now lives in cities. Global urbanization will continue at high speed; the world's urban population is expected to increase by more than 3 billion people between 2007 and 2050. While urban populations generally enjoy a higher quality of life compared to populations in rural areas, many cities in the developing world have large slums with populations that are largely excluded from access to resources, jobs, and public services. In the environmental security literature, great rural resource scarcity, causing rural to urban migration, is seen as an important source of violent conflict. This study investigates how population growth and environmental conditions affect patterns of public unrest in urban centers in the context of crucial intervening factors like democracy, poverty, economic shocks, and ongoing armed conflict. It utilizes a newly collected event dataset of urban social disturbance covering 55 major cities in Asia and Sub-Saharan Africa since 1960. The empirical analysis provides little support for the notion that environmental scarcity leads to a higher risk or frequency of social disorder. Instead, we find that urban disorder is primarily associated with a lack of consistent political institutions, economic shocks, and armed intrastate conflict.

1. Introduction

By 2050, two thirds of the world's population will live in urban areas, and nearly all population growth during this period, around 3 billion people, will be absorbed by cities (UN, 2008a). Most of this growth will take place in cities in developing countries. Rapid urbanization has led to concerns among many observers and developing country governments. In particular, the challenge relates to providing burgeoning urban populations with services like housing, electricity, water supply, health care, education and jobs. According to a survey (UN, 2008a: 12), many developing country governments discourage rapid urbanization; 78 percent of African and 71 percent of Asian governments state that they have implemented policies to reduce migrant flows to large cities.

Rapid urbanization has further been framed as a potential security issue (Gizewski & Homer-Dixon, 1995; Brennan-Galvin, 2002). In particular, rural scarcity of renewable resources like cropland, forests and freshwater, causing rural poverty, is seen as a major driver of rural-to-urban migration. While urbanization generally may not be a problem to peace and stability, in the context of economic shocks and declining state capacity, urban pressures could result in increased risks of violence and disturbance (Gizewski & Homer-Dixon, 1995). Holding that there is no simple relationship between urbanization and violence, and that previous studies have taken a too simplistic view, Gizewski & Homer-Dixon (ibid.) also argue that the future of urban violence may not resemble the past. In addition to future economic crises and weakened states, grassroots demands for democratic reforms and a gradual fading of the rural experience as a basis for evaluating urban living conditions are seen as factors that are likely to lead to greater levels of urban violence in the future in the context of high urban growth rates.

We concede with the point that urbanization has to be assessed in an economic and political context. However, we are not convinced that the future will necessarily be very different from the past. This study is aimed at investigating how urbanization, economic and political developments, and urban violence have been associated in the past. We argue that these past trends can also inform us about likely future developments. What we may expect to see, however, is that certain forms of stressors that could contribute to exacerbate the pressure from burgeoning urban populations, such as environmental degradation, economic crises, and state failure, become more common in the future. In particular, global climate change is a process that simultaneously could drive urbanization in developing countries and increase the potential for economic and institutional failure, and thus represents a security risk (e.g. Buhaug et al., 2008).

Cross-national time-series studies have found little evidence that high urbanization rates on the national level increases the risk of violent conflict, if anything, high urbanization rates appear to be associated with less conflict. However, conventional armed conflicts rarely take place in urban centers, hence we may expect to see other forms of violence and social unrest in cities that experience great pressures. This study addresses the relationship between environmental scarcity, urbanization rates, and levels of social disorder in urban centers in Asia and Sub-Saharan Africa. It utilizes a newly collected event dataset of urban social disturbance covering 55 major cities in 49 Asian and African countries for the 1960-2006 period. The data are compiled from electronic news reports in the Keesing's Record of World Events, and involves both non-violent events like peaceful demonstrations and protests, as well as violent events like riots and organized armed conflict.

In addition to focusing on the city level and urban violence in particular, we also investigate plausible interaction effects between urban growth rates and economic shocks, level

of economic development (supposedly capturing aspects of state strength) and democracy. We also directly assess the relationship between resource scarcity on the country level, assumed to capture the level of environmental stress that offset involuntary migration to urban centers, and urban social disorder. Finally, we consider whether indicators of urban environmental conditions and poverty, like the extent of slums, and household's access to water and sanitation, affect levels of urban social disorder.

Generally, what we find is that high urbanization rates do not seem to affect levels of urban social disorder, even in the context of economic shocks, low income levels or democracy. Neither do any of the environmental variables, whether national-level or urban, associated with increased disturbance. What seems to matter, though are economic shocks, regime type, and ongoing armed conflicts.

The current analysis faces important data limitations. In particular, there is a lack of reliable city-level indicators of environmental, social and economic conditions. The only extensive data collection effort on the city level, the UN HABITAT's Global Urban Observatory (GUO) dataset, only provides data for two points in time (1993 and 1998). The coverage is relatively poor, and there are uncertainties about data reliability. This problem is less severe for data on city population growth rates, since these are based on multiple sources, and also corroborated by other, independently collected data on urban population growth. We are, however, not able to distinguish between rural to urban migration and natural growth in urban populations. The next version of this paper will include a measure of urban relative to rural population growth as an indicator of the level of migration.

2. Theory

According to what is often referred to as the *resource scarcity perspective*, population growth and density may lead to scarcity of renewable natural resources such as productive land, freshwater, and forests. Resource scarcity is assumed to lead to increased inter-group competition, and under unfavorable economic and political conditions, such competition can take the form of violent conflict. Poor countries are argued to be particularly susceptible to resource conflicts as they often lack the capacity to adapt to environmental change. Weiner & Russell argue that societies have very different political, financial, and administrative capacity to respond adequately to increasing resource demands, and that such strains can threaten stability and security (2001: 3).

A major reference point in this debate is Thomas Homer-Dixon (1999; Homer-Dixon & Blitt 1998). He distinguishes between three main sources of resource scarcity (e.g. Homer-Dixon & Blitt, 1998: 6). *Supply-induced scarcity* results from degradation or depletion of natural resources. It becomes less of a resource as a result of non-sustainable use that does not allow the resource to regenerate. *Demand-induced scarcity* is primarily caused by population growth. If a resource base is constant, the availability of resources per person will diminish with the increasing number of people that have to share it. Such scarcity can also arise from an increase in demand per capita. A third form is *structural scarcity*. This is a form of scarcity that only applies to certain groups that, relative to other groups, are excluded from equal access to particular resources. Such unequal social distribution of a resource does not presuppose actual scarcity if the resource was distributed evenly. The likelihood of violent conflict is greatest when these three forms of scarcity interact.

In the resource scarcity literature, rapid urbanization is seen as a possibly destabilizing outcome of rural resource scarcity (Gizewski & Homer-Dixon, 1995; Homer-Dixon & Blitt, 1998; Homer-Dixon, 1999; Kahl, 2006). People living in increasingly environmentally marginalized areas are moving to cities, responding to 'push factors' such as increasing poverty brought about by greater degradation or more unequal access to renewable resources, and to 'pull factors' like prospects for employment, education, health care, and other social services.[1] Acknowledging that 'past research has shown surprisingly little correlation between urban growth and strife', Homer-Dixon argues that earlier research has failed to find a relationship between rapid urbanization and conflict due to simplistic bivariate studies that do not assess the interaction between urban growth and economic and political developments (1999: 155; 160).

How urban growth and changing population structure is managed will be important for citizens. Rapid urban growth can seriously constrain local governments' ability to provide basic services to populations. Conditions of rapid growth in urban populations can place strains on employment, housing, basic service provision, enforcement of law and order and development of social capital, greatly affecting the quality of life of the citizens. Goldstone (2002: 10) claims that it is exactly when overurbanization combines with underdevelopment, and where job creation and economic growth can't keep up with urban growth that violence and instability may arise. Similarly, the mixing of ethnicities and shifting demographic composition of urban centers are cited as key destabilizing factors in urban environments. Kahl (2006: 132) found that rapid rural-to-urban migration pushed the urban infrastructure and social services beyond their limits in Kenya in the 1990s, and that this was primarily to blame for urban inter-ethnic conflict. Huntington (1996: 113) argues that the 'newly uprooted masses' of rural to urban migrants throughout the Islamic World in the 1970s and 1980s were attracted to radical Islamic movements as these were providing slum dwellers with social services and offered them a 'dignified identity'.

Focusing primarily on the link between rural-to-urban migration and violence, Gizewski & Homer-Dixon (1995) point to three broad factors. First, rural–urban migrants are likely to experience economic marginalization and relative deprivation, increasing their awareness of their own situation and hence potential for political radicalization. Second, migrants may experience difficulties in adjusting socially and psychologically to life in the city, and traditional sources to social authority and control are weakened. Third, the urban environment facilitate high levels of social communication, so that the opportunity for collective political action is greater. They further hold that in order to produce violence, urban growth rates have to interact with key factors like economic crises, institutional breakdown, a high degree of communalism or ethnic cleavage, growing demands for democratization, the level of organized crime, and the availability of weapons in the urban environment. While data limitations prohibit testing rural-urban migration directly, we will consider the relationship between overall urban growth rates (capturing both natural growth, changes in definitions of urban populations or city borders, and migration) and urban disturbance. We hypothesize that:

[1] Migrants generally respond to both 'push' and 'pull' factors. Typically, as opportunities for economic outcomes in rural areas become more marginal, even limited opportunities for wage labor in the city become increasingly attractive.

H1: High urban growth rates are associated with higher levels of urban social disturbance, in particular in the context of economic shocks, low state capacity, and lack of democracy.

While rural-urban migration is seen as the mechanism linking rural resource scarcity and urban violence, we also assess this relationship directly:

H2: High levels of renewable resource scarcity on the country level are associated with higher levels of urban social disturbance.

Finally, we assess directly some indicators of urban environmental, economic and social stressors:

H3: The higher the lack of access to public services like proper housing, water and sanitation in urban areas, the higher the levels of urban social disturbance.

3. Data and Methodological Approach

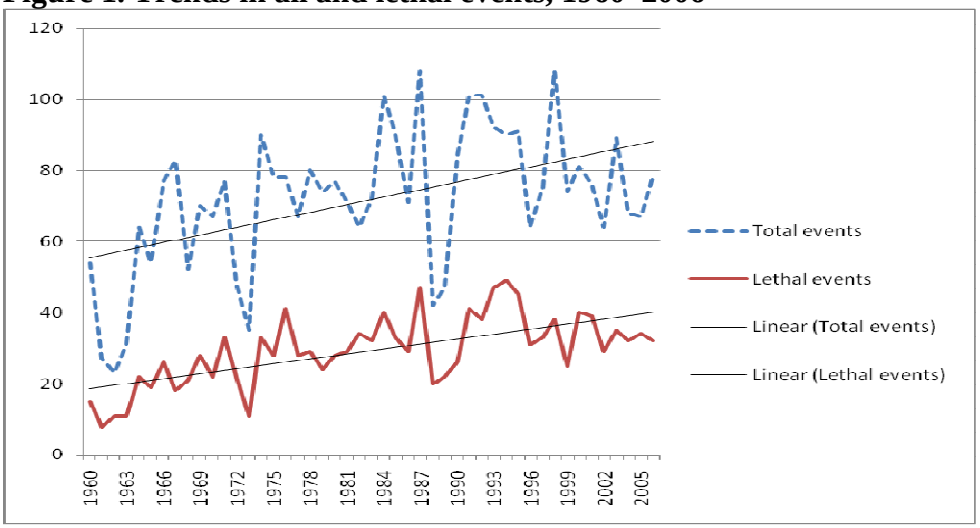
The study covers 55 major cities in 49 different countries with yearly observations for the 1960–2006 period. Most cities are found in developing countries; the data include 23 cities in Sub-Saharan Africa and 32 in Central- and East Asia. The sample is determined by the availability of the urban social disorder (USD) data, compiled from electronic news reports in the 'Keesing's Record of World Events' (KRWE). The data collection builds on a similar project developed for the State Failure Task Force (Marshall, 2001). The dataset covers different forms of both violent and non-violent politically motivated disorder, including demonstrations, rioting, terrorism and armed conflict. To the extent possible, each event is coded with precise date and location, and casualties. Here, we use two count measures of urban social disorder aggregated to the annual level for each city. We separate between *lethal events*, including only those events reported to have resulted in at least one death, while *non-lethal events* include only those events where no deaths were reported. While many non-lethal events may also be largely *non-violent* events, non-lethal events may have involved violence that did not lead to deaths, or it could be that deaths that occurred were not reported in the relevant news reports.

There are a total of 3,375 events coded, of which 1,378 (40.8 per cent) are reported to have led to deadly fatalities. Accordingly, 33.9 percent of all city-years experienced non-lethal events, while 25.2 percent of the observations hosted at least one violent event. When added together we can see that, over time, there has been an increasing trend, both in the number of total events and in the number of lethal events, albeit with very considerable variation from one year to the next (Figure 1). As illustrated by the linear trend lines, the total number of events has been rising more rapidly than the number of lethal events. This could be a consequence of better reporting, where, over time, less serious events are reported to a greater extent in the media.

While news reports in the KRWE do not cover all relevant social disturbance events, we assume that trends in reported events over time and between cities are generally representative of the true trends. It is important, however, to note potential biases. First, strong and autocratic regimes are better positioned to censor information about disturbance events. However, they are also likely to be relatively successful in preventing disturbance events from happening, making it

inherently difficult to empirically distinguish between bias and regime effect.[2] Second, certain geographic areas are receiving better media coverage than others. Events happening in countries that are low on the international agenda are arguably less likely to be reported than similar events in countries of great political and economic importance. Finally, improvements in communications technology over time and increasing international presence in more locations could lead to a time trend bias. These time trends may also vary geographically, as the media interest in specific regions and countries changes over time.

Figure 1. Trends in all and lethal events, 1960–2006



The explanatory variables are measured at either of two different levels of aggregation; city-level (for most of the urban population indicators and two proxies for environmental conditions), and state-level (remaining variables). The main explanatory variable in the models evaluating Hypothesis 1 is growth in the urban population. We consider several alternative measurements of growth to corroborate our results. The primary measure used is city *population growth*, based on city-level total population data from the UN Demographic Yearbook (UN, annual), supplemented by data from two online resources, the World Gazetteer (n.d.) and City Population (n.d.). Annual city population estimates were constructed by interpolating linearly between the available observations, and extrapolating (for a maximum of five years) based on the rate of growth between the last two observations. Inter-annual growth rates were constructed based on the annual population estimates and smoothed by estimating five-year moving averages.[3]

Supplementing the UN-based population data, we calculated the city-specific population growth rate using geographic information systems (GIS) software, based on CIESIN's Gridded Population of the World data (GPW v.3.0).[4] We selected a coarse grid resolution of 1x1 degree

[2] Pyongyang, North Korea, has been excluded from this dataset since it represents an extreme case in point.

[3] This procedure ameliorates the problem of sharp spikes in the growth data. Using the raw inter-annual growth rates produce virtually identical results.

[4] See http://sedac.ciesin.columbia.edu/gpw/.

before identifying the grid cells to which the 55 cities correspond. The GPW data are available for every 5 year since 1990, and we used linear interpolation to fill in missing values. From this, we calculated the inter-annual and five-year growth rates. In addition, we use five-year growth rates for the entire urban population based on a new dataset on urban and rural populations (UN, 2008b). Although the growth indicators are not highly correlated (0.32-0.58) all three measures produce quite similar results. To save space, we thus report results obtained with the first variable operationalization only.

In response to Hypothesis 2, we use three complementary national-level indicators of environmental scarcity, derived from Theisen (2008): per capita availability of freshwater (log-transformed), land degradation (dummy variables for 'medium' and 'high' levels of degradation, 'low' degradation being the reference category), and the amount of damaged drylands, measured in percentage of all drylands in the country. All three indicators originate from the UNEP-commissioned Global Assessment of Human Induced Soil Degradation (GLASOD) project. These data are only available for the period 1979–2001.

To empirically evaluate Hypothesis 3, we include three measures of urban environmental conditions, representing the entire urban populations in the respective countries, made available as part of the UN Population Division's World Urbanization Prospects (UN, 2007). The most general measure used is the percentage of the *urban population living in slum areas*, defined as population living in households lacking one or more of the following: durable housing, sufficient living area, access to an improved water source, access to improved sanitation, or secure tenure. The data originate from UN HABITAT. Two additional, more specific indicators that are originally collected by the World Health Organization measure the *percentage of urban population with access to an improved water source*, and the *percentage of urban population with access to improved sanitation facilities*. All three measures are available for one year of observation per country (2004-05), and these point estimates have been assigned to all years from 1995 through 2006. Furthermore, we include two city-specific measures of environmental conditions that were collected as part of the UN HABITAT's (2008) Global Urban Observatory (GUO): *percentage of households connected to piped water* and *percentage of households connected to sewerage*. The database provides estimates for two points in time only, 1993 and 1998. The 1993 estimates were assigned to the 1990-1995 period, while the 1998 estimates were assigned to 1996 through 2000.

The following control variables are included in all models: log-transformed *city population size* (UN, annual); dummy variables for *democratic* and *autocratic* regime types, coded from the Scalar Index of Polities (SIP) data (Gates et al. 2006); *level of development*, represented by log-transformed real GDP per capita data (Gleditsch, 2002); a dummy for *economic shock*, defined as a negative change in real GDP per capita since the previous year; and *ongoing armed intrastate conflict* from the UCDP/PRIO Armed Conflict Data (Gleditsch et al., 2002).

We use negative binomial regression to analyze both event count measures. This approach was chosen due to the skewed distribution of events with a few high-violence observations and a majority of relatively peaceful ones.[5] All models are run with a *lagged dependent variable* (*LDV*) to account for temporal dependence between observations. In

[5] For robustness tests, all models were also run with a fixed-effects logit estimator, using a binary dependent variable that indicates whether there was at least one disturbance event in a given city-year. Results from these tests differ only marginally from those reported here.

addition, *city fixed effects* are specified to account for unobserved heterogeneity between the cities.

4. Results and Discussion

The empirical evaluation of the proposed hypotheses is conducted by means of three sets of regression models, presented in separate tables below. Results from several complementary proxies and interaction effects are reported, covering both non-lethal and deadly urban unrest. In addition, we have tested a wide selection of alternative variable operationalizations and model specifications that generally failed to produce results significantly different from those discussed here. Overall, we find very little evidence of a systematic connection between population pressure, resource scarcity or urban environmental problems and an increased risk of violent urban unrest.

Table 1 shows the results from four pairs of models designed to test the urbanization hypothesis (H1) on fatal and non-fatal events. All models include our main proxy for urbanization: five-year moving average of population growth at the city level. Models 2–4 further include interaction terms between urbanization and democracy, economic level of development, and economic shock, respectively. In addition, all models include city population size as well as country-level controls for regime type, development, economic shock, ongoing armed conflict and a lagged dependent variable to handle duration dependence. The number of observations differs slightly between the fatal and non-fatal samples. This is because the fixed effects estimator by design excludes units without variation on the dependent variable. Three cities in our sample did not experience deadly disorder during the full sample period (Astana, Singapore, and Ulan Bator) while only one city (Singapore) also avoided non-fatal unrest.

In contrast to the demand-induced scarcity perspective, Table 1 shows no general effect of population growth on the frequency of political violence. Indeed, the negative sign of the parameter estimate found in most of the regressions actually suggest that an opposite effect is more probable. The interaction term between population growth and democracy (Model 2) fails to affect this preliminary conclusion. But surely, population growth must be a more destabilizing force in poorer societies and countries in economic recession? Not so, according to Table 1. The combined effect of high population growth and low per capita income appears to *reduce* the expected frequency of fatal urban disturbances (Model 3). The separate estimate for population growth is now positive but remains insignificant. For non-fatal events, the signs of these regression coefficients swap places but the effects are weak.[6] In Model 4, we assess the joint impact of high population growth and national economic shock (i.e. negative growth rate last year). This interaction displays a negative and significant association with fatal disorders in the city, suggesting that economic hardships are less hazardous in cities with considerable population growth. For non-fatal events, this interaction has only a negligible impact. In sum, Table 1 strongly dictates a rejection of Hypothesis 1.

So what explains urban violence, then? The variables in Table 1 with the strongest and most consistent effects are autocracy and economic shock. Regardless of severity level, social

[6] Given the high level of multicollinearity in the model, one should be careful about interpreting too much from individual p values. However, the fact that the addition of the interaction term adds little to the overall fit of the model suggests that we are right to dismiss this effect.

unrest is significantly less likely in cities in authoritarian states than in the reference group, the semi-democracies. While this might correlate with a reporting bias in the KRWE database, upon which the violence coding is based, we believe it reflects the true nature of authoritarian rule, where public demonstrations are illegal and defiance is harshly punished. Somewhat weaker in marginal impact but still robustly significant across all models, we find economic shocks to be a significant risk factor. Interestingly, this effect disappears almost completely if we use a lagged shock variable. This could indicate an endogeneity problem, or even reverse causality. Yet, violent urban protest is unlikely to have a measurable impact on the national growth rate, unless the violence were to escalate into armed conflict. In fact, we find it much more problematic to assume a one-year time lag between economic problems and people turning to the streets.

The effect of democracy is heavily dependent on the level of violence. For deadly riots, the dampening effect of democracy is stronger than the positive effect of economic shock, but for non-fatal events its influence is indistinguishable from zero. Democracies by design allow for political demonstrations, and even though the protests sometimes turn violent, they rarely evolve into bloodshed. Somewhat surprisingly, the size of the city is only weakly associated with the frequency of urban disorder. GDP per capita, too, exhibits a non-significant relationship with the dependent variable, contrasting its powerful negative effect on civil war (e.g. Hegre & Sambanis, 2006). Finally, we see that an ongoing civil conflict is strongly associated with fatal riots.

Table 1. Population growth and urban violence, 1966–2001

	Model 1		Model 2		Model 3		Model 4	
	Fatal	Non-fatal	Fatal	Non-fatal	Fatal	Non-fatal	Fatal	Non-fatal
Population growth	-0.011	-0.014	-0.006	-0.012	0.271	-0.209	0.010	-0.009
	(0.79)	(1.09)	(0.37)	(0.86)	(1.55)	(1.42)	(0.61)	(0.58)
Population growth × democracy			-0.056	-0.024				
			(1.26)	(0.63)				
Population growth × inverse GDP capita					-2.105	1.463		
					(1.62)	(1.33)		
Population growth × economic shock							-0.057	-0.015
							(2.18)**	(0.65)
City population	0.083	0.122	0.081	0.123	0.070	0.136	0.083	0.120
	(1.03)	(1.78)*	(1.00)	(1.79)*	(0.85)	(1.96)**	(1.03)	(1.74)*
Democracy	-0.366	-0.037	-0.140	0.056	-0.354	-0.050	-0.339	-0.031
	(2.25)**	(0.27)	(0.59)	(0.28)	(2.16)**	(0.37)	(2.07)**	(0.23)
Autocracy	-0.496	-0.295	-0.505	-0.298	-0.510	-0.283	-0.494	-0.292
	(4.29)***	(2.81)***	(4.36)***	(2.84)***	(4.38)***	(2.69)***	(4.28)***	(2.78)***
GDP capita	-0.113	0.136	-0.124	0.125	-0.225	0.207	-0.107	0.138
	(0.96)	(1.45)	(1.05)	(1.31)	(1.64)	(1.93)*	(0.91)	(1.47)
Economic shock	0.204	0.253	0.211	0.254	0.222	0.242	0.472	0.324
	(2.08)**	(2.90)***	(2.16)**	(2.91)***	(2.27)**	(2.75)***	(3.04)***	(2.32)**
Ongoing conflict	0.587	0.144	0.581	0.142	0.604	0.137	0.573	0.141
	(4.92)***	(1.37)	(4.85)***	(1.35)	(5.06)***	(1.30)	(4.80)***	(1.35)
LDV	0.104	0.093	0.103	0.093	0.101	0.094	0.101	0.093
	(6.25)***	(9.20)***	(6.15)***	(9.19)***	(6.03)***	(9.16)***	(6.05)***	(9.12)***
Constant	0.166	-1.772	0.231	-1.703	1.071	-2.359	0.036	-1.799
	(0.19)	(2.53)**	(0.26)	(2.40)**	(1.01)	(2.85)***	(0.04)	(2.56)**
Wald χ^2	142.87	144.95	144.20	145.15	145.08	145.50	147.71	145.89
Observations	1,626	1,707	1,626	1,707	1,626	1,707	1,626	1,707
Number of cities	50	54	50	54	50	54	50	54

Note: Negative binomial regression with city fixed effects. Absolute value of z statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Next, we turn to the environmental scarcity hypothesis (H2). This is no trivial test as good environmental data are hard to find, and good time-series environmental data are almost non-existent. In this paper, we include three complementary forms of environmental scarcity, derived from the GLASOD database. These data are by no means perfect (see e.g. Theisen, 2008), but they do come with some temporal variation.

Models 5–7 in Table 2 successively test three proxies for environmental degradation: freshwater availability, land degradation, and damaged drylands. These variables all refer to conditions in the country as a whole and need not be particularly representative for the situation in the studied cities. However, supply-induced scarcity leading to increasingly challenging living conditions in the countryside may provoke rapid urbanization, creating or amplifying social tensions in urban areas. Table 2 at best provides only indicative evidence of such a causal chain. Neither the measure for (logged) freshwater per capita nor the dummies for medium to high soil degradation are significantly associated with the frequency of violent unrest. Still, water availability displays a negative estimate for both severity levels, and just misses the 90% significant threshold for fatal events. Moreover, we see that the proportion of a country's drylands that is damaged beyond repair significantly increases the frequency of urban violence (Model 7).

The control variables behave largely similar to the reported effects in Table 1, with two exceptions. First, the dummy for economic shock is no longer associated with higher risk of city protests. This could imply a serious selection bias, although the number of included cities is still considerable. On closer inspection, we find that the powerful effect of economic shock reported above is quite sensitive to sample selection and model specification (see also Table 3). Second, we see that economic development has tripled its impact on non-fatal riots compared to the models in Table 1, and the parameter estimate is consistently positive. All else held constant, it thus appears that non-fatal urban violence is primarily a feature of relatively developed countries. That said, we refrain from placing too much emphasis on this finding as we generally have more confidence in the results obtained from analyzing a larger temporal domain.

Table 2. Country-level environmental scarcity and urban violence, 1979–2001

	Model 5		Model 6		Model 7	
	Fatal	Non-fatal	Fatal	Non-fatal	Fatal	Non-fatal
Freshwater pr capita	-0.185	-0.136				
	(1.63)	(1.29)				
Medium land degradation			0.038	-0.148		
			(0.06)	(0.39)		
High land degradation			-0.399	0.378		
			(0.61)	(0.88)		
Damaged drylands					0.010	0.007
					(2.16)**	(2.05)**
City population	-0.092	-0.007	-0.011	0.030	-0.004	0.091
	(0.69)	(0.07)	(0.09)	(0.27)	(0.03)	(0.86)
Democracy	-0.448	-0.137	-0.454	-0.146	-0.459	-0.135
	(2.22)**	(0.83)	(2.29)**	(0.88)	(2.27)**	(0.82)
Autocracy	-0.639	-0.214	-0.697	-0.184	-0.670	-0.181
	(4.68)***	(1.70)*	(5.14)***	(1.47)	(5.00)***	(1.46)
GDP capita	0.118	0.443	0.264	0.393	0.209	0.471
	(0.68)	(2.99)***	(1.37)	(2.51)**	(1.12)	(3.17)***
Economic shock	0.005	0.184	0.014	0.174	0.010	0.166
	(0.04)	(1.75)*	(0.12)	(1.65)*	(0.09)	(1.58)
Ongoing conflict	0.434	0.092	0.554	0.133	0.508	0.169
	(2.93)***	(0.66)	(3.57)***	(0.94)	(3.36)***	(1.20)
LDV	0.070	0.085	0.069	0.083	0.069	0.084
	(3.54)***	(6.33)***	(3.49)***	(6.29)***	(3.53)***	(6.41)***
Constant	1.217	-2.234	-1.645	-3.265	-1.893	-4.369
	(0.76)	(1.55)	(1.08)	(2.71)***	(1.28)	(3.86)***
Wald χ^2	63.11	74.88	71.09	79.42	73.80	81.90
Observations	939	1,006	1,018	1,041	1,018	1,041
Number of cities	45	49	48	50	48	50

Note: Negative binomial regression with city fixed effects. Absolute value of z statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Finally, we offer a series of empirical tests of Hypothesis 3. The new variables included in Models 8–12 are measured specifically for each city and provide some quantified indication of the quality of public services and extent of urban environmental problems. These data are largely time-invariant and cover only the most recent years. This limited temporal coverage, in turn, implies that a larger share of the cities lacks variation on the dependent variable, leading to a dramatic reduction in the number of observations. It should come as little surprise, then, that the environmental variables in Table 3 fail completely to substantiate the expectation formulated in H3. The only significant effect for environmental factors is found in Model 12, where cities with a larger share of the households enjoying sewerage connection are more inclined to host non-fatal disturbances. This model (as well as Model 11) presents another puzzling result too; apparently, cities in authoritarian states are now significantly positively associated with urban unrest, strongly contrasting the findings in Table 1. This lack of consistency in performance (which also applies to ongoing conflict and the lagged dependent variable) is a serious concern and suggests that the value added of these models is rather limited. In future iterations of the paper, we will explore ways to extend the sample (while avoiding untenable assumptions) in order to provide more fruitful conditions for hypothesis testing.

Table 3. City-level environmental scarcity and urban violence, 1990–2001

	Model 8		Model 9		Model 10		Model 11		Model 12	
	Fatal	Non-fatal	Fatal	Non-fatal	Fatal	Non-fatal	Fatal	Non-fatal	Fatal	Non-fatal
Urban slum	-0.036	-0.037								
	(1.12)	(1.29)								
Urban sanitation			0.016	0.015						
			(0.60)	(0.30)						
Urban water access					-0.038	-0.052				
					(0.99)	(1.43)				
Piped water							0.455	1.251		
							(0.54)	(1.64)		
Sewerage connection									0.420	1.165
									(0.59)	(2.06)**
City population	0.360	0.250	-0.024	0.218	0.066	0.080	-0.334	0.087	-0.420	0.124
	(0.87)	(0.84)	(0.05)	(0.66)	(0.17)	(0.26)	(1.15)	(0.38)	(1.27)	(0.49)
Democracy	-0.131	0.389	-0.376	0.236	-0.190	0.360	0.473	0.316	0.616	0.351
	(0.22)	(0.72)	(0.63)	(0.42)	(0.34)	(0.70)	(1.11)	(0.89)	(1.34)	(0.98)
Autocracy	-1.073	0.002	-1.078	0.150	-1.003	0.227	-0.055	0.535	0.027	0.691
	(2.62)***	(0.00)	(3.01)***	(0.41)	(2.89)***	(0.65)	(0.20)	(2.32)**	(0.09)	(2.79)***
GDP capita	-0.012	0.149	0.053	0.651	0.801	1.115	0.307	0.868	0.192	0.632
	(0.01)	(0.22)	(0.07)	(0.93)	(1.15)	(2.47)**	(0.77)	(2.28)**	(0.36)	(1.35)
Economic shock	0.335	0.430	-0.069	0.512	0.043	0.477	0.315	0.648	0.246	0.570
	(1.32)	(1.86)*	(0.28)	(2.38)**	(0.20)	(2.32)**	(1.44)	(3.51)***	(1.08)	(2.99)***
Ongoing conflict	0.205	0.065	0.760	0.215	0.689	0.087	0.421	-0.064	0.630	0.112
	(0.61)	(0.19)	(2.44)**	(0.58)	(2.36)**	(0.28)	(1.52)	(0.26)	(2.14)**	(0.41)
LDV	-0.063	-0.001	-0.077	-0.005	-0.092	-0.006	-0.036	-0.008	-0.045	-0.001
	(1.02)	(0.03)	(1.49)	(0.12)	(1.75)*	(0.16)	(0.46)	(0.23)	(0.56)	(0.02)
Constant	1.825	-0.276	-0.207	-6.454	-1.903	-4.192	-1.664	-7.577	-0.546	-5.651
	(0.27)	(0.04)	(0.04)	(1.86)*	(0.39)	(1.33)	(0.52)	(2.75)***	(0.14)	(1.82)*
Wald χ^2	12.69	11.18	16.75	9.57	17.75	11.23	10.08	22.01	12.71	27.97
Observations	214	213	240	239	247	246	285	327	269	303
Number of cities	33	33	37	37	38	38	30	35	28	33

Note: Negative binomial regression with city fixed effects. Absolute value of z statistics in parentheses. Models 8–10 represent 1995–2001 only.
* significant at 10%; ** significant at 5%; *** significant at 1%.

The largely insignificant and in some cases inconsistent results reported in Table 3 highlight a major challenge that continues to set limits to quantitative efforts to test environment-conflict linkages across cases. While recent advances in geographic information systems (GIS) and satellite imagery technology has led to massive improvements in environmental data quality for the contemporary world, accurate measures of freshwater availability or soil productivity for past decades remain wanted. As a consequence, we are more confident in the empirical evaluation of the population growth hypothesis (H1) than in the tests designed to test H2 and H3. In fact, Models 1–4 have been assessed using a wide selection of different population measures, including GIS-generated local indicators and UN statistics on national urbanization rates. We have also experimented with more substantive model specification issues, including recoding the dependent variables as binary indicators of fatal/non-fatal events in year (yes/no) and applied a fixed-effects logit estimator. All these tests failed to produce results that deviate substantively from those reported above.

5. Conclusions

This paper has found no evidence that rapid population growth in cities is associated with an increased frequency of urban violence. A variety of model specifications and variable operationalizations were tested, and all came out negative. This non-result could be due to poor data, selection bias or mis-specified models, but it might just as well reflect the true, general relationship: population growth and urban political violence are causally unrelated.

Our measure of population growth by no means satisfactorily represents rate of urbanization. Yet, the two processes are certainly positively correlated, even if the contribution of urbanization on population expansion, relative to a high fertility rate, will vary between cases. Hence, we believe that the robustly non-significant result of population growth on urban disturbances also speaks to the urbanization-violence nexus, to which much of the contemporary environmental security debate refers. In fact, it might well be the case that urbanization under certain conditions could function as a safety valve, relieving the pressure on the environment in the rural countryside. It is certainly a thought worth exploring further.

The mostly non-significant results for the large selection of environmental measures also counter the crux of the eco-scarcity literature. We are less confident about the robustness of these tests, however, as inadequate dynamics and a short temporal coverage of the environmental data substantially reduce the valid sample size. Besides, most of these indicators are measured either for the country as a whole or for all urban areas within the country. In this regard, the increasing use of GIS and geo-referenced data collection bodes well future research.

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