

GEO 506: Geographical Information System
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**The Effects of Demographic Factors
On the Concentration of Civil Wars:
A GIS-Based Analysis**

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1. Abstract

Do densely populated areas experience far more conflicts (and civil wars) than sparsely populated areas? If so, why? How do rebel groups select the sites where they will fight against the governments? Even though the conventional wisdom is telling that intrastate conflicts tend to occur further away from the capital and in remote areas where it is easier to use “hit and run” tactics for insurgent groups and especially they become relatively stronger compared to the incumbents; my findings suggest the opposite. Using the data drawn from the UCDP/ PRIO Armed Conflict Dataset (Gleditsch et al., 2002), geo-referenced data of African Civil Wars from UCDP GED (Uppsala Conflict Data Base Program Geo-referenced Data) (Sundberg et al., 2013) and population density data from USGS (U.S. Geological Survey, 2010) for the civil wars and population density in African Continent, this paper demonstrates two distinct results: First, civil wars tend to take place more in densely populated urban areas rather than less populated ones, when the states are stronger. Second, on the other hand, they tend to occur more in the sparsely populated areas when the states are weaker.

2. The Introduction

In war (and especially civil war) studies; some factors like geography (mountains, forests, rivers, seas, borders etc.) or some others like economy (precious resources (e.g. oil, diamond), GDP etc.) or demography (population density, urban/city differences etc.) have always attracted substantial interest of scholars in explaining the possible reasons and/or contributing factors for onset of civil wars. To illustrate; in previous literature; some studies (Fearon and Laitin, 2003, 75) postulate that “rough terrain, poorly served by roads, at a distance from the centers of state power, should favor insurgency and civil war” or some others studies like (Hegre, Østby & Raleigh, 2009) conclude “precious resources do not increase the likelihood of experiencing a conflict event in Central Africa and Liberia, where resources were presumed to influence conflict dynamics”. The opportunity aspects (a simple cost-benefit analysis), the motivation (e.g. relative deprivation) and grievances (ethnic affinity, religion, social class, etc.) and many other aspects of rebellion have been discussed at considerable length many times elsewhere (Collier and Hoeffler, 2004, Fortna, P., 2011, Hegre, H., Østby, G., & Raleigh, C. 2009, Kalyvas, S. N., 2004, 2006)

In this study, by employing Geographic Information Systems (GIS) as a way to model center-periphery dyads that confront governments with excluded groups, I will mainly focus on to investigate whether ‘demographic factors’ like “**population density**”, “urban/rural areas” and “center/periphery” difference in conflict zones have any impact (or relation) on the concentration of civil wars. Inherently, noticing the affects of population is not easy by only naming a population variable and searching a possible link in a highly aggregated data like I studied here. But at this point GIS will be at least provide some possible variants to investigate these causal mechanisms and will be very useful in supplying a clearer picture of the real conditions. I select the African Continent as an area of study mainly due to two particular reasons: the African Continent is where (1) civil wars largely occur and (2) the only reliable geo-referenced event datasets are available at our disposal for now. My research question in this paper is that “Do civil wars tend to take place more in populated urban areas rather than less populated ones, when the states are stronger. And/or civil war occurrences tend to occur more in the sparsely populated areas when the states are weaker?

In today’s world, we often experience that many rebel groups like the Kurdistan Workers’ Party (PKK), the Farabundo Martí National Liberation Front (Frente Farabundo Martí para la Liberación Nacional, FMLN), the Revolutionary Armed Forces of Colombia (Fuerzas Armadas Revolucionarias de Colombia, FARC) and so on fight generally against

the governments. We know that they fight or in general why they fight? But do we know also **where** they choose to fight? If they fight some particular places then it would be easier for all of us to grasp some valuable implications and find some remedies of years-long problem of civil wars and misery.

Though the place fighting occurs in the intrastate wars may change dramatically and may be determined out of unintentional selection by either party, the place is important. I emphasize that location is important and as the first law of geography according to Waldo Tobler is "Everything is related to everything else, but near things are more related than distant things." (Tobler W., 1970), then each conflict occurrences should carry some particular meanings that need further investigation.

In the current literature, conventional wisdom follows Kenneth Boulding's (1962) notion of a loss-of-strength gradient (LSG) that the capability of a country (a.k.a. its national strength) is largest at its home base and declines as the nation moves away and capable states are relatively less impeded by distance and can therefore influence more distant regions and thus given armed conflict, battles are expected to occur in areas where the projected powers of the antagonists are comparable. That is why it claims that we see civil wars in general locate further away from the capital (in peripheral areas) most of which are less populated rural areas.

On the other hand, some other influential studies (Fearon and Laitin, 2003, 80) also argue that the presence of rough terrain, poorly served by roads, at a distance from the centers of state power, should favor insurgency and civil war, which implicitly points the rural areas as a location of civil wars. And some other studies also (Collier and Hoeffer, 2004, 569) support the same logic by asserting that the areas containing forests and mountains provide rebels with a safe haven and more conflict-prone. Tough my aim is not to disprove all these studies I want to challenge these common assumptions and bring to the forefront that how GIS (Geographical Information Systems) can help us to double check these scholars' assumptions on whether remote and rural areas always **conflict-prone** or not. I will look at the correlational empirics and do some hypotheses testing to examine and show at least how many deviant cases seemingly tell different stories even on a topic we do think that we know a lot. Overall, the results provide considerable support for the proposition that civil wars in general break out more in densely populated areas than do other conflicts, where the states are stronger and more in sparsely populated areas where the states are weaker.

3. The Relationship Between Demography And The Civil War Occurrence

Examining civil wars with no or little emphasis on 'location' is not plausible. Obviously, every conflict has some relevance with their location of their occurrences. Location is important in many aspects. Why do penguins live exclusively in the Antarctica (South Pole) or polar bears live exclusively in Arctic (North Pole)? And accordingly, why civil wars occur in certain countries of the world and even in some certain geographies and conditions within these countries? To an inquisitive mind, it should have some reasons. Even though there are lots of explanatory variables interacting to explicate a real world event like war/conflict, location should precisely be one of the important ones. Then it is not implausible to ascertain what makes different each location is important. And at this point I want to assert that my curiosity and interest here is whether the demographic factors like how population density in an area can most likely have a say on explaining why, where and how often civil wars occur.

So far unfortunately we have little evidential knowledge on the local determinants of civil war—I mean, what explains where conflicts occur within countries. Lack of reliable

data certainly plays a role in explaining this deficit, but so does the tendency to consider the state as the sole recognizable actor, and hence the obvious analytical focal point. If we look at the examples throughout the world we can see many different environments where civil wars occurred and therefore we can state that a glance at today's conflicts provides only a mediocre support for our reasoning that civil wars occur in most populated areas. For example; while organized violence in the Niger Delta, Iraq, and Southern Sudan fits most of these characteristics, some others like the long-standing disputes over the self-determination of the Oromiya and Somali people tells a different story: They occur in **sparsely populated**, ethnically homogenous, and relatively well-off regions of Ethiopia. Or "some others like Aceh insurgency were confined to one of the wealthiest Indonesian provinces (largely due to enormous gas riches) and also one of the least populated ones" (Buhaug, 2010, 108).

To account for at least a rival alternative for all other possible explanations mentioned above, in the following section, I would try to outline a localized theory of civil war. I argue that a significant factor influencing the location of civil wars is a well-known feature of the demographic factors like '**population presence in the area**'. In places where population expands from high to low degrees—typically from urban and more industrialized areas to rural and less industrialized ones—emerging conflicts are likely to occur in the close periphery. Even though conventional wisdom tells us that weaker states normally pose less of a threat to armed non-governmental groups and may not be able to exert force outside urban areas, so in such countries the battles are expected to take place closer to the state's home base, however, at least in Africa this pattern is totally different. In Africa, conflicts occur surprisingly more in **densely populated** areas especially when the states are stronger. When it comes to theorize it, we can admittedly claim that rebel groups' relative lacking strength over stronger states in Africa can get these groups move and act more in urban areas and initiate more conflicts than anticipated since to materialize their goals the rebel groups have no other alternative but to target the stronger state inside the densely populated areas to sow terror in the public. Thus, populated areas for sure give these chances to them by containing many 'high-casualty' target areas like shopping malls, markets, crowded streets etc.

In the following sections, I also describe the dataset and choice of methodology, which will be explicitly more correlational. Before presenting and discussing the main findings from my empirical analysis, overall, I should state that the results provide considerable support for the proposition that civil wars in general break out in densely populated areas than do other conflicts when the states are stronger and sparsely populated areas when the states are weaker.

4. Measuring the importance of population in civil war occurrences

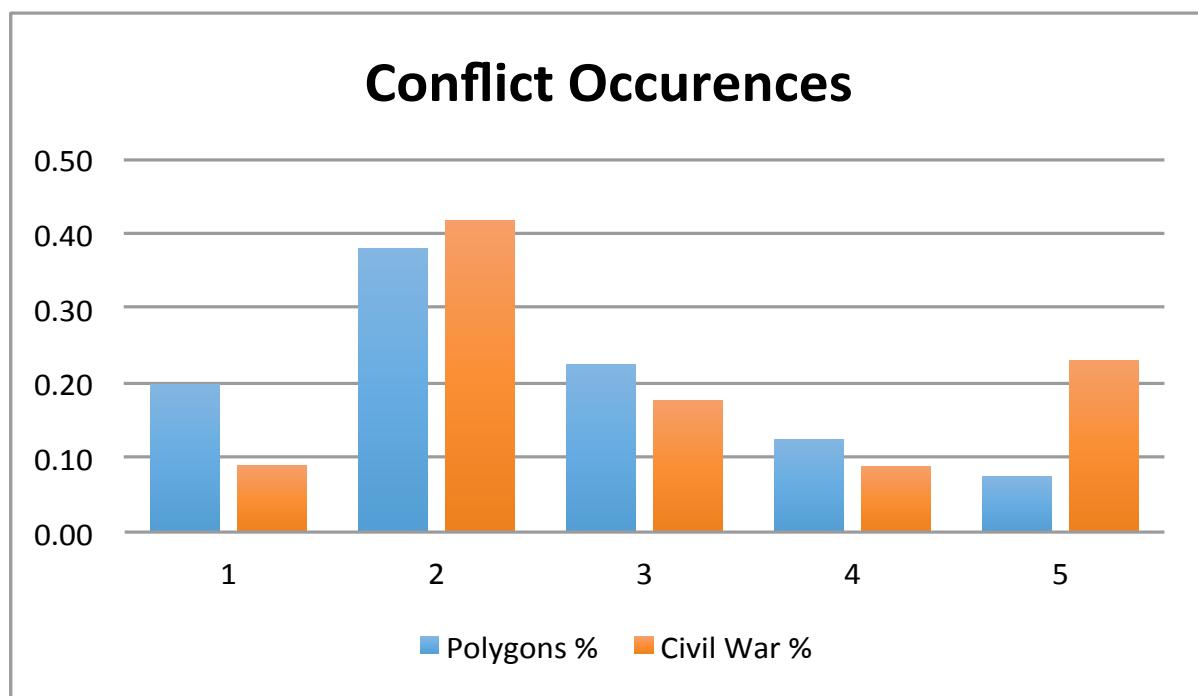
So far, empirical studies on civil war unfortunately are not successful enough to establish a link between geography and civil war. Though there are many other reasons for it, unavailability of technology that can ease the investigation of relatively hard and intricate issues like geography is surely one of them. But as Buhaug, H., & Gates, S. (2002, 400) describe in detail below, Geographical Information Systems (GIS) creates new perspectives for researches interested in the links between geography and war.

The theoretical framework for empirical studies on civil war and geography is often motivated by how local factors such as rebels' access to easily exploitable natural resources and sanctuaries in rough terrain increase the viability of insurgency. However, our review of the empirical literature shows that most studies ignore local conditions and instead use country aggregates in analysis. We argue that while it may be appropriate to focus on the national scale and use state-level geographical variables

*when exploring the risk of conflict, this research strategy is less suitable when the conflict is the unit of observation. This is particularly true for conflicts that are spatially limited and in cases with several simultaneous conflicts within the same country. We demonstrate that Geographical Information Systems (**GIS**) can be used to generate measures of geography that are unique to each conflict zone... Geographical Information Systems (**GIS**) can be used to generate **measures of geography** that are unique to each conflict zone.*

If location is important in explaining the variability in civil war occurrences, then what is the general pattern? I believe the data-generating and spatial analysis capability of GIS can offer some solutions. As Figure 1 illustrates how all cases out of some 24.000 civil wars occurred in Africa Continent between 1949-2010 scatter over the population density classification from low to high and the number of polygons including these conflict occurrences out of 1151 polygons (each polygon is a small, geographically divided part) of Africa Continent. Even though polygons are not divided evenly; in an aggregated manner their numbers achieves to offer some insights anyway.

In Figure 1, there are five population density categories: 1 (0-10 people per square kilometers), 2 (10-50), 3 (50-250), 4 (200-500) and 5 (500-1000). While blue bars represent the number of polygons in the data set and how they are scattered along population density of Africa, orange bars represent the number of conflict occurrences inside a particular population density. While we normally expect both the percentages of polygons and conflict occurrences be close to each other under the assumption of normal distribution, however, we instantly notice that though polygon distribution is a kind of normal, conflict occurrence distribution is **bimodal** for some reason. Interestingly 5.512 cases, roughly %23, fall into the most densely populated areas in Africa, which are merely 85 polygons (constituting only %7 of all polygons). That is, there is relatively a bunch of conflict occurrences (and which is clearly more than anticipated) in densely populated areas.



**Figure 1- Conflict Occurrences and Polygon Distribution
In Five Categories of Population Density**

Another interesting feature of the data is that 9980 conflicts (%42 of all) occurred in the second least populated areas (10-50 people per square km). This is also reversely correlated with the size of polygon quantities, meaning that there are more conflict occurrences in some sparsely populated areas than normally it is expected to be seen. And to my mind, even these **two peculiarities** of the data are enough to deserve further investigation.

Furthermore, examining the all conflict occurrences and population density maps shown in Figure 2, it is also apparent that ‘conflict location points’ interestingly match the most densely populated areas shown as red in the population density map on the right panel (as also shown I Figure 1 above). I add these two maps and the third map of simple overlap of the first two maps in the Figure 3 in order to show how even two simple visualization can offer some insights into various important research questions. The population density colors are monotonic starting from light yellow to darker tones in five different breaks. In Figure 3, we see that many conflict occurrences actually tend to occur in densely populated areas (which are typically more urbanized areas), which challenges the conventional wisdom strikingly.

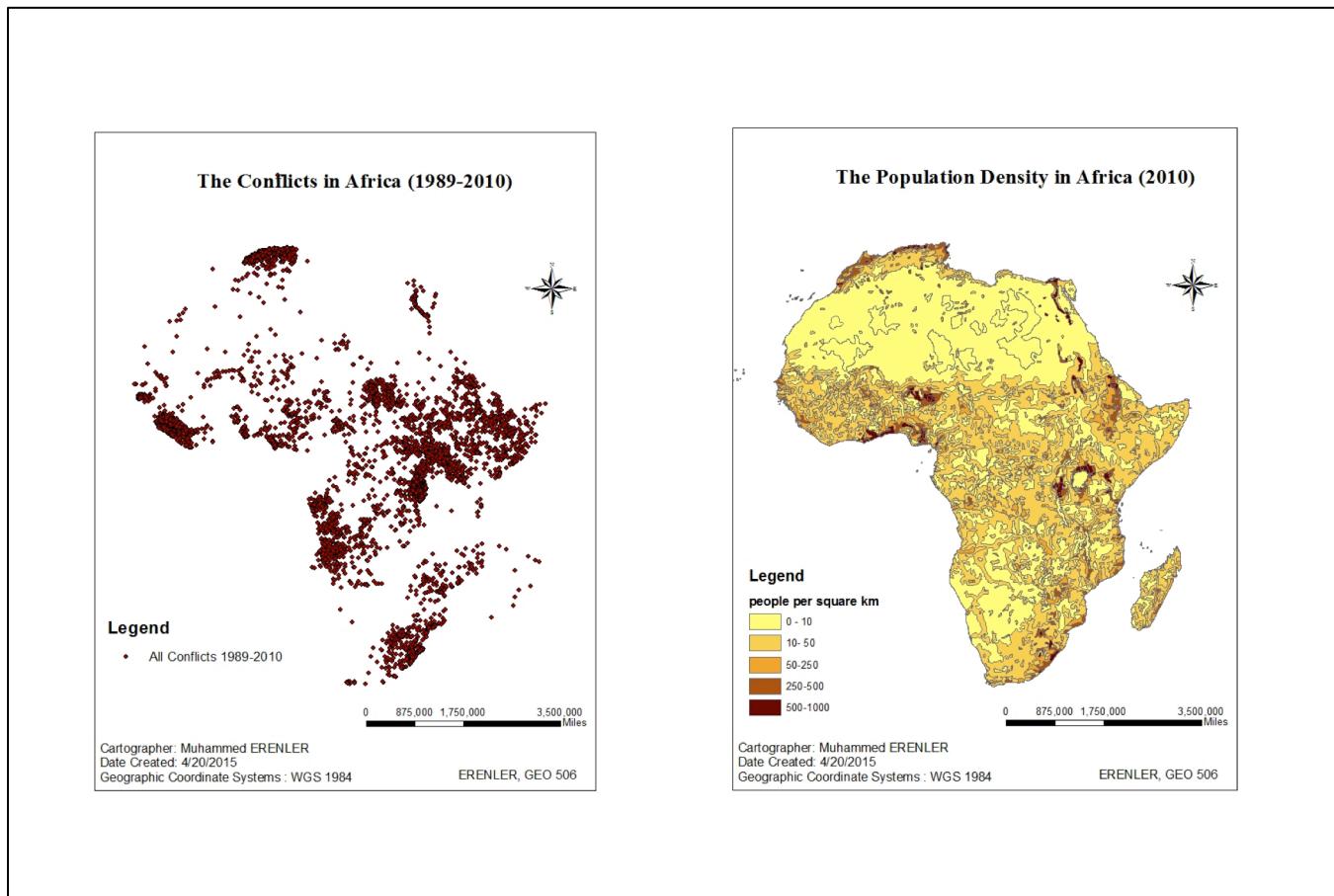


Figure 2- Conflict Occurrences and Population Density in Africa

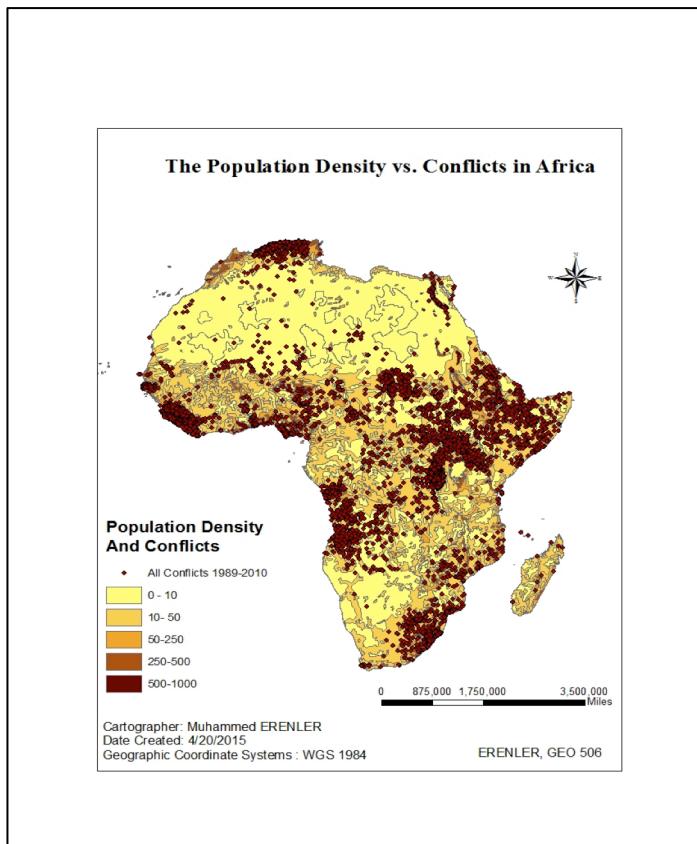


Figure 3- Conflict Occurrences and Population Density Overlap

5. Hypotheses

The opportunity aspects (a simple cost-benefit analysis), the motivation (e.g. relative deprivation) and grievances (ethnic affinity, religion, social class, etc.) aspects of rebellion have been discussed at considerable length elsewhere, so I will take these for granted and **more concentrate** in this article on the issue of **population density**. According to my theory, when the states are stronger, the rebel groups incite attacks more in populated areas in order to attract the population, galvanize their broader support and improve their “bargaining position by revealing to the regime information about rebel resolve and the likely costs of the conflict” (Wood and Kathman, 2014, 686). And populated areas serve as heavens for the rebel groups in order to achieve their main goals of terrorizing people and get some concessions from the governments because these areas often harbors more easy-to-attack high-casualty targets like shopping malls, restaurants, bus stations and markets and so on. And when the states are stronger, weaker rebels generally are compelled to employ clandestine and underground tactics; they mainly hide themselves inside the crowd and only wait to attack the targets to sow terror inside the community. Their weakness and state’s strength compels them to bring the conflicts into the more urbanized and populated areas.

The higher an area populated, the more civil wars occur. Why do highly populated areas can be important in determining the location and frequency of civil wars? The simple answer is that: “for a rebellion to occur—and succeed—the rebels must be determined and strongly motivated, share a sense of common cause, and be able to mobilize and exercise a force more powerful than the projected force of the government” (Buhaug, 2010, 109) and populated areas can provide substantial material, equipment and human resources by mobilizing/recruiting mechanisms more than sparsely populated areas. Even tough there are

currently many hot debates over the actual causes of outbreak of civil war like the motivation (e.g. relative deprivation) and identity (ethnic affinity, religion, social class, etc.) aspects of rebellion etc., they all have been discussed at considerable length elsewhere. And as I emphasized before, I shall take all for granted and concentrate here more on the relationship between conflict occurrences and densely populated areas. Then my first hypothesis as follows:

Hypothesis 1: *The intrastate conflicts tend to occur more in densely populated areas, the stronger the state, and the ceteris paribus.*

On the other hand, when the roles change, that is, the states are weaker and the rebels are stronger, this time the rebels do not primarily have to attract the attention of the population, to the contrary the governments this time have to find and attack the rebels in peripheries of the state. That is, the places of conflict occurrences are mainly determined by the relative strength of the actors. When the rebels are stronger, the governments are obliged to prove their power to protect their citizens and show them they are stronger than they have been approached. This mentality drags the governments to choose fighting in the peripheries where the rebel groups normally base their central camps, troops and headquarters. As it is clearer now, my understanding of conflict occurrences is that weaker sides choose to fight where the stronger side resides. If the weaker side is the rebel group, then it fights generally in most populated areas where the government resides. Or if the government is the weaker side, then it selects the remote areas where the rebel groups generally reside. This line of reasoning pave way to my second hypothesis as follows:

Hypothesis 2: *The intrastate conflicts tend to occur more in sparsely populated areas, the stronger the rebel groups, and the ceteris paribus.*

6. Research Design

To better understand the relationship shown above basically via visualized maps and historical narratives and to test my both hypotheses, now I will employ some statistical methods also. **First** I will examine the relationship between ‘conflict occurrences’ and ‘population density’ in an aggregated country-level data drawn from the UCDP/ PRIO Armed Conflict Dataset (Gleditsch et al., 2002), and **second** I will further investigate this relationship along with particular countries with the data both geo-referenced data of African Civil Wars from UCDP GED (Uppsala Conflict Data Base Program Geo-referenced Data) (Sundberg et al., 2013) and population density data from USGS (U.S. Geological Survey, 2010).

6.1 Heckman Selection Model and Some Distinct Cases

One particular aim of this paper is to seek to explore empirically whether the population density along with distribution of capabilities among state and non-state actors affects where conflict breaks out relative to the capital city along a one-dimensional center-periphery continuum. To this end, I first opted for the Heckman selection model, with onset of intrastate conflict as the selection criterion and the conflict–capital distance as the dependent variable in the regression stage (Buhaug, 2010). A selection model is needed if the units of observation are given non-randomly, meaning that factors that explain the feature of interest (distance from the capital to the conflict zone) also have an impact on the likelihood of the units being selected for analysis (outbreak of conflict; Heckman, 1976). Earlier research (e.g. Hegre and Sambanis, 2006) has also demonstrated that institutional consistency and development are inversely related to the risk of civil war.

I use also some control variables by following Buhaug's study (2010): As indicators of institutional capacity, I use dummy variables for democratic and autocratic regimes based on the Scalar Index of Polities, SIP (Gates et al., 2006), which are often used to measure the regime type. And we know that these data avoid some of the recent criticism that has been raised towards the Polity dataset, in particular the endogeneity problem between the "factionalism" category and civil war onset (see Strand, 2007; Vreeland, 2008). Therefore it is more reliable. Military strength is proxied by army size relative to the population (log number of soldiers per 1,000 citizens), calculated from the Correlates of War project's National Material Capability dataset, v.3.02 (Singer et al., 1972). Economic development, which is expected to capture both economic strength and ease of power projection, is represented by (logged) GDP per capita data from Gleditsch (2002). Administrative capacity, or the ability to realize the regime's tax potential, is represented by Arbetman and Kugler's (1997) relative political capacity (RPC) measure. Data on the fighting capacity of rebel groups at the onset of conflict were drawn from Cunningham et al. (2009). All state capacity variables are all lagged one year to reduce problems with reverse causality. And lastly the selection stage, which estimates the likelihood of conflict onset, includes regime type dummies, GDP capita, oil exports, log population size (World Development Indicators), and controls for serial correlation (Beck et al., 1998).

The regression stage also includes two control variables: a dummy for oil dependent economies (from Fearon and Laitin, 2003) and country area (log km²). Oil-rich countries are often argued to be weaker than their level of per capita income suggests (Ross, 2006), which implies that these states should be more prone to experience rebellion close to the capital.

In addition to the test above, I will also investigate case-by-case whole Africa Continent whether country-level approximation and story telling also follows the same pattern with the cases in general. I have examined in detail some countries to compare my hypothesis with basically what we observe via examining maps. GIS facilitates my job overwhelmingly with enabling spatial analysis and supplying proper maps. I employ 'select by attribute and location' commands in ARCGIS 12 to investigate how the conflict occurrences coincide with the population densities of the places. I will discuss the results that I have reached in detail below in the next section.

7. Results and Discussion

Above, I discussed how population density might also affect the location of rebellion, whereby densely populated areas are more prone to conflict occurrences when the states are stronger. The results in Table 1 demonstrate some interesting findings supporting it. First, population density has inversely related with the location of conflict occurrences, meaning that when the conflict area is more populated it decreases the distance of where it occurred from the capital city. This supports my first hypothesis that densely populated areas are more prone to conflicts in that all capital cities (and the core of the governments' territories) are densely populated as we experience from the above maps also. Also need to say that, in my case, "the relative location measure could be criticized on at least two grounds. First, it does not capture other major government strongholds throughout the country. This is an obvious simplification; yet, since it is applied consistently throughout the sample, a resulting bias need not be particularly troublesome. However, the strictly geographic measurement is a crude approximation also in another regard, as it completely ignores crucial demographic and cultural features of the society" (Buhaug, 2010, 123). But anyway this measurement still gives some important insights and captures one way of defining location, which has been also employed by many scholars in their analyses so far.

Table 1. The Determinants of Conflicts in African Civil Wars (1989-2010)

Regression Stage [Location]	β	p value
Population Density	-0.127	(0.11)
Democracy	-0.211	(0.23)
Autocracy	0.563	(0.01)
RPC (Relative Political Capacity)	0.667	(0.03)
Resources (oil,diamond etc.)	-1.543	(0.00)
GDP Capita (ln)	0.441	(0.00)
Regression Stage [Onset]	β	p value
Democracy	0.133	(0.32)
Autocracy	-0.361	(0.01)
Resources (Oil, diamond etc.)	0.542	(0.00)
GDP Capita (ln)	-0.373	(0.00)
N	24378	
Rho	- 0.98	
Heckman selection model estimates with p values based on clustered standard errors.		

When it comes to interpret control variables, we see first that, as expected, the estimates for both regime types are positive, though neither effect is significantly distinguishable from the inconsistent regimes with the conventional 95 percent confidence threshold. In substantive terms, conflicts in autocratic states are estimated to occur almost twice as far away from the capital city compared to conflicts in otherwise similar anocracies. And we also notice that developed states are less likely to experience violence in central parts of the country and oil-dependent countries are more prone to attract conflict near the state's headquarters than are less mineral-affluent countries. And also the RPC variable provides

compelling empirical evidence that bureaucratically more efficient regimes are significantly better able to maintain peace at the core of their territories.

When examined, particular cases also support my first hypothesis. When we scrutinize relatively stronger states like South Africa, Egypt, Algeria, we easily notice that conflicts tend to occur in densely populated areas. According to Figure 4, out of all conflicts, 71 % conflicts occurred in densely populated areas in South Africa. The proportions of conflict occurrences are respectively 73 % in Egypt, 65 % in Algeria, which tells a strong correlation for the first hypothesis, positing that conflicts tend to occur in densely populated areas in the relatively stronger states.

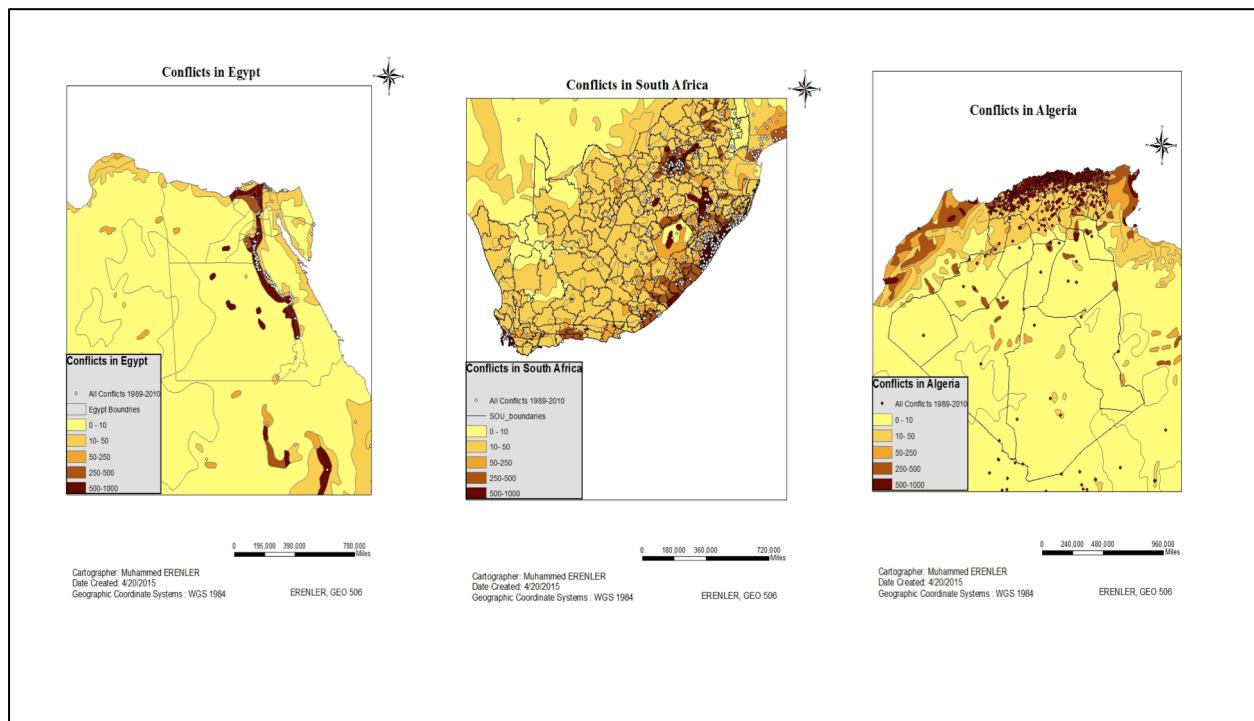


Figure 4- The Cases of the Strong States

On the other hand, other particular cases also supply partly evidence to my second hypothesis also. When we examine relatively weaker states like Ethiopia and Uganda, we instantly notice that conflicts tend to occur in sparsely populated areas. According to Figure 5, out of all conflicts, 86 % conflicts occurred in sparsely populated areas in Ethiopia and 94 % in Uganda, which provides again strong correlation for the hypothesis, positing that conflicts tend to occur in sparsely populated areas in the relatively weak states.

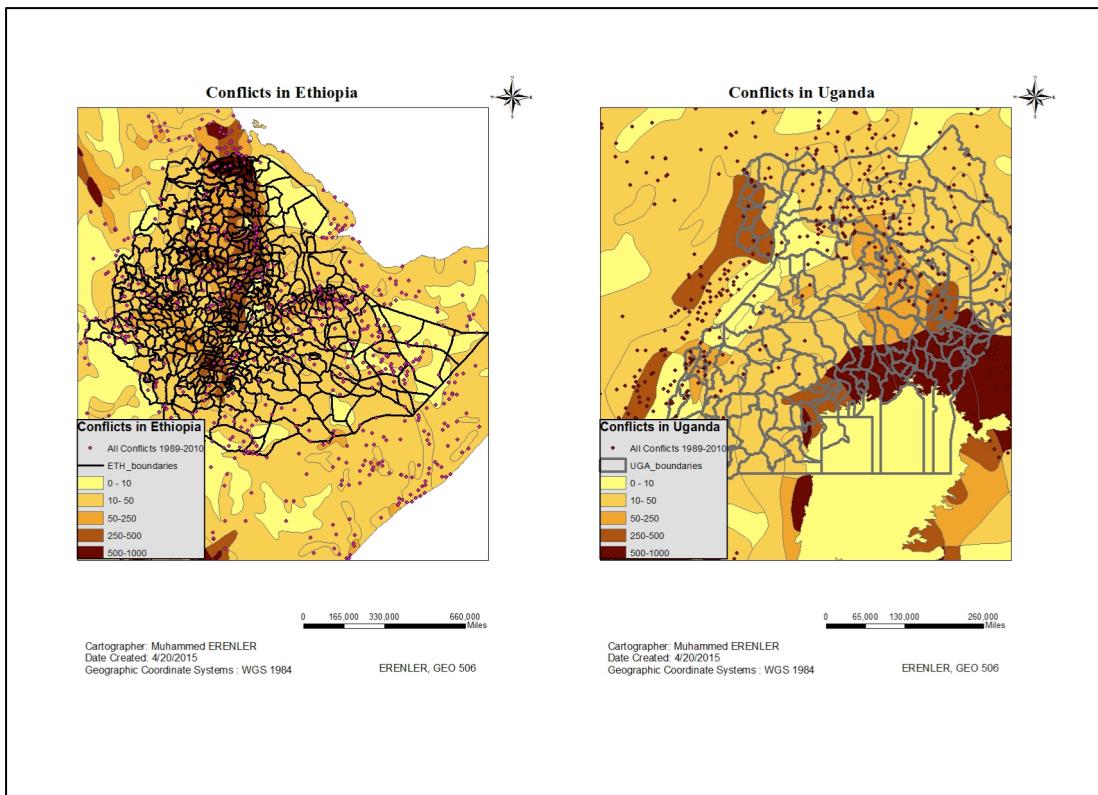


Figure 5- The Cases of the Weak States

8. Conclusion

As I discussed in detail throughout here, this paper demonstrates how a demographic factor like **population density** might affect the location of rebellion, whereby densely populated areas are more prone to conflict occurrences. My findings shows that population density has inversely related with the location of conflict occurrences, meaning that when the conflict area is more populated it decreases the distance of where it occurred from the capital city. This result supports my first hypothesis that densely populated areas more prone to conflicts in that all capital cities (and the core of the governments' territories) are densely populated as we experience from the above maps also.

And examining the maps I created, we also notice that the empirical evidence especially with their correlational aspects supports my second hypothesis, positing where the rebels are stronger (or the states are weaker) sparsely populated are more conflict-prone. As we see from Ethiopia and Uganda (p.s. there are many different countries also) cases when the states are weaker, the conflicts tend to occur in sparsely populated areas, which are generally in the peripheries. Though simply by looking at some correlational findings that I substantively have found here may not provide strong evidence for the causal mechanisms of how population density affects the location of the conflict occurrences, I believe that my attempt here may serve as a good starting point to further investigate the underlying mechanisms.

In conclusion, using the data drawn from the UCDP/ PRIO Armed Conflict Dataset (Gleditsch et al., 2002), geo-referenced data of African Civil Wars from UCDP GED (Uppsala Conflict Data Base Program Geo-referenced Data) (Sundberg et al., 2013) and population density data from USGS (U.S. Geological Survey); this paper demonstrates that population density and the conflict occurrences are positively related one another when the

states are stronger, meaning that when the population density gets higher in an area, the likelihood of conflict occurrences gets also higher. This is shown in a model that population density is reversely related with the conflict–capital distance, where when the level of population density increases, the conflict–capital distance decreases, showing that the conflicts occur more in the areas close to the capital (implicitly meaning urbanized and densely populated areas). On the other hand, though the evidence a bit weaker this time, it is shown here (especially via maps and correlations from bimodal data shown above), when the states are weaker, the conflicts tend to occur more in sparsely populated areas.

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