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Does Uranium Mining Increase Civil Conflict Risk? Evidence from a Spatiotemporal Analysis of Africa from 1945 to 2010

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Abstract

We employ a two-tier spatiotemporal analysis to investigate whether uranium operations cause armed conflict in Africa. The macrolevel analysis suggests that – compared to the baseline conflict risk – uranium ventures increase the risk of intrastate conflict by 10 percent. However, we find ethnic exclusion to be a much better predictor of armed conflict than uranium. The microlevel analysis reveals that uranium-spurred conflicts are spatiotemporally feasible in four countries: the Democratic Republic of Congo (DRC), Namibia, Niger and South Africa. We find strong evidence in the case of Niger, and partial evidence in the case of the DRC. Namibia and South Africa do not yield substantial evidence of uranium-induced conflicts. We conclude that uranium may theoretically be a conflict-inducing resource, but to the present day empirical evidence has been sparse as most countries are still in the exploration phase. Considering that the coming years will see 25 African countries transition from uranium explorers into producers, we strongly suggest that our analysis be revisited in the coming years.

Keywords: civil war, uranium, ethnicity, GIS, subnational study

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Carlo Koos and Matthias Basedau*

Article Outline

1 Introduction

The transport and final storage of radioactive waste from nuclear power plants is often accompanied by activist protests, and clashes with security forces are common. Yet at the other end of its production life cycle, uranium receives little attention.

This is surprising because uranium shares a number of core similarities with oil, the most conflict-prone resource. Oil has been identified as the only natural resource that robustly and significantly correlates with armed conflict (Dixon 2009; Ross 2004a, 2004b). However, the

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question of whether uranium may be a central driver of armed conflicts has not been the subject of comparative studies so far. With this study we want to fill this gap and ask one particular question: Does uranium increase the risk of intrastate conflicts in Africa?

Why could uranium be a conflict factor? First, much like oil, uranium is a highly strategic source of energy. Second, uranium is the core ingredient of nuclear weapons and thus enjoys the attention of both superpowers and rogue states. These two aspects make uranium a particularly delicate resource. Third, in African countries revenues from uranium production can be particularly attractive prey for both the political elite and their opponents. Fourth, uranium production often leads to considerable hazards for humans (workers, residents) and causes major ecological damage. A lack of knowledge about how to regulate and control uranium extraction and a lack of experience regarding how to negotiate with mining firms may leave particularly disadvantaged local communities as the losers in uranium ventures. Given these risky features, we generally assume that uranium operations increase the risk of violent conflict. Also, acknowledging existing group conflicts, we assume that whenever uranium mining is taking place in the homelands of (marginalized) groups who are excluded from the benefits (revenues) but have to bear the burden (ecological degradation, land disputes), conflict is more likely.

To test our assumption we conduct a comparative study of uranium mining in Africa using a two-tier analysis. First, by employing geographic information software (GIS), we perform a spatiotemporal macroanalysis to

a) determine the general conflict propensity of uranium in Africa and
b) generate a set of cases that exhibit spatial overlaps of uranium mining and intrastate armed conflict.

As a second step we then dig more deeply into the peculiarities of the selected cases in order to test whether causal mechanisms that link uranium mining, ethnic deprivation and violent conflict can be identified or whether the spatial overlaps are coincidental.

The paper proceeds as follows: In the following section we review the literature on the interplay of natural resources, ethnicity and conflict. After identifying the research gap and outlining our hypotheses, we explain our two-tier empirical approach. In the final section we present the results and discuss our findings.

2 Literature Review

2.1 Natural Resources and Intrastate Conflict

With their influential work "Greed and Grievance in Civil Wars," Collier and Hoeffler (2004) kicked off a lively scholarly debate on the role of natural resources in armed conflicts. The quintessence of their work was that dependence on primary resources (broadly defined as including oil, gemstones and agricultural commodities) promotes civil wars by providing

material opportunities (greed, according to their depiction) to rebels, rather than motives (grievances) such as the discrimination against and deprivation of identity groups. Since then the discourse on the role of natural resources has been refined, taking into account the characteristics of specific resources, the modes of extraction and the conditions under which resources contribute to rebellion. Resources have been found to contribute to rebellion via three major mechanisms (Basedau et al. 2011; Le Billon 2008; Humphreys 2005; Ross 2004b):

1) The *motives* to rebel may include competition over resource revenues or resource-related grievances such as the cost of ecological damage, the eviction of inhabitants, and the subsequent negative implications for social and economic life.
2) Resources also provide the *opportunity* for conflict by making rebellion and warfare financially (or militarily) feasible, particularly through the "lootability" of resources.
3) Resources may initiate *indirect mechanisms* that make rebellion more likely. For instance, resources may encourage rent-seeking behavior and thus negatively affect state institutions (weak state) and socioeconomic development (resource curse, Dutch disease, "white elephant" prestige projects), thereby encouraging people to rebel.

Whether these mechanisms do in fact operate in these ways depends on several resource-specific (Basedau et al. 2011; Le Billon 2009; Humphreys 2005) and contextual conditions (Dixon 2009; Fearon and Laitin 2003; Hegre and Sambanis 2006). For instance, resource-related motives derive from how revenues are distributed and whether resources are concentrated in ethnically distinct regions of a given country. Resource-specific features such as the lootability of resources are connected to the opportunity mechanism and determine insurgents' ability to access and control resource extraction. Also, contextual conditions such as the mining area's distance from the capital, geographical features (jungle, mountains) and infrastructure can substantially influence a state's counterinsurgency capacity (Fearon and Laitin 2003). With regard to indirect mechanisms, the degree to which a given country is dependent on resources will determine whether the country is vulnerable to possible price shocks.

2.2 Why Uranium Mining May Trigger Armed Conflicts

In 2009 Africa accounted for 18 percent of global uranium production (WNA 2011a). While only Niger, Namibia, Malawi and South Africa can be considered relevant producers of uranium at the moment of writing, ongoing exploration projects and dormant mines in 25 African countries from Algeria to Zimbabwe (WISE 2012a) highlight the upcoming importance of uranium mining in Africa. Exploration projects can prompt both enormous expectations of future uranium wealth and active opposition supported by human rights organizations (WISE 2009).[1] As a downside, uranium operations exhibit several features that can initiate the conflict-inducing mechanisms outlined above.

1 Although whistle-blower advocacy groups tend to focus primarily on the negative impacts, foreign investment in uranium extraction does also yield positive effects. First, uranium operations involve large invest-

1) Motives to struggle against mining firms and/or the central government, which issues the licenses, might include grievances regarding the negative effects on the environment and human well-being. For instance, radiation is set free during mining, milling and the depositing of the tailings. The use of acids during the leaching process can contaminate groundwater. The health risks for workers, inhabitants of nearby areas and livestock are tremendous. Additionally, uranium milling requires immense quantities of water, which is already scarce in dry areas such as Niger and Namibia. Also, during the development of uranium mines marginalized groups lacking political advocates may face eviction or have to bear the brunt of ecological degradation and radiation hazards. Uranium mining may furthermore trigger disputes over the distribution of revenues, particularly when the mines are situated in the settlement areas of marginalized groups that feel excluded from the benefits but nevertheless have to carry the burden.
2) Opportunities: Uranium is usually mined industrially and requires large infrastructure investments to extract and process the ore economically. Therefore, uranium is hardly a lootable resource in the sense that artisanal mining might be a possible option for rebels to raise revenues. Still, uranium does provide financial and military opportunities for insurgents, who can potentially attack facilities, control transport routes or kidnap foreign workers. In some contexts, particularly in ongoing violent conflicts, uranium firms may sponsor insurgents indirectly in order to acquire future options for extraction rights.
3) The indirect mechanisms of uranium mining may theoretically be similar to those of other resource rents, such as oil and diamonds. However, uranium mining is potentially much more dangerous (radiation) for human beings and the environment than other resources and therefore requires protective mining regulations. Weak state institutions will likely fail to implement and enforce such mining and environmental policies. This, in turn, can be a motive to rebel.

Whether these mechanisms actually operate depends on the specifics of each uranium venture, particularly the status of the operation (exploration, development, production) and the contextual political and socioeconomic conditions.

2.3 Ethnicity's Role in Armed Conflict

The research on the ethnicity–conflict nexus has expanded in recent years.[2] Though ethnic diversity per se does not necessarily lead to violent conflict (Hegre and Sambanis 2006; Hoeffler 2012),

ments and create jobs, both of which support economically underdeveloped regions. With the development of mining operations, infrastructure, especially roads and electricity but also medical facilities, is often improved. The attraction of a workforce usually leads to an increased demand for goods and services in nearby towns. In terms of the state budget, revenues can increase considerably due to corporate taxes, royalties, and increased consumer and income taxes.

2 We prefer a more constructivist understanding of ethnicity or ethnic identity (Horowitz 1985; Posner 2004): ethnic identity derives from differences in a variable set of identity markers such as a particular faith, lan-

as a "primordialist" or "culturalist" notion of the ethnicity–conflict nexus may suggest, three major mechanisms connecting ethnicity to conflict risk are frequently cited in the literature:

1) Ethnic group identities are vulnerable to sociopsychological in- and out-group dynamics and are hence a mobilization resource in political conflict. So-called "instrumentalists" assert that ethnic identities may serve as tools for individual group leaders to use for their own political or financial aims (see Blimes 2006; Østby 2008). In this way, the collective-action problem can be avoided and people can be mobilized (Olson 1965; Tilly 1978).
2) The "grievance" school of thought suggests that ethnic conflict is particularly likely when certain ethnic groups suffer from (perceived) relative deprivation (Gurr 1970, 2000) or horizontal inequalities (Østby 2008; Stewart 2002) and develop grievances that, in turn, increase the risk of ethnic rebellion or secession.
3) Finally, the effects of ethnicity might be indirect: ethnically diverse societies tend to grow more slowly (Mauro 1995) and have a low level of public goods provision (e.g. Habyarimana et al. 2007). Both of these features may indirectly increase the conflict potential.

Given the lack of more "qualitative" data, quantitative studies have used proxy indicators to investigate how conflict prone diverse societies are. The evidence on the conflict potential of particular ethnodemographic constellations remains, on the whole, far from conclusive. This is at least partially connected to the quality of classical measures of ethnicity, which have been criticized for a variety of reasons (Bussmann et al. 2009: 17 f), such as the reliability of the data (relying on the Soviet Atlas Narodov Mir from 1964), its static character and its validity with regard to the actual political relevance or quality of interethnic relations (Posner 2004). Some databases – such as the Minority at Risk (2009)[3] or Posner (2004) databases – have advanced the quality of data. Recent studies on the basis of new data have indeed found that it is the relative deprivation of ethnic groups rather than the exact constellation of diversity that matters in determining the likelihood of intrastate conflict. The new Ethnic Power Relations (EPR) data set has systematically collected information on groups' access to power from 1945 to 2005 (Cederman et al. 2009). Quantitative analyses (Cederman et al. 2010; e.g. Wimmer et al. 2009) demonstrate that the exclusion of (larger) ethnic groups increases the risk of armed conflict.

2.4 How Uranium and Ethnicity May Interact

While the scholarly debate on the causes of civil war mainly focuses on either the economic opportunity structure of the conflict actors[4] or the inequalities between identity groups (Gurr 1970;

guage, regional provenance and the like, but ultimately it results from outside-ascription and self-ascription (and is, hence, in principle subject to change).

3 The project was originally launched in 1986, but coding rules have since undergone several changes.

4 Collier et al. (2009: 23) argue that "where rebellion is feasible, it will occur without any special inducements in terms of motivation."

Østby et al. 2009), it is likely that both factors interact and exponentially multiply conflict risk. The argument is simple: separately, both ethnicity and uranium can provide motives and opportunities that increase the risk of armed conflict or other forms of political violence. If geographically and politically combined, they may result in mutually reinforcing risks and make conflict even more likely.

As outlined above, uranium operations can promote contests over revenues and have negative effects on nearby populations that, in turn, can easily be transformed into a cause to rebel. Resource-induced social disruptions provide an effective opportunity for rebel leaders to recruit disgruntled insurgents wanting to fight for a "noble" cause. Also, the financial means for rebellion can be raised by demanding ransoms for kidnapped expatriate staff. These causal mechanisms are especially pertinent to cases in which resources are concentrated within the territory of (already otherwise deprived) ethnic groups. Disaffected groups may use commodities concentrated in their territory as the grounds to seek secession.

3 Hypotheses

In this study we want to assess whether uranium mining has an impact on violent conflict in Africa. Based on the literature review we have formulated two hypotheses:

H1: Considering the risks and mechanisms of uranium mining operations outlined above, we assume that geographical areas affected by uranium operations have an increased risk of armed conflict compared to those areas where no uranium is extracted.

H2: The risk is further increased whenever uranium mining operations take place in areas where ethnic groups are marginalized, because leaders can more easily tap into and instrumentalize the motives and opportunities generated by the mining.

4 Research Design and Data

Cross-country studies on the causes of civil war have received much criticism in recent years. This criticism has pointed not only to the data quality, but also to the fallacious conclusions that may derive from highly aggregated country-level data (Buhaug and Rød 2006; Rustad et al. 2011). Buhaug and Rød (2006: 315) claim that "any statistical study of civil war that uses country-level approximations of local phenomena is potentially flawed." The problem is simple: statistically distributing national-level aggregates over a country's territory is likely to lead to incorrect results. Most phenomena connected with civil wars show significant subnational variance. Intrastate violence itself usually occurs in remote areas where the power of the central state is rather weak. For natural resource endowments such as oil, diamonds, etc., the location is completely random. Even rather slow-changing socioeconomic conditions normally vary across a country.

We employ a two-tier analysis to overcome the limitations of existing approaches and to test our hypothesis. We start with a spatiotemporal macrolevel study, which we then complement with a microlevel study on selected cases. The macro study uses GIS to uncover spatial and temporal correlations between uranium mining, settlements of deprived ethnic groups, and intrastate conflict in Africa. The findings of the macro study are intended, first, to estimate the conflict propensity of subnational areas (grids) affected by uranium and, second, to generate a set of country cases for further investigation. As the GIS technique does not allow us to test for causal relationships between uranium operations and intrastate conflict, we dig deeper in the microlevel study. The micro study is designed to scrutinize the set of countries identified and to determine whether the spatial correlations and temporal sequence identified can be confirmed in a causal test or need to be rejected.

4.1 Macrolevel: Spatiotemporal Analysis

The macrolevel study employs a GIS-supported spatiotemporal analysis and serves the purpose of identifying whether there is an increased probability that uranium production (including exploration) correlates with violent conflict. We therefore identify spatial overlaps between uranium operations (production, exploration, dormant), deprived ethnic groups' settlements and violent intrastate conflict. It is plausible that such geographical overlaps may be causally linked, but in order to test for a causal relationship we use the microlevel case studies. In addition to the spatial correlation we test for a logical sequence, meaning that uranium-spurred conflicts are only possible if uranium operations started before the conflict onset. Three variables are central to testing our hypothesis: first, intrastate conflict, the dependent variable; second, uranium operations; and third, the settlements of deprived ethnic groups. The latter two constitute the explanatory variables.

4.1.1 Intrastate Conflict (Dependent Variable)

We use two georeferenced data sets on armed conflict. The first one was used in Rustad et al. (2008)[5] and records all armed conflicts from 1946 to 2004 between a government and at least one organized armed group. In order to cover the entire period we are investigating, this data set is supplemented with a subset of the more recent georeferenced event-based conflict data set developed by Croicu and Sundberg (2012). We have selected the data for the period from 2005 to 2010 and restricted events to state-based armed conflicts in order to remain consistent with the other data. Unlike the former versions of georeferenced UCDP conflict data sets, both data sets use polygons and thus record more precise areas of conflict than the older point-radius circles. In each polygon for a given year at least 25 battle-related deaths have occurred.

5 The data set was received by the authors directly as it is not publicly available.

4.1.2 Uranium Operations (Independent Variable 1)

There is no data set on uranium mines. We have therefore constructed a georeferenced data set of our own (Koos and Laurent forthcoming), using primarily uranium mines and exploration projects reported in the International Atomic Energy Agency's "Red Book" (IAEA 2007, 2009, 2012). This information is complemented by data from the United States Geological Survey (USGS 2012), the World Information Service on Energy (WISE 2012b) and the World Nuclear Association (WNA 2011a). We prioritize these sources in order of where they appear, meaning that deposits reported by the IAEA[6] are considered more accurate than those of the industry-associated WNA. Our final list of current uranium ventures in Africa (including North Africa) totals 230 uranium operations, whereof we have been able to find accurate coordinates for 183. We use "operations" or "ventures" as the umbrella term for exploration, development, and production, and for dormant and depleted mines. For the purpose of our study all of the operational statuses are relevant and are included in the data set.[7]

4.1.3 Deprived Ethnic Groups (Independent Variable 2)

We use the georeferenced version of the Ethnic Power Relations data set (GeoEPR) developed by Wucherpfennig et al. (2010)[8]. GeoEPR codes the access of all politically relevant[9] groups to state power, whereas, in contrast, the Minorities at Risk data set (MAR 2009) only codes the status of mobilized minorities and disregards the constellation at the center of power (Cederman et al. 2010: 88). In our analysis we consider groups as deprived when they are excluded from national power arrangements (government, parliament). According to the Ethnic Power Relations data set (EPR; Cederman et al. 2009), groups with one or more of the following statuses are excluded from power:

a) "Regional autonomy" and "secessionist autonomy" describe groups who have influence at the subnational but not at the national level.
b) "Powerless" groups describes those who do not have access to national or regional power but are not specifically discriminated against.
c) "Discriminated" groups are those intentionally excluded from access to political power.

6 As the IAEA is the global forum for scientific and technical cooperation in the nuclear field, we consider information provided by the IAEA to be the most reliable.

7 The data set codebook can be requested from author via e-mail (<carlo.koos@giga-hamburg.de>).

8 We are aware that GeoEPR covers the period between 1945 and 2005, whereas our data on intrastate conflict go until 2010. The period between 2005 and 2010 is primarily important in understanding whether recent uranium operations have triggered conflicts.

9 An ethnic group is considered politically relevant if a political organization claims to represent the group's interests in national politics or if the group is being systematically discriminated against (Wucherpfennig et al. 2011: 427).

4.2 Microlevel: Systematic Case Studies

The GIS-supported macroanalysis produces a set of country cases that exhibit spatial overlaps between intrastate conflicts and uranium operations and show a logical temporal sequence (that is, uranium operations started before conflict onset). To test whether these spatial correlations are indeed causally related, these cases are systematically tested for mechanisms that connect uranium operations and intrastate conflict. Each case is tested with respect to three aspects:

a) uranium-related risks,
b) ethnicity-related risks and
c) other contextual risks such as the socioeconomic development level and geographical features of an area (e.g. Collier 2007; Fearon and Laitin 2003)[10].

5 Findings

5.1 Macrolevel: Spatiotemporal Analysis

The macroanalysis consists of a spatial analysis and is complemented by a logical sequence check. For our GIS-supported macrolevel analysis we use QuantumGIS,[11] a freeware GIS tool, to analyze spatial overlaps between uranium operations, settlements of deprived ethnic groups and intrastate conflict. There are basically two ways to analyze subnational spatial data. The first is to take subnational administrative entities (counties, districts, etc.) as the units of observation. This approach has the advantage of incorporating local power dynamics – for instance, the distance of the administrative capital from intrastate conflicts. Administrative borders do, however, change over time, and the size of areas can differ significantly in some countries, making a cross-national comparison sloppy.

The second approach is to use grid cells as the unit of observation. The advantage is, obviously, that cells do not change over time; however, they do disregard local power dynamics. Thus, both approaches have their merits and shortfalls. Following Buhaug and Rød (2006), we have decided to use 100 km by 100 km grid cells for our analysis. In doing so, Africa is divided into 2,744 grid cells, each measuring 100 km by 100 km. Each of our variables is presented as a layer in the GIS software exhibiting points (uranium), lines and polygons (ethnic groups, armed conflict). Each layer is then converted into a grid, and each cell records the existence of the variables.

After integrating the basic layers we add our georeferenced uranium data set (Koos and Laurent forthcoming). As outlined above, we have georeferenced 183 uranium operations in Africa. Uranium mines are recorded as points (see grey spots in Figure 1). In order to ac-

10 The detailed analytical grid is available in Table 2.

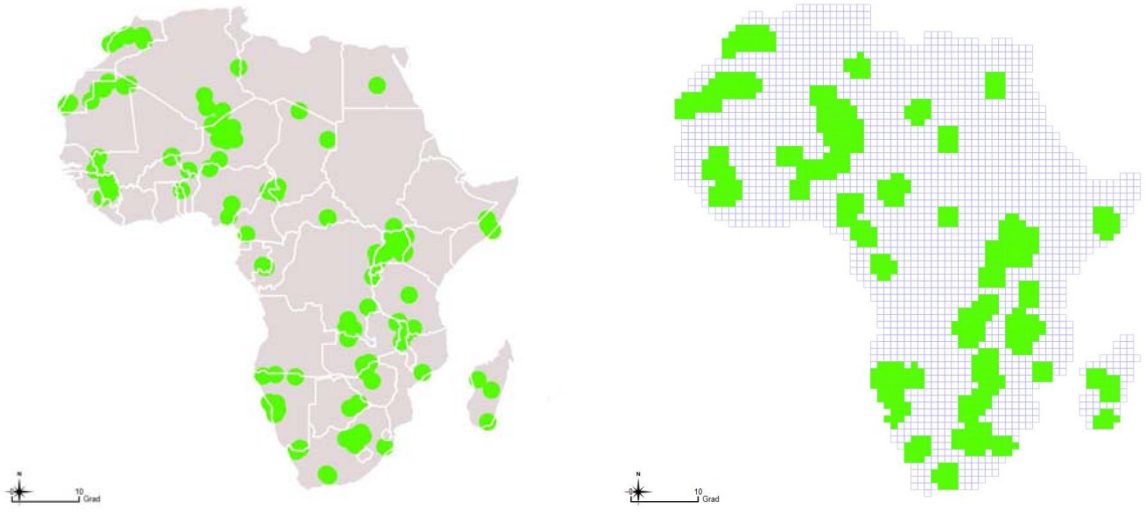
11 QuantumGIS 1.7.1 is available online: <http://qgis.org/> (20 July 2012).

count for the spatial characteristics and outcomes of uranium operations (for example, the size of the mine, environmental degradation and pollution, evictions, etc.) we transform the point data for uranium operations and add a conservative 150 km radius to extend the uranium mine's area of influence. Transforming the layer into grids results in 691 out of 2,744 African cells being filled.

We continue with the georeferenced Ethnic Power Relations data set (GeoEPR; Wucherpfennig et al. 2010), which records the settlements of politically relevant groups from 1945 to 2005 (see Figure 2). As we are focusing on deprived groups, we are only interested in those groups that have at any point in time had the status "discriminated," "powerless," "regional autonomy" or "separatist autonomy" (Cederman et al. 2009). When we apply these criteria, GeoEPR displays 141 ethnic groups in Africa that experienced the political statuses listed above between 1945 and 2005. Many of these groups have overlapping settlement areas, which are shown by nuanced, darker-grey areas in the map on the left. Of Africa's 2, 744 total cells, 1,552, or 57 percent, accommodated deprived ethnic groups between 1945 and 2005.

Finally, we transform the two georeferenced versions of UCDP's armed conflict data set (Figure 3). Varying tones of grey polygons indicate the number of conflict years experienced in each region. Dark-grey areas experienced more frequent conflicts than bright-greyareas. When transformed into grids, 1,776 cells out of 2,744 (65 percent) in Africa experienced armed conflict between 1946 and 2010.

Figure 1: Uranium Operations in Africa

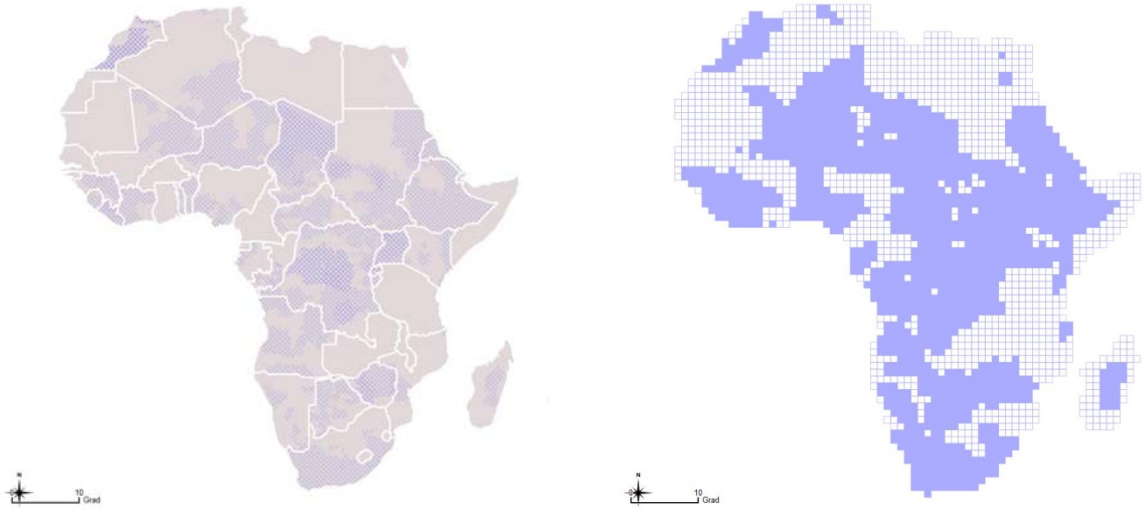


Layer: 183 georeferenced locations

Grid: 691 cells overlap with uranium operations given a radius from the operation of 150 km

Source: Authors' compilation.

Figure 2: Settlements of Deprived Ethnic Groups

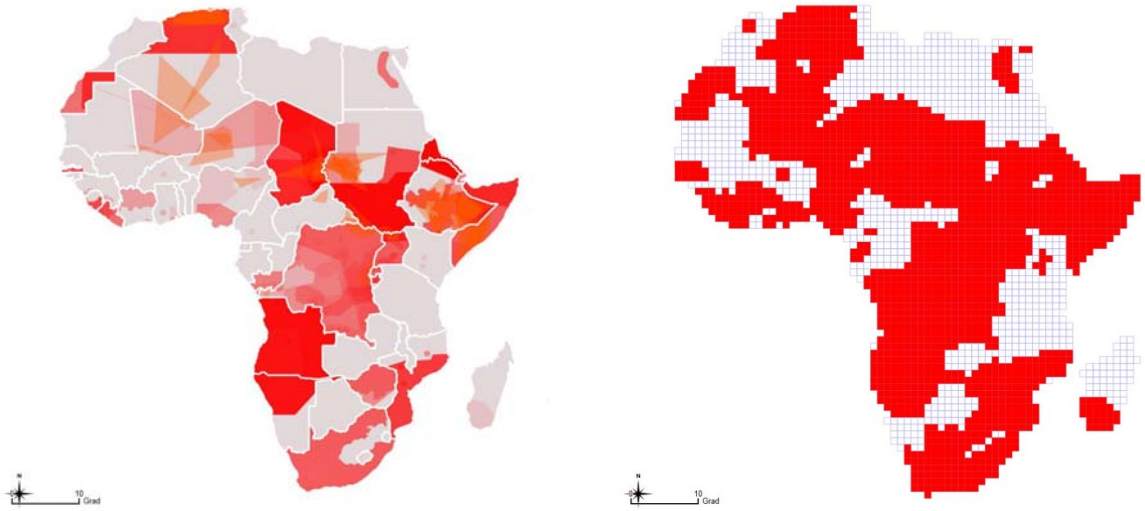


Layer: 141 georeferenced settlement areas of deprived ethnic groups

Grid: 1,552 cells overlap with deprived groups' settlements

Source: Authors' compilation.

Figure 3: Intrastate Conflict



Layer: 1,660 georeferenced areas of armed conflict between 1946 and 2010

Grid: 1,776 cells overlap with armed conflict

Source: Authors' compilation.

In our analysis, we assess whether or not a cell exhibits our variables: intrastate conflict, uranium operations and settlements of deprived ethnic groups. To answer our fundamental question – does uranium increase conflict propensity – we need an estimate for a baseline risk of conflict. Our first two models do this. We gradually add four additional models to es-

timate how conflict risk changes with the presence of uranium ventures and settlements of politically excluded ethnic groups. Table 1 presents these configurations.

Model 1 ignores whether cells exhibit uranium operations or settlements of deprived groups and accounts for the baseline conflict risk. The model's number of cells is equivalent to Africa's number of cells. As 65 percent (1,776 cells) have experienced armed conflict, this constitutes the baseline conflict risk for a cell between 1945 and 2010.

Model 2 is the alternative baseline model and also excludes the two risk factors. It only considers those cells that feature neither uranium nor ethnicity. Thirty-four percent of the cells (929 cells) display this configuration; 64 percent (594 cells) have experienced armed conflict.

Model 3 features only those cells that include uranium operations, and excludes cells that exhibit deprived ethnic groups' settlements. Only 10 percent of cells (263 cells) in Africa correspond with this configuration; 74 percent of "uranium only" cells (195 cells) have experienced armed conflict.

Model 4 considers only those cells that are home to uranium operations, and is indifferent to whether or not cells accommodate deprived ethnic groups. The total number of cells for this model adds up to 691, 25 percent of Africa's cell count. Of these, 86 percent (593 cells) have experienced armed conflict.

Model 5 considers only those cells with ethnic settlements and ignores uranium operations. The total number of cells with this configuration is 1,552, 57 percent of Africa's cell count. Ninety-three percent of these ethnic cells (1,446 cells) have experienced armed conflict, making ethnic settlements an extremely strong predictor of conflict.

Finally, Model 6 considers only cells that exhibit both uranium operations and ethnicity. The number of cells is obviously smaller with 428 cells, only 16 percent of Africa's total. Ninety-three percent of these cells (398 cells) have experienced armed conflict.

Table 1: Descriptive Analysis of Grid Cells

	(1) Baseline risk I		*(2) Baseline risk II*		*(3) Uranium only*		*(4) Uranium*		*(5) Ethnicity*		*(6) Uranium + Ethnicity*	
Uranium	0 or 1		0		1		1		0 or 1		1	
Ethnicity	0 or 1		0		0		0 or 1		1		1	
No armed conflict (0)	968	35%	335	36%	68	26%	98	14%	106	7%	30	7%
Armed conflict (1)	**1,776**	**65%**	**594**	**64%**	**195**	**74%**	**593**	**86%**	**1,446**	**93%**	**398**	**93%**
# cells in model	2,744	100%	929	100%	263	100%	691	100%	1,552	100%	428	100%
# cells in Africa	2,744	100%	2,744	34%	2,744	10%	2,744	25%	2,744	57%	2,744	16%

Source: Authors' compilation.

While the baseline risk of armed conflict lies at 65 percent (Model 1) and 64 percent (Model 2), the results indicate that uranium operations increase this risk to 74 percent (Model 3) in cells without ethnic groups. In models 4 to 6 ethnicity is included, and conflict risk increases. This

is particularly apparent in models 5 and 6. We find that the results do lend some support to Hypothesis 1, which assumes an increased conflict risk in areas with uranium operations. With respect to Hypothesis 2 (conflict risk is greater in areas with both uranium operations and ethnic discrimination), we conclude that ethnicity is indeed a stronger predictor of conflict than uranium. Given the limitations to drawing causal conclusions at the macrolevel, our analysis moves to the microlevel in order to test for causality.

5.2 Microlevel: Systematic Case Studies

The aim of the microlevel study is to test whether the correlations between uranium operations, settlements of deprived ethnic groups and armed conflict are more than coincidental; that is, we try to raise further evidence that uranium, ethnicity and armed conflict are actually linked. Our case selection process consists of three tests. First, the spatial test: to be included in the microlevel study a country needs to exhibit at least one spatial overlap between armed conflict and uranium operations. Second, a logical temporal sequence is mandatory: uranium operations must have started before the onset of armed conflict. Third, both checks need to be positive for a country to be regarded as a logically feasible case of uranium-spurred conflict.

Of the complete set of 30 African uranium countries,[12] 18 countries pass the first test and show a geographical overlap between armed conflict and uranium ventures.[13] The second test, uranium production before conflict onset, is passed by eight out of 30 countries. The third step, the condition that both the spatial and the temporal check are positive, is passed by only four countries: Democratic Republic of Congo (DRC), Namibia, Niger, and South Africa. In the following analysis each of these four country cases is investigated in three steps. We begin by addressing uranium-related risks, through

a) test of motive and opportunity mechanisms, followed by
b) ethnicity-related risk factors and
c) other contextual risks and
d) conclude with a short assessment.

5.2.1 Democratic Republic of Congo

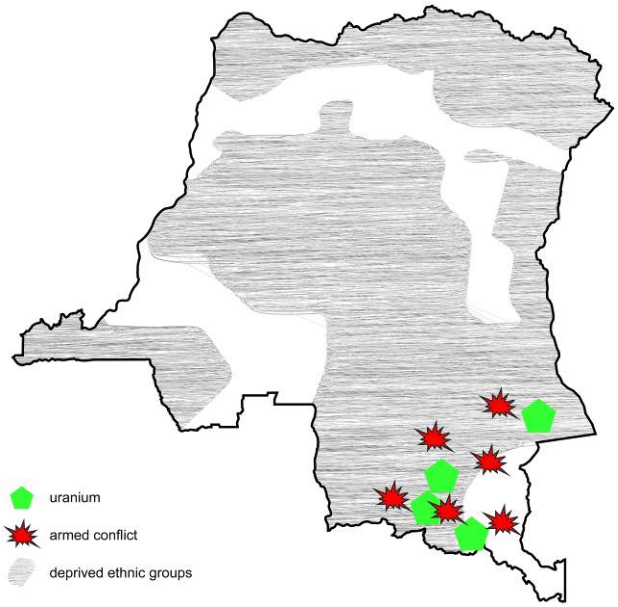
In Katanga, the southeastern province of the Democratic Republic of Congo (DRC), uranium was extracted industrially between 1920 and 1960, until the country's independence (IAEA 2009, 2012). In the following decades, from 1960 onwards, artisanal miners began extracting minerals, including uranium, from sealed mining shafts. Uranium mining areas overlap with the settlements of deprived ethnic groups (Luba Kasai, deprived from 1960 to 2005; Luba Shaba, deprived from 1966 to 1996) (Cederman et al. 2009) and armed conflict (Katanga se-

12 We include all uranium mining statuses – for instance, exploration, development, production and dormant mines – because each status can affect the causal mechanisms outlined in the literature review.

13 Please refer to the table in in the appendix for detailed results of the case selection process.

cession: 1960–1965). In addition to the spatial correlation, the temporal sequence makes a uranium-driven armed conflict logically feasible.

Map 1: Democratic Republic of Congo (Katanga Secession 1960–1965)



Source: Authors' compilation.

5.2.1.1 Uranium-Related Risks

Uranium production in the DRC began in the 1920s. The largest mine, Shinkolobwe, in Katanga's "Copperbelt" supplied uranium for the nuclear bombs that were dropped on Hiroshima and Nagasaki (UNEP and UN-OCHA 2004). Between 1940 and 1960 the DRC accounted for 60 percent of the global uranium output (ENCA 2011). When the DRC gained independence from Belgium in 1960, Moise Tshombe, a Katangan politician, declared the province of Katanga independent from the DRC. The Katangan secessionists were supported by Belgian troops (Gérard-Libois 1966: 101), and Tshombe was close to Belgian mining firms that produced mainly copper, as well as considerable amounts of gold and uranium. Gaining control of the lucrative mining sector and its revenue flows was a central motive for secession and subsequently led to this armed conflict (Horowitz 1985: 256; Nzongola-Ntalaja 2002: 99–205). The external support from Belgian troops created key opportunity structures for rebelling against the central state.

After independence, Shinkolobwe, the major uranium mine, had been closed (ENCA 2011; Global Witness 2004). When prices for copper increased in the late 1990s, artisanal mining of copper, cobalt and uranium began at Shinkolobwe. Following expressions of concern by the IAEA and the UN about illegal uranium trading, the mine was officially closed in 2004 and nearby mining villages were destroyed by security forces (UNEP and UN-OCHA 2004; WNA 2011b). However, artisanal mining resumed shortly after the official closure. Due to the absence of industrial infrastructure, no processing is done on location. Radiation levels

around the mine are high as the whole area around Shinkolobwe is contaminated with nuclear waste (UNEP and UN-OCHA 2004). Although no major armed conflicts (according to the UCDP definition) have occurred in the area since 1965, artisanal mining and nonstate actors' access to uranium permanently threatens the integrity of the state as insurgent groups may have incentives to gain control of resource areas.

While the poor quality of mining regulations and the lack of wealth-sharing regimes for uranium revenues at the time of the conflict were a central issue in the rebelling Katangans' political discourse (Lemarchand 1964), independent documents (such as legislation, mining codes) are not available to verify these claims. Only in 2002 was a new mining code introduced to regulate mining activities, the taxation of mining firms (30 percent income tax, 2 percent royalties) and the sharing of revenues (60 percent to the central government, with the rest to be invested in community and infrastructure development). However, the political elite lacks the will and the resources to implement these formal regulations and to ensure transparency and compliance (Global Witness 2004; Open Society Institute of Southern Africa et al. 2009). To some degree, this more recent information supports earlier claims of poor policy implementation and governance, providing at least partial evidence of the indirect conflict mechanism (for more on poor regulatory capacity, see also Section 2.2, point 3).

5.2.1.2 Ethnicity-Related Risks

The Luba people, most notably the Luba-Kasai and the Luba-Shaba (Katangan) subtribes, had experienced deprivation in the mineral- and uranium-producing areas since the late eighteenth century. Many Luba-Kasai were brought to Katanga as workers during Belgium's rule (Horowitz 1985: 255; Lemarchand 1964: 235). In the 1960s the Luba-Kasai dominated the administrative and business sectors in Katanga, which created tension between them and the native Katangans (International Crisis Group 2006). Commenting on post-independence DRC, Lemarchand (1964: 235) notes that compared to other provinces, Katanga's economic exploitation by the political and economic elite in Kinshasa led to strong grievances among its resident population. Supported by Belgian troops, Moise Tshombe mobilized the deprived Katangans and led them into Katanga's secessionist conflict.

5.2.1.3 Contextual Risks

Following the gaining of independence from Belgium, the DRC government was financially and structurally weak and not capable of controlling its large territory. The remote Katanga province was hard to control, particularly as it received third-party support from Belgian professional troops. Geographically, its peripheral location, an almost non-existing road network, the mountains and the jungle were advantageous for Katanga's uprising (Karaskiewicz and Kelty 1970).

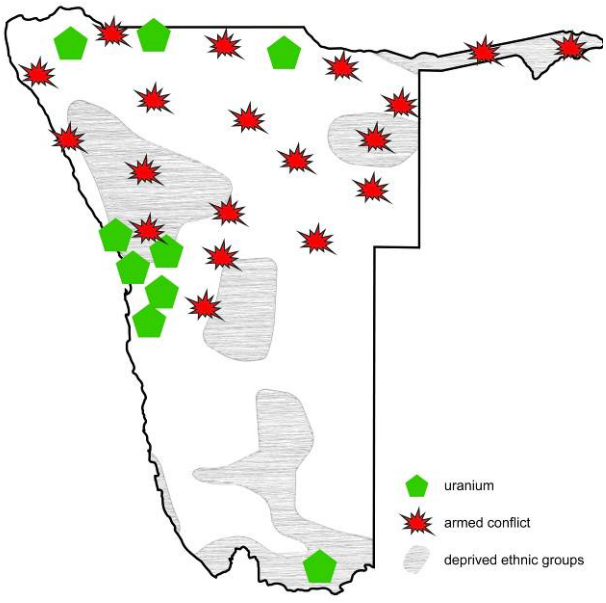
5.2.1.4 Case Summary

The exploitation of Katangan mineral resources by the central government in Kinshasa – first and foremost copper, as well as gold and uranium – generated grievances among the native Luba-Shaba. The secessionist conflict in Katanga was driven by the local people's goal of controlling the local extractive sector and revenues and was supported by Belgium (third-party support). Ethnicity-related risks were distinct and contributed significantly to political and armed mobilization.

5.2.2 Namibia

Uranium mining in Namibia started in 1960, when Namibia was ruled by South Africa. Today Namibia is the largest African uranium producer. Some mining areas are located in the homelands of the Topnaar Nama, a small ethnic group that is categorized as deprived (Cederman et al. 2009). Further, an armed conflict, the Namibian War of Independence, took place between 1966 and 1988. Although the temporal sequence lends support to the idea that the conflict between South Africa and the South-West Africa People's Organization (SWAPO), which led to Namibia's independence in 1990 (Eriksen and Moorsom 1989: 234; Tsokodayi 2011), was spurred by uranium, we do not find hard evidence that uranium mining was connected to the outbreak of the conflict.

Map 2: Namibia (War of Independence 1966–1988)



Source: Authors' compilation.

5.2.2.1 Uranium-Related Risks

With an output of 4,500 tons in the year 2010 (WNA 2011a), Namibia is now the fourth-largest uranium producer worldwide. Exploration for the first mine (Rössing) started in

1960, and production started in 1976. Rössing is the world's largest open-pit mine and is now owned by Anglo-Australian Rio Tinto, whereas back in the prewar period most mining operations belonged to South African firms. While local Namibians found jobs in the uranium mines, they only occupied rather low-level positions (Leys et al. 1995: 10). A rather delicate nugget of information is that the Iranian government holds 15 percent of the Rössing mine (*The Namibian* 2011). The second mine, Langer Heinrich, went into operation in 2007 and is owned by the Australian firm Paladin Energy (WISE 2012c). The Namibian government plans to increase uranium production's contribution to the GDP from 5.5 percent in 2008 to 15 percent by 2015 (*The Namibian* 2011). This exemplifies the fact that since 1960 uranium production has been central to the Namibian economy. There is no explicit evidence that disputes over the control of resources and the distribution of revenues have been central motives for rebellion. While the argument is rather speculative, there are reasons to believe that the control of resources (diamonds, uranium) was one of many motives behind Namibia's war for independence. If we look at the historical patterns of other liberation struggles, we see that the fight against resource exploitation by outsiders, in this case South Africa (Freeman 1992: 30), and for the control of assets has commonly been an important aspect of calls for political support from the particular population.

Environmental pollution through uranium mining has been reported; in particular, water shortages and contamination are major problems for the home communities (Shindondola-Mote 2009: 29; Suchanek 2008; *The Namibian* 2005a). NGOs have thus tried to raise awareness and mobilize the population to oppose new uranium developments (*The Namibian* 2005b, 2006, 2012). The working conditions for mining staff have improved since the 1970s but are still poor according to workers. In the 1990s several workers suffered from or died of cancer. In 2011 workers went on strike for bonuses and outstanding salaries (EIU 2011; Shindondola-Mote 2009: 34–42).

Although these reports of pollution and poor working conditions refer to rather recent events, we argue – given the lack of information from before and during the time of conflict – that uranium-related risks, particularly the risks for the population and the environment, were similar if not higher at that time, but were not reported on. At the time of the conflict, the uranium-producing areas were under the control of South Africa (Freeman 1992). There is no evidence that rebels from the SWAPO were able to access or interfere with uranium production.

5.2.2.2 Ethnicity-Related Risks

The Topnaar Nama (population of approximately 200,000; Lewis 2009) live near the Rössing mine and have experienced the effects of environmental degradation. While the group has been negatively affected by uranium mining, has experienced economic deprivation (Suchanek 2008) and lacks political agents (Ejikeme 2011: 13), there is no evidence at all regarding the group's connection with the Namibian War of Independence or any other violent conflict.

5.2.2.3 Contextual Risks

Thanks to its extractive industries Namibia has always belonged to the richer African countries, a status that is represented in its comparably sound infrastructure. The South African regime invested heavily in Namibia's infrastructure (roads, railway, communication) to ensure the functioning and mobility of its own military (Freeman 1992: 30), which in turn allowed it reasonable control of the vast territory.

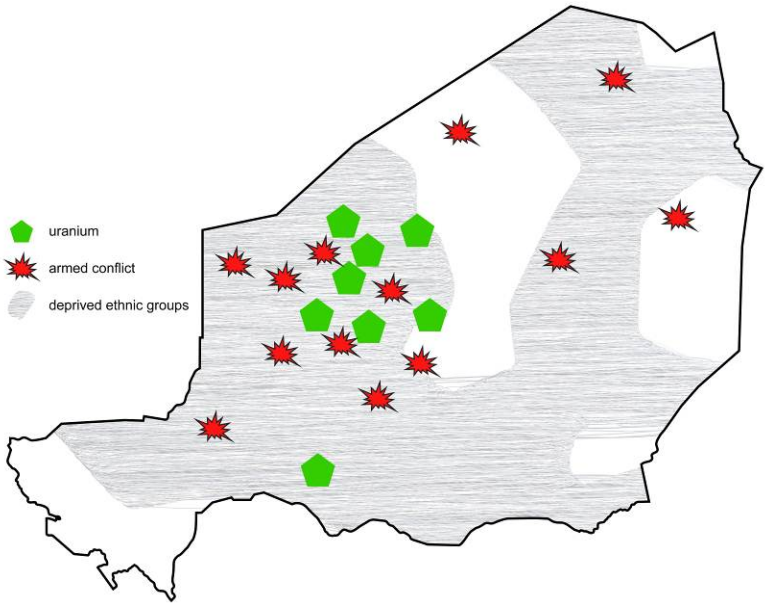
5.2.2.4 Case Summary

Neither uranium in particular nor minerals more generally have been reported to be crucial in Namibia's armed fight for independence. Rather, suppression by the South African apartheid regime and the Africa-wide wave of independence can be considered the drivers of the rebellion.

5.2.3 Niger

Industrial mining began in 1957. Today Niger is Africa's second-largest uranium producer. The uranium mines lie exclusively in the area inhabited by the Tuareg, who are classified as being a deprived group for the periods from 1960 to 1992 and from 1996 to 2005 (Cederman et al. 2009). Armed conflict took place between 1990 and 1995 and from 2007 to 2009. The temporal sequence, uranium operations before conflict onset, supports the hypothesis of a uranium-driven conflict.

Map 3: Niger (Tuareg Rebellion 1990–1995 and 2007–2009)



Source: Authors' compilation.

5.2.3.1 Uranium-Related Risks

The exploration phase started in Arlit (SOMAIR open-pit mine) in 1971 and three years later in Akouta (COMINAK underground mine). Both mines were developed and are still run by the French state-owned company AREVA (Keenan 2008). While there is no evidence that the native Tuareg fought for the control of the uranium mines themselves, their central demand was a higher share of the revenues from the uranium being extracted in their homelands.

Environmental damage has occurred through poorly secured tailings, which can contain up to 80 percent radioactive waste rock. Strong winds spread radioactive dust over hundreds of kilometers, and scrap materials are being used by the local population for construction and households. Waste rock is used for road construction (Hecht 2012). Water sources are contaminated at levels up to 500 times the WHO's threshold for radiation. Additionally, groundwater levels have sunk from 50 to 300 meters since uranium mining started (Greenpeace 2010; Keenan 2008).

Working conditions at both mines have been reported to be poor (Keenan 2008: 455; WISE 2012d). The mortality rate due to respiratory infections at Arlit is 16 percent, almost twice the national average of 9 percent. A political NGO called Aghir In Man has been formed to represent the rights of uranium workers (Greenpeace 2010).

Particularly at the beginning of the second rebellion there were attacks on uranium mining facilities (for example, the attack on Immouraren base in April 2007). These included the abduction of a foreign uranium executive and an attack on the compound of an electricity company that powers uranium mines (*Africa Confidential* 2007; Hecht 2012: 2; Lawel 2010). While rebels never took complete control of the mines, there were able to interrupt the uranium operations.

5.2.3.2 Ethnicity-Related Risks

Uranium is extracted in the large territories that are partly inhabited by the Tuareg, who have traditionally pursued a nomadic lifestyle. The cultural rift between the Tuareg and the other ethnic groups of Niger contributed to their political and economic marginalization and, subsequently, their exclusion from development (*Africa Confidential* 2007; Keenan 2008). Additionally, they have had a history of conflicts over land rights with the dominant Hausa tribe (Greenpeace 2010).

The Tuareg's grievances enabled them to rally support among their people. The armed conflict with the Nigerien government started in 1990 when Tuareg rebels (Coordination de la Résistance Armée, CRA) demanded more decentralization and a share of the revenues from the uranium that was mined in their homelands (Keenan 2008). The peace agreement of 1995 granted 10 to 15 percent of uranium revenues to the North and provided more autonomy for the region. After the signing of the 1995 peace accord the Union des Forces de la Résistance Armée (UFRA), a breakaway faction, formed; it reinitiated the conflict with the government in 1997. A ceasefire agreement was signed the same year and resulted in peace. The

peace agreement held for several years. Conflicts over working conditions, ecological degradation and water shortages from uranium mining manifested as largely peaceful demonstrations and strikes (Deschamps 2000; Lawel 2010).

In 2007 the newly formed Mouvement Nigérien pour la Justice (MNJ) started a new struggle for decentralization and ignored the 1995 peace accord. The MNJ demanded a higher share of uranium revenues and more effective regulation of the mining process in order to protect the environment (Keenan 2008; Lawel 2010; Muna 2009).

5.2.3.3 Contextual Risks

Niger is among the poorest countries in Africa. The country's sheer size, a lack of roads and massive desert areas make it difficult for its security forces to control. The return of thousands of militarily trained Tuareg fighters from Lebanon, Palestine and Afghanistan in the late 1980s (Deycard 2011: IV–V) further worsened the security situation.

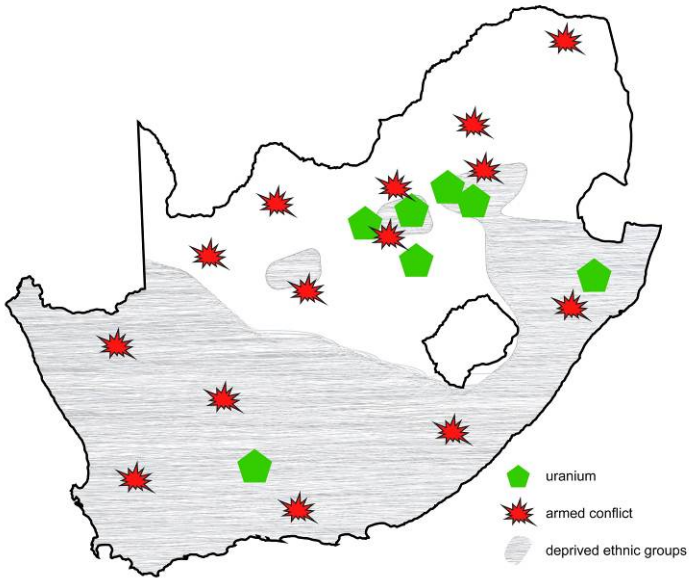
5.2.3.4 Case Summary

In the case of Niger, the contest over uranium revenues played a strong role in the outbreak of violent conflict between the Tuareg rebels and the Nigerien government. The Tuareg's political marginalization and economic deprivation was not originally connected to uranium, but was rather a consequence of the Tuareg's cultural marginalization and remote living areas. However, decades of uranium production generated strong grievances, above all related to ecological damage and the excessive water usage required for uranium milling. In addition, the Tuareg community's exclusion from the uranium revenues was a central motive for its uprising. The case of Niger supports our hypothesis with evidence on all levels, uranium-related motives and opportunities as well as ethnicity-related risk factors.

5.2.4 South Africa

In South Africa the intrastate conflict (anti-apartheid struggle from 1981 to 1988), industrial uranium mining (1944–present), and settlements of the Zulu (deprived: 1946–1993) and the Xhosa (deprived: 1946–1993) (Cederman et al. 2009) overlap spatially. In addition, the temporal sequence makes uranium-driven conflict logically feasible.

Map 4: South Africa (Anti-Apartheid Struggle, 1981–1988)



Source: Authors' compilation.

5.2.4.1 Uranium-Related Risks

In South Africa uranium is only a by-product of the much more important gold and copper extraction. Still, South Africa holds 8 percent (435,000 tons) of the world's known recoverable uranium resources. The first company to exploit uranium-rich slurries was formed in 1951 (WNA 2011c). With the four uranium mines currently producing, South Africa extracted 583 tons in 2010 (WNA 2011d). There is no evidence that the control of the uranium mines or the distribution of uranium revenues have been contested.

The safety of workers has been an issue but has improved recently. While in 1998 one out of 20 mine workers was exposed to elevated radiation levels, stronger regulations have since been introduced. The workforce of AngloGold is equipped with radiation dosimeters, and workers have an annual exposure limit of 20 millisieverts, the global standard for nuclear workers[14] (Scheele and Wilde-Ramsing 2011).

Ecological problems with uncovered tailings threaten to contaminate the groundwater. In 2008 high concentrations (150 times the threshold) of radioactive substances were found in vegetables near Johannesburg *(The Independent Online* 2008). Dust-related pollution, the destruction of aquifers, and acid mine drainage from flooded mines are the major ecological issues related to the industry (Scheele and Wilde-Ramsing 2011; WISE 2012e).

Given the lack of uranium-related reports during the time of conflict, we argue that hazards for the population and the environment were worse at that time than in the last decade. However, recent grievances regarding ecological damage and workers' safety have been expressed through nonviolent strikes and protest marches.

14 For instance, smoking 30 cigarettes per day accrues to 60–80 millisieverts per year.

5.2.4.2 Ethnicity-Related Risks

The GIS analysis has identified the Zulu and Xhosa as deprived ethnic groups living in uranium-producing regions. Although the Zulu and the Xhosa were, like other groups, discriminated against under the apartheid regime, evidence of a connection between uranium mining and the discrimination cannot be found. However, Greenpeace (2011: 16) and Fig (2006: 61–69) do report one incident where the Namaqualand region was chosen as a disposal site for nuclear waste because of its remoteness from white settlements.

The armed conflict between the government of South Africa and the armed wings of the African National Congress (ANC), the Pan African Congress (PAC) and the Azanian People's Organisation (Azapo) took place between 1981 and 1988. The black population rose up against the white minority apartheid regime and fought for the implementation of a democratic system (Clark and Worger 2011).

5.2.4.3 Contextual Risks

South Africa is the richest and most developed country in Africa, something which has been reflected in its capacity to exert control over its territory and particularly over its resource production areas.

5.2.4.4 Case Summary

In the case of South Africa, there is no evidence to support our hypothesis that the conflict was connected to uranium. The struggle against the apartheid regime was largely driven by the suppression of the black population.

5.2.5 Microlevel Summary

What conclusions can we draw from the analysis of these four cases? Only in the case of Niger does the evidence substantially support our hypotheses of a uranium-spurred (H1) and an ethnically aggravated (H2) conflict. In the DRC uranium played only a partial role in the conflict onset, while ethnic deprivation has stronger explanatory power. The cases of Namibia and South Africa do not support our first hypothesis. Thus, two out of four cases exhibit at least a partial influence of the uranium sector on armed conflict. However, ethnicity-related risks, existent in all cases, appear to better explain conflict onset. The explanatory power of other contextual risks is supportive in explaining conflict onset in the DRC and Niger.

Table 2: Conflict Motives and Opportunities

	DRC	*Namibia*	*Niger*	*South Africa*
Hypotheses				
Uranium-driven conflict (H1)	partly	no	yes	no
Ethnicity-driven conflict (H2)	yes	yes	yes	yes
1. Uranium-related risks				
1.1 Motives				
Resource control contested	yes	no	no	no
Distribution of revenues contested	yes	no	yes	no
Ecological damage | protest	yes/no	yes/no	yes/yes	yes/yes
Uranium workers' protest	no	no[15]	yes	yes
1.2 Opportunities				
Rebels access resources and trade	yes	no	no	no
Rebels receive major third-party support (e.g., future wealth)	yes	no	n/a	no
Rebels kidnap/attack uranium personnel	no	no	yes	no
Rebels attack transport routes, facilities	no	no	yes	no
1.3 Indirect mechanisms				
Poor mining policies | poor compliance	yes/yes	yes/yes	yes/yes	no/no
Insufficient revenue-sharing regime	yes	yes	yes	no
2. Ethnicity-related risks				
Particular groups live in resource area	yes	yes	yes	yes
Groups are economically deprived	partly	yes	yes	yes
Groups are politically deprived	yes	yes	yes	yes
Politically organized	yes	no	yes	no
Grievances | resource-related	yes/yes	yes/yes	yes/yes	yes/no
Active protest	yes	no	yes	yes
Armed protest	yes	no	yes	yes
3. Contextual risks				
Country belongs to poor African countries	yes	no	yes	no
Resource area *not* under government control	yes	no	yes	no
Terrain conducive to rebellion (e.g., jungle, mountain, poor roads, remote)	yes	no	yes	no
Natural resources (other than uranium) relevant in conflict?	yes	yes	no	yes

Source: Authors' compilation.

6 Conclusion

Hypothesis 1 suggested that uranium operations – encompassing the whole lifecycle from exploration to depletion – increase the likelihood of armed conflict as they may generate uranium-related motives and opportunities. Motives may include not only ambitions to control the uranium extraction or the desire for a greater share of revenues, but also (other) grievances such as ecological degradation and health hazards. Opportunities may come from the illegal access to and trade of uranium. Rebels may receive external support from "inves-

15 While there have been protests in the last decade, there is no evidence of protests before or during the conflict (see page 15).

tors," or they may kidnap expatriate workers or attack facilities and transport routes. Hypothesis 2 claims that whenever uranium ventures operate in the homelands of deprived ethnic groups, conflict risk will increase. This aspect is particularly relevant as ethnicity may serve as an efficient mobilization tool for rebellion.

Our approach to testing the hypotheses was to employ a two-tier analysis. The macroanalysis utilized GIS techniques to

a) determine the patterns of uranium-based conflicts and
b) generate a set of country cases suited for the subsequent microanalysis.

Regarding the general conflict patterns, the macroanalysis has found that compared to a baseline risk of armed conflict in Africa of 64–65 percent, areas with uranium operations experience an increased risk of 74–86 percent. In areas with uranium and deprived ethnic groups, the conflict risk lies at 93 percent. We conclude that uranium does not substantially increase conflict risk but that settlements of deprived ethnic groups do and should thus be considered a much stronger predictor of intrastate conflict. From a macro perspective, we do not find sufficient evidence to support Hypothesis 1, but our evidence partially supports Hypothesis 2 (ethnicity).

In the generation of cases for the microlevel study, the spatiotemporal analysis yielded four countries where uranium ventures, marginalized ethnic group settlements and intrastate conflict not only overlapped spatially but also corresponded to the necessary temporal sequence. These cases, the DRC, Namibia, Niger and South Africa, have been tested for causal mechanisms connecting uranium, ethnic discrimination and armed conflict. For this test we used an analytical framework that asked for the uranium-related motive and opportunity mechanisms, as well as ethnicity-related, and other, risks. Of these four cases, only Niger exhibits a strong causal relationship between uranium and armed conflict, even though ethnicity-related discrimination also played a prominent role in the rebellion. In the case of the DRC's Katanga secession, the wider extractive industry (copper, gold, uranium) generated conflict motives and opportunities. The role of ethnicity in mobilization was also strong. In Namibia's struggle for independence, the control of resources (gold, diamonds, uranium) and the fight against exploitation by South Africa may have partially contributed to the insurgency, but this is speculation rather than the result of hard evidence. In the fight against South Africa's apartheid regime, there is no evidence that uranium and armed conflict were even remotely connected. Readdressing the hypotheses, the microlevel study finds weak support for uranium-spurred conflicts (H1) but strong support for ethnicity-driven conflicts (H2).

Putting these results in context means that out of the five countries in Africa currently producing uranium – the DRC, Malawi, Namibia, Niger, South Africa – only one has experienced armed conflict where uranium was a central trigger (Niger) and one has experienced a struggle for secession where the control over resources, including uranium, played a partial role in the conflict (DRC). In the remaining 25 uranium (exploring) countries, there has so far been no connection between uranium and armed conflict. However, since these 25 uranium-

exploring countries in Africa – many of them with politically unstable contexts – will become uranium producers in the coming years, the risk of conflict is real. We thus strongly recommend that our analysis be revisited at a future date.

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6 Appendix – Spatiotemporal Triangulation

				spatial			*temporal*			*triangulation*		
	current u-status	# uranium sites	ac in country	overlap u+c	overlap u+e	overlap u+e+c	u→c	e→c	u+e→c	u→c	e→c	u+e→c
Algeria	dorm	5	1	1	1	1	n/a	n/a	n/a	n/a	n/a	n/a
Botswana	expl	10	0	0	0	0	0	0	0	0	0	0
Burkina Faso	expl	2	1	0	0	0	0	0	0	0	0	0
Burundi	expl	1	1	1	1	1	0	1	0	0	1	0
Cameroon	expl	3	1	0	0	0	0	0	0	0	0	0
CAR	devp	5	1	0	1	0	0	1	0	0	1	0
Chad	expl	4	1	1	1	1	0	1	0	0	1	0
DRC	dorm	8	1	1	1	1	1	1	1	1	1	1
Egypt	dorm	1	1	0	0	0	0	1	0	0	0	0
Gabon	dorm	8	0	0	0	0	1	1	1	0	0	0
Guinea	expl	4	1	1	1	1	0	1	0	0	1	0
Madagascar	expl	3	1	1	1	0	0	1	0	0	1	0
Malawi	prod	3	0	0	0	0	0	0	0	0	0	0
Mali	expl	1	1	0	0	0	1	1	0	0	0	0
Mauretania	expl	6	1	1	0	0	n/a	0	0	n/a	0	0
Morocco	dorm	8	1	1	1	0	0	1	0	0	1	0
Mozambique	expl	1	1	1	0	0	0	1	0	0	1	0
Namibia	prod	39	1	1	1	1	1	1	1	1	1	1
Niger	prod	34	1	1	1	1	1	1	1	1	1	1
Nigeria	expl	4	1	1	1	1	n/a	1	n/a	n/a	1	n/a
Senegal	expl	1	1	0	0	0	0	0	0	0	0	0
Sierra Leone	expl	1	1	1	1	1	n/a	1	n/a	n/a	1	n/a
Somalia	dorm	3	1	1	0	0	n/a	0	0	n/a	0	0
South Africa	prod	46	1	1	1	1	1	1	1	1	1	1
South Sudan	expl	1	1	1	1	1	n/a	1	n/a	n/a	1	n/a
Tanzania	expl	4	0	0	0	0	0	0	0	0	0	0
Togo	expl	1	1	0	1	0	1	0	0	0	0	0
Uganda	expl	12	1	1	1	1	0	1	0	0	1	0
Zambia	devp	9	0	0	0	0	0	0	0	0	0	0
Zimbabwe	expl	2	1	1	1	1	0	1	0	0	1	0

Source: Authors' compilation.

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