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Preparing for Genocide: Quasi-Experimental Evidence from Rwanda*

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Abstract

This paper provides evidence for how an authoritarian state can mobilize civilians to participate in mass violence through a top-down policy. We analyze a Rwandan mandatory community program that required citizens to participate in community work and political meetings every Saturday in the years before the 1994 genocide. We exploit cross-sectional variation in meeting intensity induced by exogenous weather fluctuations, and find that a one standard-deviation increase in the number of rainy Saturdays resulted in a 16 percent lower civilian participation rate in genocide violence. The natural placebo test – rainfall on all other weekdays – yields no statistically significant results. Moreover, the result is entirely driven by areas under the control of pro-Hutu parties, and we find evidence that the political elites used the program beyond simple propaganda, bringing civilians together and practicing mobilization. We also present suggestive evidence that in areas with opposition parties in power, the effects turn positive, implying that the meetings there were used to overcome hatred. Our robust findings shed light on the potentially detrimental role of government-ordered community meetings. Its importance derives, at the very least, from the resurgence of similar practices in sub-Saharan Africa.

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1 Introduction

Large, disorganized groups that engage in protest, social unrest, or genocide first have to solve their collective action problem. To illustrate this, in several civil wars and conflicts, ordinary and seemingly unorganized civilians participate in violence. Are these people solely driven by deep-rooted hatred (bottom-up dynamics), or is the violence organized by the political leaders (top-down organization)? Civilian participation in violence often magnifies and escalates a given conflict with disastrous effects on the social fabric and the economy, not least the human suffering. It is therefore crucial to understand its causes. During the Rwandan Genocide in 1994, around 430,000 Hutu civilians joined the army and militiamen in killing an estimated 800,000 Tutsis and moderate Hutus in only 100 days. Anecdotal evidence for the Rwandan case points to a top-down preparation of the genocide: In the years before the genocide, the political elites abused the weekly-held community meetings called *Umuganda* (initially designed as mandatory work meetings to improve local infrastructure) to mobilize the civilian Hutu population against the ethnic Tutsi minority (Cook, 2004; Straus, 2006; Verwimp, 2013).

This paper provides the first empirical analysis of how important local, elite-led community meetings might have been in inducing the civilian population to participate in violence. Examining the possibly negative effect of these community meetings is of general importance: There is a widely held belief that community meetings foster social capital by providing arenas for people to meet, solve free-rider problems, and create public goods (Guiso, Sapienza and Zingalez, 2008; Grootaert and van Bastelaer, 2002; Knack and Keefer, 1997; Putnam, 2000). Consistently, many development agencies today focus on community-driven development projects in which deliberative forums and grass-root participation play a central role (see Mansuri and Rao (2012) for a recent overview). We investigate whether there is a "dark side" to these community meetings where social capital does not bridge the societal, ethnic divides but rather enforces bonding within groups, within the Hutu population in the Rwandan case. Understanding this process is even more important since *Umuganda* was formally re-introduced in Rwanda in 2008, and similar practices have been set up in Burundi, and are discussed in the Democratic Republic of Congo and recently in Kenya (Daily Nation, 2016).

Furthermore, the Rwandan Genocide is part of a wider phenomenon of violent collective action such as civil conflict and social unrest. Understanding its mobilization dynamics is important for interpreting and handling other violent events involving civilian actors such as the 2007 post-election violence in Kenya. At the same time, the empirical literature on how groups solve their collective action problem is scarce.

Identifying the causal effect of these meetings on participation in genocide is difficult for two reasons. First, we lack data on the number of people participating in *Umuganda* or the number of meetings taking place in each area. Second, even if such data existed, our estimates would likely suffer from an omitted variable bias. On the one hand, area-specific unobservable characteristics that affect both genocide participation and *Umuganda* intensity, for instance local leader quality, could produce a spurious positive correlation between the two, thus biasing the estimate upwards. On the other hand, if *Umuganda* meetings were strategically used in areas where genocide participation was unobservably low, the estimate would be downward biased.

To overcome these data and endogeneity issues, we use exogenous rainfall variation to estimate the effect of *Umuganda* meetings on participation in civil conflict. The idea is simple: we expect the meetings to be less enjoyable when it rains and, furthermore, to be canceled altogether under heavy rains. Although we lack data to directly test this conjecture, it is supported by anecdotal evidence. Moreover, in the following analysis we present several tests that strongly suggest that our reduced-form effects are working via the *Umuganda* meetings. Since the community work took place on *Saturdays*, we can isolate the *Umuganda* effect from general rainfall effects (e.g. rainfall affecting income through agriculture) by only using the variation in Saturday rainfall while controlling for average daily rainfall. We use the number of Saturdays with heavy rainfall during the 3.5 year pre-genocide period (from October 1990, the outbreak of the civil war, to March 1994, the eve of the genocide) as our variable of interest.[1]

Furthermore, we can provide a first placebo check by controlling for heavy rainfall

[1] After the start of the civil war in October 1990, the tensions between Hutu and Tutsi intensified and the Hutu-dominated government became more aggressive towards the Tutsi minority, eventually culminating in the genocide. The increasing inter-ethnic hatred was for instance expressed in the government-funded journal *Kangura* (Melvern, 2004).

on all other six weekdays. This placebo test also allows us to rule out that other factors correlated with rainfall, such as geography, are driving the results as these factors should then be correlated with rainfall also on other weekdays. Nevertheless, we show that the results are robust to controlling for geographical factors such as sector ruggedness. To control for local characteristics, we include 142 commune fixed effects. Thus, we ensure that identification only stems from local variation in rainfall on Saturdays, which is arguably exogenous and should only affect genocide participation through its effect on *Umuganda* meeting intensity. There is, however, one major concern regarding the exclusion restriction: The effect we estimate might simply be a consequence of people getting together in general on Saturdays rather than the political leaders manipulating the population during the *Umuganda* meetings. We will argue in great detail why this concern is unwarranted.

We proxy for genocide violence by the number of people prosecuted in the Gacaca courts, normalized by sector Hutu population.[2] About 10,000 local Gacaca courts were set up all over the country to prosecute the crimes committed during the genocide. Importantly, these courts distinguished between civilian perpetrators and organized perpetrators such as members of militia gangs, the national army or the local police. Since organized perpetrators (mostly army and militiamen) moved around during the genocide, it is unclear whether the sector where they were exposed to pre-genocide *Umuganda* is the same as the locality where they appear in our prosecution data. To avoid this measurement error, we focus on civilian participation. Using prosecution instead of actual participation rates may introduce some bias. However, the Gacaca data is strongly correlated with other measures of genocide violence from various other sources and, using an alternative genocide measure from a different source, we present a number of additional tests to rule out that any systematic errors are biasing our results.

Our reduced-form results indicate a negative relationship between canceled *Umuganda* meetings (rainy Saturdays) and civilian participation in genocide violence: A one standard-deviation increase in the number of rainy Saturdays is associated with a 16 percent decrease in the civilian participation rate. Interestingly, this relationship is

[2]Sector is the second smallest administrative unit in Rwanda, with an average size of 14 square kilometers and 4,900 inhabitants.

entirely driven by sectors that are ruled by the pro-Hutu parties, and tracing the effects over time suggests that the meetings during the last 11 months before the genocide were the most important. This rules out long-term mechanisms, such as the infrastructure built during the meetings driving the results. Rather, we find evidence suggesting that the political elites used the program beyond simple propaganda, bringing people together and practicing mobilization. We also present suggestive empirical evidence that in areas with opposition parties in power, the effects turn positive, implying that the meetings there were used to create bonds between the two ethnicities.

Our results have important policy implications and are also relevant for other countries. Community meetings have recently been seen as a panacea for development by many NGOs and government agencies (Mansuri and Rao, 2012). Our results suggest that they can be captured and abused by local elites, thus calling for caution. In 2008, the Rwandan government reintroduced *Umuganda*. This might be worrisome since there is still tension between the Tutsi and Hutu population in the country. Furthermore, similar practices have been set up in Burundi and are being discussed in the Democratic Republic of Congo (DRC) and Kenya; all countries with a history of violent conflict along ethnic lines, which once more calls for caution when establishing an institution such as mandatory community meetings.

Our work contributes to the literature in several ways. Firstly, it advances the very scarce literature on the "dark side" of social capital (Satyanath, Voigtlaender and Voth, forthcoming), in contrast to several studies highlighting its positive effects (Guiso, Sapienza and Zingalez, 2008; Grootaert and van Bastelaer, 2002; Knack and Keefer, 1997). Secondly, it adds to a small empirical literature on how groups engaging in conflict, social unrest, or protest, solve their collective action problem. In line with Rogall (2014), we show that the Rwandan Genocide was carefully prepared by the political elites – a top-down approach. Thirdly, it complements the literature on the Rwandan Genocide (Friedman, 2013; Rogall, 2014; Verpoorten, 2012a-b; Verwimp, 2006; Yanagizawa-Drott, 2014) by providing novel evidence on its careful preparation.

Furthermore, Blattman and Miguel (2010) review the economics literature on conflict, vehemently calling for well-identified studies on the roots of individual participation in violent conflict. Recent studies on the determinants of conflict and participation in violence and killings consider government policy, income, foreign aid, and institutions (Dell, 2015; Mitra and Ray, 2014; Nunn and Qian, 2014; Dube and Vargas, 2013; Besley and Persson, 2011, respectively). Our study adds to this literature by providing novel evidence on the strong effects of local, elite-controlled community meetings on civilian participation in violence. The paper is also related to a literature in economics stressing the importance of political elites and their effects on institutions and conflict (Jones and Olken, 2009).

On the methodology side, our results add to the recent discussion on the effects of rainfall on conflict other than through the income channel (Iyer and Topalova, 2014; Rogall, 2014; Sarsons, 2015). Prominent studies that use various rainfall measures as instruments for income in Africa include Brückner and Ciccone (2010) and Miguel, Satyanath and Sergenti (2004).

The rest of the paper is organized as follows. Section 2 provides some background information on the Rwandan Genocide and *Umuganda*. Section 3 presents the data used for the analysis and Section 4 lays out our empirical strategy. Section 5 presents the main results and assesses their robustness, Section 6 discusses mechanisms and channels, and Section 7 concludes with possible policy implications.

2 Background

A History of Conflict Tensions between the Hutu and Tutsi populations have been present in Rwanda at least since colonial times. The origins of the two groups and the distinction between them is debated.[3] What seems clear is that Belgian colonizers deepened the division between the two ethnic groups, and deliberately favored the Tutsi minority. Strong tensions rose between the two groups that culminated in the Rwandan revolution of 1959, where the Tutsi monarchy was replaced by a Hutu republic. During this period, many Tutsi civilians were killed; others fled Rwanda for neighboring

[3] The Tutsi minority (with a pre-genocide population share of around 10 percent) are said to have descended from Hamitic migrants from the north of Africa, and the Hutu majority from the Bantu group, who traditionally lived in Rwanda. However, others say that the two ethnicities do have a common ancestry.

countries such as Burundi, Tanzania and, in particular, Uganda. In the 1960s, episodes of political stability alternated with times of violence, but the underlying tensions never ceased.

In 1974 – paramount to the introduction of a modern version of *Umuganda* – Juvénal Habyarimana took power in Rwanda through a coup d'état. His subsequent rule was based on a pro-Hutu ideology ("Hutu power"), further discussed in the next section. In October 1990, the Rwandan Patriotic Front (RPF) invaded Rwanda from Uganda, starting the Rwandan civil war. The RPF was a Tutsi rebel army, who had emerged in exile, eager to replace the Hutu-led government. Fighting between the Hutu-led government and the Tutsi rebels continued until the Arusha Accords were signed in August 1993.[4] A multi-party system was installed in the early phase of the peace talks, but this had little effect on reducing societal tension and conflict. On April 6 1994, an airplane with President Habyarimana on board was shot down over Kigali. Whether the Tutsis or Hutus are responsible for this attack remains unclear till this day, but quickly after the attack, extremists within the Hutu-dominated parties announced a new interim government and started a 100-day period of ethnic genocide throughout Rwanda. Around 800,000 people, mostly Tutsis and moderate Hutus lost their lives. The mass killings stopped in mid-July, when the RPF Tutsi rebels defeated the Rwandan Hutu army and the militia groups such as the Interahamwe.

A large number of Hutu civilians participated in the genocide violence, directed by the interim government (Dallaire, 2003). According to the Gacaca data that we use for this analysis, there were approximately 430,000 civilian perpetrators.[5]

Umuganda The practice of *Umuganda* dates back to pre-colonial times. During a day of community service, villagers would get together to build houses for the poor, or help each other out in the fields in times of economic hardship (Mukarubuga, 2006). Rather than being mandatory, *Umuganda* was initially considered a social obligation (Melvern, 2000). This changed during the colonial period, when the Belgian colonizers

[4]The essence of this treaty was a power-sharing government, including representatives from both sides of the conflict.

[5]For more information, see for example Straus (2006), Hatzfeld (2005), Dallaire (2003), Des Forges (1999), Gouveritch (1998), and Prunier (1995).

used *Umuganda* for organizing compulsory work. Consistently, the locally employed term for *Umuganda* in this period was *uburetwa*, or *forced labor* (IRDP, 2003). All men had to provide 60 days of communal work per year. Most of the manual labor was hereby carried out by members of the ethnic Hutu majority under the supervision of Tutsi chiefs (Pottier, 2006).

When *Umuganda* was re-introduced in 1974, the newly installed President Habyarimana, of the Hutu ethnic group, turned it into a political doctrine, which once again changed its meaning (Mamdani, 2001). Verwimp (2000, p. 344) cites Habyarimana:

> *"The doctrine of our movement [Movement for Development, MRND] is that Rwanda will only be developed by the sum of the efforts of its people. That is why it has judged the collective work for development a necessary obligation for all inhabitants of the country."*

The program combined a practical motivation – achieving development objectives despite weak state finances – with a strong ideological element. Participation was again made compulsory through government coercion, and failure to participate usually involved paying a fine.[6] The local leaders of the neighborhood who presided over a group of ten households were responsible for the weekly *Umugandas* and could decide who were to participate and demand fines from those failing to participate (Verwimp, 2000). The state chose the projects on which at least one adult male per family had to work on outdoor communal projects *every* Saturday morning (Uvin, 1998). According to a 1986 report, the main tasks consisted in anti-erosion measures and road maintenance work (Guichaoua, 1991).[7] In the meetings held before or after the community work, local or higher officials disseminated information about the governing principles of the ruling party, The National Republican Movement for Democracy and Development (MRND), and messages from the government (Guichaoua, 1991).

Habyarimana's ideology stressed the importance of the cultivator as the true Rwan-

[6] In today's Rwanda, the fine for not participating in *Umuganda* is slightly less than $10.

[7] Specifically, 56 percent of the work performed during *Umuganda* included various types of anti-erosion measures, such as terracing and digging ditches; 21 percent consisted of maintenance work of communal roads; 15 percent were construction of communal buildings while 3 percent were related to construction of water supply systems and another 3 percent were related to agriculture (Guichaoua, 1991).

dan (Straus, 2006). This view clearly embraced the Hutu population with their history as cultivators, as opposed to the Tutsi pastoralists. During the period leading up to the genocide, *Umuganda* was used to strengthen group cohesion within the "indigenous" ba-Hutu and marginalize the "non-indigenous" ba-Tutsi (Lawrence and Uwimbabazi, 2013). The patriotic focus of *Umuganda* became particularly salient in the early 1990's when *"government propaganda gave no choice to Rwandans other than to attend Umuganda for political mobilization,"* (Lawrence and Uwimbabazi, 2013, p. 253).

Although little is known about the link between participation in *Umuganda* before the genocide and participation in violence during the genocide – a link which we hope to shed some light on in this paper – anecdotal evidence speaks to the importance of *Umuganda* as an instrument for local party and state officials to mobilize the peasant population. Since all Rwandans of working age, be it farmers or intellectuals, were required to participate in *Umuganda* (Guichaoua, 1991), the meetings were ideal for reaching the entire population. Although only a correlation, Straus (2006) shows that 88 percent of the perpetrators he interviewed regularly participated in *Umuganda* before the genocide.

Umuganda was also used during the genocide itself, with the new name *gukorn akazi*, or "do the work", which meant the killing of Tutsis (Verwimp, 2013). Other slogans related to *Umuganda* used before the genocide such as "clearing bushes and removing bad weeds" now had a completely altered connotation (Lawrence and Uwimbabazi, 2013). By equating participation in genocide violence with participation in *Umuganda*, the Hutu elite could signal that participation in genocide violence, just like participation in *Umuganda*, was a social obligation for all "true" Rwandans.

In 2008, the Tutsi-led government re-introduced *Umuganda* in Rwanda to promote development and reduce poverty in the aftermath of the genocide (Uwimbabazi, 2012). Participation is once more mandatory for all able-bodied individuals between 18 and 65 years of age, and typical tasks include cleaning streets, cutting grass and trimming bushes along roads, repairing public facilities or building houses for vulnerable individuals. The meetings now take place on the last Saturday of every month.

3 Data

We combine several datasets from various sources to construct our final dataset with a total of 1,433 Rwandan sectors. Sectors are the second smallest administrative level in Rwanda, and the level for which our outcome data on perpetrators is available. Table 1 reports the summary statistics for our variables.

Participation Rates Ideally, we would like to have a direct measure of participation rates. Since such data does not exist, we follow the literature and use prosecution rates for crimes committed during the genocide as a proxy (Friedman, 2013; Heldring, 2014; Rogall, 2014; Yanagizawa-Drott, 2014). Thus, we use a nation-wide sector-level dataset, provided by the government agency ”National Service of Gacaca Jurisdiction”, which collects the outcome of the almost 10,000 local Gacaca courts set up throughout the country to prosecute the genocidaires. Importantly, people were prosecuted in the sector where they committed their crimes and did not have to be physically present to be prosecuted. The courts identify two categories of perpetrators that we distinguish between in our analysis.

The first category, which we refer to as “organized perpetrators”, includes people that were either leaders and organizers, or committed particularly brutal crimes. Most of these perpetrators either belonged to the army or the militia or were local leaders. Approximately 77,000 cases were handled in this category.[8]

The second category, which we refer to as “civilian perpetrators”, includes accomplices rather than leaders and instigators. People accused in this category were not members of any of the organized groups mentioned for the first category and are thus considered to be civilians. Approximately 430,000 cases were recorded in this category. Our analysis includes 416,000 of these.[9]

[8]According to the precise definition taken from the National Service of Gacaca Jurisdiction this category concerns: (i) planners, organizers, instigators, supervisors of the genocide; (ii) leaders at the national, provincial or district level, within political parties, army, religious denominations or militia; (iii) well-known murderers who distinguished himself because of the zeal that characterized him in the killings or the excessive wickedness with which the killings were carried out; (iv) people who committed rape or acts of sexual torture.

[9]According to the precise definition taken from the National Service of Gacaca Jurisdiction this category concerns: (i) authors, co-authors, accomplices of deliberate homicides, or of serious attacks that caused someone’s death; (ii) persons who – with the intention of killing – caused injuries or committed

As mentioned, the second category is our main outcome variable. In our analysis, we normalize the number of civilian prosecutions by sector Hutu population (Figure 1).[10]

The reliability of the prosecution data is an important issue for our analysis. In particular, if the prosecution process induced systematic errors our results may be biased. For instance, in sectors with a lot of violence, the killings might have been so widespread that no witnesses were left to accuse the perpetrators, thus resulting in low prosecution rates. Another concern is that *Umuganda* meetings did not lead to increased participation in violence, but rather only made the prosecution process easier because people knew whom to accuse. To address these concerns, we show that our results are robust to using an alternative measure of genocide violence from a different data source: the presence of mass graves. Our results are also similar when dropping those sectors with mass graves in the baseline regressions.

In addition, Friedman (2013) shows that the Gacaca data is positively correlated with several other measures of genocide violence from different sources.[11] More precisely, she states that *"the Gacaca courts have been very thorough in investigating, and reports of those afraid to speak are rare, so this data is likely to be a good proxy for the number of participants in each area,"* Friedman (2013, pp. 19-20).

Another concern is that some of the people prosecuted in the Gacaca courts might not have committed their crimes during the genocide, but rather during the civil war preceding the genocide (October 1990 until August 1993). In particular, we cannot rule out that (a) some perpetrators may, in fact, have been accused of participation in massacres and other kinds of violence during the civil war (and not during the genocide), and (b) that individuals who had previously participated in violence during the civil war were more likely to have been recognized and trialed for genocide crimes than individuals who "only" participated in the genocide. In order to mitigate this concern, we exclude communes with violence against the Tutsi during the period October 1990 to

other serious violence, but without actually causing death; (iii) persons who committed criminal acts or became the accomplice of serious attacks, without the intention of causing death.

[10]Figure A.1 in the Appendix maps the number of civilian prosecutions without normalization.

[11]These sources include a 1996 report from the Ministry of Higher Education, Scientific Research and Culture (Kapiteni, 1996); the PRIO/Uppsala data on violent conflicts (Gleditsch et al, 2002); and a database of conflict from Davenport and Stam (2009).

March 1994 (Viret, 2010). Importantly, violence against the Hutu population was not trialed in the Gacaca courts (Human Rights Watch, 2011; Longman, 2009).

Rainfall Data As our source of exogenous weather variation, we use rainfall data from the National Oceanic and Atmospheric Administration (NOAA) database of daily rainfall estimates, which stretches back to 1984.[12] The NOAA data combines actual weather station data with satellite information to obtain rainfall estimates at 0.1-degree ($\sim$ 11 kilometers at the equator) latitude-longitude intervals. This data has two important advantages. First, since Rwanda is a small country, the high spatial resolution is crucial for obtaining reasonable variation in rainfall. Second, the high temporal resolution, i.e. daily estimates, allows us to confine the variation in rainfall to the exact days of *Umuganda*. Given Rwanda's hilly terrain, there is considerable local variation in rainfall. Moreover, these sectors criss-cross the various rainfall grids and each sector polygon is likely to overlap with more than one rainfall grid. The overall rainfall in each sector is thus obtained through a weighted average of the grids, where the weights are given by the relative areas covered by each grid. Naturally, there will always be some measurement error in the satellite data. However, as long as this error is classical it should only work against our findings. Moreover, in the following analysis we show that our results only hold using rainfall during the 3.5 years before the genocide (and no other 3.5 year period between 1984 and 2016). This rules out systematic errors in the rainfall data.

Sector Boundary, Road and City Data A sector boundary map is provided by the Center for Geographic Information Systems and Remote Sensing of the National University of Rwanda (CGIS-NUR) in Butare. Importantly, the map comes with information on both recent and old administrative groupings. Since Rwandan sectors have been reorganized under different higher administrative units several times after 1994, this information allows us to match sectors across the datasets (e.g. the 1991 census and the Gacaca records).

[12] Technically, the rainfall data is already available for 1983. However, for that year rainfall information is missing for several days and we therefore do not use it.

Africover provides spatial maps with major cities and roads derived from satellite imagery. The Africover project is part of the FAO's assistance to the Nile Basin countries in mapping out infrastructure. The maps are used to calculate several distance measures, such as the distance of the sector to the nearest main road, to the nearest city, to the country borders and to Kigali and Nyanza, the recent capital and the old Tutsi Kingdom capital, respectively. This data is also used to calculate sector areas.

Additional Data In addition to the data described above, we use census data on population size, ethnic composition, and radio ownership. These data are retrieved from Genodynamics and the IPUMS International census data base from 1991.[13] Except for the population data, these variables are only available at a more aggregated (commune) level than the sector, which is our unit of analysis.[14] We define ethnicity as the share of people that are Hutu or Tutsi, respectively. Importantly, the Tutsi minority is spread out across the whole of Rwanda with an average population share of about 10 percent. We calculate the Tutsi minority share used in the following analysis as the share of Tutsis normalized by the share of Hutus. As a measure of inter-ethnic connectedness we also calculate Inter-ethnic Marriage Polarization: $\sum_{i=1}^{F_c} \frac{N_{ic}}{N_c} \cdot h_{ic} \cdot t_{ic}$, where N_c is the total number of married people in all households F_c in commune c, N_{ic} the number of married people in household i and h_{ic} is the fraction of married household members in household i that are Hutu and t_{ic} the fraction that are Tutsi, respectively. The higher this measure is, the higher is the inter-ethnic connectedness.

Verpoorten (2012b) provides data on the location of mass graves based on satellite maps from the Yale Genocide Studies Program. Guichaoua (1991) provides information on the party affiliation of the commune leaders (called burgomasters) at the eve of the genocide.

The Terrain Ruggedness Index is obtained from Nunn and Puga (2012). Using elevation data at 30 arc-seconds ($\sim$ 0.9 kilometers at the equator) latitude-longitude grid cells, ruggedness is calculated in the following way. Let $e_{r,c}$ denote elevation at

[13] No census data was collected between 1991 and the genocide. However, mobility between sectors was highly limited because of governmental restrictions and land market controls (Prunier, 1995). This implies that the population data from 1991 is informative also of the situation in the wake of the genocide.

[14] The commune is one administrative level above the sector. There are 1433 sectors and 142 communes in our data. Thus, a commune includes on average 10 sectors.

the point located in row r and column c of a grid of elevation points. Then the Terrain Ruggedness Index at that point is given by $\sum_{i=r-1}^{i=r+1}\sum_{j=c-1}^{j=c+1}(e_{i,j}-e_{r,c})^2$. The elevation data source is GTOPO30 (US Geological Survey, 1996), a global elevation data set developed through a collaborative international effort led by staff at the US Geological Survey's Center for Earth Resources Observation and Science (EROS).

Yanagizawa-Drott (2014) provides data on the share of each sector that received the RTLM radio signal as well as the distance of each sector to the closest out of the two RTLM transmitters in the country and the mean and variance of sector elevation. The so-called "hate radio station" RTLM, set up in July 1993, broadcasted anti-Tutsi propaganda.

Matching of data and summary statistics The different datasets are matched by sector names within communes. A commune (142 in total) is the administrative unit above the sector. Unfortunately, the matching is not perfect: some sectors have different names in different data sources, and in some cases, two or more sectors within the same commune have identical names, which prevents successful matching. Nonetheless, in total, only about five percent of the sectors do not have a unique match across all datasets. Furthermore, these issues are likely idiosyncratic, which means that they will simply result in a lower precision in the estimates than in the case of perfect matching.

4 Empirical Strategy

To identify the effect of *Umuganda* meetings on participation in genocide violence, and because we lack data on the number of people participating in *Umuganda*, we use heavy rainfall as an instrument for low participation and estimate the reduced-form effect of heavy rainfall on civilian genocide participation. Our identification strategy thus rests on two assumptions. First, sectors with heavier rainfall on Saturdays experienced fewer or less intensive *Umuganda* meetings (first stage). Second, conditional on our control variables, rainfall on Saturdays does not have any direct effect on genocide violence other than through the *Umuganda* meetings (exclusion restriction).

First Stage Ideally, we would like to directly test the first-stage relationship using data on the number of people participating in *Umuganda* before the genocide. Unfortunately, such data does not exist. There is, however, abundant anecdotal evidence from today's Rwanda for expecting a strong first stage. Articles in the Rwandan media report low attendance at *Umuganda* meetings on days with heavy rain. One Rwandan newspaper writes that during a *Umuganda* meeting in Kigali's Gitega sector, participation was very limited because it started raining just as *Umuganda* started (Makuruki, 2015). According to our data, total rainfall in the area that day was 11 mm. Official government reports also document how the rains affect *Umuganda*. In Remera and Bwishyura sectors (in the southeast and the west of Rwanda), *Umuganda* was stopped because it started to rain (NDOW, 2016 and KDOW, 2016). Total rainfall on those days was 9 and 16 mm, respectively. Similarly heavy rainfalls affected most *Umuganda* meetings in Gicumbi district (in the north of Rwanda) with rainfall that day ranging from 9 to 15 mm (GDOW, 2015).[15]

Several other studies have documented and exploited negative relationships between rainfall and participation in open-air events. One of the first examples is Collins and Margo (2007) who use rainfall in April 1968 as an instrument for participation in the US riots after the death of Dr Martin Luther King. More recent examples include Madestam et al. (2013) and Madestam and Yanagizawa-Drott (2011). Similarly, several other studies use rainfall and other weather phenomena for an exogenous variation in voter turnout on election days (Eisinga et al., 2012; Gomez et al., 2012; Fraga and Hersh, 2011; Hansford and Gomez, 2010; Horiuchi and Saito, 2009).

However, in all these cases, rainfall has an effect both on the direct cost of attending the open-air event and the opportunity cost of attending. For example, Lind (2014) finds that voter turnout in Norway increases when it rains on the election day because bad weather reduces the opportunity cost of going to the polling station. Since *Umuganda* was mandatory, the opportunity cost mechanism is, however, unlikely to play any role. Instead, rainfall made the meetings and the work less productive, or led to cancella-

[15] As another example of how rainfall affects open-air events, a Rwandan newspaper reports that President Kagame's visit to Rwimiyaga sector was canceled due to heavy rains in the sector (Kigali Today, 2016). Rainfall that day was 15 mm.

tions. Still, the true functional form between rainfall and participation in mandatory community work is unknown.

To make progress, we assume – consistent with the anecdotal evidence – that the typical *Umuganda* tasks, consisting exclusively of outdoor work, became difficult or impossible to perform once a certain rainfall threshold had been reached.[16] Following Harari and La Ferrara (2013), who define an extreme weather shock as two standard deviations from the long-term average, we choose this threshold to be 10 mm.[17] Thus, we use the number of Saturdays from October 1990 to March 1994 with rainfall above 10 mm as our main explanatory variable.[18] The starting date of our period of interest coincides with the outbreak of a civil war in Rwanda. We choose this starting date because it marks the beginning of a period of increased tensions between the two ethnic groups. Figure 2 shows that there is significant local variation in the number of rainy Saturdays for our period of interest.[19] Furthermore, in Figure 3 we plot the number of rainy Saturdays after netting out commune fixed effects and average rainfall controls. This map further confirms that there is substantial local variation and little spatial clustering.

To better understand whether rainfall affected the extensive or the intensive margin of *Umuganda* meetings, we can vary these rainfall thresholds. More specifically, we also report the results when using thresholds between 5 and 15 mm (in increments of 1 mm). If we see effects already at low thresholds, it speaks for less enjoyable meetings or an effect at the intensive margin. If the effects are only seen at higher levels, cancellations are more likely to be driving the results, i.e. an effect at the extensive margin.

[16]The typical *Umuganda* tasks took place outside and, as mentioned above, included landscaping, road maintenance, construction and agriculture (Guichaoua, 1991).

[17]The long-term average daily rainfall in Rwanda from 1984 to 1994 was 2.6 mm with a standard deviation of 3.8 mm. We calculate this number taking the average across all sectors and all days from 1984 to 1994. Two standard deviations from the long-term average correspond to 10.24 mm. In Table A.1 in the Appendix, we show that our results are also robust to using average daily rainfall on Saturdays and all other weekdays.

[18]Madestam et al. (2013) use a threshold of 0.1 inches (2.5 mm) of rainfall, a light drizzle, to predict participation in the Tea Party Tax Day rally in the US. While a 2.5 mm threshold may be appropriate to capture participation in a voluntary rally in the US, we believe that our case, mandatory meetings, requires a higher threshold. Madestam et al. (2013) also use 0.35 inches ($\approx$ 9 mm) as a robustness check for a higher threshold of rainfall. In Figure 5, we show that our results are also robust to using this threshold.

[19]In Figure A.2 in the Appendix we further show that there is significant local rainfall variation for all other weekdays.

Exclusion Restriction Our empirical strategy relies on the counterfactual assumption that, absent the *Umuganda* meetings, rainfall on Saturdays had no effect on genocide violence. This is unlikely the case without further precautions. Rainfall on Saturdays, like on all other weekdays, is likely to affect rain-fed production and is therefore correlated with income. Income, in turn, potentially affects genocide participation since participation was often driven by material incentives and because higher income enabled people to pay bribes to avoid participation in the genocide (Hatzfeld, 2005). Besides affecting agricultural outcomes, heavy rainfall might destroy infrastructure such as roads or housing, which also affects households' economic well-being and, therefore, their likelihood of participating in conflict.

To address this problem, and to isolate the Saturday rainfall effect, we control for average daily rainfall from January 1984 to September 1990 and our period of interest from October 1990 to March 1994. Furthermore, we control for sector Hutu population and rainfall on all other six weekdays. The absence of systematic, significant effects for days other than Saturdays serves as a first placebo test. In particular, this placebo test allows us to rule out that any other factors correlated with rainfall, such as geography, are driving the results because these factors should then naturally be correlated with rainfall on all other days as well. Nevertheless, we show, for instance, that our results are robust to controlling for sector ruggedness. To account for local characteristics, we also add 142 commune fixed effects.[20]

At this point, we still need to argue that no other events potentially happening parallel with *Umuganda* on Saturdays could be driving our results. In particular, one might be concerned that people meeting and interacting in general might affect the participation in genocide violence. Although we cannot directly test for this, we will provide several indirect tests alleviating this concern.

[20]Furthermore, in the Appendix we split the sample into sectors with high Saturday rainfall and low Saturday rainfall (split at the median) and report summary statistics for all of our exogenous variables for both sub-samples. Table A.2 confirms that there are no significant differences between the two samples.

Specifications We run the following reduced-form regression to estimate the effect of *Umuganda* meetings on participation in genocide violence

$$(1) \qquad \frac{G_{ic}}{H_{ic}} = \alpha + \beta \ \#Saturdays(Rainfall > t\ mm)_{ic} + \mathbf{X}_{ic}\pi + \gamma_c + \varepsilon_{ic},$$

where G_{ic} is the number of Hutus prosecuted in each of the two categories of perpetrators (civilians or organized), i.e. our proxy for participation in genocide violence, and H_{ic} is the Hutu population in sector i in commune c. $\#Saturdays(Rainfall > t\ mm)_{ic}$ is our explanatory variable of interest: the number of Saturdays from October 1990 to March 1994 with rainfall above t mm. Our main specification uses 10 mm as a measure of heavy rainfall, but our results are robust to using other rainfall thresholds. $\mathbf{X}_{ic}$ is a vector of sector-specific controls, including sector Hutu population, average daily rainfall from January 1984 to September 1990, average daily rainfall from October 1990 to March 1994 and the number of all other weekdays with rainfall above t mm during our period of interest, October 1990 to March 1994. Finally, γ_c are commune fixed effects, and ε_{ic} is the error term. We allow the error terms to be correlated across sectors within the same commune by clustering the standard errors on the commune level. For the sake of robustness, we also allow error terms to be correlated across sectors within districts and within a 25, 50, and 75 km radius (Conley, 1999).[21] Moreover, since the prosecution rates are heavily skewed to the right, we weight our observations by total sector population size, but our results do not rely on this weighting scheme. The coefficient of interest, β, captures the percentage point change in genocide participation following an additional Saturday with rainfall above t mm (we measure participation rates in percent).

5 Results

Main Effects The reduced-form relationship between the share of civilian perpetrators and the number of Saturdays with rainfall above 10 mm is strongly negative and

[21] The results are reported in Table A.3 in the Appendix. Districts were introduced after the genocide and we only report results here for the sake of robustness.

statistically significant at the 99 percent significance level (regression 1 in Table 2) and this relationship holds up when adding 142 commune fixed effects (regression 2) and the number of other weekdays with rainfall above 10 mm (regression 3). Regarding magnitude, the point estimate of -0.321 (standard error 0.109, regression 3 with all controls) suggests that a one standard-deviation increase in the number of rainy Saturdays reduces the civilian participation rate by 1.3 percentage points (note that the civilian participation rate is measured in percent).[22] If we assume a one-to-one relationship between the number of rainy Saturdays and the number of canceled *Umuganda* meetings, a one standard-deviation increase in the number of canceled meetings reduces the average civilian participation rate by about 16 percent (interpreted at the mean share of civilian perpetrators, which is around 8 percent). Reassuringly, none of the other weekdays is systematically and significantly related to civilian violence (we cannot reject the null that these coefficients are all equal to zero, p-value 0.952).

Furthermore, to rule out that multicollinearity between rainfall on the different weekdays might be hiding otherwise significant effects, we rerun our main specification using daily rainfall above 10 mm for each weekday in a separate regression. Figure 4 confirms that only Saturday rainfall is significantly related to civilian participation in violence. The coefficients for rainfall on all other weekdays are much smaller in magnitude and statistically insignificant.[23]

To understand whether rainfall led to cancellations, or rather lowered the *Umuganda* meeting attendance, we vary the threshold in increments of 1 mm: from 5 to 15 mm. Figure 5 reports the results. Heavy rainfall on Saturdays is negatively related to civilian participation for all thresholds above 5 mm and significant at least at the 90 percent confidence level for all thresholds between 10 and 14 mm. The fact that the strongest effects are observed for thresholds above 9 mm suggests that cancellations rather than lower attendance (or less enjoyable meetings) led to the decrease in violence in places

[22] A standard deviation in the number of rainy Saturdays is 4.24.

[23] In our main specifications, we control for long-term and general rainfall effects by including average daily rainfall before and during our period of interest. Another approach would be to use rainfall shocks, i.e. deviations of Saturday rainfall from long-term averages normalized by their long-term standard deviation. In Table A.4 in the Appendix, we show that our results are robust to using linear Saturday rainfall shocks as well as sector-specific rainfall thresholds (recall that in our main specification this Rwanda-wide threshold is 10 mm): The effects for Saturday rainfall are always highly statistically significant and similar in magnitude, while rainfall on the other weekdays do not seem to matter.

with a larger number of rainy Saturdays. Note that for higher thresholds the magnitude of the effects decreases again (in absolute value). This is not surprising since when using these high thresholds, days where *Umuganda* was canceled will be wrongly assigned to the control group and thus create a non-random measurement error.

It is important to note that since we use variation only at a high number of *Umuganda* meetings actually taking place (on average there are 18 Saturdays with rainfall above 10 mm, which corresponds to about 10 percent of all Saturdays in our period of interest), the above coefficient does not allow us to back out the counterfactual number of perpetrators if all meetings had been canceled. In particular, it is likely that the effects at the lower, out-of-sample end would be smaller if learning effects of *Umuganda* only arise after a while; for example, it might require a few meetings before the elites' propaganda convinces the population. Such potential non-linearities in the relationship between canceled *Umuganda* meetings and genocide participation would speak against using a simple linear extrapolation. To nevertheless get an idea of the magnitude of our results, we might consider the hypothetical situation of all sectors having 32 meetings canceled (the maximum in our sample, which amounts to about 8 months). Our main result suggests that the number of civilian perpetrators would then have fallen by around 50 percent.

To provide additional suggestive evidence that learning and practice seemed to have mattered, we show that *Umuganda* was especially successful in areas with many Saturday meetings in a row. In other words, in localities that did not have consecutive cancellations due to rain. To this end, we count the number of times a sector had two or three rainy Saturdays in a row and interact this number with the number of rainy Saturdays. Since there are almost no places with four rainy Saturdays in a row, we also count the number of 4-week and 5-week periods where a sector had at least three rainy Saturdays. The periods will then always start and end with a rainy Saturday. The results, presented in Table 3, show that the coefficients of all interaction terms are negative. However, for both two and three rainy Saturdays in a row, the effects are statistically insignificant (regressions 1 and 2). One explanation is that two rainy Saturdays may be too short of an interruption to disturb any learning effects of *Umuganda*, and unfortunately there are very few sectors with three rainy Saturdays in a row, which leaves us with too little variation to be able to draw any conclusions. Reassuringly though, we find significant effects for the interaction with the number of 4-week periods with at least three rainy Saturdays. The point estimate of -0.202 (standard error 0.116) suggests that a one standard-deviation (0.4) increase in the number of rainy Saturdays in a row decreases the effectiveness of *Umuganda* by 25 percent (regression 3). Finally, allowing for two non-rainy Saturdays in the 5-week periods weakens the results (regression 4).

Reliability of the Gacaca Data and Robustness Checks Next, we perform a number of robustness checks and placebo tests, reported in Table 4. First, to rule out that some systematic error in the prosecution data is biasing our results, we use an alternative measure of genocide violence from a different data source: the location of mass graves (obtained through satellite images). Consistently, regressions 1 and 2 show that sectors with many rainy Saturdays are less likely to have a mass grave site altogether. The point estimate of -0.012 (standard error 0.004, regression 2) is significant at the 99 percent level. Moreover, the reduced-form point estimates are essentially identical to our baseline results and similarly significant at the 99 percent confidence level when dropping sectors with at least one mass grave (indicating high death rates, regression 3). This finding rules out that, for example, survival bias is driving our results, or that *Umuganda* did not induce higher participation, but rather made the prosecution process easier.

The results are also unaffected by adding a number of additional controls that potentially affect civilian participation in violence (regression 4). These include sector ruggedness, distance to the border, distance to cities, distance to Kigali and distance to Nyanza as well as Hutu population density. To illustrate why these can potentially affect our outcome: sector ruggedness is likely to be correlated with sector rainfall and to capture micro-climate effects; being close to the border potentially made it easier for the Tutsi or moderate Hutus to leave the country; the distance to cities, in particular the capital Kigali, is likely to be correlated with economic activity and public goods provision; and Nyanza was the old Tutsi Kingdom capital and sectors further away from it still exhibit lower Tutsi shares, on average. Lastly, Hutu population density is meant to capture social pressure as well as food pressure, both important reasons for the genocide (Verpoorten, 2012a).[24]

The results are also robust to functional form. In regressions 5 and 6 we logaritmize our dependent variable.[25] Once more, the point estimates on Saturday rainfall is highly significant at the 99 percent level while none of the other weekdays matter. Moreover, the point estimate of -0.036 (standard error 0.012, regression 6) suggests that a one standard-deviation increase in the number of rainy Saturdays decreases civilian participation by about 15 percent (similar to the magnitude from our baseline results above).

In the spirit of a placebo check, the results for organized perpetrators are small and insignificant (regressions 7 to 8). This is not surprising: since organized perpetrators mainly consisted of members of the militia or the army, it is unclear that the sector where they committed their genocide crimes (and where they were subsequently prosecuted) is the same as the one where they lived – and were exposed to *Umuganda* – before the genocide. Thus, they may not have been exposed to the same number of *Umuganda* meetings as the inhabitants of that sector. If this is the case, when using organized perpetrator share as the outcome, our data is likely to suffer from measurement error.

To test for outliers, we also drop one commune at a time. The resulting estimates range from -0.280 to -0.364 and are significantly different from zero at the 99 percent confidence level in all cases (Figure A.3 in the Appendix). In addition, Figure 6 graphically shows that the negative relationship between the number of rainy Saturdays and civilian violence is not driven by any outliers (and neither is the null result for all other weekdays (Figure A.4 in the Appendix)).

Placebo Check As another placebo check, we rerun the main specification using Saturday rainfall during the 3.5 year pre-genocide calendar period (October 1, YEAR to March 31, YEAR+4), using data from all years in the period 1984-2016. To illustrate this, we begin with the period from October 1, 1984 until March 31, 1988 and end with the period from October 1, 2012 until March 31, 2016. Reassuringly, the coefficient

[24]The food pressure argument assumes a Malthusian model: a fixed amount of agricultural land feeds a growing population (fertilizers were hardly used in Rwanda (Percival and Homer-Dixon, 2001)).

[25]To account for observations with no violence we add a 1 to the dependent variable.

on Saturday rainfall from 1990 to 1994, the actual pre-genocide period, is an extreme outlier to the left in the distribution of the resulting 23 coefficients: none of the other point estimates are larger in absolute value (the result is shown in Figure 7).[26]

Exclusion Restriction After demonstrating a strong and robust effect of high Saturday rainfall on civilian participation in genocide, we still have to argue that this effect results from people *participating in Umuganda*.

Most importantly, since major outdoor events, such as music festivals or soccer games, usually take place on weekends and are potentially affected by rainfall, one might be concerned that people meeting and interacting in general could affect participation in genocide violence. However, recalling our main result in Table 2, we find no significant effect for Sunday rainfall. Since people traditionally attend church on Sundays, this is the first piece of evidence speaking against social meetings in general driving our results. Furthermore, our results are robust to dropping the capital Kigali and other major cities in the sample; places where one might expect these major outdoor events to predominantly take place (regressions 1 and 2 in Table 5) .

In a similar vein, heavy rainfall on public holidays, another occasion for people to meet, does not seem to matter: the point estimate on the number of public holidays with rainfall above 10 mm is statistically insignificant and small (regression 3 in Table 5; holiday variables are normalized by their standard deviation).[27] The same is true when adding religious and non-religious holidays separately to the regression (regression 4).[28]

Throughout our period of interest from 1990 to 1994, violent acts against Tutsis and moderate Hutus were already taking place. If these pre-genocide perpetrators are included in the Gacaca data, and there is a relationship between rainfall before the

[26]In Figure A.5 in the Appendix we rerun the above placebo check using alternative thresholds to calculate our variables of interest. In particular, we use 5 to 15 mm thresholds in increments of 1 mm. We also report results for a linear specification with average weekly rainfall. Consistent with the results from Figure 5, the data passes the placebo test for all thresholds between 7 and 14 mm and for average rainfall.

[27]Note that we exclude holidays that fall on a Saturday since these might still have been subject to *Umuganda*.

[28]Religious holidays are, for instance, Easter and Christmas. Non-religious holidays in Rwanda are, for instance, Independence Day and Labor Day.

genocide and targeted violence during that period, for instance through transport costs, our estimates would be biased. To rule out this possibility, we drop communes where violence against the Tutsi took place before the genocide (Viret, 2010). Reassuringly, our results for civilian participation are robust (regression 5).

Another concern is that our estimates might be picking up effects from rainfall during the genocide rather than the 3.5 years pre-genocide period. To address this concern we control for the number of Saturdays (and all other weekdays) with rainfall above 10 mm during the period of the genocide (regression 6). Once more, our results hold up.

To provide further evidence that the effects we measure above result from the political elites abusing *Umuganda* meetings, we split the sample of sectors into areas with local pro-Hutu party leaders and opposition party leaders (the location of these sectors can be seen in Figure 8).[29] Interestingly, the negative relationship from above seems to be entirely driven by the pro-Hutu governed areas. The point estimate on Saturday rainfall is -0.388 (standard error 0.101, regression 8), which is slightly larger than our main effect and again highly significant at the 99 percent confidence level. The opposite seems to be true in opposition-governed areas: The point estimate on Saturday rainfall is large and positive, albeit given the small sample of only 161 sectors, it is insignificant (0.717, standard error 0.798, in regression 9 and 0.415, standard error 0.764, in regression 10 with all other weekday controls).

However, one concern is that the positive point estimates for opposition areas might be driven by larger Tutsi populations rather than by the identity of local leaders, since localities with opposition parties in power had, on average, larger Tutsi populations. To rule this out, we restrict the sample to sectors with large local Tutsi populations.[30] Reassuringly, the coefficient on Saturday rainfall turns negative and gets close to our baseline result for the full sample (regression 11).

As a final test, in Table A.5 in the Appendix, we pool the pro-Hutu and opposition samples and add an interaction term between heavy Saturday rainfall and a dummy tak-

[29]The opposition parties include the Liberal Party (PL) and the Social Democratic Party (PSD). The pro-Hutu parties were the National Revolutionary Movement for Development (MRND) and the Republican Democratic Movement (MDR).

[30]We use sectors with Tutsi minority shares above 22 percent. This number is chosen to match the number of observations in regression 10.

ing on the value of one if the local leader is from an opposition party. For robustness sake, we do this separately for each threshold in the interval between 8 mm to 12 mm. While the coefficient on Saturday rainfall – the effect in pro-Hutu sectors – is negative and highly significant throughout and similar to our baseline result, the interaction term with the opposition leaders is positive, and, with only a few exceptions, statistically significant. On the other hand, the interaction term between Saturday rainfall and the Tutsi minority share are mostly insignificant and even negative throughout. This provides further support that the differential effects are due to political leadership as opposed to the size of the Tutsi minority.

Although only suggestive, taken at face value, the numbers imply that in these opposition sectors, the meetings were used to create bonds between the two ethnicities.

6 Channels

In this section, we attempt to better understand the channels and mechanisms behind the effect of *Umuganda* on civilian violence. Since we lack the detailed data to answer this question unambiguously, we take an agnostic approach and present suggestive empirical evidence.

6.1 Tracing the Effects over Time

In the preceding section we presented suggestive evidence that practice and repetition seemed to have mattered for *Umuganda's* effectiveness. To understand whether the observed effects result from long-term or short-term mobilization, we trace the effects over time.

First, we consider *Umuganda* before our period of interest,[31] that is, the period of January 1984 to September 1990. Results, reported in Table 6, suggest that Saturday rainfall during the 1980s and beginning of the 1990s did not affect participation in violence. This is true both when we consider the entire period and when we split it into three equal-length time intervals. The coefficients are close to zero and insignificant

[31]Recall that our period of interest is October 1, 1990 until March 31, 1994.

throughout (regressions 1 and 2). Before offering an interpretation, we take a closer look at our period of interest.

Regression 3 shows that our main results are robust to controlling for Saturday rainfall during the pre-civil war period: 1984 to 1990 (split into 3 intervals). Next, we split our period of interest into three equal-length time intervals (14 months each). The results suggest that the effects are mainly driven by Saturday rainfall just before the genocide (regression 4). Splitting our pre-genocide/civil war period into 6 time intervals (each with a length of 7 months) confirms the previous result that the time right before before the genocide mattered the most (regression 5). A further split into 12 intervals shows that the last three coefficients on Saturday rainfall are highly significant, suggesting that the last 11 months before the genocide mattered the most. This result is similar when adding our additional controls (regression 6).[32] Interestingly, the time around which we start observing significant results coincides with the launch of radio RTLM, which lead to a further radicalization of the country (Yanagizawa-Drott, 2014). In a final step, we estimate results separately for the periods before and after RTLM. As expected, we see the strongest effects for the time after RTLM (regressions 8 and 9).[33]

Taken together, the results in this subsection suggest that the mechanism behind our main results is short-term mobilization of civilians during meetings rather than long-term effects of *Umuganda* on civilian participation working through e.g. improvements of the road system (recall that this was one of the major *Umuganda* tasks). In the next subsection, we provide a more detailed interpretation.[34]

[32]Note that with 42 months in total, 3, 6 and 12 are natural divides.

[33]The fact that effects are stronger after the launch of RTLM could support an alternative explanation for our findings: If people only listened to the radio on Saturdays and if heavy rainfall reduces radio signal strength (radio fade), our results may be driven by RTLM rather than by the *Umuganda* meetings. However, there are several reasons why this is unlikely to explain our findings. Firstly, there are anecdotal accounts that in the period just before and during the genocide, people listened to RTLM all the time. An example is the following quote by Des Forges, interviewed regarding RTLM: *"People listened to the radio all the time, and people who did not have radios went to someone else's house to listen to the radio,"* Rwanda Initiative (2004). Yet, we find no effects of rainfall on our outcome variable for weekdays other than Saturdays. Secondly, we find opposite effects in opposition-governed sectors. Thirdly, radio fade is not only driven by rainfall in each sector but rather by rainfall along the way between the radio transmitter and the sector. In Table A.6 in the Appendix, we control for rainfall along the way between each sector and the transmitters (we count both the number of days that average rainfall exceeds a given threshold and the number of days that rainfall anywhere along the way exceeds that threshold). Importantly, our main results are robust to including these controls.

[34]In the Appendix, we analyze the effects over time for pro-Hutu and opposition-governed areas separately. For pro-Hutu governed areas, the results mirror the general results from above, with the strongest

6.2 Heterogeneous Effects

To gain a deeper understanding of possible mechanisms, in this subsection we investigate whether there are heterogeneous effects depending on factors such as the party affiliation of the local leadership or the composition of the population in a sector. Since the mechanisms in pro-Hutu governed areas and opposition-governed areas are likely to differ, we analyze these two sub-samples separately. Building on the findings presented in the previous sub-section, we also separately examine the effects of Saturday rainfall before and after the launch of RTLM for the pro-Hutu governed areas. The small number of opposition-governed areas makes us unable to identify such effects in the opposition areas. The results for pro-Hutu governed areas are reported in Tables 7 and 8, while the results for opposition-governed areas are presented in Table 9. To ease comparison, all interaction variables are normalized by their standard deviations.

Pro-Hutu Sectors Starting with the pro-Hutu governed sectors, a natural first question is whether the political Hutu elites mostly used *Umuganda* meetings to spread propaganda and inform civilians about the views of the pro-Hutu government – something a radio reporter might have done just as well – or whether the *Umuganda* meetings worked on top of political propaganda by allowing local elites to bring civilians together, and thus functioned as a coordination device. If the *Umuganda* meetings mostly functioned as an information device the effect of canceled *Umuganda* meetings, i.e. Saturday rainfall, should be less negative (more muted) in sectors that were already informed through the radio.

We have two measures of access to information: a) the fraction of Hutus that owned a radio,[35] and b) the fraction of the sector that received the RTLM radio signal.[36] If

effects appearing just before the start of the genocide (Table A.7). For opposition-governed areas, the effects are positive for the time before RTLM and negative thereafter (Table A.8). However, sample sizes are, in this case, small and the results are at best suggestive. Nevertheless, for the sake of robustness, we can reproduce these results using alternative thresholds (Table A.9). Our interpretation of these suggestive results is that, with the launch of RTLM, the hate messages and anti-Tutsi propaganda intensified to a level that was difficult for the local opposition leaders to overcome. Unfortunately, due to the small sample size, we cannot split our period of interest into 12 or even 6 shorter intervals.

[35]Two radio stations existed in Rwanda in the period before the genocide: Radio Rwanda and Radio RTLM, the former having national coverage. Both informed listeners about the pro-Hutu view of the government but Radio RTLM was propagating more aggressively against the Tutsis.

[36]The RTLM coverage data and propagation control variables are taken from Yanagizawa-Drott

Umuganda mostly worked through information we should observe a positive interaction effect of Saturday rainfall with radio ownership or RTLM coverage, respectively. If *Umuganda* and the radio broadcasts were complementing each other, we should instead observe a negative interaction effect.

The point estimate on the interaction term with radio ownership is indeed positive (0.046, regression 1 in Table 7), but small and statistically insignificant (standard error 0.062). The point estimate on the interaction term with RTLM is negative, but also far from conventional significance levels (regression 2, Table 7). However, since RTLM started broadcasting in July 1993, only meetings after that date could have been affected by RTLM coverage. Splitting our period of interest accordingly, this is exactly what we observe. The interaction term between RTLM coverage and the number of rainy Saturdays between July 1993 and March 1994 is negative (-0.147, standard error 0.085) and significant at the 90 percent level (regression 2, Table 8). In terms of magnitude, the effects suggest that a one standard-deviation increase in RTLM coverage increased *Umuganda's* positive effect on violence by about 38 percent. Interestingly, we still find no effects for Hutu radio ownership (regression 1 in Table 8). One explanation for observing statistically significant interaction effects with RTLM coverage, but not with radio ownership, may be that the latter also picks up wealth effects. It could also be the case that the point estimate on radio ownership reflects the combined effect of having access to both radio stations, with Radio Rwanda being much less radical than RTLM, and that any effect of RTLM is therefore diluted. Nonetheless, these results suggest that *Umuganda* and the RTLM broadcasts were complements in the mobilization process. Note that the interaction effects for Hutu radio ownership are robust to adding all the other interaction terms (regressions 6 to 8 in Table 7 and Table 8).[37]

One concern is that the radio signal might be weaker on days with heavy rainfall, meaning that our negative interaction effects might simply show that rainfall reduced the effects of RTLM. However, since villagers listened to RTLM all-week-around we

(2014). Since Yanagizawa-Drott's sample is smaller than ours, we lose a number of observations.

[37]Note further that we do include the interaction with RTLM coverage in the regressions with all interaction effects. This is because RTLM coverage is exogenous (see Yanagizawa-Drott (2014) for details) and thus unlikely to bias any results (or be biased itself). Besides, we would lose valuable observations.

should then also find a negative interaction for all other weekdays. Table A.10 in the Appendix shows that this is not the case.

To analyze more directly whether *Umuganda* was used by the local elites to bring people together, thus working as a coordination device, we next consider the interaction of Saturday rainfall with Hutu population density. Results, presented in regression 3 in Table 7, provide support for the coordination mechanism. The coefficient on the interaction term is positive and highly significant at the 99 percent confidence level. The point estimate of 0.093 (standard error 0.023) suggests that a one standard-deviation increase in the Hutu population density reduced the effects of *Umuganda* by about 24 percent. Thus, *Umuganda* appear to have been particularly effective in sparsely populated areas. Once more, the effect seems to be driven by rainfall after the launch of RTLM (regression 3 in Table 8) and it is robust to adding the other interaction terms (regressions 6 to 8 in Table 7 and Table 8).

The effectiveness of *Umuganda* might also depend on the size of the Tutsi minority. It is possible that large or well-integrated Tutsi minorities boycotted or hindered the effectiveness of *Umuganda* meetings. To examine this, we interact the Saturday rainfall with the number of Tutsis relative to the number of Hutus in each sector, and with the share of inter-ethnic marriages within each sector (a measure of inter-ethnic connectedness), respectively. The results, presented in regressions 4 to 8 in Table 7, speak against such a mechanism. The point estimates on the interaction terms between Saturday rainfall and the Tutsi population share/connectedness measure are insignificant and, if anything, negative.

This is perhaps not surprising since the Tutsi were the clear minority in Rwanda, never holding the majority in any sector, and therefore their presence presented no real threat to the activities of the Hutu elites. In fact, taken at face value, the negative point estimates suggest that the meetings were more successful in sectors with larger and better integrated Tutsi minorities. The perceived Tutsi threat might have been more salient in these sectors and the enemy easier to point out. Being threatened by "the Tutsi enemy" should have been especially salient after the launch of RTLM, and consistently we find large and mostly significant, negative interaction effects of the Tutsi minority size/connectedness with Saturday rainfall during the time period after the launch of RTLM (regressions 4 to 8 in Table 8).

Opposition Sectors As a final step, we present suggestive evidence for areas with opposition party leadership. Because of the small number of opposition-governed sectors the results in this subsection should be interpreted with caution.

First, in these sectors, it seems that the local elites used the *Umuganda* meetings to compensate for the anti-Tutsi propaganda spread on the radio. The interaction effect of Saturday rainfall with radio ownership among the Hutus and RTLM coverage are both negative, and the latter is significant at the 95 percent confidence level (Table 9, regressions 1 and 2). The point estimate on RTLM coverage of -2.264 (standard error 0.999) suggests that the positive effect of *Umuganda* is about 1.5 times lower in areas with a RTLM coverage level of one standard deviation as compared to areas with no coverage at all (regression 2). Once more, the results in Table A.10 in the Appendix suggest that this effect is not due to heavy rainfall reducing radio signal strength. Further note that, in this sub-sample, the interaction effects for Hutu radio ownership are robust to adding all other interaction variables and even turn statistically significant (regressions 6 to 8).

Interactions of Saturday rainfall with population density do not show the same pattern as for the pro-Hutu governed areas. The interaction term in regression 3 is small and statistically insignificant (-0.177, standard error 0.529). This is also the case once we add all other interaction variables (regressions 6 to 8).

Finally, the local opposition leaders seem to have been more effective in sectors with larger Tutsi minorities. The interaction of Saturday rainfall with inter-ethnic marriage is positive and, except for one specification, statistically significant (regressions 5, 7, and 8). This is consistent with the opposition leaders having to overcome a potential pro-Hutu bias among the Hutu population (which potentially was less pronounced in integrated sectors). Also note that the sheer size of the Tutsi minority does not deliver a clear picture. Point estimates are always positive (regressions 4, 6, and 8), but turn statistically insignificant once inter-ethnic marriage is controlled for (regression 8).

Summary Summing up, our results in this subsection indicate that in pro-Hutu governed areas *Umuganda* meetings and the RTLM broadcasts were complements in the mobilization process and meetings were most effective in sparsely populated areas, thus functioning as a coordination device. In opposition-governed areas, our results suggest that local elites used the *Umuganda* meetings to compensate for the anti-Tutsi resentments spread on the radio or present in the Hutu population.

7 Discussion and Conclusion

This paper explores how an authoritarian state can mobilize civilians to participate in mass violence through a strong top-down policy. The policy, *Umuganda*, required Rwandan citizens to attend politically infused work meetings every Saturday in the years before the 1994 genocide. We map out the causal effect of *Umuganda* on genocide participation by using exogenous weather fluctuations on each Saturday, which would affect participation in the work meetings, and compare it to all other weekdays.

Our results show that the local Hutu elites used these mandatory community meetings to mobilize the civilian population for genocide. More precisely, we find that a one standard-deviation increase in the number of rainy Saturdays (*Umuganda* days) decreased the share of civilian perpetrators in the Rwandan Genocide by around 16 percent. This effect is entirely driven by areas ruled by the pro-Hutu parties, and having more meetings in the last 11 months before the genocide seems to have been particularly important for mobilization.

Our findings are important for several reasons. First, a large number of civilians participated in the killings during the Rwandan Genocide. While it is a common understanding that this genocide was centrally planned and organized, little is known about the link between the planning and the wide acceptance of the genocide among the civilian population. Our paper suggests that weekly held community meetings played a major role in this preparation and mobilization process.

Second, the Rwandan Genocide is part of a wider phenomenon of civil conflict and social unrest. Understanding its mobilization dynamics is important for interpreting and handling other events where civilian actors matter, such as the 2007 post-election violence in Kenya where *"communities turned on each other with crude weapons as they were encouraged, and even paid, by power-hungry politicians."* (BBC, 2010). Moreover, Brown (1999) suggests that the vast majority of civil conflicts is elite-triggered.

Third, people getting together during community meetings is commonly said to foster a sense of belonging and create social capital, generally viewed as positive for development and community building (Knack and Keefer, 1997; Grootaert and van Bastelaer, 2002; Guiso, Sapienza and Zingalez, 2008). As emphasized by Putnam (2000), social capital can bridge the divides in a society. However, we show that there is a "dark side" to these community meetings. More specifically, our results indicate that when placed in the wrong hands, the effects can become disastrous.

A more optimistic view of this institution might explain why the current Rwandan government reinstalled *Umuganda* in 2008: When placed in the right hands, it could (partly) work against propaganda and overcome hatred. Indeed, official statements about *Umuganda* emphasize values such as "solidarity" and "reconciliation", and the practice is said to foster a sense of community. These mandatory work days are now held monthly, on the last Saturday of every month. A similar practice is also present in Burundi and is being discussed in the Democratic Republic of Congo and Kenya. Our analysis clearly shows that these meetings are powerful instruments and warrant caution, not least in countries with histories of ethnic tensions.

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Figures

Figure 1: Civilian Participation, normalized by Hutu Population

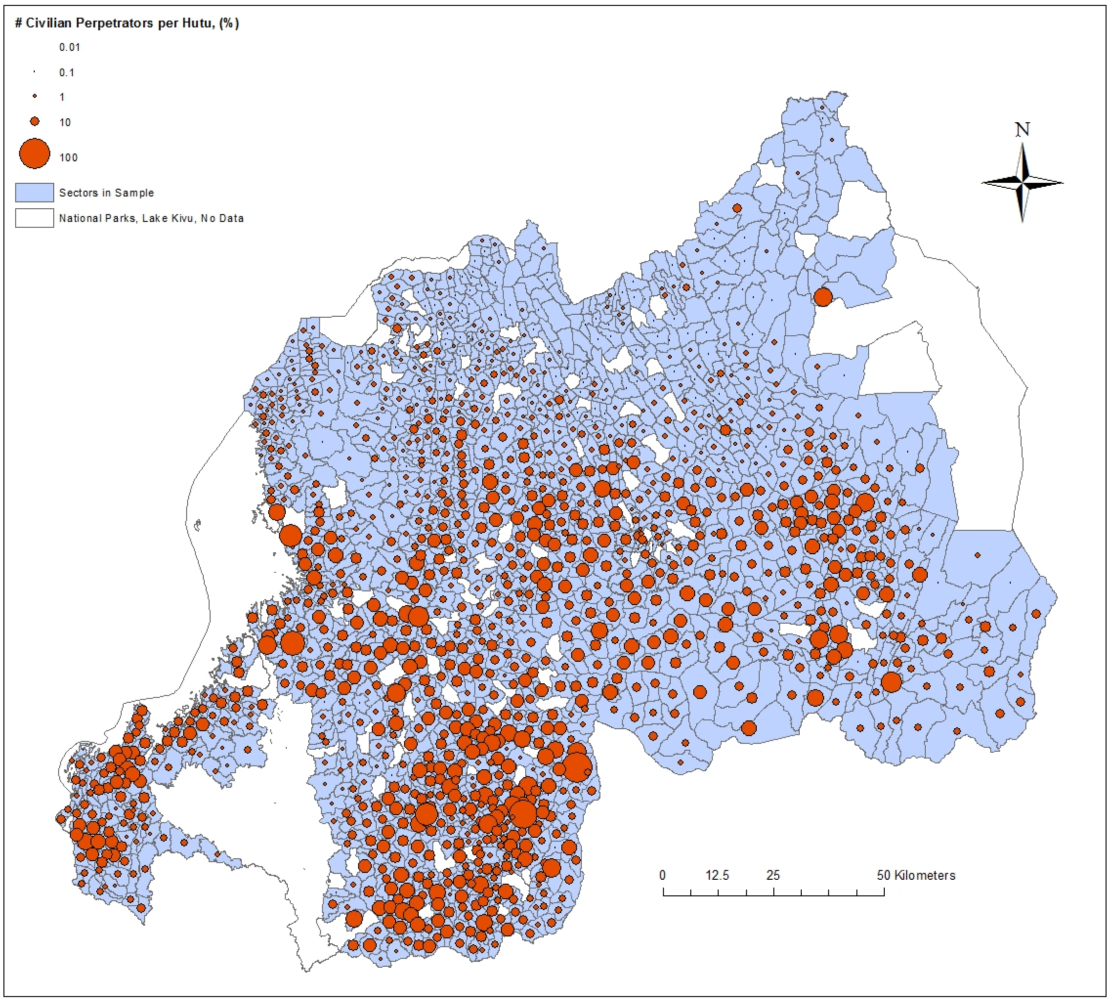


Figure 2: Local Variation in Saturday Rainfall

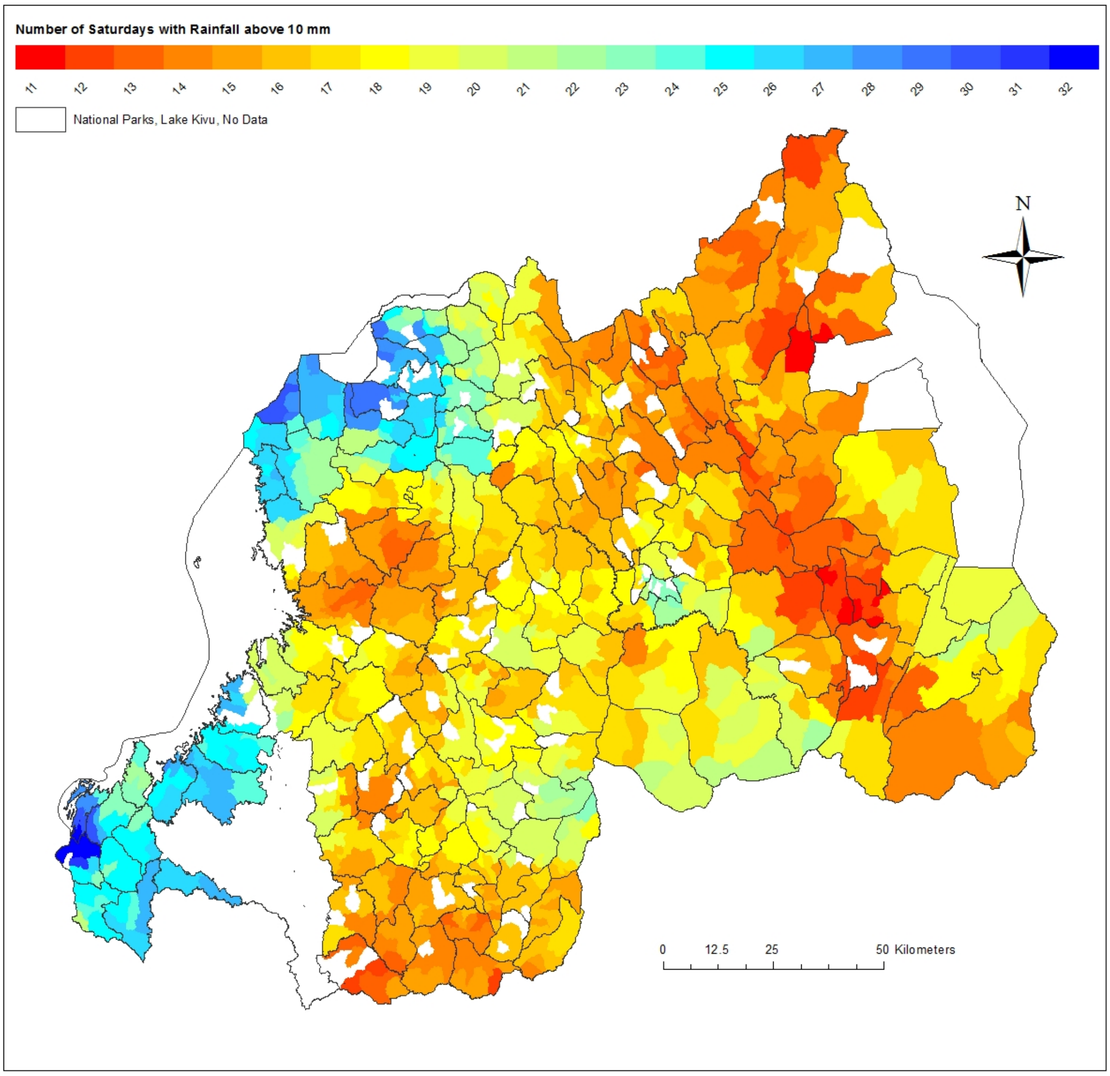
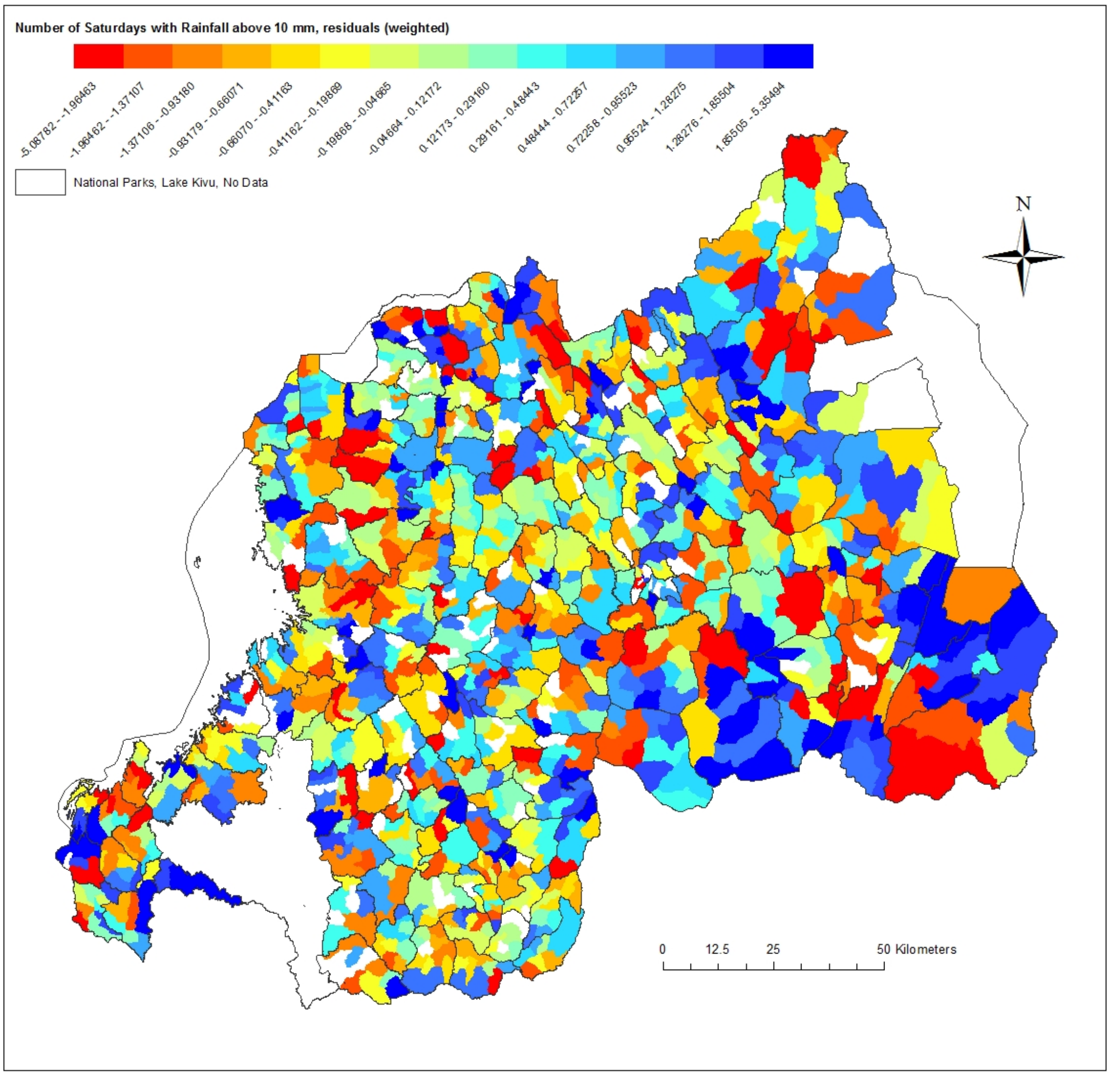
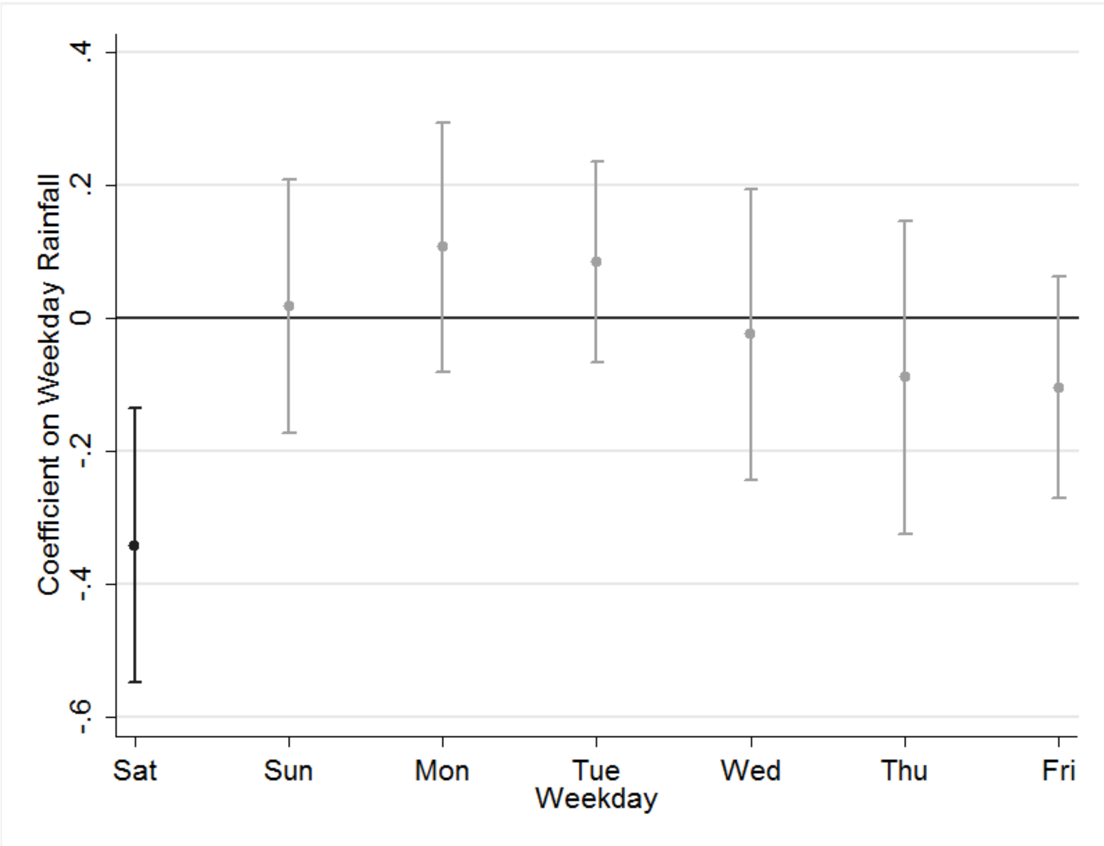


Figure 3: Local Variation in Saturday Rainfall – Residuals



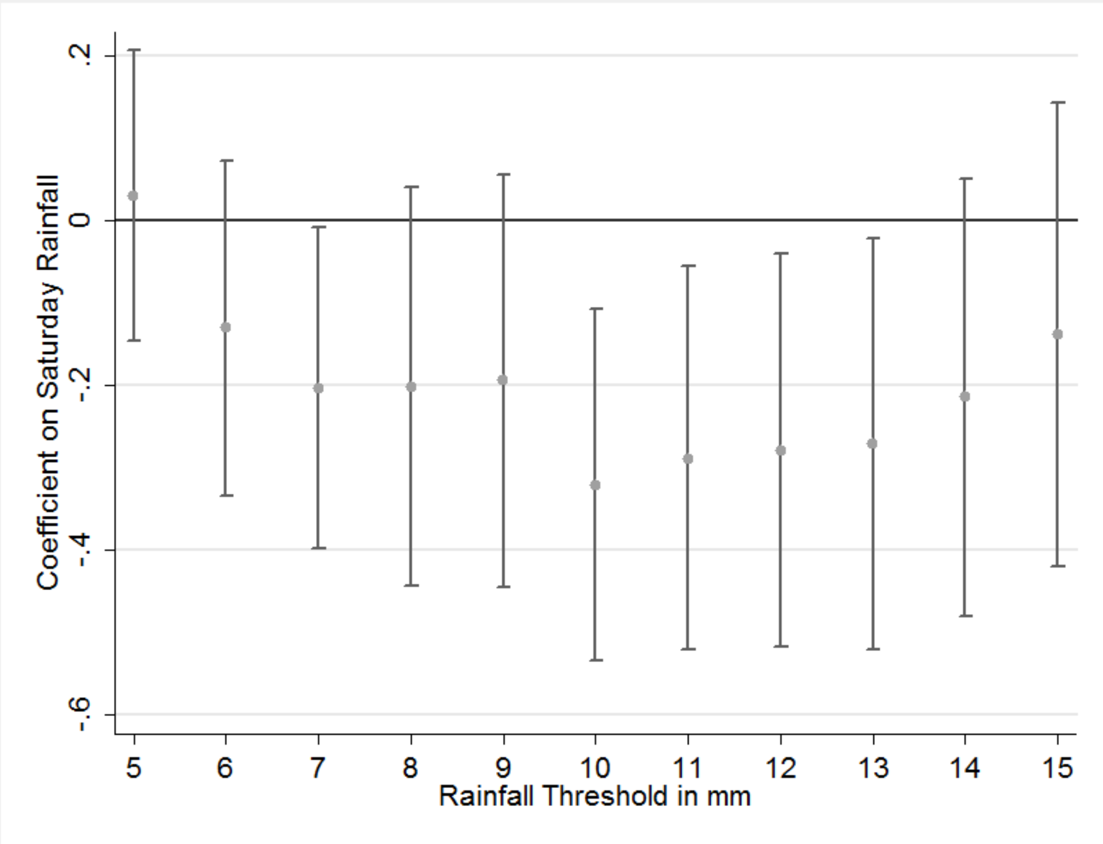
Notes: The map plots the residuals of the number of Saturdays with rainfall above 10 mm after netting out commune fixed effects and our other average rainfall controls.

Figure 4: Effects of Rainfall by Weekday



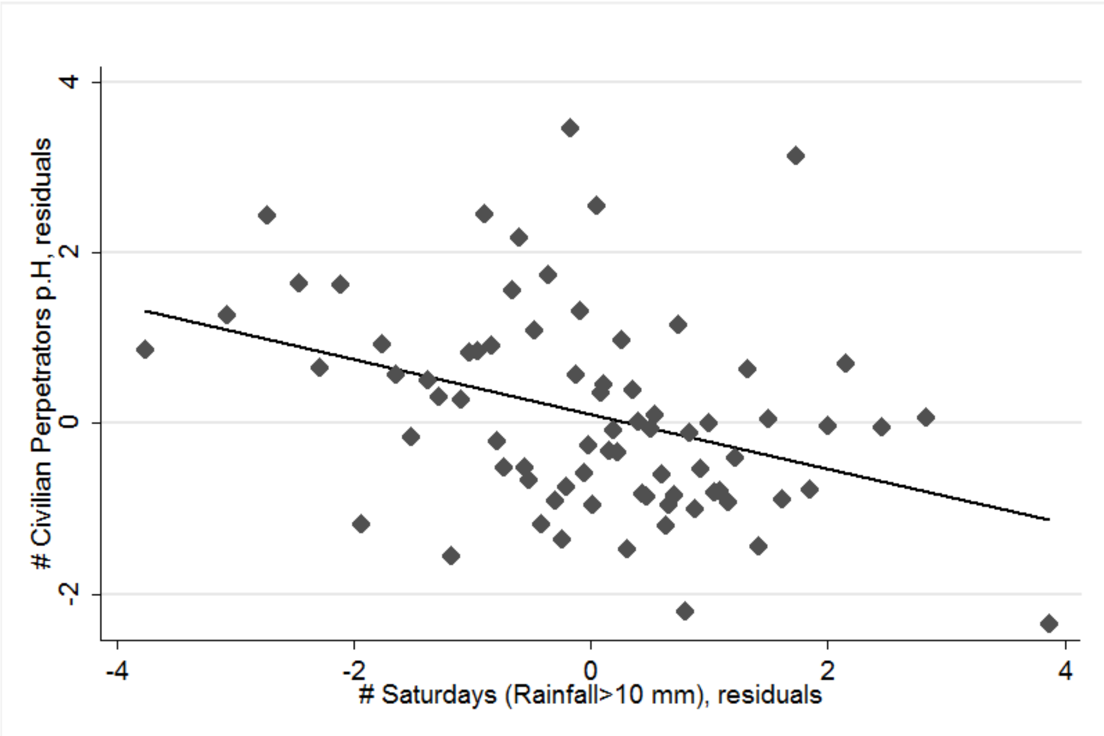
Notes: The figure shows the coefficients on the number of days with rainfall above 10 mm (together with 95 percent confidence bounds) for each weekday entering our main specification separately (regression 2 in Table 2). Each point represents a separate regression.

Figure 5: Different Thresholds



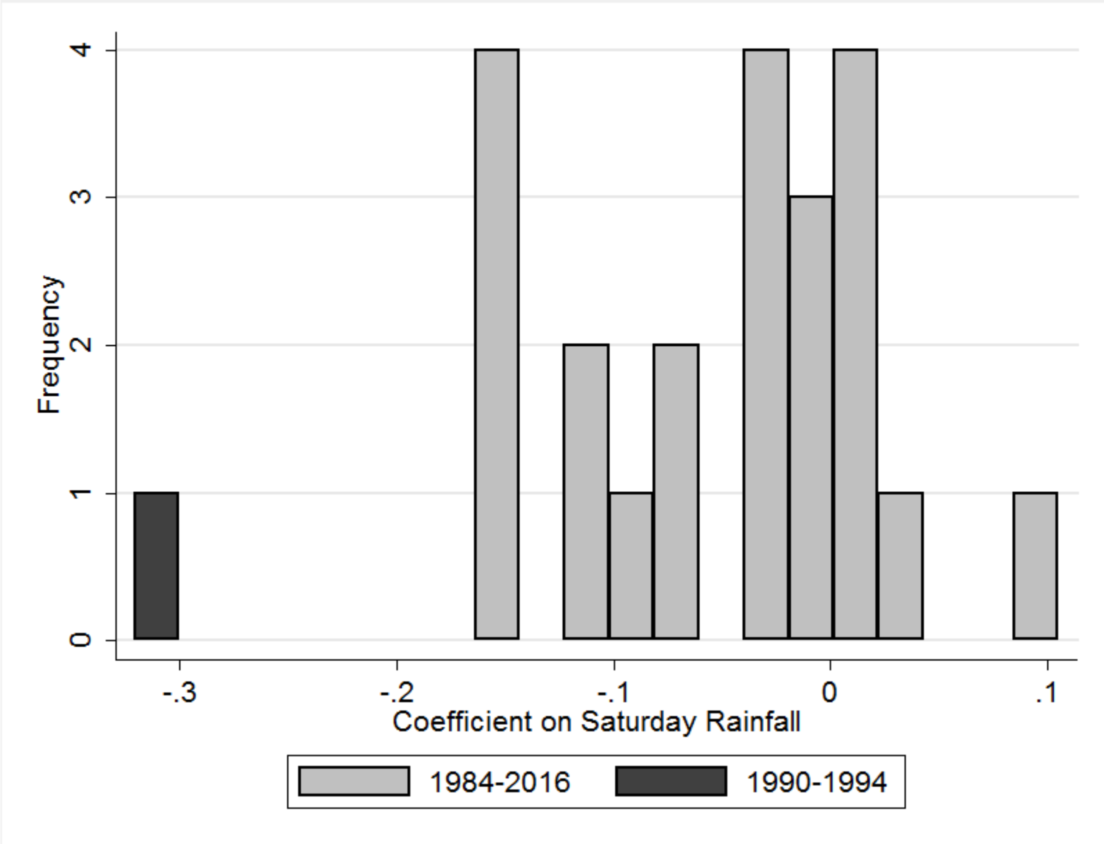
Notes: The figure shows the coefficients on the number of rainy Saturdays (together with 95 percent confidence bounds) when varying the rainfall threshold in our main specification (regression 3 in Table 2). Each point represents a separate regression.

Figure 6: Saturday-Rainfall-Violence Relationship



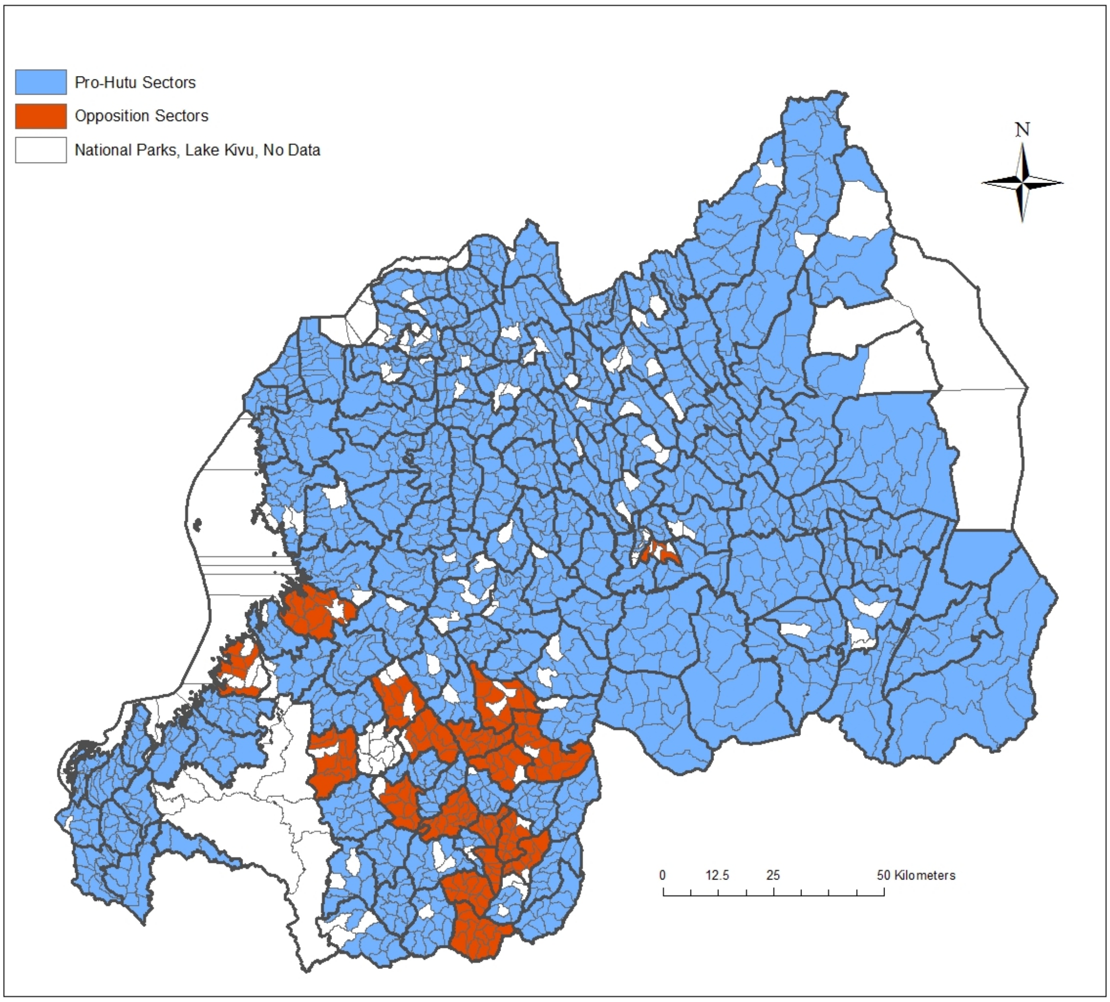
Notes: Observations are grouped into 75 equal-sized bins. We use all controls in regression 3 in Table 2 to construct residuals.

Figure 7: Placebo Check



Notes: The figure shows the distribution of coefficients on the number of rainy Saturdays when using Saturday rainfall during the 3.5 years of the pre-genocide calendar period (October 1, YEAR to March 31, YEAR+4) from the years 1984 to 2016 to construct our variable of interest in regression 3 in Table 2.

Figure 8: Location of Pro-Hutu and Opposition Sectors



Tables

Table 1: Summary Statistics

	Mean	Std.Dev.	Obs.
A. Violence & Population			
# Civilian Perpetrators	290.25	286.43	1433
# Militiamen	51.76	70.51	1433
# Civilian Perpetrators per Hutu (p.H.)	7.66	7.94	1433
# Militiamen per Hutu (p.H.)	1.41	2.10	1433
Pre-Genocide Violence against Tutsi, dummy	0.15	0.36	1433
Mass Grave found in Sector, dummy	0.05	0.21	1432
Hutu Population in Sector, ’000	4.26	2.17	1433
Population in Sector, ’000	4.88	2.48	1433
Hutu Population Density, per square km	425.07	605.37	1433
Population Density, per square km	498.60	850.61	1433
B. Rainfall			
# Sun(Rainfall>10 mm)	15.14	5.19	1433
# Mon(Rainfall>10 mm)	15.13	4.22	1433
# Tue(Rainfall>10 mm)	18.10	3.52	1433
# Wed(Rainfall>10 mm)	20.51	4.76	1433
# Thu(Rainfall>10 mm)	21.53	3.97	1433
# Fri(Rainfall>10 mm)	17.02	4.75	1433
# Sat(Rainfall>10 mm)	18.25	4.24	1433
Average Daily Rainfall, 1980s, mm	2.75	0.48	1433
Average Daily Rainfall, 1990s, mm	2.44	0.55	1433
# Sun(Rainfall>10 mm), Genocide Period	0.32	0.48	1433
# Mon(Rainfall>10 mm), Genocide Period	1.30	0.46	1433
# Tue(Rainfall>10 mm), Genocide Period	1.42	0.72	1433
# Wed(Rainfall>10 mm), Genocide Period	0.55	0.69	1433
# Thu(Rainfall>10 mm), Genocide Period	0.00	0.07	1433
# Fri(Rainfall>10 mm), Genocide Period	1.17	0.39	1433
# Sat(Rainfall>10 mm), Genocide Period	0.05	0.22	1433
# Pub. Holidays(Rainfall>10 mm)	0.85	0.20	1433
# Non-Rel. Holidays(Rainfall>10 mm)	1.56	0.21	1433
# Rel. Holidays(Rainfall>10 mm)	1.00	0.11	1433
C. Other Variables			
Fraction of Hutu with Radio	0.33	0.09	1433
Tutsi Minority Share	0.10	0.13	1433
Inter-ethnic Marriage Polarization	0.01	0.01	1433
Ruggedness Index	3.45	1.38	1433
Distance to Kigali	62.65	30.00	1433
Distance to Main City	22.78	14.69	1433
Distance to Town	16.58	8.83	1433
Distance to Nyanza	64.36	30.74	1433
Distance to the Main Road	6.71	5.77	1433
Distance to the Border	22.60	13.93	1433
RTLM Coverage	0.19	0.22	1057
Distance to Transmitter	5.18	2.85	1057
Mean Altitude, km	1.71	0.23	1057
Variance in Altitude, m	9070.29	10370.73	1057

Notes: The # prosecuted militiamen is crime category 1: prosecutions against organizers, leaders, army and militia; # prosecuted civilians is crime category 2: prosecutions against civilians. The per Hutu (p.H.) variables are expressed in percent. Pre-Genocide Violence against Tutsi, is a dummy taking on the value of 1 if the sector experienced violence against Tutsi in the pre-genocide period. The two average daily rainfall variables are measured in millimeters. The distance variables are measured in kilometers. Population is the population number in the sector and Population Density is population per square kilometers, from the 1991 census. Radio ownership and ethnicity data are taken from the 1991 census, available only at the commune level. There are 142 communes in the sample. The Tutsi Minority Share is defined as the fraction of Tutsi normalized by the fraction of Hutu. The formulas for Inter-ethnic Marriage Polarization and the Ruggedness Index can be found in the Data Section in the paper. RTLM Coverage is the share of the sector that received the RTLM radio signal. Distance to Transmitter is the distance of the sector to the closest RTLM transmitter (there were two).

Table 2: Main Effects

Dependent Variable:	# Civilian Perpetrators, p.H.		
	(1)	(2)	(3)
# Sat(Rainfall>10 mm)	−0.354	−0.341	−0.321
	(0.115)***	(0.105)***	(0.109)***
# Sun(Rainfall>10 mm)			0.025
			(0.092)
# Mon(Rainfall>10 mm)			0.071
			(0.097)
# Tue(Rainfall>10 mm)			0.029
			(0.075)
# Wed(Rainfall>10 mm)			0.018
			(0.103)
# Thu(Rainfall>10 mm)			−0.051
			(0.112)
# Fri(Rainfall>10 mm)			−0.043
			(0.093)
Standard Controls	yes	yes	yes
Commune Effects	no	yes	yes
R^2	0.18	0.53	0.53
N	1433	1433	1433

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994 (and similarly for all other weekdays). **# Civilian Perpetrators per Hutu (p.H)** are measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table 3: Rainy Saturdays in a Row

Dependent Variable:	# Civilian Perpetrators, p.H.			
	(1)	(2)	(3)	(4)
# Sat(Rainfall>10 mm)	−0.307	−0.261	−0.278	−0.330
	(0.139)**	(0.118)**	(0.111)**	(0.110)***
... x # Seq. with 2 Rainy Saturdays in a Row	−0.003			
	(0.031)			
... x # Seq. with 3 Rainy Saturdays in a Row		−0.072		
		(0.090)		
... x # 4-week Seq. with at least 3 Rainy Saturdays			−0.202	
			(0.116)*	
... x # 5-week Seq. with at least 3 Rainy Saturdays				−0.088
				(0.240)
Standard Controls	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes
Commune Effects	yes	yes	yes	yes
R^2	0.53	0.53	0.53	0.53
N	1433	1433	1433	1433

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994. **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. As an example, **# 4-week Seq. with at least 3 Rainy Saturdays** is the number of 4 week sequences with at least 3 rainy Saturdays, i.e. rainfall above 10 mm (sequences start and end with a rainy Saturday). **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table 4: Reliability of Gacaca Data and Robustness Checks

Dependent variable:	Mass Grave in Sector		# Civilian Perpetrators, p.H.		Log [# Civilian Perpetrators, p.H.]		# Organized Perpetrators, p.H.	
	Alternative Dep. Var.		Without Mass Graves	Additional Controls	Transformed Dep. Var.		Other Dep. Var.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# Sat(Rainfall>10 mm)	−0.014	−0.012	−0.318	−0.318	−0.040	−0.036	−0.047	−0.040
	(0.004)***	(0.004)***	(0.111)***	(0.113)***	(0.013)***	(0.012)***	(0.030)	(0.028)
# Sun(Rainfall>10 mm)		0.002	0.038	−0.001		0.004		−0.041
		(0.003)	(0.094)	(0.099)		(0.011)		(0.030)
# Mon(Rainfall>10 mm)		−0.002	0.050	0.111		0.008		0.086
		(0.004)	(0.095)	(0.097)		(0.013)		(0.029)***
# Tue(Rainfall>10 mm)		0.007	0.068	0.024		−0.007		−0.036
		(0.004)*	(0.079)	(0.076)		(0.012)		(0.028)
# Wed(Rainfall>10 mm)		0.006	0.014	0.009		0.002		0.013
		(0.004)	(0.100)	(0.098)		(0.013)		(0.027)
# Thu(Rainfall>10 mm)		−0.003	−0.049	−0.033		−0.030		−0.065
		(0.004)	(0.108)	(0.113)		(0.018)		(0.037)*
# Fri(Rainfall>10 mm)		−0.008	−0.008	−0.009		−0.009		0.006
		(0.003)**	(0.091)	(0.093)		(0.011)		(0.025)
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes
Additional Controls	no	no	no	yes	no	no	no	no
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.15	0.16	0.53	0.53	0.71	0.71	0.37	0.38
N	1432	1432	1367	1433	1433	1433	1433	1433

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994 (and similarly for all other weekdays). **# Civilian Perpetrators per Hutu (p.H)** and **# Organized Perpetrators per Hutu (p.H)** are measured in percent. In **regressions 1 and 2** we use a dummy indicating whether a mass grave was found in the sector as an alternative dependent variable. In **regression 3** we drop sectors with mass graves (indicating high death rates). In **regression 4** we add additional controls. In **regressions 5 and 6** we logaritmize the dependent variable. In **regressions 7 and 8** we use the number of organized perpetrators prosecuted in the sector as another dependent variable. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table 5: Exclusion Restriction

Dependent variable:	# Civilian Perpetrators, p.H.										
	Without Kigali	Without Major Cities	Public Holidays		Excl. Pre-Violence	Genocide Rainfall	Local Pro-Hutu Leaders		Local Opposition Leaders		Large Tutsi Minority
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
# Sat(Rainfall> 10 mm)	−0.341	−0.347	−0.319	−0.308	−0.416	−0.284	−0.407	−0.388	0.717	0.415	−0.599
	(0.110)***	(0.113)***	(0.106)***	(0.105)***	(0.123)***	(0.110)**	(0.096)***	(0.101)***	(0.900)	(0.798)	(0.764)
# Sun(Rainfall> 10 mm)	0.026	0.046	0.028	0.031	0.035	0.010		0.015		0.389	−0.336
	(0.095)	(0.099)	(0.093)	(0.094)	(0.108)	(0.091)		(0.089)		(0.795)	(0.825)
# Mon(Rainfall> 10 mm)	0.065	0.049	0.073	0.064	0.113	0.020		0.028		0.041	−0.586
	(0.097)	(0.099)	(0.095)	(0.097)	(0.113)	(0.096)		(0.093)		(0.366)	(0.857)
# Tue(Rainfall> 10 mm)	0.021	0.035	0.034	0.037	−0.011	0.018		0.029		−0.008	0.237
	(0.077)	(0.076)	(0.084)	(0.082)	(0.085)	(0.069)		(0.073)		(0.413)	(0.550)
# Wed(Rainfall> 10 mm)	−0.003	0.007	0.017	0.017	−0.018	0.037		−0.023		0.709	0.886
	(0.108)	(0.115)	(0.105)	(0.102)	(0.107)	(0.105)		(0.103)		(0.400)*	(0.508)*
# Thu(Rainfall> 10 mm)	−0.038	−0.040	−0.050	−0.049	0.082	0.017		−0.116		0.845	−0.445
	(0.115)	(0.119)	(0.112)	(0.113)	(0.126)	(0.119)		(0.107)		(0.615)	(0.458)
# Fri(Rainfall> 10 mm)	−0.048	−0.033	−0.039	0.004	0.034	−0.046		0.005		−0.185	−0.219
	(0.093)	(0.098)	(0.106)	(0.119)	(0.108)	(0.095)		(0.089)		(0.419)	(0.604)
# Pub. Holidays(Rainfall>10 mm)			−0.082								
			(0.433)								
# Non-Rel. Holidays(Rainfall>10 mm)				−0.214							
				(0.341)							
# Rel. Holidays(Rainfall>10 mm)				−0.576							
				(0.409)							
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Genocide Controls	no	no	no	no	no	yes	no	no	no	no	no
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.53	0.53	0.53	0.53	0.50	0.53	0.56	0.56	0.33	0.35	0.52
N	1422	1358	1433	1433	1213	1433	1266	1266	161	161	168

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994 (and similarly for all other weekdays). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. In **regression 1** we drop sectors in the capital Kigali and in **regression 2** we drop all sectors in and close to the cities. In **regressions 3 and 4**, we also control for the number of public holidays (separated into religious and non-religious holidays in regression 4) with rainfall above 10 mm. In **regression 5**, we drop sectors were violence against Tutsi took place before the genocide. In **regression 6**, we control for the number of Saturdays with rainfall above 10 mm during the genocide (and similarly all other weekdays). In **regressions 7 and 8**, the sample is restricted to sectors in communes ruled by pro-Hutu parties. In **regressions 9 and 10**, the sample is restricted to sectors in communes ruled by opposition parties. In **regression 11** the sample is restricted to sectors with large Tutsi minority shares. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Genocide Controls** include the number of Saturdays with rainfall above 10 mm during the period of the genocide (and similarly for all other weekdays). All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table 6: Mechanism: Effects over Time

Dependent variable:	# Civilian Perpetrators, p.H.								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
# Sat(Rainfall>10 mm) - Pre-Political Umuganda Period									
Period 84-90: whole period	−0.016								
	(0.059)								
Period 84-90: 1. 27 Months		−0.238	−0.211	−0.227	−0.236	−0.258	−0.289	−0.253	−0.282
		(0.166)	(0.164)	(0.164)	(0.165)	(0.165)	(0.176)	(0.163)	(0.171)
Period 84-90: 2. 27 Months		0.076	0.123	0.111	0.124	0.112	0.110	0.118	0.117
		(0.120)	(0.121)	(0.123)	(0.120)	(0.122)	(0.118)	(0.119)	(0.116)
Period 84-90: 3. 27 Months		0.024	0.068	0.069	0.074	0.110	0.094	0.099	0.082
		(0.162)	(0.158)	(0.157)	(0.158)	(0.159)	(0.171)	(0.154)	(0.168)
# Sat(Rainfall>10 mm) - Political Umuganda Period									
Period 90-94: whole period			−0.329						
			(0.113)***						
Period 90-94: 1. 14 Months				−0.170					
				(0.215)					
Period 90-94: 2. 14 Months				−0.059					
				(0.172)					
Period 90-94: 3. 14 Months				−0.592					
				(0.161)***					
Period 90-94: 1. 7 Months					−0.141				
					(0.197)				
Period 90-94: 2. 7 Months					−0.094				
					(0.466)				
Period 90-94: 3. 7 Months					0.078				
					(0.261)				
Period 90-94: 4. 7 Months					−0.272				
					(0.250)				
Period 90-94: 5. 7 Months					−0.264				
					(0.254)				
Period 90-94: 6. 7 Months					−0.840				
					(0.233)***				
Period 90-94: 1. 3.5 Months						−0.299	−0.365		
						(0.346)	(0.354)		
Period 90-94: 2. 3.5 Months						−0.147	−0.169		
						(0.287)	(0.308)		
Period 90-94: 3. 3.5 Months						−0.177	0.111		
						(0.847)	(0.885)		
Period 90-94: 4. 3.5 Months						−0.220	−0.299		
						(0.452)	(0.448)		
Period 90-94: 5. 3.5 Months						−0.443	−0.508		
						(0.417)	(0.403)		
Period 90-94: 6. 3.5 Months						0.559	0.522		
						(0.427)	(0.427)		
Period 90-94: 7. 3.5 Months						−0.475	−0.460		
						(0.658)	(0.662)		
Period 90-94: 8. 3.5 Months						−0.171	−0.181		
						(0.264)	(0.291)		
Period 90-94: 9. 3.5 Months						−0.130	−0.046		
						(0.254)	(0.235)		
Period 90-94: 10. 3.5 Months						−1.996	−1.847		
						(0.594)***	(0.595)***		
Period 90-94: 11. 3.5 Months						−0.939	−0.843		
						(0.278)***	(0.285)***		
Period 90-94: 12. 3.5 Months						−0.581	−0.599		
						(0.318)*	(0.320)*		
Period 90-94: before RTLM								−0.099	−0.106
								(0.144)	(0.147)
Period 90-94: after RTLM								−0.889	−0.853
								(0.219)***	(0.216)***
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Additional Controls	no	no	no	no	no	no	yes	no	yes
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.53	0.53	0.53	0.53	0.53	0.54	0.54	0.54	0.54
N	1433	1433	1433	1433	1433	1433	1433	1433	1433

Notes: All of the regressors in this table capture the number of Saturdays with rainfall above 10 mm for different time periods. **Regressor 1** is the number of rainy Saturdays for the period January 1984 to September 1990. **Regressors 2 to 4** are the number of rainy Saturdays for the period January 1984 to September 1990 (split into three time intervals of equal length). **All the other regressors** are from the time period October 1990 to March 1994 (split into various different time intervals of equal length, i.e. 3, 6, 12, and before/after RTLM). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table 7: Mechanism: Interaction Effects – Pro-Hutu Sectors

Dependent variable:	# Civilian Perpetrators, p.H.							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# Sat(Rainfall>10 mm)	−0.577	−0.352	−0.463	−0.288	−0.275	−0.452	−0.512	−0.544
	(0.266)**	(0.168)**	(0.109)***	(0.123)**	(0.115)**	(0.291)	(0.281)*	(0.303)*
... x Radio Ownership	0.046					0.031	0.060	0.062
	(0.062)					(0.074)	(0.074)	(0.077)
... x RTLM Coverage		−0.035						
		(0.043)						
... x Hutu Population Density			0.093			0.086	0.108	0.116
			(0.023)***			(0.030)***	(0.028)***	(0.029)***
... x Tutsi Minority Share				−0.175		−0.226		0.180
				(0.186)		(0.184)		(0.338)
... x Inter-ethnic Marriage					−0.142		−0.234	−0.341
					(0.096)		(0.067)***	(0.212)
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes	yes	yes	yes
Additional Controls	yes	yes	yes	yes	yes	yes	yes	yes
RTLM Controls	no	yes	no	no	no	no	no	no
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.56	0.54	0.56	0.56	0.56	0.57	0.57	0.57
N	1266	921	1266	1266	1266	1266	1266	1266

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994. **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Radio Ownership** is the fraction of Hutu owning a radio. **RTLM coverage** is the fraction of the sector area that receives the RTLM signal. **Tutsi Minority Share** is the fraction of Tutsi divided by the fraction of Hutu. **Inter-ethnic Marriage** is a measure of inter-ethnic connectedness defined in the Data Section in the paper. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. **RTLM Controls** are distance to the closest RTLM transmitter as well as mean and variance of sector elevation. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table 8: Mechanism: Interaction Effects – Pro-Hutu Sectors (before/after RTLM)

Dependent variable:	# Civilian Perpetrators, p.H.							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# Sat(Rainfall>10 mm), before RTLM	−0.626	−0.290	−0.296	−0.179	−0.116	−0.537	−0.547	−0.609
	(0.352)*	(0.206)	(0.128)**	(0.136)	(0.126)	(0.357)	(0.347)	(0.364)*
... x Radio Ownership	0.099					0.078	0.104	0.110
	(0.086)					(0.087)	(0.092)	(0.094)
... x RTLM Coverage		0.041						
		(0.070)						
... x Hutu Population Density			0.072			0.072	0.097	0.105
			(0.057)			(0.056)	(0.055)*	(0.057)*
... x Tutsi Minority Share				−0.081		−0.092		0.251
				(0.181)		(0.172)		(0.334)
... x Inter-ethnic Marriage					−0.144		−0.191	−0.327
					(0.098)		(0.088)**	(0.228)
# Sat(Rainfall>10 mm), after RTLM	−0.584	−0.628	−0.881	−0.498	−0.625	−0.351	−0.504	−0.457
	(0.507)	(0.391)	(0.209)***	(0.200)**	(0.222)***	(0.530)	(0.541)	(0.522)
... x Radio Ownership	−0.044					−0.061	−0.040	−0.038
	(0.121)					(0.150)	(0.148)	(0.145)
... x RTLM Coverage		−0.147						
		(0.085)*						
... x Hutu Population Density			0.152			0.174	0.182	0.172
			(0.083)*			(0.083)**	(0.085)**	(0.084)**
... x Tutsi Minority Share				−0.490		−0.656		−0.359
				(0.270)*		(0.260)**		(0.495)
... x Inter-ethnic Marriage					−0.156		−0.350	−0.170
					(0.175)		(0.125)***	(0.282)
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes	yes	yes	yes
Additional Controls	yes	yes	yes	yes	yes	yes	yes	yes
RTLM Controls	no	yes	no	no	no	no	no	no
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.57	0.54	0.57	0.57	0.57	0.57	0.57	0.57
N	1266	921	1266	1266	1266	1266	1266	1266

Notes: **# Sat(Rainfall>10 mm), before (after) RTLM** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to June 1993 (July 1993 to March 1994). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Radio Ownership** is the fraction of Hutu owning a radio. **RTLM coverage** is the fraction of the sector area that receives the RTLM signal. **Tutsi Minority Share** is the fraction of Tutsi divided by the fraction of Hutu. **Inter-ethnic Marriage** is a measure of inter-ethnic connectedness defined in the Data Section in the paper. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. **RTLM Controls** are distance to the closest RTLM transmitter as well as mean and variance of sector elevation. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table 9: Mechanism: Interaction Effects – Opposition Sectors

Dependent variable:	# Civilian Perpetrators, p.H.							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# Sat(Rainfall>10 mm)	3.349	1.524	0.238	−1.240	−1.015	2.117	5.085	4.205
	(2.204)	(1.171)	(0.882)	(0.905)	(1.033)	(1.686)	(2.035)**	(1.828)**
... x Radio Ownership	−0.929					−0.966	−2.117	−2.007
	(0.607)					(0.508)*	(0.753)**	(0.723)**
... x RTLM Coverage		−2.264						
		(0.999)**						
... x Population Density			−0.177			−0.217	−0.130	−0.158
			(0.529)			(0.563)	(0.532)	(0.537)
... x Tutsi Minority Share				0.990		1.035		0.552
				(0.562)*		(0.564)*		(0.549)
... x Inter-ethnic Marriage					0.814		1.670	1.487
					(0.674)		(0.770)**	(0.740)*
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes	yes	yes	yes
Additional Controls	yes	yes	yes	yes	yes	yes	yes	yes
RTLM Controls	no	yes	no	no	no	no	no	no
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.40	0.38	0.39	0.40	0.40	0.41	0.42	0.42
N	161	132	161	161	161	161	161	161

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994. **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Radio Ownership** is the fraction of Hutu owning a radio. **RTLM coverage** is the fraction of the sector area that receives the RTLM signal. **Tutsi Minority Share** is the fraction of Tutsi divided by the fraction of Hutu. **Inter-ethnic Marriage** is a measure of inter-ethnic connectedness defined in the Data Section in the paper. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. **RTLM Controls** are distance to the closest RTLM transmitter as well as mean and variance of sector elevation. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Appendix – For Online Publication

A.1 Additional Figures

Figure A.1: Gacaca Data: Civilian Participation

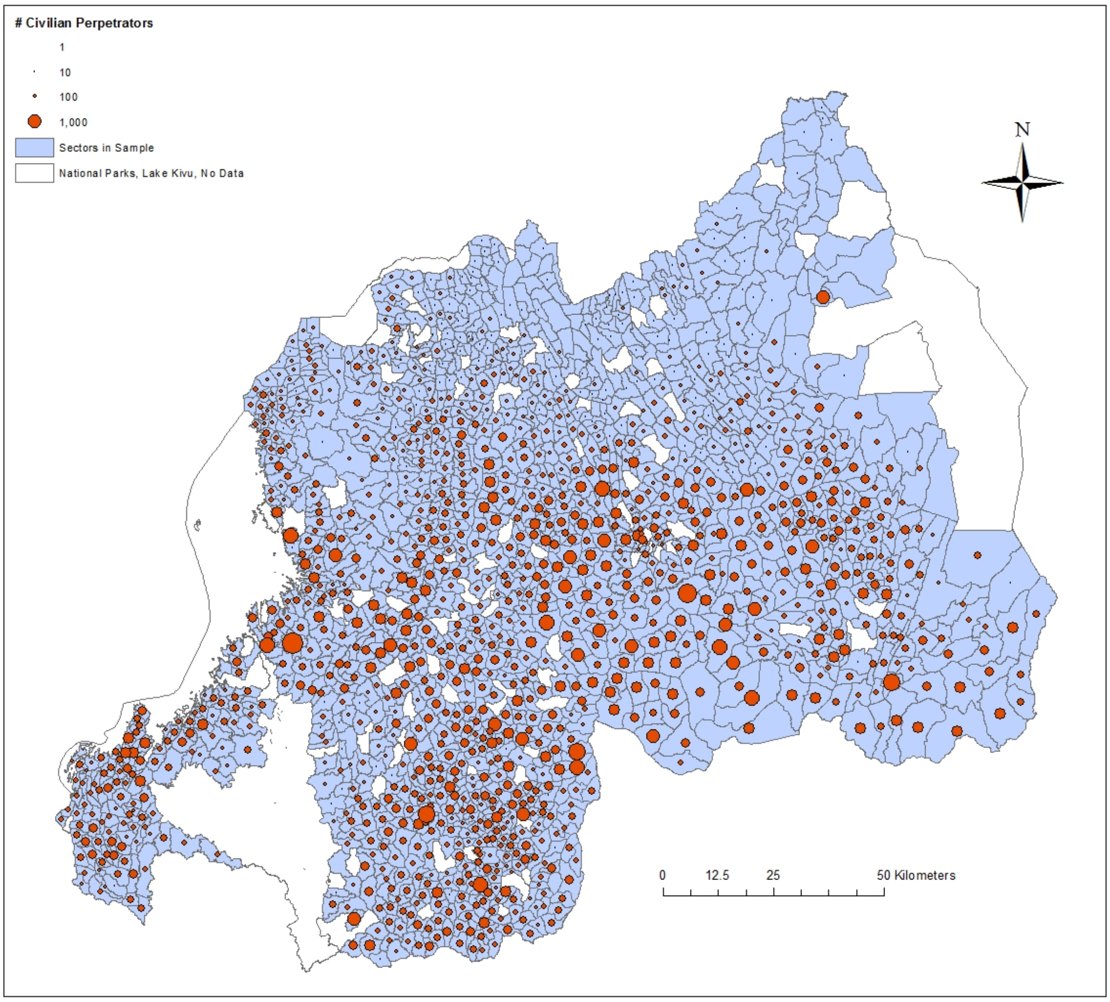
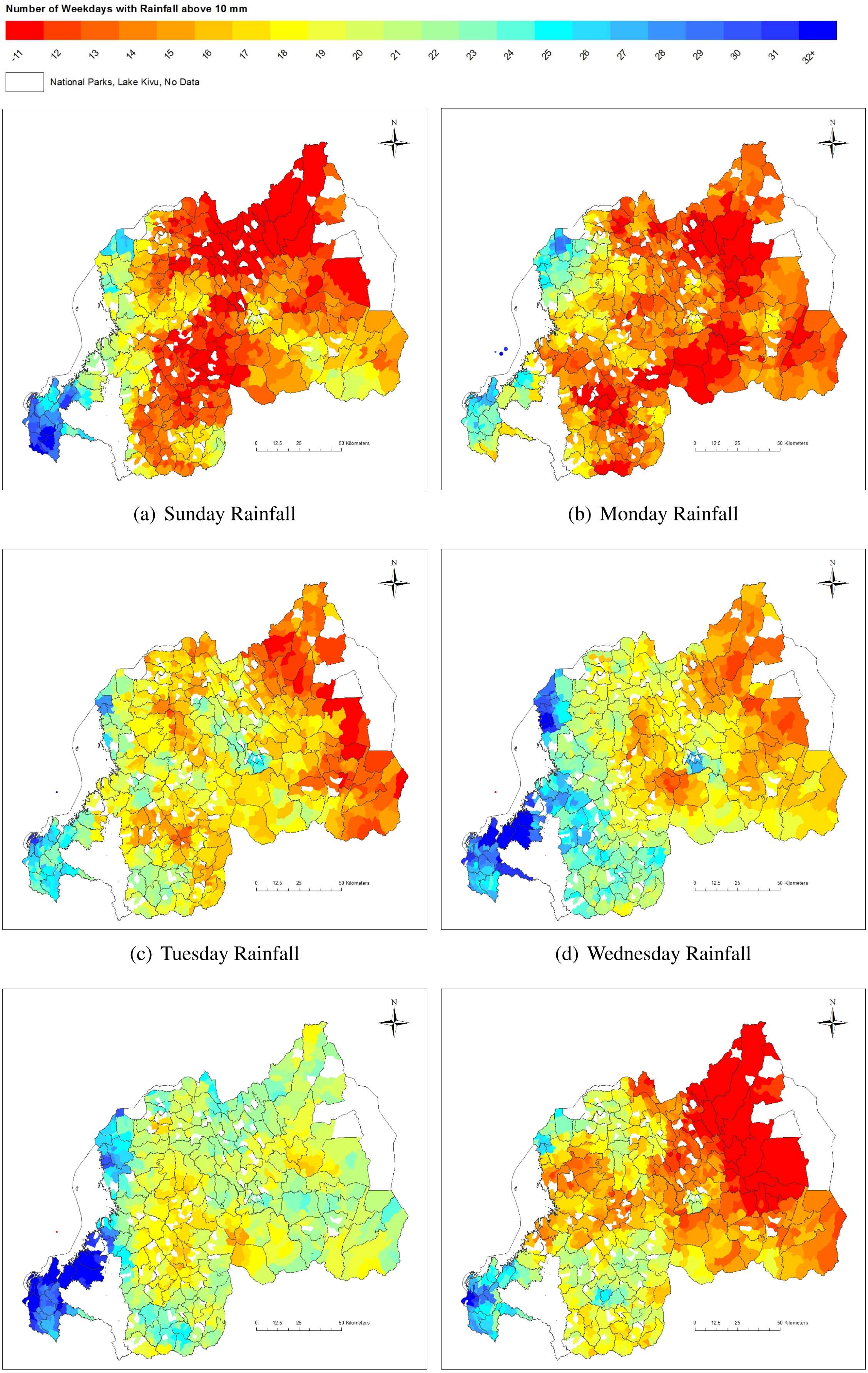


Figure A.2: Local Rainfall Variation for all Other Weekdays



(a) Sunday Rainfall

(b) Monday Rainfall

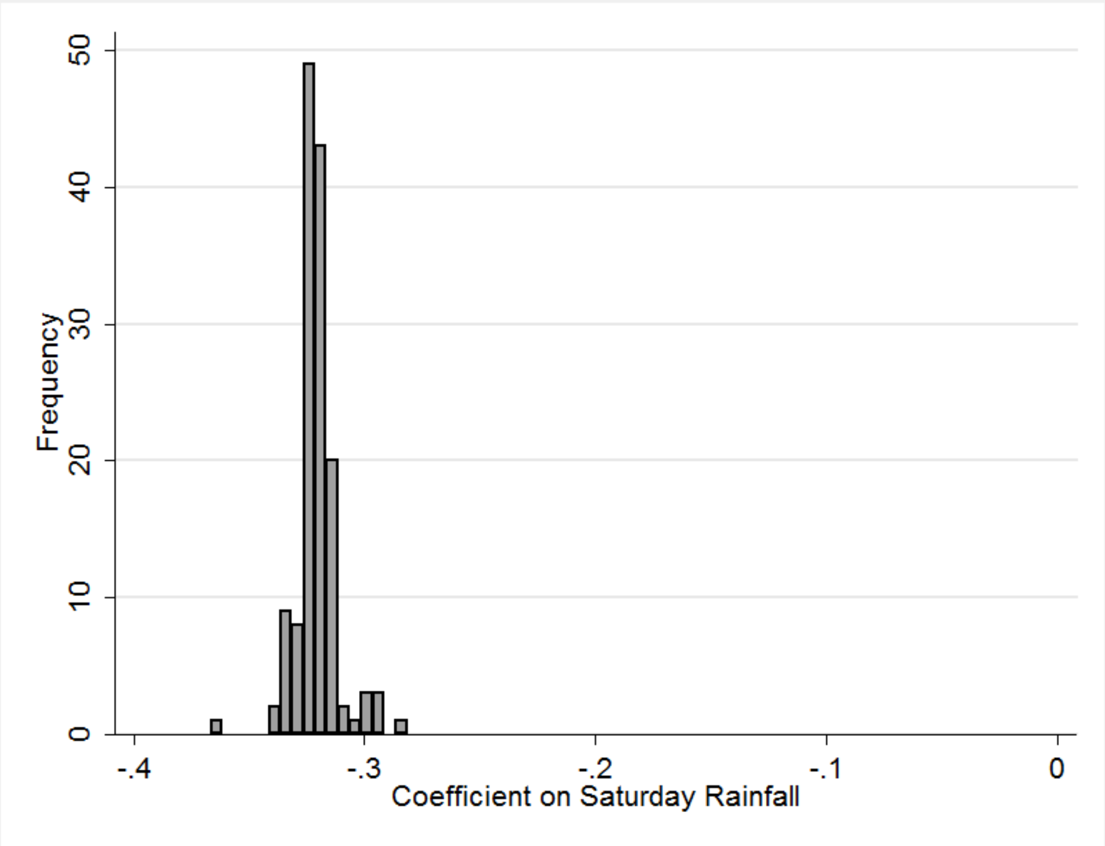
(c) Tuesday Rainfall

(d) Wednesday Rainfall

(e) Thursday Rainfall

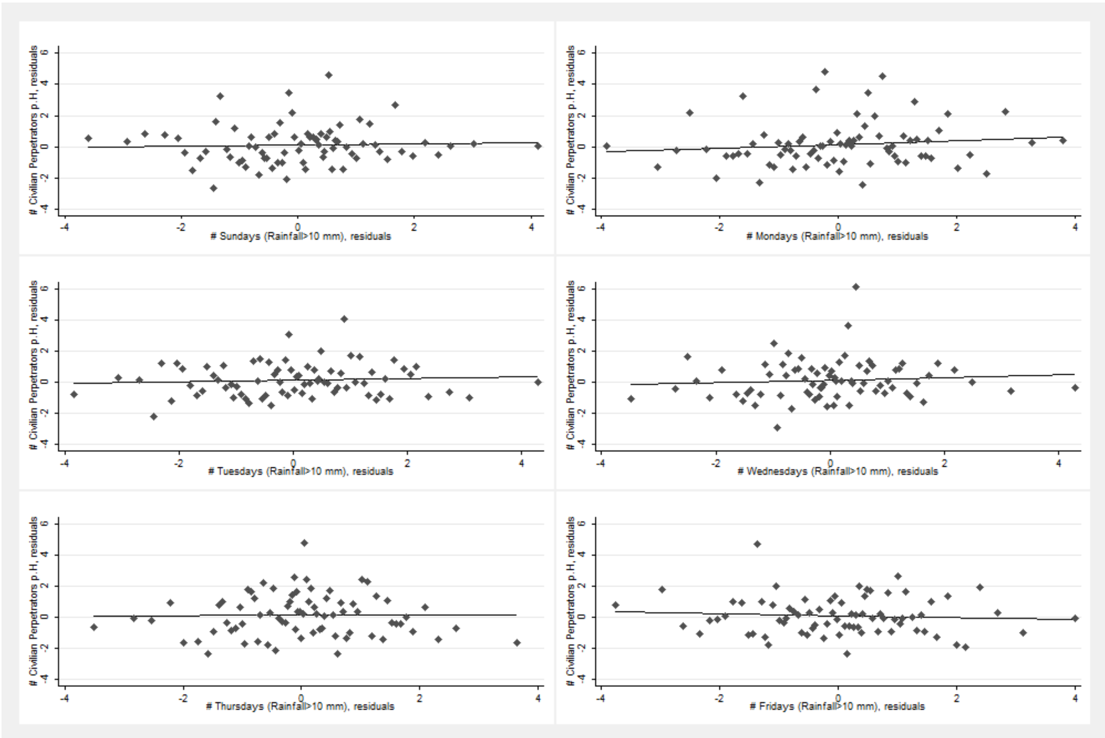
(f) Friday Rainfall

Figure A.3: Outliers



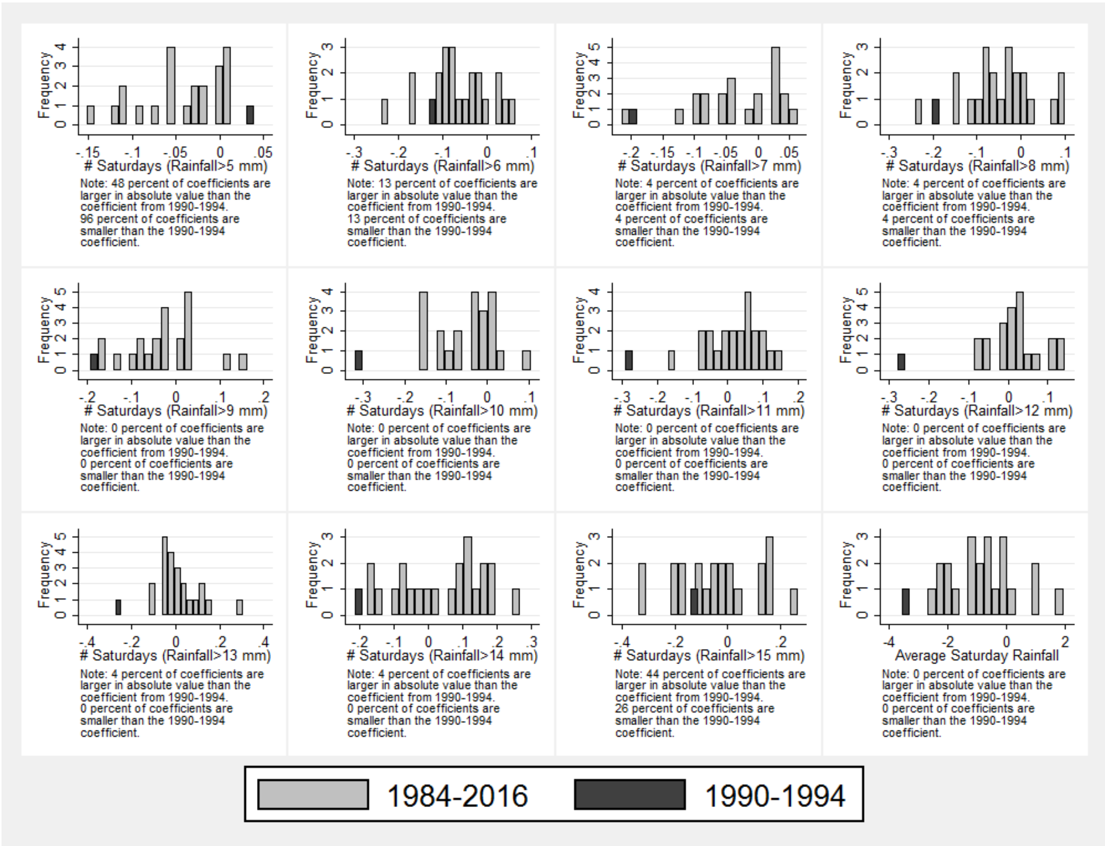
Notes: This figure shows the distribution of point estimates on the number of rainy Saturdays when dropping one commune at a time in our baseline specification (regression 3 in Table 2 in the paper).

Figure A.4: Relationship between Civilian Violence and Rainfall for all Other Weekdays



Notes: Observations are grouped into 75 equal-sized bins. We use all controls in regression 3 in Table 2 in the paper to construct residuals.

Figure A.5: Placebo Check – Different Rainfall Thresholds



Notes: The figure shows the distribution of coefficients on the number of rainy Saturdays when using Saturday rainfall during the 3.5 years of the pre-genocide calendar period (October 1, YEAR to March 31, YEAR+4) from the years 1984 to 2016 to construct our variable of interest. We vary the thresholds from 5 mm to 15 mm in increments of 1 mm. The last figure (bottom right) uses average Saturday rainfall.

A.2 Additional Tables

Table A.1: Main Effects – Linear Specification

Dependent Variable:	# Civilian Perpetrators, p.H.							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Average Rainfall Sat	−3.646	−3.553						
	(1.379)***	(1.438)**						
Average Rainfall Sun		−0.084	−0.161					
		(1.661)	(1.618)					
Average Rainfall Mon		0.188		1.181				
		(1.426)		(1.686)				
Average Rainfall Tue		0.711			1.162			
		(1.112)			(1.368)			
Average Rainfall Wed		0.992				1.483		
		(1.208)				(1.249)		
Average Rainfall Thu		−1.084					−0.749	
		(1.061)					(1.188)	
Average Rainfall Fri		−0.299						0.071
		(0.873)						(0.775)
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.53	0.53	0.52	0.53	0.53	0.53	0.53	0.52
N	1433	1433	1433	1433	1433	1433	1433	1433

Notes: **Average Rainfall Sat** is the average daily Saturday rainfall during the period from October 1990 to March 1994 (and similarly for all other weekdays). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.2: Summary Statistics by Rainfall on Saturdays

	Low Rainfall	High Rainfall	
	Mean (Std.dev.)	Mean (Std.dev.)	p-Value of Difference
Population in Sector, '000	5.035	4.729	0.248
	(2.394)	(2.561)	
Hutu Population in Sector, '000	4.435	4.092	0.275
	(1.938)	(2.376)	
Tutsi Population in Sector, '000	0.600	0.638	0.154
	(0.698)	(0.414)	
Population Density, per square km	610.455	386.897	0.595
	(1177.130)	(195.841)	
Hutu Population Density, per square km	522.167	328.106	0.545
	(830.348)	(159.941)	
Tutsi Population Density, per square km	88.287	58.791	0.935
	(355.393)	(56.559)	
Inter-ethnic Marriage Polarization	0.010	0.013	0.243
	(0.012)	(0.010)	
Sector Centroid Latitude, km	9781.806	9768.154	0.384
	(39.477)	(45.812)	
Sector Centroid Longitude, km	789.015	832.588	0.319
	(40.174)	(37.962)	
Distance to Kigali	67.074	58.241	0.451
	(36.333)	(21.036)	
Distance to Main City	19.347	26.205	0.939
	(10.652)	(17.165)	
Distance to Town	17.453	15.717	0.305
	(8.717)	(8.872)	
Distance to Nyanza	68.704	60.022	0.077
	(20.841)	(37.656)	
Distance to the Main Road	6.620	6.804	0.466
	(6.286)	(5.208)	
Distance to the Border	21.490	23.717	0.249
	(13.759)	(14.022)	
Ruggedness Index	3.617	3.281	0.936
	(1.505)	(1.211)	
RTLM Coverage	0.270	0.101	0.361
	(0.264)	(0.130)	
Distance to Transmitter	4.761	5.607	0.928
	(3.316)	(2.213)	
Mean Altitude, km	1.751	1.672	0.835
	(0.266)	(0.183)	
Variance in Altitude, m	11506.127	6629.833	0.213
	(12646.727)	(6583.779)	

Notes: The full sample is split into two subsamples of equal size at the median value of average Saturday rainfall. The p-value of the test of equality of means is based on standard errors clustered at the commune level (and after netting out commune fixed effects). The distance variables are measured in kilometers. Hutu (Tutsi) population is the Hutu (Tutsi) population number in the sector and population density variables are measured as population per square kilometers, from the 1991 census. Latitude and Longitude (in km) are used to construct Conley standard errors in Table A.3. The formulas for Inter-ethnic Marriage Polarization and the Ruggedness Index can be found in the Data Section in the paper. RTLM Coverage is the share of the sector that received the RTLM radio signal. Distance to Transmitter is the distance of the sector to the closest RTLM transmitter (there were two). There are 142 communes in the sample.

Table A.3: Additional Standard Errors

Dependent Variable:	# Civilian Perpetrators, p.H.			
	25 km	50 km	75 km	District
	(1)	(2)	(3)	(4)
# Sat(Rainfall>10 mm)	−0.316	−0.316	−0.316	−0.321
	[0.128]**	[0.132]**	[0.130]**	[0.108]***
# Sun(Rainfall>10 mm)	0.034	0.034	0.034	0.025
	[0.094]	[0.087]	[0.080]	[0.095]
# Mon(Rainfall>10 mm)	0.116	0.116	0.116	0.071
	[0.094]	[0.104]	[0.105]	[0.102]
# Tue(Rainfall>10 mm)	0.047	0.047	0.047	0.029
	[0.100]	[0.113]	[0.105]	[0.112]
# Wed(Rainfall>10 mm)	0.095	0.095	0.095	0.018
	[0.106]	[0.092]	[0.092]	[0.086]
# Thu(Rainfall>10 mm)	−0.019	−0.019	−0.019	−0.051
	[0.120]	[0.131]	[0.144]	[0.121]
# Fri(Rainfall>10 mm)	−0.059	−0.059	−0.059	−0.043
	[0.110]	[0.105]	[0.088]	[0.097]
Standard Controls	yes	yes	yes	yes
Commune Effects	yes	yes	yes	yes
R^2	0.49	0.49	0.49	0.53
N	1433	1433	1433	1433

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994 (and similarly for all other weekdays). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. In **regressions 1 to 3 standard errors** correcting for spatial correlation within a radius of 25km, 50km and 75km are in square brackets, Conley (1999). The radius used in each regression is given in the column header. In **regression 4** we cluster at the district level. There are **142 communes** and **30 districts** in the sample. Regression 4 is run using weighted least squares (WLS) estimation with Hutu population size as weights. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.4: Alternative Rainfall Measures

Dependent variable:	# Civilian Perpetrators, p.H.									
					Thresholds on Average					
					$x = 9$ *mm*		$x = 10$ *mm*		$x = 11$ *mm*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Saturday Rainfall Shock	−23.967	−24.169	−22.667	−21.699						
	(8.025)***	(9.502)**	(7.700)***	(7.633)***						
Sunday Rainfall Shock		2.652		4.737						
		(10.166)		(6.219)						
Monday Rainfall Shock		−1.739		5.341						
		(8.690)		(6.590)						
Tuesday Rainfall Shock		8.873		2.988						
		(7.500)		(5.136)						
Wednesday Rainfall Shock		6.379		2.373						
		(6.903)		(6.938)						
Thursday Rainfall Shock		−7.824		−2.234						
		(6.790)		(8.569)						
Friday Rainfall Shock		−2.799		−4.121						
		(5.684)		(6.139)						
# Sat(Rainfall> x mm)					−0.258	−0.257	−0.297	−0.259	−0.376	−0.273
					(0.086)***	(0.092)***	(0.087)***	(0.091)***	(0.094)***	(0.092)***
# Sun(Rainfall> x mm)						0.161		0.037		−0.026
						(0.083)*		(0.098)		(0.106)
# Mon(Rainfall> x mm)						−0.034		−0.014		−0.091
						(0.084)		(0.075)		(0.087)
# Tue(Rainfall> x mm)						0.004		0.010		0.096
						(0.081)		(0.077)		(0.085)
# Wed(Rainfall> x mm)						−0.055		−0.041		0.036
						(0.098)		(0.117)		(0.117)
# Thu(Rainfall> x mm)						0.065		−0.085		−0.066
						(0.100)		(0.111)		(0.113)
# Fri(Rainfall> x mm)						−0.128		−0.029		−0.186
						(0.106)		(0.111)		(0.120)
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
N	1433	1433	1433	1433	1433	1433	1433	1433	1433	1433

Notes: **Saturday Rainfall Shocks** in regressions 1 and 2 (regressions 3 and 4) are defined as the average Saturday rainfall (number of Saturdays with rainfall above 10 mm) during our period of interest minus long-term average rainfall (long-term number of Saturdays with rainfall above 10 mm) normalized by its long-term standard deviation (and similarly for all other weekdays). The long-term averages/standard deviations are for the period January 1984 until September 1990. **In regressions 5 to 10** the rainfall thresholds are defined as t times the standard deviation of the long-term average plus the long-term average for each sector, where t is such that the sector-specific cutoffs match our usual cutoffs on average (i.e. 9 mm, 10 mm, and 11 mm). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.5: Differential Effects in Opposition Sectors – Interactions (Alternative Thresholds)

Dependent variable:	# Civilian Perpetrators, p.H.				
	Thresholds				
	8 mm	9 mm	10 mm	11 mm	12 mm
	(1)	(2)	(3)	(4)	(5)
# Sat(Rainfall> x mm)	−0.315	−0.351	−0.414	−0.379	−0.374
	(0.128)**	(0.110)***	(0.120)***	(0.113)***	(0.127)***
... x Opposition Leaders	1.202	1.653	1.096	1.063	1.053
	(0.759)	(0.768)**	(0.769)	(0.572)*	(0.565)*
... x Tutsi Minority Share	−1.577	−0.903	−0.800	−2.635	−2.046
	(1.581)	(1.197)	(1.407)	(1.427)*	(1.050)*
Standard Controls	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes
Commune Effects	yes	yes	yes	yes	yes
R^2	0.53	0.54	0.53	0.54	0.53
N	1427	1427	1427	1427	1427

Notes: **# Sat(Rainfall>x mm)** is the number of Saturdays with rainfall above *x* mm during the period October 1990 to March 1994 (and similarly for all other weekdays). The thresholds *x* are given in the column headers. **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Opposition Leader** is a dummy taking on the value of 1 if the commune in which the sector lies had an opposition party leader. **Tutsi Minority Share** is the fraction of Tutsi divided by the fraction of Hutu. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above *x* mm during the period October 1990 to March 1994. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.6: Controlling for Potential Radio Fade

Dependent Variable:	# Civilian Perpetrators, p.H.			
	(1)	(2)	(3)	(4)
# Sat(Rainfall>10 mm)	−0.295	−0.265	−0.308	−0.308
	(0.115)**	(0.123)**	(0.113)***	(0.108)***
# Sun(Rainfall>10 mm)	0.045	0.040	0.048	0.043
	(0.097)	(0.105)	(0.096)	(0.101)
# Mon(Rainfall>10 mm)	0.084	0.085	0.044	0.052
	(0.102)	(0.099)	(0.100)	(0.101)
# Tue(Rainfall>10 mm)	0.035	−0.044	0.024	−0.057
	(0.079)	(0.087)	(0.079)	(0.088)
# Wed(Rainfall>10 mm)	0.013	0.043	0.003	−0.025
	(0.107)	(0.096)	(0.105)	(0.101)
# Thu(Rainfall>10 mm)	−0.041	−0.027	−0.025	−0.010
	(0.129)	(0.131)	(0.126)	(0.120)
# Fri(Rainfall>10 mm)	−0.091	−0.091	−0.059	−0.046
	(0.097)	(0.103)	(0.095)	(0.089)
Standard Controls	yes	yes	yes	yes
Weekday Rainfall, all Transmitters	yes	yes	no	no
Max. Weekday Rainfall, all Transmitters	no	yes	no	no
Weekday Rainfall, Closest Transmitter	no	no	yes	yes
Max. Weekday Rainfall, Closest Transmitter	no	no	no	yes
Commune Effects	yes	yes	yes	yes
R^2	0.54	0.54	0.53	0.54
N	1433	1433	1433	1433

Notes: **# Sat(Rainfall>10 mm)** is the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994 (and similarly for all other weekdays). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Weekday Rainfall, all Transmitters** is the number of Saturdays with rainfall along the way between sector and the two RTLM transmitters above 10 mm (and similarly for all other weekdays). **Max. Weekday Rainfall, all Transmitters** is the number of Saturdays with maximum rainfall along the way between sector and the two RTLM transmitters above 10 mm (and similarly for all other weekdays). **Weekday Rainfall, Closest Transmitter** is the number of Saturdays with rainfall along the way between sector and the closest RTLM transmitter above 10 mm (and similarly for all other weekdays). **Max. Weekday Rainfall, Closest Transmitter** is the number of Saturdays with maximum rainfall along the way between sector and closest RTLM transmitter above 10 mm (and similarly for all other weekdays). All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.7: Mechanism: Effects over Time – Pro-Hutu Sectors

Dependent variable:	# Civilian Perpetrators, p.H.								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
# Sat(Rainfall>10 mm) - Pre-Political Umuganda Period									
Period 84-90: whole period	0.017								
	(0.055)								
Period 84-90: 1. 27 Months		−0.199	−0.166	−0.178	−0.168	−0.184	−0.170	−0.201	−0.191
		(0.159)	(0.153)	(0.152)	(0.149)	(0.147)	(0.158)	(0.150)	(0.159)
Period 84-90: 2. 27 Months		0.082	0.137	0.132	0.142	0.134	0.128	0.132	0.127
		(0.127)	(0.125)	(0.125)	(0.125)	(0.128)	(0.124)	(0.123)	(0.121)
Period 84-90: 3. 27 Months		0.082	0.133	0.129	0.108	0.141	0.132	0.158	0.150
		(0.168)	(0.163)	(0.162)	(0.163)	(0.166)	(0.180)	(0.160)	(0.176)
# Sat(Rainfall>10 mm) - Political Umuganda Period									
Period 90-94: whole period			−0.404						
			(0.102)***						
Period 90-94: 1. 14 Months				−0.327					
				(0.157)**					
Period 90-94: 2. 14 Months				−0.148					
				(0.176)					
Period 90-94: 3. 14 Months				−0.583					
				(0.165)***					
Period 90-94: 1. 7 Months					−0.093				
					(0.192)				
Period 90-94: 2. 7 Months					−0.548				
					(0.256)**				
Period 90-94: 3. 7 Months					0.100				
					(0.260)				
Period 90-94: 4. 7 Months					−0.447				
					(0.250)*				
Period 90-94: 5. 7 Months					−0.415				
					(0.206)**				
Period 90-94: 6. 7 Months					−0.756				
					(0.225)***				
Period 90-94: 1. 3.5 Months						−0.220	−0.248		
						(0.331)	(0.340)		
Period 90-94: 2. 3.5 Months						−0.088	−0.130		
						(0.301)	(0.322)		
Period 90-94: 3. 3.5 Months						−0.794	−0.539		
						(0.621)	(0.717)		
Period 90-94: 4. 3.5 Months						−0.623	−0.728		
						(0.297)**	(0.301)**		
Period 90-94: 5. 3.5 Months						−0.234	−0.339		
						(0.400)	(0.395)		
Period 90-94: 6. 3.5 Months						0.419	0.341		
						(0.434)	(0.438)		
Period 90-94: 7. 3.5 Months						−0.556	−0.552		
						(0.654)	(0.633)		
Period 90-94: 8. 3.5 Months						−0.345	−0.418		
						(0.260)	(0.291)		
Period 90-94: 9. 3.5 Months						−0.276	−0.141		
						(0.207)	(0.218)		
Period 90-94: 10. 3.5 Months						−2.054	−1.796		
						(0.603)***	(0.599)***		
Period 90-94: 11. 3.5 Months						−0.841	−0.749		
						(0.269)***	(0.275)***		
Period 90-94: 12. 3.5 Months						−0.552	−0.556		
						(0.317)*	(0.314)*		
Period 90-94: before RTLM								−0.219	−0.236
								(0.114)*	(0.117)**
Period 90-94: after RTLM								−0.827	−0.777
								(0.215)***	(0.205)***
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Additional Controls	no	no	no	no	no	no	yes	no	yes
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.55	0.55	0.56	0.56	0.56	0.56	0.57	0.56	0.57
N	1266	1266	1266	1266	1266	1266	1266	1266	1266

Notes: All of the regressors in this table capture the number of Saturdays with rainfall above 10 mm for different time periods. **Regressor 1** is the number of rainy Saturdays for the period January 1984 to September 1990. **Regressors 2 to 4** are the number of rainy Saturdays for the period January 1984 to September 1990 (split into three time intervals of equal length). **All the other regressors** are from the time period October 1990 to March 1994 (split into various different time intervals of equal length, i.e. 3, 6, 12, and before/after RTLM). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.8: Mechanism: Effects over Time – Opposition Sectors

Dependent variable:	# Civilian Perpetrators, p.H.				
	(1)	(2)	(3)	(4)	(5)
# Sat(Rainfall> 10 mm) - Pre-Political Umuganda Period					
Period 84-90: whole period	−0.644				
	(0.614)				
Period 84-90: 1. 27 Months		−1.435	−1.444	−1.445	−1.606
		(1.257)	(1.178)	(1.003)	(1.243)
Period 84-90: 2. 27 Months		−0.051	−0.204	−0.304	0.198
		(0.443)	(0.604)	(0.638)	(0.723)
Period 84-90: 3. 27 Months		−0.382	−0.586	−1.148	−1.119
		(0.691)	(0.861)	(1.005)	(1.155)
# Sat(Rainfall> 10 mm) - Political Umuganda Period					
Period 90-94: whole period			0.555		
			(0.952)		
Period 90-94: before RTLM				0.950	0.507
				(1.004)	(0.996)
Period 90-94: after RTLM				−1.472	−0.959
				(1.339)	(1.441)
Standard Controls	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes
Additional Controls	no	no	no	no	yes
Commune Effects	yes	yes	yes	yes	yes
R^2	0.36	0.36	0.37	0.38	0.41
N	161	161	161	161	161

Notes: All of the regressors in this table capture the number of Saturdays with rainfall above 10 mm for different time periods. **Regressor 1** is the number of rainy Saturdays for the period Janary 1984 to September 1990. **Regressors 2 to 4** are the number of rainy Saturdays for the period Janary 1984 to September 1990 (split into three time intervals of equal length). **All the other regressors** are from the time period October 1990 to March 1994 (split into various different time intervals of equal length, i.e. before/after RTLM). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.9: Mechanism: Effects over Time – Opposition Sectors (Alternative Thresholds)

Dependent variable:	# Civilian Perpetrators, p.H.											
	8 mm Threshold			9 mm Threshold			11 mm Threshold			12 mm Threshold		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
# Sat(Rainfall> x mm) - Pre-Political Umuganda Period												
Period 84-90: whole period												
Period 84-90: 1. 27 Months	−0.197	−0.011	0.520	−0.590	−0.383	−0.077	−0.756	−0.681	−0.533	−0.104	0.536	0.873
	(0.300)	(0.338)	(0.531)	(0.489)	(0.433)	(0.507)	(0.626)	(0.556)	(0.604)	(1.399)	(1.168)	(1.089)
Period 84-90: 2. 27 Months	−0.445	−0.568	−0.432	−0.034	−0.492	−0.732	−0.110	−0.021	0.172	−0.323	−0.315	−0.418
	(0.506)	(0.508)	(0.625)	(0.558)	(0.558)	(0.587)	(0.901)	(0.894)	(0.851)	(0.608)	(0.615)	(0.569)
Period 84-90: 3. 27 Months	−1.058	−1.222	−1.253	−0.689	−1.137	−1.726	−0.034	−0.210	−1.082	−0.110	−0.876	−0.886
	(0.668)	(0.758)	(0.839)	(0.651)	(0.615)*	(0.935)*	(0.791)	(0.726)	(1.330)	(0.598)	(0.492)*	(0.740)
# Sat(Rainfall> x mm) - Political Umuganda Period												
Period 90-94: whole period	0.613			0.907			0.301			1.186		
	(0.622)			(0.683)			(0.865)			(0.945)		
Period 90-94: before RTLM		1.027	1.021		1.682	1.754		1.014	1.013		2.340	1.961
		(0.782)	(0.732)		(0.621)**	(0.539)***		(0.818)	(0.937)		(0.967)**	(1.037)*
Period 90-94: after RTLM		−1.087	−1.001		−2.290	−2.837		−2.150	−2.781		−2.828	−3.371
		(0.965)	(0.916)		(1.131)*	(1.174)**		(1.132)*	(1.285)**		(1.689)	(1.836)*
Standard Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other Weekday Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Additional Controls	no	no	yes	no	no	yes	no	no	yes	no	no	yes
Commune Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.39	0.40	0.43	0.40	0.43	0.45	0.35	0.36	0.40	0.39	0.41	0.44
N	161	161	161	161	161	161	161	161	161	161	161	161

Notes: All of the regressors in this table capture the number of Saturdays with rainfall above *x* mm for different time periods. The threshold *x* is defined in the column header. **Regressor 1** is the number of rainy Saturdays for the period Janary 1984 to September 1990. **Regressors 2 to 4** are the number of rainy Saturdays for the period Janary 1984 to September 1990 (split into three time intervals of equal length). **All the other regressors** are from the time period October 1990 to March 1994 (split into various different time intervals of equal length, i.e. before/after RTLM). **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Other Weekday Controls** include the number of Sun/Mon/Tue/Wed/Thu/Fri with rainfall above 10 mm during the period October 1990 to March 1994. **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.

Table A.10: Interactions Effects between RTLM and Rainfall on Other Weekdays

Dependent Variable:	# Civilian Perpetrators, p.H.			
	(1)	(2)	(3)	(4)
# Sun-Fri(Rainfall>10 mm)	0.022	0.029		
	(0.054)	(0.059)		
... x RTLM Coverage	−0.009	−0.005		
	(0.009)	(0.009)		
# Sun-Fri(Rainfall>10 mm), before RTLM			0.022	0.015
			(0.065)	(0.072)
... x RTLM Coverage			−0.003	0.004
			(0.025)	(0.029)
# Sun-Fri(Rainfall>10 mm), after RTLM			0.032	0.090
			(0.113)	(0.128)
... x RTLM Coverage			−0.025	−0.032
			(0.071)	(0.086)
Standard Controls	yes	yes	yes	yes
Saturday Weekday Controls	yes	yes	yes	yes
Additional Controls	no	yes	no	yes
RTLM Controls	yes	yes	yes	yes
Commune Effects	yes	yes	yes	yes
R^2	0.49	0.50	0.49	0.50
N	1057	1057	1057	1057

Notes: **# Sun-Fri(Rainfall>10 mm)** is the number of weekdays (except for Saturdays) with rainfall above 10 mm during the period October 1990 to March 1994. **# of Sun-Fri(Rainfall>10 mm), before (after) RTLM** is the number of weekdays (except for Saturdays) with rainfall above 10 mm during the period October 1990 to June 1993 (July 1993 to March 1994). **RTLM Coverage** is the fraction of the sector that receives the RTLM signal. **# Civilian Perpetrators per Hutu (p.H)** is measured in percent. **Standard Controls** include Hutu population, average daily rainfall for January 1984 to September 1990 and average daily rainfall for October 1990 to March 1994. **Saturday Weekday Controls** are the number of Saturdays with rainfall above 10 mm during the period October 1990 to March 1994 (regressions 1 and 2) and the number of Saturdays with rainfall above 10 mm before and after RTLM (regressions 3 and 4). **Additional Controls** are sector ruggedness, Hutu population density, distance to Kigali, Nyanza, the border, the closest main road and the closest main city and town. **RTLM Controls** are distance to the closest RTLM transmitter as well as mean and variance of sector elevation. All regressions are run using weighted least squares (WLS) estimation with Hutu population size as weights. There are **142 communes** in the sample. **Standard errors** are clustered at the commune level. *significant at 10 percent, **significant at 5 percent, ***significant at 1 percent.