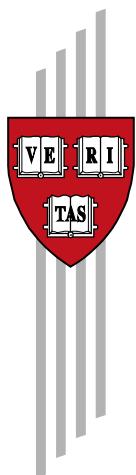


# **Maintaining Local Public Goods: Evidence from Rural Kenya**

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## **Maintaining Local Public Goods: Evidence from Rural Kenya**

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**Abstract:** Political Scientists have produced a substantial body of theory and evidence that explains variation in the availability of local public goods in developing countries. Existing research cannot explain variation in how these goods are maintained over time. I develop a theory that explains how the interactions between government and community institutions shape public goods maintenance. I test the implications of this theory using a qualitative case study and a randomized field experiment that assigns communities participating in a waste management program in rural Kenya to three different institutional arrangements. I find that localities with no formal punishments for littering experienced sustained reductions in littering behavior and increases in the frequency of public clean-ups. In contrast, communities in which government administrators or traditional leaders could punish littering experienced short-term reductions in littering behavior that were not sustained over time.

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## **Introduction**

The lack of local public goods is a pressing problem in many parts of the world.<sup>1</sup> Many development projects focus on building the infrastructure that is necessary to deliver public services to the poor, such as water and sanitation, roads, schools, and health facilities. Despite massive investments in public goods, the availability of many basic services is uneven and unsustainable in many communities (World Bank 2003). Massive investments in public goods have not necessarily lead to increased access to basic services for many of the poorest individuals in the world (Travis et al 2004; Clemens et al 2007).

Researchers in comparative politics and political economy have produced an array of theory and evidence attempting to explain variation in the availability of local public goods. This body of research can be divided into two subsets: one focused on government provision of public goods and one focused on collective action by community members. The first subset finds that variations in representative and bureaucratic institutions can explain patterns in public goods provision (Besley et al 2004; Wantchekon 2004; Olken 2010; Tsai 2007; Banerjee and Somanathan 2007; Min and Golden 2013). This research suggests that although principal-agent problems can prevent politicians and bureaucrats from providing public goods, outcomes can be improved through transparency reforms that allow voters to hold the government

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<sup>1</sup> Pure public goods are defined as goods that are typically underprovided by markets due to a combination of two defining characteristics: non-rivalry and non-excludability (Cornes and Sandler 1996; V. Ostrom and E. Ostrom 1999). Local public goods are typically defined as goods that are non-rival and non-excludable within a limited geographical area, but are subject to crowding or exclusion if individuals from outside that geographical area attempt to access the good (Cornes and Sandler 1996).

accountable and informal institutions that constrain the behavior of politicians and bureaucrats (Reinikka and Svensson 2005; Tsai 2007; Cleary 2007; Bjorkman and Svensson 2009; Baldwin and Huber 2010; Baldwin 2013; Pande 2011; Humphreys and Weinstein 2012; Diaz-Cayeros et al 2014).

The second branch of research on local public goods focuses on how community-level rules and norms make it possible for groups of individuals to overcome collective action problems (Ostrom 1990; Taylor and Singleton 1993). The literature generally finds that communities characterized by shared beliefs and dense social ties are able to overcome free-rider problems through decentralized monitoring and social sanctions (Miguel 2004; Miguel and Gugerty 2005; Habyarimana et al 2007; Habyarimana et al 2009; Khwaja 2009). A related body of research has studied the creation of participatory institutions for implementing donor- and government-funded local development projects, finding little evidence that such interventions have a sustained effect on creating new social norms and networks that promote ongoing collective action (Fearon et al 2009; Miguel et al 2012; Mansuri and Rao 2012; Beath et al 2013).

Despite the theoretical and empirical contributions of both streams of research on local public goods, this research cannot explain patterns in public goods maintenance over time. Existing research on local public goods focuses almost exclusively on explaining whether or not public goods are provided. What this focus overlooks is that in many cases where public goods are provided, there is often variation in the extent to which these goods are maintained over time (Shanley and Grossman 2007; Khwaja

2009; Ostrom and Lam 2010). In some localities, the schools, health centers, and roads are successfully maintained for decades after they are created, while in others, they are dilapidated and unusable within years or months. Why are some communities able to maintain the viability of local public goods over time, while others are unable to do so?

In this paper, I develop a novel theoretical approach to public goods maintenance. The theory yields two testable predictions: 1) variations in patterns of public goods maintenance can be explained by the extent to which government and community institutions motivate ongoing provision of the good and prevent actions that harm it, and 2) cases in which the content of government and community institutions are in conflict with each other will lead to problems with maintaining local public goods over time.

I test these observable implications using data from a mixed-methods case study of solid waste management in the Laikipia region of rural Kenya. In this case study, I used in-depth qualitative research as the basis for a randomized field experiment that randomly assigned communities participating in a waste management program to three different institutional arrangements: 1) mobilization of collective action by community groups to clean up trash over time; 2) collective action plus implementation of a littering punishment by government chiefs; 3) collective action plus implementation of a littering punishment by traditional elders.

The major findings from the field experiment are consistent with the predictions of my theory of public goods maintenance. First, the evidence indicates divergences in

the patterns of public waste between the three treatment groups, with trash levels dropping much more quickly in localities in which littering was punished by either government or community leaders compared to localities in which there was no formal punishment for littering. Second, localities in which there was no explicit punishment for littering experienced more sustained reductions in littering behavior versus localities in which government administrators or traditional leaders could punish littering. Survey evidence indicates that this difference is driven in part by fewer instances of community clean-ups in localities assigned to one of the two treatment groups in which littering is punished.

The paper proceeds as follows. In the next section, I outline a theory of public goods maintenance and articulate two testable hypotheses. I then outline the design and implementation of the waste management field experiment, detailing the experimental design, data, and empirical strategy. I then present the results of the experiment, using two types of outcome measures: 1) systematic observations of public waste levels and littering behavior and 2) a survey on attitudes and behavior related to public waste and littering. I conclude by discussing the relationship between the experimental findings and the theory developed in this paper, as well as the broader implications of this study.

## **Theory and Hypotheses**

For the purpose of developing a theory of public goods maintenance, I focus on a hypothetical situation in which there are two kinds of public goods providers: a government and a community (Ostrom 1996; Joshi and Moore 2004; Lieberman 2011).

I also focus only on a subset of local public goods that can be both degraded and replenished over time. In the context of local public goods, degradation refers to a decrease in the quality or quantity of a good over time, either through interaction with the natural environment or through the actions of individuals using the good. While some degradation of a public good may be a result of wear and tear through normal usage, the rate of degradation can be increased or decreased by frequency of harmful action, in which individuals use a public good in a way that reduces its availability to others.

Replenishment of a local public good refers to the replacement or restoration of a good that has been consumed, congested, or degraded. Ability to replenish a good is the main distinction that separates the maintenance problems associated with degradable local public goods from common pool resource problems. Although both types of good can be degraded by the actions of users, the major distinction is that common pool resources cannot be replenished, at least over the short term (Ostrom 1990). As a result, the types of potential solutions to the problem of maintenance vary between replenishable local public goods and common pool resources. In the common pool resources situation, the difficulty of replenishment means that creating institutions to prevent harmful actions is the only way to ensure the maintenance of the resource over time (Ostrom 1990). In contrast, replenishable local public goods can be maintained by a mix of harm prevention and repeated provision.

Diverse combinations of government and community institutions shape the ability of governments and communities to prevent harmful actions and motivate repeated provision of local public goods. Building on the assumption that local public goods can be provided and maintained by some combination of government and community action, Figure 1 presents the four broad types of government and community institutions that can play a role with respect to solving public goods maintenance problems: government accountability institutions, government law enforcement institutions, collective action institutions, and community governance institutions. Each of these types of institutions is the subject of a well-developed and robust literature in political science and several related disciplines.<sup>2</sup>

<Figure 1 About Here>

The literature on institutions and public goods synthesized in Figure 1 can be summarized by the following testable hypothesis:

**Hypothesis 1:** Patterns in public goods maintenance are caused by the presence or absence of government and/or community institutions that prevent harmful action and motivate repeated provision. In particular:

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<sup>2</sup> Each of these literatures is too large to fully review here. On Government Accountability Institutions, see World Bank 2003, Persson and Tabellini 2005, and Golden and Min 2013. On Government Law Enforcement Institutions, see Herbst 2000 and Boone 2003. On Collective Action Institutions see Singleton and Taylor 1992, Ostrom 2000, Miguel and Gugerty 2005, and Habyarimana et al 2007. On Community Governance Institutions, see Ostrom 1990 and Agrawal 2001.

**Hypothesis 1a:** Localities in which government or community institutions neither provide a local public good nor prevent harmful actions will be characterized by low availability of the public good.

**Hypothesis 1b:** Localities in which government or community institutions provide a public good, but do not prevent harmful actions, will be characterized by cycles of degradation and restoration of local public goods.

**Hypothesis 1c:** Localities in which government or community institutions prevent harmful actions, but do not repeatedly provide local public goods, will be characterized by short-term maintenance but gradual degradation.

**Hypothesis 1d:** Localities in which government or community institutions both repeatedly provide a public good and prevent a harmful action will be characterized by long-term, stable availability of the local public good.

Although the existing bodies of research on institutions and public goods do not explicitly theorize how interactions between government and community institutions can shape various dimensions of the public goods maintenance problem, a related literature on power can help to explain how institutions and public goods outcomes shape each other over time (Barnett and Duvall 2005; Moe 2005).<sup>3</sup>

I focus on two types of power that shape the interaction between institutions and public goods maintenance. The first form of power is material, and stems from the

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<sup>3</sup> In this literature, power is defined as the ability of one person or organization to get another person or organization to do something that they would not otherwise do (Dahl 1957).

ability of one actor to affect the physical well-being of another actor, either through the use of force or the imposition of economic incentives or sanctions (Dahl 1957; Gaventa 1982). The other category of power is cultural, rather than material. This form of power is rooted in the ability to define categories of people, to categorize actions as appropriate or inappropriate, and to define the categories of social action as acceptable or unthinkable in the first place (March and Olsen 1996; Barnett and Duvall 2005; Wedeen 2002).

Rather than operating in isolation, material and cultural power often have an interactive effect on the design and evolution of institutions, and can shape their effectiveness over time (Laitin 1986; Scott 1998). If compliance with institutions depends in part on the extent to which an individual has internalized the rule or norm's prescriptive content, the link between hegemonic discourse and material bargaining power can substantially impact both the short-term and long-term effectiveness of a given institution (Levi 1989; Levi et al 2009; March and Olsen 1996; Ostrom 2005; Wedeen 2002).

This perspective can explain the fragility and unintended consequences frequently associated with many local public goods interventions, particularly those that originate from governments and international donors in developing countries (Ferguson 1990; Scott 1998). The difference in material power between governments or donors and local communities means that the powerful actor's favored set of institutions will be used to deliver or maintain a given public good (Evans 2005; Mansuri and Rao 2012).

The normative content of these institutions will be shaped by the culturally inscribed understandings of what constitutes "good behavior" and "good outcomes" employed by the powerful actor. Because attempts to create new institutions rarely take place in a vacuum, these precepts are often imposed onto the set of local norms and rules surrounding the use of a given public good or set of public goods (Ndegwa 1997).

Integrating the concept of power into the theory of institutions and public goods maintenance yields a second testable prediction:

**Hypothesis 2:** Patterns of harmful action and public goods replenishment are shaped by the normative content of government and/or community institutions that are linked to public goods maintenance. In particular,

**Hypothesis 2a:** A normative match between institutions maintaining a local public good will increase the effectiveness of both institutions over the long term, leading to low levels of harmful action and high levels of repeated provision.

**Hypothesis 2b:** A normative mismatch between institutions maintaining a local public good can reduce the effectiveness of both institutions over the long term, leading to high levels of harmful action and low levels of repeated provision.

## **Research Design**

### *Case Selection*

To test the observable implications of the theory of public goods maintenance developed in this paper, I conducted an in-depth, mixed-methods case study of solid waste management in the Laikipia region of Kenya from 2006 to 2010. This case study

is comprised of two distinct types of evidence: 1) a qualitative mapping of the institutions that shape public goods maintenance in the region, and 2) a randomized field experiment in which I assigned communities to three different combinations of government and community institutions designed to maintain the solid waste management program over time.

I selected Kenya as the setting for testing my theory of public goods maintenance because it has a large number of both government and community institutions that may potentially be harnessed to prevent harmful actions and ensure continued provision of local public goods (Ensminger 1990; Ndegwa 1997). I chose Laikipia as my study site within Kenya for similar reasons. Laikipia is located in the ecological and cultural frontier zone between the agricultural regions of central Kenya and the semi-arid northern region of the country. While central Kenya is typically characterized by public goods maintenance by government institutions and northern Kenya is characterized by greater reliance on community governance institutions, Laikipia's location straddling these two regions makes it an ideal location for assessing how interactions between government and community institutions shape public goods maintenance.<sup>4</sup>

Finally, I chose solid waste management in Laikipia's rural town centers as the local public good that would be the main focus of my mixed-methods case study. These centers, which are aggregations of small shops, cafes, and both short and long-term

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<sup>4</sup> On social change and state building in central Kenya, see Bates 2005. On community governance in northern Kenya, see Spencer 1998. On Laikipia's cultural and political diversity and fluidity, see Lawrence 1968, Cronk 2004, Jennings 2005, and Hughes 2006.

lodgings, form the backbone for economic exchange in Laikipia and throughout rural Kenya. At the time of the initial qualitative research in 2006 and 2007, litter and waste were highly visible in rural centers throughout Laikipia (Field Notes, July 2006; February-March 2007). Solid waste management can be provided through clean-ups and the provision of trash cans, while littering is the harmful action that degrades the local public good of cleanliness within the center.

#### *Qualitative Findings: Institutions and Waste Management in Laikipia*

The qualitative research reveals three important aspects of institutions and solid waste management in Laikipia.<sup>5</sup> First, I find that the elected local government in the region - the Laikipia County Council- was formally allocated responsibility to collect trash and provide waste management infrastructure throughout the region, but that its actual performance in providing these services was limited and insufficient. At the time of the qualitative research, the Laikipia County Council had no waste management presence in many centers (Field Notes, April 2007). In many other centers, it hired one employee to collect trash in the center. The conventional wisdom among residents of Laikipia was that these limited services were concentrated in county council representatives' home centers, and that the trash collection employee was typically a relative or friend of the councilor (Field Notes, Interviews, and Focus Groups, May-June 2007).

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<sup>5</sup> In the discussion that follows, I cite to aggregate field notes and interviews to protect the anonymity of individual respondents. I provide more information on the qualitative data collection and respondents in the supplemental materials that are available online.

Second, I found that local civil society organizations - community-based organizations (CBOs), local nongovernmental organizations (NGOs), and religious organizations - were the primary community institutions involved in organizing clean-ups. These organizations would organize occasional center cleanups, mobilizing their members and residents of the town center to collect and burn trash (Field Notes and Interviews, March 2007). In some cases these cleanups were motivated by national holidays or visits by dignitaries (Field Notes, June 2007). In other cases, civil society groups organized clean-ups as a way to energize their membership and build their reputation within the local community (Interview, March 2007). These clean-ups were typically ad hoc mobilizations, rather than deliberate attempts to create a solid waste management system or to change waste disposal behavior. Local civil society organizations typically lacked the financial resources to provide public trash cans or other types of physical infrastructure (Field Notes, April-May 2007).

Third, I was able to identify both government and community institutions that were involved in preventing actions that harm local public goods throughout Laikipia. Government chiefs are the most important government law enforcement institution that I identified in rural Laikipia. In Kenya, government chiefs are residents of a locality who are hired as administrators by the central government, and who are authorized to implement government policies at the grassroots level (Field Notes and Interviews, July 2006 and February 2007). Government chiefs are also authorized to create and enforce bylaws regarding public order in their locality (Field Notes and Interviews, February-

March 2007). Although waste management falls within the set of roles that chiefs can undertake, none of the chiefs in Laikipia were regularly engaged in punishing littering (Field Notes and Interviews, June and September 2007).

Community elders are the most important community governance institution that I identified in rural Laikipia. Community elders are the members of the oldest living age set in a given locality or clan (Field Notes and Interviews, February-March 2007).<sup>6</sup> In contrast to chiefs, who are able to act unilaterally in the name of the government, elders create and enforce rules by negotiation and consensus in their collective role as senior members of the community (Spencer 1965; Ensminger 1990). Elders typically create and enforce rules related to the management of grazing land, migration, marriage, and security (Field Notes and Interviews, February-March 2007). Although some elders reported creating rules regarding waste disposal within their own households, these interviewees reported that community elders were not typically involved in collectively punishing littering behavior (Field Notes and Interviews June and September 2007).

#### *Field Experiment Design<sup>7</sup>*

Drawing on these three elements of the qualitative findings, I worked with my Kenyan research team to create a new local NGO called the SAFI Project.<sup>8</sup> The main

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<sup>6</sup> Age sets are generational cohorts created by circumcision. Age sets formed the backbone for social, political, and military organization for many pre-colonial East African communities. For a general overview of age sets and elders in Africa, see Eisenstadt 1954 and Spencer 1998. On age sets and elders in the communities that live in Laikipia, see Spencer 1965 on the Samburu, Lambert 1956 and Lawren 1968 on the Kikuyu, and Cronk 2004 on the Mukogodo and Maasai.

<sup>7</sup> Detailed experimental protocols are available in the supplemental materials that are available online.

public goods provided by SAFI's waste management program were two weeks of education and mobilization campaigns regarding the health and environmental problems associated with public waste, the organization of a community clean-up day in the center, and the provision of physical waste management infrastructure in the form of public trash cans and trash pits.<sup>9</sup>

To test my theory of public goods maintenance, I worked with SAFI's staff to design and implement a randomized field experiment. Drawing on the qualitative analysis, I identified three institutional building blocks which both had potential to be harnessed for maintaining trash projects: 1) provision of clean-ups through CBOs and local NGOs, 2) punishment of littering by Government Chiefs, and 3) punishment of littering by Community Elders.

In order to test my hypotheses about public goods maintenance, I combined these elements into three treatment groups and a control group (Figure 2). I included the control group to replicate the status quo of having no institutions devoted to repeated provision of solid waste management or punishment of littering behavior. As a result, control group centers received no SAFI Project program, mobilization, or education.

Within the first treatment group, CBOs and local NGOs were encouraged to organize clean-ups, creating a local institutional context in which repeated provision of

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<sup>8</sup> SAFI stands for Sanitation Activities Fostering Infrastructure. SAFI also means cleanliness in Swahili, one of Kenya's two official languages.

<sup>9</sup> SAFI provided 10 public trash cans and 5 trash pits to each center in which it worked.

sanitation is attained through collective action, but in which government or community institutions do not explicitly prevent harmful action. To implement this treatment, SAFI staff held a planning meeting bringing together the members of the town center's major civil society groups as well as the rest of the citizens living in and around the center.

Each civil society group was asked to nominate 1-2 members of their organization to serve on their center's trash committee. The responsibilities of the trash committee in this "Collective Action" group were to organize semi-regular cleanups of the center, to empty the trash cans into the pits, to encourage the community living around the center not to litter, and to ensure that no one stole the trash cans.

<Figure 2 About Here>

In the second treatment group, local government officials were encouraged to create a rule to prevent the harmful action of littering. Program coordinators added an explicit bylaw against littering to the structure of the SAFI Project Community Waste Management Program agreement. When chiefs assigned to this treatment group signed the agreement allowing SAFI to work in the town center in their jurisdiction, they agreed to formally create and enforce that rule.

At the onset of the program rollout, none of the chiefs in the Laikipia region had exercised their authority to make rules regarding littering. This allowed the SAFI staff to create a situation in which centers assigned to the Collective Action treatment would have a waste disposal program, but no anti-littering rules, whereas centers assigned to the "Chief" treatment would have a waste-disposal program and an anti-littering rule

enforced by the local government administrator. The punishment for littering agreed upon by the implementation team was a day of labor on community projects for the first infraction and a fine of 500 Kenyan Shillings (approximately \$6.00) for the second. The punishment for stealing a trash can was a fine of 1800 Kenyan Shillings (approximately \$20).

In final treatment group, community elders were encouraged to enforce an anti-littering rule. Centers receiving this treatment have a full waste management program, as in the other two treatment groups; however, in this “Elders” treatment, elders from the community or communities surrounding the center have authority to enforce the anti-littering rule and punishments. Like the Chief treatment, this treatment was implemented with the permission and assistance of the local chief.

When introducing the Elders treatment to the chief, the SAFI coordinator asked the chief to create an anti-littering rule, and to delegate the authority to enforce that rule to the elders in the surrounding community. The coordinator then asked the chief to introduce him to the elders in each of the ethnic communities living in the area around the center. The elders from each ethnic community were asked to nominate a representative to serve on the center waste disposal committee alongside the representatives of the civil society groups based in the center. The coordinator then interviewed a selection of individuals living in and around the center to confirm that the elders identified by the chief were in fact active in dispute resolution and the enforcement of locally created rules.

Figures 3 and 4 summarize the linkage between the theory of public goods maintenance and the three treatment groups that SAFI implemented. In the context of waste management in Laikipia, Hypothesis 1 can be translated to the prediction that the centers in the treatment group with no treatment or with collective action only will have more trash on the ground compared to centers in either of the treatment groups with the anti-littering rule.<sup>10</sup> The finding that there are no differences between the control group or the treatment group in which there is no punishment for littering and the two treatment groups in which littering is punished would serve as evidence against the hypothesis that patterns of public goods maintenance are jointly shaped by institutions that motivate repeated provision and prevent harmful action.

<Figure 3 About Here>

Linking Hypothesis 2 to Laikipia's institutional context is more difficult, because this hypothesis predicts that the effectiveness of public goods maintenance over time depends on the match between the normative content of the government and community institutions that maintain public goods in a given locality. Both the qualitative evidence summarized above and the broader secondary literature on Kenya indicate that any of the three treatment groups could be considered to be in line with local social norms.<sup>11</sup> As a result, it is equally plausible to make the prediction that any of

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<sup>10</sup> Due to sample size restrictions, it was not possible to include a fourth treatment group to test Hypothesis 1c, which makes predictions about public goods maintenance outcomes in localities in which institutions prevent harmful action but do not repeatedly provide public goods.

<sup>11</sup> On the legitimacy of provision of public goods through collective action in Kenya, see Miguel and Gugerty 2005 and Gugerty and Kremer 2008. On the legitimacy of combining collective action and state

the three treatment groups will lead to stronger long-term performance compared to other treatments.

Given the ex ante uncertainty of the match between each treatment group and local social norms, the design of the experiment makes it possible to test observable implications based on three additional assumptions. The implication of these additional assumptions is that if collective action alone is more locally legitimate than collective action combined with government or community punishment, over the long term we would expect the first treatment group to outperform the other two, both with respect to littering behavior and the frequency of clean-ups. The same logic holds for the alternative assumptions about the legitimacy of the other treatment groups. The finding that there are no long-term differences between the three treatments with respect to long-term patterns of clean-ups and littering behavior would serve as evidence against the hypothesis that the normative content of government and community institutions has an impact on long-term patterns of public goods maintenance.

<Figure 4 About Here>

To implement the field experiment, I divided Laikipia into six regional blocks. Three of these regional blocks were located in Laikipia East District, two were in Laikipia West District, and one was located in Laikipia North District. Each region contained six centers, for a total sample of 36 centers.

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administrative institutions, see Brass 2012. On the legitimacy of combining collective action and elders, see Ensminger 1990 and Lesorogol 2005.

I utilized a cross-sectional time-series experimental design, randomly assigning centers to two different parts of the SAFI Project program: 1) one of the three treatment groups or the control group and 2) one of six different program implementation periods (Simonton 1977; Allison 1994). In each block, one center was randomly assigned to each of the three treatment groups and the remaining 3 centers in the block were assigned to the control group. I then randomly assigned each of the regional blocks to one of six implementation periods (Bruhn and McKenzie 2009). The SAFI Project team rolled out the program in the 18 treatment centers over the course of six consecutive two-week periods separated by one week of break, creating a full implementation period of 18 weeks.<sup>12</sup>

#### *Data<sup>13</sup>*

In order to analyze the effect of each of the three treatments described above on the availability of sanitation and the prevention of littering, I devised measures of these two concepts based on both structured qualitative observations of environmental conditions and behavior and a survey of related attitudes and behaviors.

The amount of trash on the ground is measured using techniques originally developed in the field of community waste management (Galli and Corish 1998). For the purpose of this analysis, we selected five 3 x 2 meter plots in each of the 36 centers in the sample. The research team selected plots that varied with respect to proximity to

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<sup>12</sup> Information on the random assignment of centers to treatment groups and of regional blocks to implementation periods is available in the online supplemental materials.

<sup>13</sup> All data and code for used for analysis will be made available online at The Dataverse Network (<http://thedata.org>) upon publication.

shops, roads, and dumping sites. In each center, the project staff trained a local enumerator to count all of the trash in each of the five plots once per week and to record the number of pieces of plastic, food, and other types of waste in a notebook. In the analyses that follow, I use a measure of *Trash Count*, which is the weekly average of the number of pieces of trash in each of the five count zones.

To measure littering behavior, enumerators in each center collected observational data on the waste-disposal decisions of individuals. The project staff trained an enumerator to sit in an inconspicuous but central location in each center and record what happened each time they saw someone with a piece of trash in his or her hand. The enumerator recorded the result of each “littering opportunity” (dropped on ground, kept in hand, put in trash can or pit) on a small scrap of paper and then transferred the records to a notebook at her home. Each enumerator was instructed to sit and record observations for one hour per week. In the analyses that follow, I use a measure of *Proportion Littering*. I created this measure by dividing the number of individuals observed dropping a piece of trash on the ground by the total number of littering opportunities, producing a decimal between 0 and 1.<sup>14</sup>

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<sup>14</sup> In one center, spot checks by SAFI staff revealed that the enumerator in one center falsified trash count and littering data for 13 weeks. This enumerator was dismissed, and the data from the weeks under suspicion are omitted from the analyses below. The falsified data were used to identify other possible instances of enumerator malfeasance, resulting in the identification of 121 problematic center-week observations in the trash count dataset and 82 problematic observations in the littering behavior dataset. These observations are also omitted from the analyses below. More information on the omitted observations is available in the online supplemental materials, along with robustness checks including all problematic observations.

I supplement these structured observations with an individual-level survey on attitudes and behavior towards trash and littering<sup>15</sup>. The survey was administered over the course of 4 weeks in August 2009 (18 months after the end of the last round of implementation) to 30 individuals in each of the 36 centers included in the SAFI Project experiment. Given that the population of interest in this survey is people who could potentially litter or engage in public cleanups in each of the 36 centers in the control or treatment groups in the experiment, I decided to interview people as they moved through the center, rather than at their homes.

Following the precedent of surveys of mobile, hard-to-enumerate populations, the sampling strategy depended on using spatial-temporal clusters as sampling units and randomly selecting interviewees from the people who passed through the observation area during the given time period (Sudman 1980; Kanouse et al 1999). In each center, I chose three different observation areas within the center. In addition, each day was divided into two time periods: Early (10 AM-Noon) and Late (4 PM to 6 PM). Stratifying by day of the week, two observation area/time of day clusters were selected on each of three days in a given week, for a total of 6 observation areas/time slots in each center.

In each selected day/time slot, the survey enumerator recorded the outcome of each littering opportunity within the sampled observation and time period, just as in the existing littering behavior observation protocol. From each list of littering opportunities

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<sup>15</sup> The full survey questionnaire, in English and Swahili, is included in the supplemental materials that are available online.

observed in a given counting area/time slot, the enumerator chose a random start point, then selected interviewees' names off of the list based on a predetermined sampling interval. Each enumerator interviewed 5 individuals per enumeration period.<sup>16</sup>

After the enumerator selected the four potential interviewees in this manner, he/she then located each of them within the center (or at home if they had left the center). The enumerators were trained to find each of the selected individuals within 2 hours of the counting period, as trips to the center by people living in the periphery typically last about 3-4 hours. In the event that the individual could not be found within the specified time period, the enumerator continued to search for them until they found them. If they could not find them in the center by the end of the day, they were instructed to interview them at home. Finding respondents at their homes was not difficult, as the location of residence is relatively well known for most individuals living in or near each center.

Table 1 presents the descriptive statistics of the pre-treatment measures of Trash Count and Littering Behavior, along with individual-level covariates that will be included in the analyses of the survey data. Column 1 presents the summary statistics for the full sample; Columns 2 - 5 present summary statistics for the control group and the three treatment groups.

Columns 6 and 7 present the likelihood ratio and *p*-value of a balance check conducted using a likelihood-ratio test (Gerber and Green 2012). Gender is the only

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<sup>16</sup> The sampling interval for each center was based on the average number of Littering Opportunities observed in that center during August of the previous year.

covariate that is not balanced between the randomly assigned treatment groups. The proportion of surveyed individuals for women is significantly higher in the three treatment groups, as compared to the control group.

<Table 1 About Here>

### *Empirical Strategy*

For the measures of trash counts and littering behavior, the cross-sectional time-series (CSTS) nature of the experiment presents both opportunities and challenges. The weekly measurement of outcomes increases the total number of observations. Combined with the random assignment of centers to both treatment status and implementation wave, this increases the statistical power of the experiment (Green et al 2009). At the same time, utilizing cross-sectional time series data is rare within the literature on field experiments in political science and development economics, and the methodological literature on the use of observational CSTS data highlights a number of challenges associated with using such data. In particular, CSTS data are subject to problems of serial autocorrelation and unobserved heterogeneity from pooling cross-sectional and time-series data (Simonton 1977; Allison 1994; Beck and Katz 1995; Green et al 2001).

As an attempt to balance the unique advantages and disadvantages of conducting a cross-sectional time-series randomized field experiment, the primary empirical strategy used in this case is to normalize each weekly observation for each center with respect to the timing of the treatment implementation. This process involves three steps. First, each center's time-series is normalized to the week of implementation in

that center's region, producing a variable called *Treatment Time*. For each region, Treatment Time is equal to 0 in the week in which the program was implemented in the treatment centers in that region. Weeks before treatment implementation are denoted by negative values of Treatment Time, while post-treatment weeks are denoted by positive values. Since the staggered roll-out means that each region has a different number of observations before and after treatment, the analysis of this data is limited to the number of weeks in which data was collected before the first roll-out group (all observations in which treatment time is greater than or equal to 9) and the number of weeks in which data was collected after the last roll-out group (all observations in which treatment time is less than or equal to 95).

Second, for the purposes of the analyses in this paper, I collapse the post-treatment observations into three 32-week periods by averaging the weekly outcome measures for each center over the given period. The three post-treatment periods are defined as follows: *Short-Term* is all weeks where treatment time is greater than or equal to 0 and less than or equal to 31. *Medium-Term* is all weeks where treatment time is greater than or equal to 32 and less than or equal to 65. *Long-Term* is all weeks where treatment time is greater than equal to 66 and less than or equal to 95. In addition, all weeks where treatment time is less than zero and greater than -9 are coded as part of the *Before Treatment* period.

I analyze the effect of the three treatments on trash count and littering behavior measures using both cross-sectional regressions and difference-in-differences models.<sup>17</sup> For the cross-sectional regressions, I estimate the following equation by Ordinary Least Squares:

$$y_c = \beta_0 + \beta_1 T_c^E + \beta_2 T_c^C + \beta_3 T_c^{CA} + R'_c \Gamma + \varepsilon_c$$

where  $T_c^E$ ,  $T_c^C$ , and  $T_c^{CA}$  are dummy variables coded 1 if the center received the Elders, Chief, or Collective Action treatment,  $R_c$  is a fixed effect for regional blocks, and  $\varepsilon_c$  is an error term.

For the difference-in-differences models, I estimate the following equation:

$$y_{ct} = \beta_0 + \beta_1 P_{ct} + \beta_2 T_{ct}^E + \beta_3 T_{ct}^E * P_{ct} + \beta_4 T_{ct}^C + \beta_5 T_{ct}^C * P_{ct} + \beta_6 T_{ct}^{CA} + \beta_7 T_{ct}^{CA} * P_{ct} + R'_{ct} \Gamma + \varepsilon_{ct}$$

where the treatment group dummy variables, regional block fixed effect, and error term are denoted as they are above,  $P_{ct}$  is a dummy variable coded 1 for the post-treatment time period, and  $T_{ct} * P_{ct}$  is a dummy variable coded 1 for a center in a treatment group in the post-treatment time period. In this model,  $\beta_3$ ,  $\beta_5$ , and  $\beta_7$  are the coefficients of interest for each of the three treatment groups.

I analyze the survey data by first recoding survey questions that are based on ordinal scales into dichotomous variables. I then estimate a linear probability model using Ordinary Least Squares.<sup>18</sup> I estimate the following equation:

<sup>17</sup> Wald post-estimation tests are used to test the differences between coefficients in both models (Maddala 1992).

<sup>18</sup> Alternative analyses of the survey data using logit models are available in the supplemental materials.

$$y_{ic} = \beta_0 + \beta_1 T_c^E + \beta_2 T_c^C + \beta_3 T_c^{CA} + S'_{ic} \Sigma + R'_c \Gamma + \varepsilon_{ic}$$

where the treatment group dummy variables, regional block fixed effect, and error term are denoted as they are above, and  $S_{ic}$  is a vector of individual-level covariates. The covariates measure a variety of individual characteristics that may influence their attitudes and behavior towards trash and littering. The covariates included in the individual-level analyses are *Age* and *Number of Visits* and dummy variables for *Gender*, *Education Level (Primary, Secondary, and Post-Secondary)*, *Distance from Center (Less than 1 KM, 1 to 5 KM, 5-10 KM, and More than 10 KM)*, *Pastoralist Tribe*. Because centers were the units that were assigned to treatment, I utilize cluster robust standard errors at the center level (Bloom 2005).

## Results

### *Trash Accumulation*

In the cross-sectional regression, the effect of the Elders and Chief treatments on the trash count measure are statistically significant in all three post-treatment periods, while the effect of the Collective Action treatment is only significant in the Medium-Term and Long-Term (Table 2).<sup>19</sup> The amount of trash on the ground decreased immediately in the two treatment groups in which the chiefs and elders were involved in punishing littering, but it appears to have taken several months to reach the same level

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<sup>19</sup> Robustness checks using the full time-series with panel analysis models are available in the online supplemental materials.

in the treatment group in which there is collective action with no punishment for littering.

<Table 2 About Here>

The results for the difference-in-differences model are slightly different from the cross-sectional regressions (Table 3). In particular, the difference-in-differences estimator for the Collective Action treatment is not significant in any of the three time periods. The coefficient for the Elders treatment is only significant in the second and third periods, and the estimator for the Chief treatment is the only one that is significant in all three periods. In both sets of regressions, none of the differences between the coefficients of interest for the three treatment groups are statistically significant.

<Table 3 About Here>

These results provide support for Hypothesis 1. The cross-sectional and difference-in-differences models both indicate that the patterns of trash accumulation in the Collective Action treatment group are different from the patterns in the Chief and Elders groups. This supports the core theoretical argument that patterns of trash accumulation over time can be explained in part by the ways in which institutions that prevent harmful action interact with institutions that encourage repeated provision of the public good.

### *Littering Behavior*

In the cross-sectional analysis for the Short-Term, all three treatments have a large and significant effect on reducing the proportion of individuals observed littering

(Table 4). Each of the three treatments are associated with differences in littering behavior of between 42 and 48.4 percentage points relative to the control group, and the differences between the coefficients for the three treatment groups are not statistically significant. However, the Collective Action group is the only treatment in which the effect on littering behavior remains substantively large and statistically significant in the regressions for the Medium-Term and Long-Term. In these periods, this treatment is associated with treatment effects of 23 percentage points and 21.4 percentage points, respectively.

<Table 4 About Here>

The effect of the Elders treatment on littering behavior is also statistically significant in the Medium-Term, even though the point estimate is reduced to 12.6 percentage points, but by the Long-Term the point estimate is further reduced to 5.4 percentage points and is no longer statistically significant. The Long-Term difference in the size of the coefficients between the Collective Action treatment group and the Elders treatment group is statistically significant. In contrast, the size and significance of the coefficient of the Chief treatment disappears in both the Medium-Term and Long-Term, reducing to 7.52 percentage points and 5.48 percentage points, respectively. The difference in the size of the treatment effect between the Collective Action treatment group and the Chief treatment group is significant in the second and third periods.

The results of the difference-in-differences models are consistent with the cross-sectional regressions (Table 5). In the short-term, the treatment effects sizes for all three

groups are substantively large and statistically significant, while only the coefficient for the Collective Action group is significant in the Medium-Term and Long-Term regressions. The difference between the Collective Action treatment and Chief treatment is statistically significant in both the second and third periods, and the difference between the Collective Action treatment and the Elders treatment is significant in the third period.

<Table 5 About Here>

These results indicate that there are differences in the ability of each of the three treatment groups to induce long-term behavioral change. This provides support for the version of Hypothesis 2 that assumes that collective action by community groups is the best match with local social norms. In particular, the statistical evidence supports the conclusion that while all three of the treatment groups lead to a reduction in littering behavior in the short-term, this effect is only sustained over the long-term in the Collective Action treatment group. By approximately a year after the implementation of the waste management program, any discernible effect of the SAFI Project intervention on littering behavior has disappeared in centers in which SAFI project staff encouraged chiefs or elders to punish littering.

#### *Attitudes and Behavior Toward Trash, Littering, and Clean-ups*

Table 6 shows the effect of treatment on individuals' answers to questions about trash and littering behavior. Column 1 shows that only the Collective Action treatment has a significant positive impact on individuals stating that trash was a major problem

in their center. Living in a center assigned to receive the Collective Action treatment increases the likelihood that an individual assesses trash to be a problem by 3.8%.

<Table 6 About Here>

Column 2 of Table 6 indicates that individuals who live in centers that were randomly assigned to the Collective Action treatment group were 14.2% less likely to report littering as compared to individuals living in centers assigned to the control group. Column 3 indicates that none of the treatment group dummy variables have a significant effect on the match between their reported and observed littering behavior. Although individuals in the Collective Action were significantly less likely to report littering compared to individuals in other groups, they were actually no less likely to litter when observed by the survey enumerator.

The significant effect of the Collective Action treatment on perception of trash as a problem and self-reported littering results indicates that this treatment may have resulted in the creation of shared social norms against littering behavior. In contrast, encouraging chiefs or elders to punish littering behavior may have failed to lead to the creation of a new social norm against littering, which inhibited sustainable changes in littering behavior.

<Table 7 About Here>

The survey questions about participation in trash clean-ups and frequency of clean-ups are useful in assessing the validity of this interpretation. Table 7 shows the results of the regressions for three measures of public clean-ups: willingness to

participate in a hypothetical clean-up, self-reported participation in previous cleanups, and frequency of clean-ups. The most consistent result that emerges from these three models is the relationship between the Collective Action treatment group and self-reported participation in and frequency of public trash clean-ups. Column 1 shows that all three treatments increased the probability that individuals reported willingness to participate in a hypothetical cleanup in their center. However, compared to individuals in the control group, individuals in the Collective Action treatment group were 25 % more likely to report having actually participated in a cleanup themselves and reported on average two more trash cleanups per month, all else held equal. Individuals in the Chief treatment group reported almost one more cleanup per month, relative to the control group.

Table 8 presents the effects of the three treatment groups on self-reported social sanctioning and reporting behavior. This table shows the effect of treatment assignment on individuals' self-reported willingness to take action when they see someone littering in the center, either by means of verbally scolding or warning the person (Column 1) or reporting the incident to someone else (Column 2). The results in Column 1 reveal that only the Chief treatment has a significant effect on the likelihood of individuals reporting that they scold others for littering. The results in Column 2 indicate that the Collective Action treatment has a statistically significant effect on the probability that individuals report telling someone else about littering behavior.

<Table 8 About Here>

Taken together, the survey results show that of the three treatments, only the Collective Action treatment had significant effects on the broad cross-section of self-reported attitudes and behaviors regarding trash and littering. These findings support the interpretation that collective action by community groups was on average the most legitimate way to maintain solid waste management in the centers included in the sample, which in turn shaped the frequency of both collective action and littering behavior over time. This provides additional support for Hypothesis 2, which predicts that the normative content of institutions shapes the effectiveness of those institutions over time.

## **Discussion**

In summary, the analysis of the effect of the SAFI Project experiment on trash accumulation and littering behavior yielded two main results. First, there is evidence that the punishment of littering by either government chiefs or local elders led to more rapid reductions in the amount of trash on the ground than in the treatment group in which there was no formal punishment for littering. Second, although all three treatments led to large reductions in littering behavior over the short-term, this reduction was only sustained over time in the group in which there was no punishment for littering.

The most important findings of the individual-level analyses are that the Collective Action treatment led to the highest assessment of trash as a problem, the highest self-reported rates of public clean-ups, and the lowest self-reported rates of

littering behavior. The qualitative fieldwork that preceded the field experiment indicated that civil society organizations are more actively involved in addressing public waste problems in Laikipia than either chiefs or elders. As a result, one interpretation of the empirical results is that the maintenance of a solid waste management project by local civil society groups alone is more legitimate in this context than civil society mobilization coupled with punishment by chiefs or elders.

Although chiefs and elders do have the authority to prevent harmful actions against a variety of local public goods using punishments, their connection to collective action by community organizations may not be consistent with local practices regarding solid waste management. This could have the effect of reducing the legitimacy of the entire project, leading to reductions in the frequency of clean-ups and increases in littering rates. In addition, if chiefs or elders failed to actually enforce the littering rule, this could have driven reduced compliance, both due to a lowered deterrent effect of the punishment and a decrease in community members' perception of the effectiveness and legitimacy of that institution.

## **Conclusion**

In this paper, I developed a theory of public goods maintenance and presented the results of a qualitative case study and randomized field experiment that assess how the interaction of government and community institutions shape the dynamics of public goods maintenance. The results of the experiment provided support for the theory, showing that interactions between government and community institutions shape

patterns of public goods maintenance over time. In particular, the results indicate that although punishing littering behavior can lead to short-term reductions in trash accumulation, such institutions do not lead to sustainable changes in littering behavior and may crowd out ongoing collective action and the creation of new social norms that are necessary to maintain waste management over time.

To what extent can these findings from a small-scale experiment on rural solid waste management in 36 localities in one region of Kenya be extended to public goods maintenance in other contexts? I argue that the relative effectiveness of the Collective Action treatment is shaped by the legitimacy of public goods maintenance by civil society organizations in Laikipia, Kenya. As a result, it is incorrect to interpret these findings as stating that punishment of littering (and other actions that harm public goods) by governments or communities is always ineffective. In contexts in which punishment of littering by governments or traditional leaders is more closely matched with local norms and practices, we would expect to see much stronger performance of the Chief and Elders treatments.

More generally, this finding has important implications for the study and practice of international development, particularly the recent trend toward localizing development through community-driven development projects (Mansuri and Rao 2012). Although many development projects are designed to build new institutions that facilitate ongoing collective action (Fearon et al 2009; Casey et al 2012), relatively few of these interventions explicitly engage with the full diversity of institutions on the ground.

The evidence in this paper indicates that failure to engage with local institutions may severely limit the short-term and long-term effectiveness of such donor-driven community development projects (Ferguson 1992; Swidler 2013; Mansuri and Rao 2012). The theory developed in this paper provides researchers and practitioners with a flexible framework for identifying and classifying the government and community institutions that could be harnessed to maintain any local public goods project.

Similarly, the research design employed in this paper provides a model for how to move from one-shot program evaluations to ongoing monitoring of public goods projects over time. Many attempts to monitor and evaluate donor-funded community development projects typically look only at short-term impacts of interventions on public goods availability. The evidence presented in this paper illustrates that even a public good as simple as solid waste management exhibits tremendous variation over space and time. A project that looks like a success one day may look like a failure mere months later and vice versa. By combining randomized field experiments with in-depth qualitative research and ongoing monitoring, donors, governments, and communities will be better able to harness research as a tool to monitor and maintain public goods projects.

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## Tables and Figures

Covariate	1 Full Sample	2 Control	3 Collective Action	4 State	5 Elders	6 Likelihood Ratio	7 P- Value	8 N
<b>Baseline Measures</b>								
Trash Count	19.9861	21.49472	16.94	20.8228	17.371	3.01	0.3908	36
Proportion Littering	66.24%	66.90%	63.88%	64.88%	67.79%	1.77	0.622	36
<b>Gender (Proportion Female)</b>	39.72%	36.61%	41.93%	46.52%	40%	7.07	.0697*	36
<b>Age</b>	30.039	30.14	31.49	29.11166	29.21111	0.05	0.829	36
<b>Education</b>								
None	13.58%	11.94%	14.84%	13.07%	17.78%	1.42	0.2339	36
Primary	36.76%	35.11%	27.04%	38.17%	50%	0.42	0.5188	36
Secondary	36.20%	38.53%	43.17%	32.91%	25.56%	1.13	0.2874	36
Post- Secondary	10.40%	10.35%	12.74%	12.01%	6.67%	0	0.9614	36
<b>Distance From Center</b>								
Resident	44.51%	45.30%	34.74%	54.75%	41.67%	0.08	0.7721	36
Less Than 1 KM	25.52%	23.46%	29.28%	23.46%	30%	1.58	0.2082	36
1-5 KM	18.99%	19.20%	28.78%	13.12%	14.40%	0.01	0.907	36
5-10 KM	6.47%	6.68%	4.43%	5.47%	8.89%	0.05	0.83	36
More than 10 KM	2.75%	3.13%	2.22%	2.67%	2.22%	0.46	0.496	36
<b>Number of Visits Per Week</b>	5.38	5.41	5.12	5.65	5.32	0.03	0.8563	36
<b>Pastoralist (Proportion)</b>	30.63%	29.76%	35.14%	24.93%	34.44%	0.06	0.7996	36

Table 1: Descriptive Statistics and Check of Covariate Balance using Baseline Measures  
of Outcomes and Individual-Level Covariates

	Trash Count, Short Term	Trash Count, Medium Term	Trash Count, Long Term
Elders	-9.380** (4.222)	-11.68*** (3.894)	-10.75** (4.069)
Chief	-8.321* (4.222)	-9.000** (3.894)	-7.599* (4.069)
Collective Action	-5.717 (4.222)	-9.321** (3.894)	-8.334* (4.069)
Constant	21.25*** (3.702)	17.33*** (3.643)	18.94*** (3.806)
Observations	36	36	36
R-squared	0.328	0.414	0.344
<b>Wald Test</b>			
Elders vs. Chief	0.04	0.31	0.40
Elders vs. Collective Action	0.50	0.24	0.23
Chief vs. Collective Action	0.25	0.00	0.02

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Table 2: Cross-Sectional Regressions of Trash Count on Treatment Groups, Divided by Period

	Trash Count, Short Term	Trash Count, Medium Term	Trash Count, Long Term
Elders	0.0384 (4.304)	0.0384 (4.249)	0.0384 (4.342)
Elders*After	-9.421 (6.493)	-11.71* (6.008)	-10.79* (6.141)
Chief	3.848 (4.304)	3.848 (4.249)	3.848 (4.342)
Chief*After	-12.43* (6.493)	-12.85** (6.008)	-11.45* (6.141)
Collective Action	0.356 (4.304)	0.356 (4.249)	0.356 (4.342)
Collective Action*After	-6.097 (6.493)	-9.678 (6.008)	-8.691 (6.141)
After Treatment	-2.029 (3.044)	-1.426 (3.004)	-2.122 (3.071)
Constant	22.30*** (3.228)	20.04*** (3.186)	21.20*** (3.257)
Observations	72	72	72
R-squared	0.287	0.352	0.319
<b>Wald Test</b>			
Elders vs. Chief	0.14	0.02	0.01
Elders vs. Collective Action	0.17	0.08	0.08
Chief vs. Collective Action	0.63	0.19	0.13

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Table 3: Difference-in-Differences Regressions of Trash Count on Treatment Groups, Divided By Period

	Proportion Littering, Short Term	Proportion Littering, Medium Term	Proportion Littering, Long Term
Elders	-0.454 *** (0.0544)	-0.126 * (0.0648)	-0.0456 (0.0559)
Chief	-0.484 *** (0.0544)	-0.0752 (0.0648)	-0.0548 (0.0559)
Collective Action	-0.420 *** (0.0544)	-0.230 *** (0.0648)	-0.214 *** (0.0559)
Constant	0.786 *** (0.0477)	0.535 *** (0.0606)	0.588 *** (0.0523)
Observations	36	36	36
R-squared	0.846	0.447	0.463
<b>Wald Test</b>			
Elders vs. Chief	0.20	0.41	0.02
Elders vs. Collective Action	0.27	1.71	6.09 **
Chief vs. Collective Action	0.93	3.80 *	5.44 **

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Table 4: Cross-Sectional Regressions of Proportion Littering on Treatment Groups, Divided By Period

	Proportion Littering, Short Term	Proportion Littering, Medium Term	Proportion Littering, Long Term
Elders	-0.0612 (0.0466)	-0.0612 (0.0557)	-0.0612 (0.0494)
Elders*After	-0.389*** (0.0703)	-0.0651 (0.0787)	0.0156 (0.0699)
Chief	-0.0960** (0.0466)	-0.0960* (0.0557)	-0.0960* (0.0494)
Chief*After	-0.381*** (0.0703)	0.0208 (0.0787)	0.0412 (0.0699)
Collective Action	-0.0621 (0.0466)	-0.0621 (0.0557)	-0.0621 (0.0494)
Collective Action*After	-0.353*** (0.0703)	-0.168** (0.0787)	-0.152** (0.0699)
After Treatment	-0.123*** (0.0329)	-0.257*** (0.0394)	-0.245*** (0.0349)
Constant	0.890*** (0.0349)	0.832*** (0.0417)	0.852*** (0.0371)
Observations	72	72	72
R-squared	0.855	0.703	0.709
<b>Wald Test</b>			
Elders vs. Chief	0.01	0.79	0.09
Elders vs. Collective Action	0.17	1.14	3.85*
Chief vs. Collective Action	0.11	3.83*	5.12**

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Table 5: Difference-in-Differences Regressions of Proportion Littering on Treatment Groups, Divided By Period

	1	2	3 Self-Reported and Observed Littering Match
	Is Trash a Problem?	Do You Litter?	
Elders	0.0116 (0.0251)	-0.0833 (0.0539)	-0.00407 (0.0995)
Chief	0.0222 (0.0161)	-0.0581 (0.0588)	0.129 (0.127)
Collective Action	0.0377** (0.0171)	-0.142** (0.0607)	-0.0570 (0.103)
Gender	0.0112 (0.0175)	-0.00812 (0.0282)	0.00490 (0.0327)
Age	0.00324 (0.00276)	0.00281 (0.00505)	0.00962 (0.00569)
Age Squared	-0.0000388 (0.0000313)	-0.0000322 (0.0000671)	-0.0000889 (0.0000731)
Education-Primary	0.0366 (0.0224)	-0.102* (0.0511)	-0.0743 (0.0574)
Education-Secondary	0.0431** (0.0191)	-0.219*** (0.0482)	-0.177*** (0.0538)
Education-Post-Secondary	0.0686*** (0.0221)	-0.309*** (0.0664)	-0.150 (0.101)
Distance- < 1 KM	0.0256 (0.0162)	0.0358 (0.0393)	0.111* (0.0553)
Distance- 1-5 KM	0.00335 (0.0214)	0.0774 (0.0477)	0.104** (0.0400)
Distance- 5-10 KM	-0.00925 (0.0489)	0.127* (0.0729)	0.150* (0.0828)
Distance- > 10 KM	0.0184 (0.0469)	0.0464 (0.0711)	0.169 (0.118)
Number of Visits Per Week	0.00974 (0.00632)	-0.00129 (0.0137)	0.0276 (0.0164)
Pastoralist	0.00254 (0.0126)	-0.00649 (0.0453)	-0.0164 (0.0671)
Constant	0.810*** (0.0565)	0.415*** (0.149)	-0.0304 (0.179)
Observations	1024	1020	853
R-squared	0.051	0.119	0.073

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Table 6: Regressions of Attitudes Towards Trash and Littering on Treatment Groups and Individual Attributes

	1 Would You Participate in a Cleanup Today?	2 Have You Ever Participated in a Cleanup?	3 Number of Monthly Cleanups in Center
Elders	0.0974*** (0.0352)	0.152 (0.110)	0.722 (0.519)
Chief	0.0759** (0.0371)	0.110 (0.0910)	0.841* (0.483)
Collective Action	0.0997*** (0.0252)	0.250** (0.0997)	2.129*** (0.373)
Gender	0.0195 (0.0170)	0.0576* (0.0312)	0.129 (0.119)
Age	0.00443 (0.00306)	0.00933 (0.00582)	0.0623* (0.0323)
Age Squared	-0.0000399 (0.0000331)	-0.000118 (0.0000761)	-0.000670 (0.000418)
Education-Primary	0.0350 (0.0359)	0.0713 (0.0560)	0.540** (0.206)
Education-Secondary	0.0735** (0.0337)	0.142** (0.0570)	0.650*** (0.166)
Education-Post-Secondary	0.0945*** (0.0344)	0.195*** (0.0713)	0.875*** (0.259)
Distance- < 1 KM	0.000349 (0.0369)	0.0159 (0.0564)	-0.00177 (0.177)
Distance- 1-5 KM	-0.0527 (0.0498)	-0.113* (0.0633)	-0.394* (0.230)
Distance- 5-10 KM	-0.171** (0.0769)	-0.143 (0.0963)	-0.116 (0.257)
Distance- > 10 KM	-0.0832 (0.0792)	-0.138 (0.100)	0.176 (0.456)
Number of Visits Per Week	0.00277 (0.00764)	0.0421** (0.0178)	0.159*** (0.0572)
Pastoralist	0.0610** (0.0245)	0.0285 (0.0385)	-0.302 (0.214)
Constant	0.724*** (0.0988)	-0.277 (0.176)	-2.366*** (0.783)
Observations	985	989	906
R-squared	0.083	0.179	0.254

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Table 7: Regressions of Self-Reported Clean-up Participation and Frequency on Treatment Groups and Individual Attributes

	1 If you see Someone Littering, Would You Yell at Them?	2 If You See Someone Littering, Would You Tell on Them?
Elders	0.0668 (0.0513)	0.124 (0.0771)
Chief	0.118* (0.0585)	0.0488 (0.0447)
Collective Action	0.110 (0.0768)	0.138** (0.0727)
Gender	0.0266 (0.0269)	-0.0132 (0.0136)
Age	-0.00846 (0.00548)	0.000922 (0.00271)
Age Squared	0.000133** (0.0000653)	-0.0000248 (0.0000323)
Education-Primary	0.0620 (0.0402)	0.0458 (0.0372)
Education-Secondary	0.0400 (0.0450)	0.0649* (0.0377)
Education-Post-Secondary	0.0637 (0.0577)	0.0730* (0.0368)
Distance- < 1 KM	-0.0217 (0.0316)	-0.0512** (0.0246)
Distance- 1-5 KM	-0.0471 (0.0335)	-0.0311 (0.0271)
Distance- 5-10 KM	-0.0400 (0.0602)	-0.0134 (0.0478)
Distance- > 10 KM	-0.0176 (0.0854)	-0.0353 (0.0578)
Number of Visits Per Week	0.0161* (0.00882)	0.00106 (0.00565)
Pastoralist	0.0697 (0.0418)	0.0260 (0.0268)
Constant	0.0411 (0.122)	-0.0739 (0.0845)
Observations	922	922
R-squared	0.201	0.151

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Table 8: Actions Against Littering Behavior on Treatment Groups and Individual Attributes

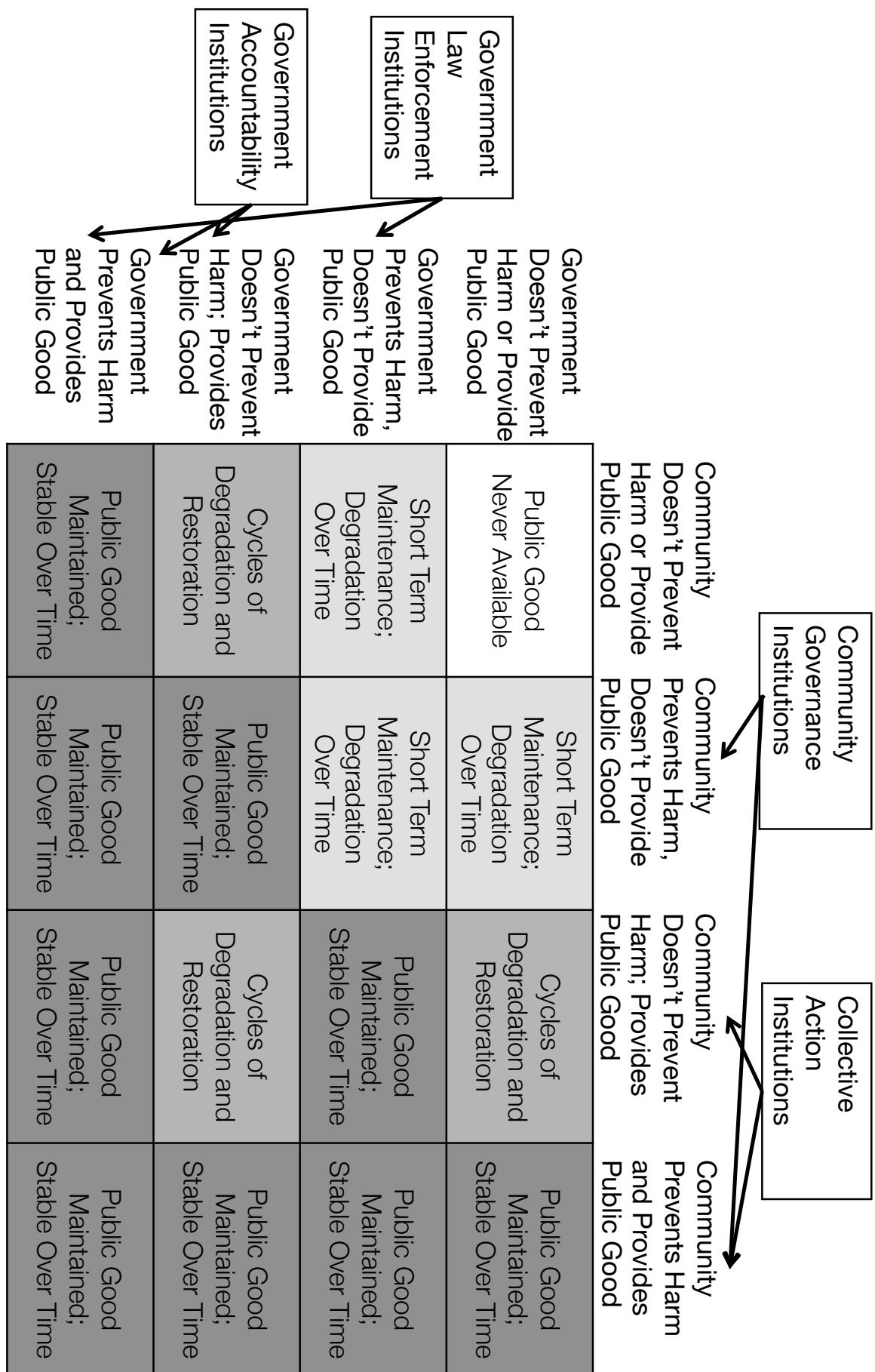


Figure 1: Government and Community Institutions and Public Goods Maintenance

Element of Theory	Treatment Group
No Government or Community Institution Provides Public Good; No Government or Community Institutions Punish Harmful Action	<b>Control Group-</b> No Intervention by Project Staff
Community Collective Action Provides Public Good; No Government or Community Institutions Punish Harmful Action	<b>Collective Action Treatment Group-</b> Mobilization of Ongoing Solid Waste Management and Clean-Ups by Community Groups <b>PLUS</b> Ups by Community Groups
Community Collective Action Provides Public Good; Government Law Enforcement Institutions Punish Harmful Action	<b>Chief Treatment Group-</b> Mobilization of Ongoing Solid Waste Management and Clean-Ups by Community Groups <b>PLUS</b> Punishment of Littering by Government Chiefs
Community Collective Action Provides Public Good; Community Governance Institutions Punish Harmful Action	<b>Elders Treatment Group-</b> Mobilization of Ongoing Solid Waste Management and Clean-Ups by Community Groups <b>PLUS</b> Punishment of Littering by Community Elders

Figure 2: Creating Treatment Groups for the Solid Waste Management Experiment in Laikipia, Kenya

**General Hypothesis**

**Observable Implication for Waste Management Experiment**

H1a: No PG Institutions → Low Availability of Public Good	Control Group- No Intervention by Project Staff	→ Highest Levels of Trash Accumulation
H1b: PG Provision Institutions Only → Cycles of Degradation and Restoration	Collective Action by Community Groups	→ Uneven Decreases and Increases in Trash Accumulation
H1d: PG Provision Institutions + Harm Prevention Institutions → Public Good Maintained Over Time	Collective Action + Littering Punishment by Government Chief or Community Elders	→ Lowest Levels of Trash Accumulation

Figure 3: Empirical Predictions of Hypothesis 1 for the Waste Management Experiment

<b>General Hypothesis</b>	<b>Observable Implication for Waste Management Experiment</b>
<b>Alternative Assumption #1: Collective Action By Community Groups Matches Local Norms</b>	
Collective Action by Community Groups	→ Long Term Decrease in Trash and Littering; Increase in Cleanups
Collective Action + Littering Punishment by Chief or Elders	→ Long Term Increase in Trash and Littering; Decrease in Cleanups
<b>Alternative Assumption #2: Collective Action + Government Chief Enforcement Matches Local Norms</b>	
Collective Action by Community Groups + Chief Enforcement	→ Long Term Decrease in Trash and Littering; Increase in Cleanups
Collective Action (Alone) and Collective Action + Littering Punishment by Elders	→ Long Term Increase in Trash and Littering; Decrease in Cleanups
<b>Alternative Assumption #3: Collective Action + Community Elder Enforcement Matches Local Norms</b>	
Collective Action by Community Groups + Elder Enforcement	→ Long Term Decrease in Trash and Littering; Increase in Cleanups
Collective Action (Alone) and Collective Action + Littering Punishment by Chief	→ Long Term Increase in Trash and Littering; Decrease in Cleanups

Figure 4: Empirical Predictions of Hypothesis 2 for the Waste Management Experiment

Maintaining Local Public Goods:  
Evidence from Rural Kenya

Online Supplemental Materials

Appendix A: Overview of Qualitative Research and Sources

Appendix B: Experiment Protocol and Materials

- B1: General Instructions
- B2: Treatment Assignment
- B3: Chief Meeting Variations
- B4: Chief Consent Form
- B5: Public Meeting Agenda- Collective Action
- B6: Public Meeting Agenda- Chief
- B7: Public Meeting Agenda- Elders

Appendix C: Survey Instrument

- C1: English
- C2: Swahili

Appendix D: Robustness Checks

- D1: Enumerator Malfeasance and Omitted Observations
- D2: Alternative Cross-Sectional Time-Series Specifications
- D3: Logit Model for Survey Data

## **Appendix A: Overview of Qualitative Research and Sources**

The qualitative research that is referenced in this paper was conducted at three distinct times: June 2006, February- June 2007, and September 2007. The principal qualitative data collection methods were in-depth semi-structured interviews and participant observation. In several instances, I led focus group discussions. Interviews and focus groups were conducted in local languages, primarily Swahili, Maa, and Kikuyu. I typically worked with two local translators, one who asked the questions and translated answers to me, and one who took notes in English. Most interviews were recorded on a digital voice recorder and translated to English by a third translator. The selection of translators, locations, and interviewees was largely driven through social network-based snowball sampling, building off of the social networks of my initial host organization and translator.

The table below provides an outline of the qualitative research dates, locations, and interviewees. Names and identifying details of interviewees have been omitted to comply with IRB requirements.

Month	Location	Qualitative Research Activities
July 2006	Dol Dol	Interview with Retired Chief, Focus Group with Youth, Interview with Civil Society Leaders, Participant Observation
	Timau	Interview with Civil Society Leader, Participant Observation
February 2007	Kimanjo	Participant Observation
	Ewaso	Participant Observation
	Ethi	Interview with Elders
	Ngare Ndare	Interview with Elders, Participant Observation
	Dol Dol	Interview With Elders, Chief
March 2007	Jua Kali	Interview with Elders
	Naibor	Interview with Elders, Participant Observation
	Ngare Ngiro	Interview with Elders, Participant Observation
	Dol Dol	Interview with Elders, Chiefs, Group Ranch Leaders, Councilor
	Il Polei	Interview with Elders, Chief, Councilor, Group Ranch Leaders
	Kimanjo	Interview with Elders, Current and Former Councilor
	Chumvi	Interview with Elders, Focus Group with Teenagers
	Nanyuki	Interviews with Civil Society Leaders, Participant Observation
April-May 2007	Ol Donyiro	Participant Observation, Interview with Elders, Civil Society Leaders, and Chief

	Ol Kinyei	Participant Observation
	Kimanjo	Participant Observation
	Il Polei	Participant Observation, Interview with Civil Society Leaders
	Dol Dol	Interviews with Civil Society Leaders
	Nanyuki	Interviews with District and Council Officials
June 2007	Il Polei	Focus Group with Men and Women, Participant Observation
	Dol Dol	Focus Group, Interview with Elders, Participant Observation
	Matanya	Participant Observation
	Munyankalo	Focus Group with Youth
September 2007	Rumuruti	Interview with Civil Society Leaders, County Council Officials
	Karaba	Interview with Chief
	Tandari	Interview with Civil Society Leaders
	Gatundia	Participant Observation
	Mile Saba	Participant Observation
	Dol Dol	Participant Observation
	Ewaso	Interviews with Elders and Civil Society Leaders
	Il Polei	Participant Observation
	Matanya	Interview with Chief and Civil Society Leaders
	Mathangiro	Interview with Chief and Civil Society Leaders

## **Appendix B: Experiment Protocol and Materials**

### **B1: General Instructions**

#### **SAFI Project Pilot Study**

#### **Implementation Components in all Treatment Groups**

##### *Working with the Chief and Other Leaders*

The first step of the SAFI project is to obtain support for the community waste disposal effort from the area Chief. This purpose of this contact is to gain general support and permission for the project in each of the proposed project sites. Chiefs will be the main contact for other types of leaders in the center, including Area Councilors, Group Ranch committees (where applicable), elders, CBO leaders, and other local opinion leaders. In two of the project groups, we will work with the area chief to draft a set of relevant and effective rules, punishments, and by-laws concerning waste management and littering.

##### *Town Planning Meeting/Town Committee*

The second step is to bring the community together to create a plan for the waste removal implementation in each of the study sites. The SAFI project will provide bins for the disposal of both plastic and organic waste, will demarcate specific sites in each town center for burning/composting waste, and will organize a committee to empty bins and burn trash. This members of this committee will be chosen by the major community groups in and around the center at the planning meeting.

##### *Community Mobilization and Awareness*

After local leadership has been mobilized and specific local action plans have been developed, the next step is to inform individuals about the negative economic, social, and health consequences of environmental degradation and to empower the community to take positive action against these problems. Through a series of community meetings, workshops, and home-to-home mobilizations in each of the project sites, we will foster dialogue and discussion about waste removal, conservation, and natural resource use. In addition, we will use these mobilization efforts to introduce the specific features and rules of the SAFI waste disposal plan to each member of each participating community.

##### *Community Cleanup*

Through a partnership with local community based organizations, we will organize a large-scale community cleanup day in each of the project sites. As well as providing a clean slate from which to launch an ongoing waste-management program, the community cleanup days will foster community spirit and unity by bringing everyone together to help remove litter and waste from public spaces.

##### *Data Collection, Community Feedback, and Reporting*

In all 18 project towns (as well as 18 towns receiving no implementation), an enumerator based in each project site will record and monitor the performance of the waste disposal program and anti-littering rules, using the littering behavior sheet and litter count sheet. In addition, after all 18 implementations are complete, a survey of attitudes towards littering will be conducted in all 36 centers. Together, the lead researcher and enumerators will work to analyze the data on an ongoing basis and make the findings available to the community through a second round of public meetings,

workshops, and home-to-home visits. In this way, the research will be used to help the waste removal initiative operate as effectively as possible as well as to inform the community about the most effective way to implement projects and policies in other issue areas.

## **B2: Treatment Assignment**

### **SAFI Project Pilot Study**

### **Work Schedule, Treatment Groups, Experimental Design, and Field Coordinator Assignments**

36 SAFI Project Centers, grouped into 6 regions:

Laikipia North Region (Il Polei, Ndikir, Ewaso, Dol Dol, Kimanjo, Naibor)

Laikipia East, Region 1 (Katheri, Sirimon, Endana, Jua Kali, Ngare Ngiro, Silent)

Laikipia East, Region 2 (Akorino, Mathangiro, Mwireri, Umande, Mumero, Ndemu)

Laikipia East, Region 3 (Chumvi, Ngare Ndare, Ethi, Mile Nane (Kalalu), Mia Moja, Munyankalo)

Laikipia West, Region 1 (Muthara, Karaba, Gatiundia, Kuderira, Junction, Mutanga)

Laikipia West, Region 2 (Mile Saba, Karandi, Muthengira, Kwawanjiku, Tandari, Gatero)

Schedule and groups:

Period 1- Laikipia East, Region 2

November 17-December 1, 2007

Elders-Mwireri. Field Coordinator: **Simon**

Chief- Mathangiro. Field Coordinator: **Mosiany**

Collective Action. Akorino- **Margaret**

Control Centers- Mumero, Ndemu, Umande

Period 2- Laikipia West, Region 2

December 8-December 22, 2007

Elders- tandare. Field Coordinator: **Kamau**

Chief-Karandi. Field Coordinator: **Simon**

Collective Action- Mile Saba. Field Coordinator: **Mosiany**

Control Centers-Muthengera, Kwawanjiku, Gatero

Period 3- Laikipia West, Region 1

December 29, 2007-January 12, 2008

Elders- Gatundia. Field Coordinator: **Margaret**

Chief- Kuderira. Field Coordinator: **Kamau**

Collective Action. Field Coordinator: Karaba Center- **Simon**

Control Centers-Junction,Mutanga, Mutara

Period 4- Laikipia East, Region 1- Kamau, Margaret, Mosiany

January 19- February 2, 2008

Elders -Endana. Field Coordinator: **mosiany**

Chief- Ngare Ngiro. Field Coordinator: **kamau**

Collective Action- Silent. Field Coordinator: **Margaret**

Control Centers-Jua Kali, Katheri, Sirimon

Period 5- Laikpia East, Region 3 Mosiany, Margaret, Simon  
February 9-February 23, 2008

Elders-Ethi. Field Coordinator: **Mosiany**

Chief- Ngare Ndare. Field Coordinator: **Margaret**

Collective Action-Chumvi. Field Coordinator: **Simon**

Control Centers-Mia Moja, Kalalu, Munyankalo

Period 6- Laikipia North Region- Simon, Mosiany, Kamau

March 1-March 15, 2008

Elders-Ewaso. Field Coordinator: **simon**

Chief- Ndikir. Field Coordinator: **kamau**

Collective Action-Il Polei. Field Coordinator: **mosiany**

Control Centers-Dol Dol, Kimanjo, Naibor

### **B3: Chief Meeting Variations**

#### **SAFI Project Pilot Study- Meeting with Area Chief Program for Each Treatment Group**

##### **Group 1- Elders Encouraged to Punish Littering**

###### **I. Introduction of Project**

- a. Going over schedule of implementation, and implementation steps
- II. Agreeing on enforcing punishments against littering
  - a. Punishment for Littering- Cleanup work
  - b. Punishment for Stealing Bins- Fine of KSh 1800

###### **III. Obtaining list of organized groups in town and their leaders**

- a. NGOs
- b. CBOs
- c. Youth Groups
- d. Women's Groups
- e. Religious groups
- f. Any other organized groups

###### **IV. Obtaining list of wazee in each sub-area**

- a. Chief's mzee in each sub-area (including town)
- b. Other wazee or important traditional leaders that the chief mentions

###### **V. Signing Agreement of understanding and support**

##### **Group 2- Chiefs Encouraged to Punish Littering**

###### **I. Introduction of Project**

- a. Going over schedule of implementation, and implementation steps
- II. Agreeing on enforcing punishments against littering
  - a. Punishment for Littering- Cleanup Work
  - b. Punishment for Stealing Bins- Fine of KSh 1800

###### **III. Obtaining list of organized groups in town and their leaders**

- a. NGOs
- b. CBOs
- c. Youth Groups
- d. Women's Groups
- e. Religious groups
- d. Any other organized groups

###### **VI. Signing Agreement of understanding and support**

##### **Group 3- Collective Action**

###### **I. Introduction of Project**

- a. Going over schedule of implementation, and implementation steps
- II. Obtaining list of organized groups in town and their leaders

- a. NGOs
- b. CBOs
- c. Youth Groups
- d. Women's Groups
- e. Religious groups
- f. Any other organized groups

###### **III. Signing Agreement of understanding and support**

## **B4: Chief Consent Form**

### **SAFI Project Pilot Study Agreement of Understanding and Support with Area Chief**

This Town has been selected to participate in a pilot study regarding littering behavior and trash collection, which is being jointly undertaken by [NAME REDACTED], a researcher from the US, and the SAFI project. This project will involve each of the following:

1. 1) The observation and monitoring of individuals' littering behavior
2. 2) Using survey questionnaires to ask people about their attitudes regarding trash collection
3. 3) Small group discussions

In addition, this town may receive an anti-littering program that will include some or all of the following:

1. 4) Large Scale public mobilization and education campaigns
2. 5) The installation of trash bins
3. 6) The creation punishments against littering
4. 7) The creation of a town committee to monitor the day-to-day performance of the trash collection program

Before commencing the work, we will let you know if this town is receiving a program and which specific components the town will receive. Even if the town is not selected to receive a program in the first phase, we will share the findings of the research in a public feedback meeting and will use the data to design a program for this town in the second phase of the project.

We expect your cooperation in implementing these project components and helping us to inform the people in this community about the research. If at any time, you or any of the citizens have any problems with the research or with the program, please contact us immediately.

I understand the nature of the research that will undertaken in this town. I also understand that this town may not immediately receive an anti-littering program. As a result, I give [NAME REDACTED] and the SAFI project full authority to conduct the program in this town.

Signed \_\_\_\_\_  
Date \_\_\_\_\_

## **B5: Public Meeting Agenda- Collective Action**

### **SAFI Project Pilot Study-Town Planning Meeting SAMPLE PROGRAM-Collective Action**

- I. Introduction of Coordinator- Town Facilitator
- II. Introduction of Project- SAFI coordinator
  - a. The problem of trash
    - i. Speech
    - ii. Discussion
  - b. The Plan of The SAFI project
    - i. Our role is facilitating- providing bins, other supplies
    - ii. Community Project-
      - 1. Trash Committee
  - c. Location for Bins/Pits
  - d. Town Committee
    - i. Jobs of The town committee
      - 1. organizing emptying of bins
      - 2. monitoring littering
      - 3. Informing people who litter that littering is bad behavior and is bad for everyone in the center
    - ii. Composition of Town Committee
      - 1. Stakeholder Groups based in Center
      - iii. Method of Choosing Town Committee
        - 1. Election/nomination by each stakeholder group later in planning meeting
  - e. Community Clean-up day
    - i. Announce Date
    - ii. Announce Activities
      - 1. Digging Compost
      - 2. Parade/Demonstration Marching Into Town
      - 3. Speeches
      - 4. Cleaning up trash
- III. Chiefs to comment or emphasize the introduction
- IV. Any Other leaders to comment or emphasize
- V. Open Comments from Meeting Attendees
- VI. Select town committee/show them the selection system
  - a. Split up/ for each stakeholder group
  - b. Elections/nomination
- VII. Conclusion

## **B6: Public Meeting Agenda- Chief**

### **SAFI Project Pilot Study-Town Planning Meeting SAMPLE PROGRAM-Chief**

- I. Introduction of Coordinator- Town Facilitator
- II. Introduction of Project- SAFI coordinator
  - a. The problem of trash
    - i. Speech
    - ii. Discussion
  - b. The Plan of The SAFI project
    - i. Our role is facilitating- providing bins, other supplies
    - ii. Community Project-
      - 1. Trash Committee
  - c. Location for Bins/Pits
  - d. **Punishment**
    - i. **Reason for Punishment**
    - ii. **Type of Punishments**
      - 1. **For every time a person is caught littering, they have to spend one day working to clean trash in the center (pick up litter, help empty bins)**
      - 2. **For every bin a person steals, they will pay a fine equal to three times the cost of one bin (KSh 1800)**
  - e. Town Committee
    - i. Jobs of The town committee
      - 1. organizing emptying of bins
      - 2. monitoring littering
      - 3. reporting littering to the chief for fines
    - ii. Composition of Town Committee
      - 1. Stakeholder Groups based in Center
      - iii. Method of Choosing Town Committee
        - 1. Election/nomination by each stakeholder group later in planning meeting
  - f. Community Clean-up day
    - i. Announce Date
    - ii. Announce Activities
      - 1. Digging Compost
      - 2. Parade/Demonstration Marching Into Town
      - 3. Speeches
      - 4. Cleaning up trash
  - III. Chiefs to comment or emphasize the introduction
  - IV. Any Other leaders to comment or emphasize
  - V. Open Comments from Meeting Attendees
  - VI. Select town committee/show them the selection system
    - a. Split up/ for each stakeholder group
    - b. Elections/nomination
  - VII. Conclusion

## **B7: Public Meeting Agenda- Elders**

## **SAFI Project Pilot Study-Town Planning Meeting**

### **SAMPLE PROGRAM- Elders**

- I. Introduction of Coordinator- Town Facilitator
- II. Introduction of Project- SAFI coordinator
  - a. The problem of trash
    - i. Speech
    - ii. Discussion
  - b. The Plan of The SAFI project
    - i. Our role is facilitating- providing bins, other supplies
    - ii. Community Project-
      - 1. Trash Committee
  - c. Location for Bins/Pits
  - d. **Punishment**
    - i. **Reason for Punishment**
      - 1. **Littering is bad behavior that hurts everyone in the center- as a result, people who litter should have to take responsibility**
    - ii. **Type of Punishment**
      - 1. **For every time a person is caught littering, they have to spend one day working to clean trash in the center (pick up litter, help empty bins)**
      - 2. **For every bin a person steals, they will pay a fine equal to three times the cost of one bin (KSh 1800)**
  - e. Town Committee
    - i. Jobs of The town committee
      - 1. organizing emptying of bins
      - 2. monitoring littering
      - 3. reporting littering to the chief for fines
    - ii. Composition of Town Committee
      - 1. Stakeholder Groups based in Center
      - 2. **Traditional Leaders from surrounding area**
    - iii. Method of Choosing Town Committee
      - 1. Election/nomination by each stakeholder group later in planning meeting
      - 2. **Election/Nomination by mzee from the surrounding sub-areas later in the planning meeting**
  - f. Community Clean-up day
    - i. Announce Date
    - ii. Announce Activities
      - 1. Digging Compost
      - 2. Parade/Demonstration Marching Into Town
      - 3. Speeches
      - 4. Cleaning up trash
- III. Chiefs to comment or emphasize the introduction
- IV. Any Other leaders to comment or emphasize
- V. Open Comments from Meeting Attendees
- VI. Select town committee/show them the selection system

- a. Split up/ for each stakeholder group/ Traditional Group
- b. Elections/nomination

VII. Conclusion

## **Appendix C: Survey Instrument**

### **C1: English**

Trash and Littering Questionnaire

<Name of Village>

Questionnaire # \_\_\_\_\_

### **Verbal Informed Consent**

I am working with [NAME OF RESEARCHER]. In this research project, we hope to learn about trash and the environment in \_\_\_\_\_ <Name of Village>

All of the information that you provide will be kept confidential. Your participation is completely voluntary, and you can decline to answer any individual question or stop this interview at any time. If you have any questions about this research project or your participation in it, you can contact [NAME OF NGO CONTACT] or your District Commissioner.

After hearing this information, do you agree to participate?"

### **Part I: Background information**

Number	Questions	Answers
1	What is your age ? (An Estimate is okay)	_____
2	What is your tribe?	
3	What is your level of education?	None Some Primary School Primary Complete Some Secondary School Secondary Complete College University
4	Approximately how far do you live from _____ (name of town center where interview is happening).	Live in the Center Less than 1 KM 1-5 KM 5-10 KM More than 10 KM  Don't Know Don't Understand Refused to Answer
5	In the past week, how many times have you come to _____ (Name of town center where interview is happening)?	Live There/Every Day 6 5 4 3

		<p>2 1 This is the first time  Don't Know</p>
6	Is there another center,/town, or/city that you go to more often than (Town Where interview is happening)?	<p>Yes – Which one _____  No</p>
7	How often do you go to that center?	<p>Live There Every Day 2 or three times per week Once Per Week Once Per Month Less than Once per month  Depends _____ (Explain)</p>

## Section II: Questions about Littering and Waste

Number	Questions	Answers
8	Do you consider trash Trash(SAFI SAFI) to be a major problem in <town name>?	<p>Yes No  Don't Know Don't Understand Refused to Answer</p>
9	In the past month, how many times has trash been cleaned up <picked up> in <name of village>?	<p>0 1 2 3 4 More than 4 How Many _____  Don't Know Don't Understand Refused to Answer</p>
10	Have you ever participated in a clean-up in <name of village>?	<p>No Yes Who organized it _____  Don't Know Don't Understand</p>

		Refused to Answer
11	Has anyone you know ever participated in a clean-up in <name of village>?	No Yes Who organized it _____  Don't Know Don't Understand Refused to Answer
12	If a public clean-up were organized today, do you think you would you participate?	No Yes  Don't Know Don't Understand Refused to Answer
13	When you have a piece of trash in _____ ( <i>Name of Village</i> ), what do you usually do with it?	Drop it On the Ground Put it in a public bin or pit Keep it with me until I go home  Depends on Situation (explain)  Other _____  Don't Know Don't Understand Refused to Answer
14	When you see someone dropping waste on the ground in _____ what do you usually do?	Do Nothing  Yell at that person/ Talk to them  Tell someone else about it Who?  Other (Explain) _____ Depends on situation (Explain)  Don't Know Don't Understand Refused to Answer

15	Do you think most people you know would do the same thing as you if they saw someone littering?	No, I think most people I know would behave differently Yes, I think most people I know would do the same as me.  I don't know what the people I know would do.  Don't Know Don't Understand Refused to Answer
16	If the chief saw someone dropping trash on the ground in _____, what do you think he would do?  1.	Nothing Give a warning/Talk to them  Punish them <i>Describe</i> _____  Tell someone else <i>Who</i> _____  Don't Know Don't Understand Refused to Answer
17	If a mzee (local elder) saw someone dropping trash on the ground in _____, what do you think he would do?  1.	Nothing Give a warning/Talk to them  Punish them <i>Describe</i> _____  Tell someone else <i>Who</i> _____  Don't Know Don't Understand Refused to Answer
18	Do you know of anyone else who has punished people in _____ for dropping trash on the ground in the past year?	No Yes <i>Who</i> _____  <i>Describe punishment</i> _____  Don't Know Don't Understand Refused to Answer
19	In general, do you think it fair to punish people who	No Yes

	drop trash on the ground?	Don't Know Don't Understand Refused to Answer
--	---------------------------	---

## C2: Swahili

Trash and Littering Questionnaire  
<Name of Village>

Jina la mshiriki \_\_\_\_\_  
Mwanamme ( ) Mwanawake ( )

### Utangulizi

**Ninafanya kazi na \_\_\_\_\_, katika utafiti huu, tunasoma kuhusu SAFISAFI na masingira.**

**Kwa ripoti ambayo tuambia tutauweka kwausiri, na ushiriki wako niwakijitolea, na unawesa kukataa wakati wowote. Ukiwa na swali lolote kutokana utafiti huu, anwani ni..... au mkuu wa wilaya.**

Je, kwa ripoti ulio sikia, unakubalikushiriki?

### Part I: Background information

Namba ri	Maswali	Majibu
1	Je , una mwiaka mingapi?	_____
2	kabila lako?	_____
3	umefika wapi ki masomo?	a) hakuna b) shule ya msingi c) shule ya upili d) mimemalisa shule ya upili e) koleji f) chuo kikuu
4	unaishi umbali wa kiasi gani kutoka kwa kijiji _____	a) naishi kijijini b)chini ya kilomita moja c)zaidi ya moja mpaka tano d)kilomita tano mpaka kumi e)zaidi ya ilomita kumi  f)sijui g) sielewi h) amekataa kujibu
5	wiki iliopita mara ngapi umetembea kijijini _____	a) naishi kwa kijiji b) 6 c) 5 d) 4

		e) 3 f) 2 g) mara ya kwanza  h) sijui
6	kuna kijiji, mji au jiji wewe utembelea zaidi kuliko ?	a) Ndio– Gani? _____  b) Akuna
7	kwa wiki zilizopita umetembelea kijiji _____ mara ngapi?	a) naishi kwa kijiji b) 6 c) 5 d) 4 e) 3 f) 2 g) mara ya kwanza  h) sijui

## Section II: Questions about Littering and Waste

Nambari	Maswali	Majibu
8	Unajua SAFISAFI? Unachukulia SAFISAFI kama shida kubwa katika kijijini _____?	a) ndio b) hapana  c) sijui d) sielewi e) amekataa kujibu
9	Kwa miezi zilizopita mara ngapi muliokota SAFISAFI kwenye kijijini _____?	a) 0 b) 1 c) 2 d) 3 e) 4 f) zaidi ya nne.....ngapi?  _____  g) sijui h) sielewi i) amekataa kujibu
10	Umewai shiriki kuokota SAFISAFI?	a) sijawai b) nimewahi ....nani alipanga? _____  c) sijui d) sielewi

		e) amekataa kujibu
11	Kuna mtu yejote amewaishiriki kuokota SAFISAFI unaye mjua?	a) sijawai b) nimewahi ....nani alipanga? _____  c) sijui d) sielewi e) amekataa kujibu
12	je, ingepangwa kuokota SAFISAFI leo, je ungeshiriki?	a) hapana b) ndio  c) sijui d) sielewi e) amekataa kujibu
13	Je, wakiti ukiwa na kipande cha SAFISAFI hua una kifanya nini?	a) tupa chini b) tupa kwenye pipa ama shimo c) naweka mpaka nyumbani  d) inategemea  e) sijui f) sielewi g) amekataa kujibu
14	Ukimwona mtu akitupa SAFISAFI chini? Ua unafanya nini?	a) akuna b) unampigia kelele c)ambia mtu mwingine..... nani? _____  d) inategemea  e) sijui f) sielewi g) amekataa kujibu
15	Je , unafikiria kwamba watu wengi wanawesa kufanya jambo lolote wakimwona mtu akitupa SAFISAFI chini?	a)hapana , nafikiria watu wengi wata chukulia vingine  b) ndio, nafikiria watu watafanya vilivyo  c)sijui watu wengi watafana nini  d) sijui e) sielewi f) amekataa kujibu
16	Je, chifu akimwona mtu akitupa SAFISAFI chini atafanya nini ?	a) hakuna b) ahmuonya c) atamua dhibu.....elezea adhabu _____

	1.	d) atamwambia mtu mwingine..... <i>Nani?</i> _____  e) sijui f) sielewi g) amekataa kujibu
17	Je,mzee wa kijiji akimwuona mtu akitupa SAFISAFI chini unafkiria atafanya nini? 1.	a) hakuna b) ahmuonya c) atamuia dhibu..... <i>elezea</i> <i>adhabu</i> _____ d) atamwambia mtu mwingine..... <i>Nani?</i> _____  e) sijui f) sielewi g) amekataa kujibu
18	Je, umamjua mtu ye yeyote umewai kua thibu watu kwa kutupa SAFISAFI chini kwamwiaka iliopita.	a) Hapana b) Ndio <i>Nani?</i> _____  <i>elezea adhabu</i> _____  c) sijui d) sielewi e) amekataa kujibu
19	kwaujumla, je unafikiria nihaki kuwaadhibu watu kwa kutupa SAFISAFI chini?	a) Hapana b) Ndio  c) sijui d) sielewi e) amekataa kujibu

## **Appendix D: Robustness Checks**

### **D1: Enumerator Malfeasance and Omitted Observations**

In Ndikir center, spot checks by SAFI staff revealed that the enumerator in one center falsified trash count and littering data for 13 weeks. This enumerator was fired, and the data from the weeks under suspicion are omitted from the analyses in Tables 2 through 5 in the main text. The falsified data were used to identify other possible instances of enumerator malfeasance, resulting in the identification of 121 problematic center-week observations in the trash count dataset and 82 problematic observations in the littering behavior dataset. These observations are also omitted from the analyses in Tables 1 through 5 in the main text.

The breakdown of problematic observations by center is as follows:

Center Name	Treatment Status	Type of Problem	Number of Weeks
Dol Dol	Control Group	Irregular Change in Trash Count	33
Endana	Elders Treatment Group	Irregular Changes in Littering Behavior	21
Jua Kali	Control Group	Irregular Changes in Littering Behavior	20
Mumero	Control Group	Irregular Change in Trash Count	46
Munyankalo	Control Group	Irregular Change in Trash Count	21
Ndikir	Chief Treatment Group	Possible Enumerator Misconduct	13
Ndikir	Chief Treatment Group	Irregular Changes in Littering Behavior	20
Ngare Ndare	Elders Treatment Group	Irregular Change in Trash Count	21
Ngare Ngiro	Chief Treatment Group	Irregular Changes in Littering Behavior	21

Tables D1-1 through D1-4 present the cross-sectional regressions and difference-in-differences models used in tables with two alternative datasets. Tables D1-1 and D1-3 present the Trash Count analyses using the full dataset with no problematic observations omitted. Tables D1-2 and D1-4 present the Trash Count analyses omitting only the observations with confirmed enumerator malfeasance. Tables D1-5 through D1-8 present the same analyses for the Proportion Littering measure.

	Trash Count, Short Term	Trash Count, Medium Term	Trash Count, Long Term
Elders	-11.97* (6.459)	-12.65** (5.211)	-12.99** (5.561)
Chief	-7.385 (6.459)	-9.977* (5.211)	-4.356 (5.561)
Collective Action	-8.304 (6.459)	-10.30* (5.211)	-10.58* (5.561)
Constant	21.91 *** (5.664)	17.82 *** (4.874)	19.15 *** (5.202)
Observations	36	36	36
R-squared	0.212	0.303	0.285
<b>Wald Test</b>			
Elders vs. Chief	0.34	0.18	1.61
Elders vs. Collective Action	0.21	0.14	0.13
Chief vs. Collective Action	0.01	0.00	0.84

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 1: Cross-Sectional Regressions of Trash Count on Treatment Groups, Divided by Period – All Observations

	Trash Count, Short Term	Trash Count, Medium Term	Trash Count, Long Term
Elders	-11.97* (6.564)	-12.65** (5.211)	-12.99** (5.561)
Chief	-10.92 (6.552)	-9.977* (5.211)	-4.356 (5.561)
Collective Action	-8.310 (6.564)	-10.30* (5.211)	-10.58* (5.561)
Constant	22.46*** (5.756)	17.82*** (4.874)	19.15*** (5.202)
Observations	36	36	36
R-squared	0.196	0.303	0.285
<b>Wald Test</b>			
Elders vs. Chief	0.02	0.18	1.61
Elders vs. Collective Action	0.21	0.14	0.13
Chief vs. Collective Action	0.11	0.00	0.84

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 2: Cross-Sectional Regressions of Trash Count on Treatment Groups, Divided by Period – No Malfeasance

	Trash Count, Short Term	Trash Count, Medium Term	Trash Count, Long Term
Elders	0.0384 (5.307)	0.0384 (4.916)	0.0384 (5.012)
Elders*After	-12.01 (8.005)	-12.69* (6.953)	-13.03* (7.088)
Chief	3.848 (5.307)	3.848 (4.916)	3.848 (5.012)
Chief*After	-11.49 (8.005)	-13.83* (6.953)	-8.204 (7.088)
Collective Action	0.356 (5.307)	0.356 (4.916)	0.356 (5.012)
Collective Action*After	-8.684 (8.005)	-10.66 (6.953)	-10.94 (7.088)
After Treatment	0.396 (3.753)	-0.449 (3.476)	0.125 (3.544)
Constant	21.42*** (3.980)	19.80*** (3.687)	20.18*** (3.759)
Observations	72	72	72
R-squared	0.202	0.275	0.266
<b>Wald Test</b>			
Elders vs. Chief	0.00	0.02	0.31
Elders vs. Collective Action	0.11	0.06	0.06
Chief vs. Collective Action	0.08	0.14	0.10

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 3: Difference-in-Differences Regressions of Trash Count Littering on Treatment Groups, Divided By Period – All Observations

	Trash Count, Short Term	Trash Count, Medium Term	Trash Count, Long Term
Elders	0.0450 (5.359)	0.0384 (4.916)	0.0384 (5.012)
Elders*After	-12.02 (8.083)	-12.69* (6.953)	-13.03* (7.088)
Chief	3.874 (5.359)	3.848 (4.916)	3.848 (5.012)
Chief*After	-15.04* (8.069)	-13.83* (6.953)	-8.204 (7.088)
Collective Action	0.363 (5.359)	0.356 (4.916)	0.356 (5.012)
Collective Action*After	-8.698  (8.083)	-10.66  (6.953)	-10.94  (7.088)
After Treatment	0.409 (3.789)	-0.449 (3.476)	0.125 (3.544)
Constant	21.69*** (4.019)	19.80*** (3.687)	20.18*** (3.759)
Observations	72	72	72
R-squared	0.201	0.275	0.266
<b>Wald Test</b>			
Elders vs. Chief	0.09	0.02	0.31
Elders vs. Collective Action	0.11	0.06	0.06
Chief vs. Collective Action	0.41	0.14	0.10

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 4: Difference-in-Differences Regressions of Trash Count Littering on Treatment Groups, Divided By Period – No Malfeasance

	Proportion Littering, Short Term	Proportion Littering, Medium Term	Proportion Littering, Long Term
Elders	-0.454 *** (0.0536)	-0.126 * (0.0649)	-0.0624 (0.0572)
Chief	-0.453 *** (0.0536)	-0.0765 (0.0649)	-0.0799 (0.0572)
Collective Action	-0.420 *** (0.0536)	-0.230 *** (0.0649)	-0.206 *** (0.0572)
Constant	0.781 *** (0.0470)	0.535 *** (0.0607)	0.594 *** (0.0535)
Observations	36	36	36
R-squared	0.846	0.446	0.444
<b>Wald Test</b>			
Elders vs. Chief	0.00	0.39	0.06
Elders vs. Collective Action	0.28	1.70	4.21 *
Chief vs. Collective Action	0.25	3.73 *	3.24 *

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 5: Cross-Sectional Regressions of Proportion Littering on Treatment Groups, Divided By Period – All Observations

	Proportion Littering, Short Term	Proportion Littering, Medium Term	Proportion Littering, Long Term
Elders	-0.454 *** (0.0544)	-0.126 * (0.0649)	-0.0624 (0.0572)
Chief	-0.483 *** (0.0543)	-0.0765 (0.0649)	-0.0799 (0.0572)
Collective Action	-0.420 *** (0.0544)	-0.230 *** (0.0649)	-0.206 *** (0.0572)
Constant	0.786 *** (0.0477)	0.535 *** (0.0607)	0.594 *** (0.0535)
Observations	36	36	36
R-squared	0.846	0.446	0.444
<b>Wald Test</b>			
Elders vs. Chief	0.19	0.39	0.06
Elders vs. Collective Action	0.27	1.70	4.21 *
Chief vs. Collective Action	0.91	3.73 *	3.24 *

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 6: Cross-Sectional Regressions of Proportion Littering on Treatment Groups, Divided By Period – No Malfeasance

	Proportion Littering, Short Term	Proportion Littering, Medium Term	Proportion Littering, Long Term
Elders	-0.0612 (0.0464)	-0.0612 (0.0557)	-0.0612 (0.0496)
Elders*After	-0.389*** (0.0700)	-0.0651 (0.0787)	-0.00118 (0.0701)
Chief	-0.0960** (0.0464)	-0.0960* (0.0557)	-0.0960* (0.0496)
Chief*After	-0.350*** (0.0700)	0.0195 (0.0787)	0.0161 (0.0701)
Collective Action	-0.0621 (0.0464)	-0.0621 (0.0557)	-0.0621 (0.0496)
Collective Action*After	-0.353*** (0.0700)	-0.168** (0.0787)	-0.144** (0.0701)
After Treatment	-0.123*** (0.0328)	-0.257*** (0.0394)	-0.253*** (0.0351)
Constant	0.888*** (0.0348)	0.832*** (0.0418)	0.859*** (0.0372)
Observations	72	72	72
R-squared	0.851	0.703	0.725
<b>Wald Test</b>			
Elders vs. Chief	0.21	0.77	0.04
Elders vs. Collective Action	0.17	1.14	2.77
Chief vs. Collective Action	0.00	3.78*	3.48*

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 7: Difference-in-Differences Regressions of Proportion Littering on Treatment Groups, Divided By Period – All Observations

	Proportion Littering, Short Term	Proportion Littering, Medium Term	Proportion Littering, Long Term
Elders	-0.0612 (0.0466)	-0.0612 (0.0557)	-0.0612 (0.0496)
Elders*After	-0.389*** (0.0702)	-0.0651 (0.0787)	-0.00118 (0.0701)
Chief	-0.0959** (0.0466)	-0.0960* (0.0557)	-0.0960* (0.0496)
Chief*After	-0.381*** (0.0701)	0.0195 (0.0787)	0.0161 (0.0701)
Collective Action	-0.0620 (0.0466)	-0.0621 (0.0557)	-0.0621 (0.0496)
Collective Action*After	-0.353*** (0.0702)	-0.168** (0.0787)	-0.144** (0.0701)
After Treatment	-0.123*** (0.0329)	-0.257*** (0.0394)	-0.253*** (0.0351)
Constant	0.890*** (0.0349)	0.832*** (0.0418)	0.859*** (0.0372)
Observations	72	72	72
R-squared	0.855	0.703	0.725
<b>Wald Test</b>			
Elders vs. Chief	0.01	0.77	0.04
Elders vs. Collective Action	0.17	1.14	2.77
Chief vs. Collective Action	0.10	3.78*	3.48*

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix D1 Table 8: Difference-in-Differences Regressions of Proportion Littering on Treatment Groups, Divided By Period – No Malfeasance

## D2: Alternative Cross-Sectional Time-Series Specifications

In Tables D2-1 through D2-4 below, I present alternative analyses of the Trash Count and Proportion Littering measures that utilize the full Cross-Sectional Time-Series dataset. I estimate two different Cross-Sectional Time-Series models. First, I estimate a fixed effects model:

$$y_{ct} = \beta_0 + \beta_1 P_{ct} + \beta_2 T_{ct}^E + \beta_3 T_{ct}^E * P_{ct} + \beta_4 T_{ct}^C + \beta_5 T_{ct}^C * P_{ct} + \beta_6 T_{ct}^{CA} + \beta_7 T_{ct}^{CA} * P_{ct} + C'_c \Gamma + W_t \Gamma + R'_c \Gamma + \varepsilon_{ct}$$

$T_{ct}^E$ ,  $T_{ct}^C$ , and  $T_{ct}^{CA}$  are dummy variables coded 1 if center  $c$  had received the Elders, Chief, or Collective Action treatment in week  $t$ .  $P_{ct}$  is a dummy variable for the three post-treatment periods used in the main text,  $C_c$  is a fixed effect for centers,  $W_t$  is a fixed effect for weeks,  $R_c$  is a fixed effect for regional blocks, and  $\varepsilon_{ct}$  is an error term.

Second, I estimate a random effects model:

$$y_{ct} = \beta_0 + \beta_1 P_{ct} + \beta_2 T_{ct}^E + \beta_3 T_{ct}^E * P_{ct} + \beta_4 T_{ct}^C + \beta_5 T_{ct}^C * P_{ct} + \beta_6 T_{ct}^{CA} + \beta_7 T_{ct}^{CA} * P_{ct} + \gamma_c + W_t \Gamma + R'_c \Gamma + \varepsilon_{ct}$$

where  $\gamma_c$  is a random effect for center, and all treatment group dummies, period dummies, error terms, and week and region fixed effects are denoted as above. Each of the models is also estimated without week fixed effects in Column 1 of each table in Appendix D2. For the models below, I use the version of the dataset used in the main text. Versions of these models using the alternate datasets Appendix D1 are available on request.

	1 Trash Count	2 Trash Count
Elders	-6.581** (2.913)	-6.443** (2.641)
Chief	-11.05** (4.422)	-10.99** (4.453)
Collective Action	-6.012 (6.276)	-5.849 (6.126)
Before Treatment	4.593* (2.405)	2.682 (1.891)
After Treatment – Short Term	1.771 (2.703)	-0.280 (1.591)
After Treatment – Medium Term	1.338 (2.225)	0.765 (1.583)
After Treatment – Long Term	-1.833 (1.555)	-0.871 (1.158)
Elders* After Short Term	-0.326 (2.051)	-0.352 (2.095)
Elders*After Medium Term	-3.246 (2.128)	-3.193 (2.121)
Elders*After Long Term	-1.255 (1.396)	-1.295 (1.348)
Chief* After Short Term	-1.183 (2.885)	-1.212 (2.959)
Chief*After Medium Term	-2.293 (1.707)	-2.270 (1.888)
Chief*After Long Term	0.875 (1.612)	0.851 (1.651)
Collective Action * After Short Term	2.424 (1.778)	2.388 (1.854)
Collective Action *After Medium Term	-1.738 (1.865)	-1.707 (1.947)
Collective Action *After Long Term	0.243 (1.624)	0.220 (1.613)
Constant	23.30*** (3.109)	20.38*** (1.769)
Observations	4228	4228
R-squared	0.235	0.203

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks. Column 1 includes week fixed effects.

Appendix D2 Table 1: Alternative Cross-Sectional Time Series for Trash Count, Fixed Effects

	1 Trash Count	2 Trash Count
Elders	-6.673** (2.879)	-6.590** (2.601)
Chief	-10.88** (4.338)	-10.72** (4.334)
Collective Action	-6.121 (6.073)	-6.022 (5.824)
Before Treatment	4.587* (2.392)	2.675 (1.875)
After Treatment – Short Term	1.769 (2.706)	-0.284 (1.600)
After Treatment – Medium Term	1.329 (2.229)	0.745 (1.592)
After Treatment – Long Term	-1.831 (1.559)	-0.868 (1.163)
Elders* After Short Term	-0.330 (2.058)	-0.356 (2.104)
Elders*After Medium Term	-3.238 (2.135)	-3.181 (2.130)
Elders*After Long Term	-1.262 (1.404)	-1.306 (1.358)
Chief* After Short Term	-1.191 (2.891)	-1.224 (2.968)
Chief*After Medium Term	-2.297 (1.716)	-2.276 (1.898)
Chief*After Long Term	0.856 (1.618)	0.821 (1.660)
Collective Action * After Short Term	2.437 (1.782)	2.409 (1.857)
Collective Action *After Medium Term	-1.714 (1.878)	-1.671 (1.965)
Collective Action *After Long Term	0.252 (1.634)	0.234 (1.627)
Constant	22.11*** (3.555)	19.13*** (2.398)
Observations	4228	4228
R-squared	0.234	0.203

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks. Column 1 includes week fixed effects.

Appendix D2 Table 2: Alternative Cross-Sectional Time Series for Trash Count, Random Effects

	1 Proportion Littering	2 Proportion Littering
Elders	0.154** (0.0596)	0.147** (0.0629)
Chief	0.138*** (0.0466)	0.125** (0.0496)
Collective Action	0.139 (0.0869)	0.128 (0.0962)
Before Treatment	0.304*** (0.0901)	0.392*** (0.0300)
After Treatment – Short Term	0.292*** (0.0866)	0.250*** (0.0382)
After Treatment – Medium Term	0.136** (0.0571)	0.120*** (0.0333)
After Treatment – Long Term	0.133*** (0.0424)	0.135*** (0.0329)
Elders* After Short Term	-0.540*** (0.0775)	-0.553*** (0.0783)
Elders*After Medium Term	-0.236*** (0.0559)	-0.236*** (0.0563)
Elders*After Long Term	-0.160** (0.0710)	-0.161** (0.0705)
Chief* After Short Term	-0.523*** (0.0726)	-0.527*** (0.0728)
Chief*After Medium Term	-0.135*** (0.0421)	-0.136*** (0.0401)
Chief*After Long Term	-0.100** (0.0467)	-0.101** (0.0471)
Collective Action * After Short Term	-0.450*** (0.0821)	-0.457*** (0.0827)
Collective Action *After Medium Term	-0.291*** (0.0556)	-0.290*** (0.0564)
Collective Action *After Long Term	-0.277*** (0.0572)	-0.276*** (0.0542)
Constant	0.568*** (0.0996)	0.448*** (0.0307)
Observations	4203	4203
R-squared	0.348	0.307

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks. Column 1 includes week fixed effects.

Appendix D2 Table 3: Alternative Cross-Sectional Time Series for Proportion Littering,  
Fixed Effects

	(1) Proportion Littering	(2) Proportion Littering
Elders	0.150** (0.0593)	0.132** (0.0603)
Chief	0.131*** (0.0458)	0.100** (0.0456)
Collective Action	0.130 (0.0828)	0.0954 (0.0767)
Before Treatment	0.302*** (0.0900)	0.381*** (0.0282)
After Treatment – Short Term	0.292*** (0.0865)	0.248*** (0.0381)
After Treatment – Medium Term	0.136** (0.0571)	0.119*** (0.0334)
After Treatment – Long Term	0.133*** (0.0424)	0.134*** (0.0330)
Elders* After Short Term	-0.539*** (0.0776)	-0.551*** (0.0783)
Elders*After Medium Term	-0.236*** (0.0559)	-0.235*** (0.0563)
Elders*After Long Term	-0.160** (0.0710)	-0.160** (0.0704)
Chief* After Short Term	-0.523*** (0.0727)	-0.525*** (0.0731)
Chief*After Medium Term	-0.134*** (0.0421)	-0.135*** (0.0400)
Chief*After Long Term	-0.100** (0.0468)	-0.0999** (0.0476)
Collective Action * After Short Term	-0.449*** (0.0822)	-0.450*** (0.0825)
Collective Action *After Medium Term	-0.290*** (0.0559)	-0.285*** (0.0578)
Collective Action *After Long Term	-0.276*** (0.0572)	-0.271*** (0.0543)
Constant	0.544*** (0.0977)	0.436*** (0.0334)
Observations	4203	4203
R-squared	0.348	0.307

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks. Column 1 includes week fixed effects.

Appendix D2 Table 4: Alternative Cross-Sectional Time Series for Proportion Littering, Random Effects

### D3: Logit Model for Survey Data

Tables D3-1, D3-2, and D3-3 below present the analyses from Tables 6, 7, and 8 in the paper using Logit models rather than OLS.

	1	2	3 Self-Reported and Observed Littering
	Is Trash a Problem?	Do You Litter?	Match
Elders	0.349 (0.659)	-0.548 (0.356)	-0.0314 (0.504)
Chief	0.928* (0.509)	-0.376 (0.382)	0.644 (0.595)
Collective Action	2.360** (0.918)	-1.183** (0.566)	-0.313 (0.613)
Gender	0.416 (0.569)	-0.0593 (0.190)	0.0219 (0.174)
Age	0.121 (0.0903)	0.0218 (0.0349)	0.0520 (0.0319)
Age Squared	-0.00158 (0.000988)	-0.000254 (0.000460)	-0.000486 (0.000398)
Education-Primary	0.793 (0.493)	-0.535* (0.266)	-0.372 (0.264)
Education-Secondary	1.241*** (0.430)	-1.321*** (0.258)	-0.938*** (0.270)
Education-Post-Secondary	0 (.)	-2.230*** (0.541)	-0.750 (0.532)
Distance- < 1 KM	0.856 (0.620)	0.276 (0.250)	0.569** (0.268)
Distance- 1-5 KM	0.0540 (0.572)	0.544* (0.300)	0.535** (0.209)
Distance- 5-10 KM	-0.182 (0.922)	0.781* (0.435)	0.788* (0.420)
Distance- > 10 KM	0.356 (1.270)	0.282 (0.457)	0.844 (0.597)
Number of Visits Per Week	0.272* (0.160)	-0.0157 (0.0854)	0.140* (0.0815)
Pastoralist	-0.114 (0.526)	-0.000888 (0.260)	-0.0877 (0.362)
Constant	-0.747 (1.357)	-0.216 (0.934)	-2.616** (0.973)
Observations	917	1020	853

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix C3 Table 1: Regressions of Attitudes Towards Trash and Littering on Treatment Groups and Individual Attributes, Logit Model

	1 Would You Participate in a Cleanup Today?	2 Have You Ever Participated in a Cleanup?	3 Number of Monthly Cleanups in Center
Elders	1.416** (0.560)	0.706 (0.541)	0.673 (0.625)
Chief	0.941 (0.582)	0.506 (0.423)	0.775 (0.548)
Collective Action	1.648** (0.664)	1.203** (0.521)	2.575*** (0.360)
Gender	0.281 (0.243)	0.277* (0.149)	0.198 (0.159)
Age	0.0665 (0.0394)	0.0529* (0.0297)	0.0739** (0.0362)
Age Squared	-0.000641 (0.000465)	-0.000662 (0.000402)	-0.000791* (0.000463)
Education-Primary	0.402 (0.386)	0.374 (0.287)	0.680** (0.294)
Education-Secondary	0.973*** (0.348)	0.721** (0.299)	0.944*** (0.291)
Education-Post-Secondary	1.258*** (0.419)	0.982** (0.375)	1.489*** (0.387)
Distance- < 1 KM	-0.0558 (0.558)	0.0802 (0.269)	0.122 (0.293)
Distance- 1-5 KM	-0.703 (0.588)	-0.561* (0.307)	-0.0873 (0.406)
Distance- 5-10 KM	-1.629*** (0.589)	-0.751 (0.532)	-0.670 (0.495)
Distance- > 10 KM	-1.003 (0.855)	-0.709 (0.536)	-0.754 (0.743)
Number of Visits Per Week	0.0256 (0.0810)	0.198** (0.0871)	0.222** (0.0885)
Pastoralist	0.791** (0.333)	0.149 (0.199)	-0.317 (0.369)
Constant	0.0821 (1.147)	-3.859*** (0.981)	-4.976*** (1.072)
Observations	985	989	906

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix C3 Table 2: Regressions of Self-Reported Clean-up Participation and Frequency on Treatment Groups and Individual Attributes, Logit Model

	1	2
	If you see Someone Littering, Would You Yell at Them?	If You See Someone Littering, Would You Tell on Them?
Elders	0.549 (0.388)	2.132** (0.787)
Chief	0.889** (0.367)	1.093 (0.784)
Collective Action	0.835 (0.516)	2.108** (0.812)
Gender	0.186 (0.207)	-0.165 (0.231)
Age	-0.0597 (0.0398)	0.303* (0.156)
Age Squared	0.000935* (0.000461)	-0.00544** (0.00243)
Education-Primary	0.434 (0.303)	1.303 (0.891)
Education-Secondary	0.277 (0.346)	1.650* (0.958)
Education-Post-Secondary	0.465 (0.489)	1.686* (0.879)
Distance- < 1 KM	-0.152 (0.241)	-0.890** (0.349)
Distance- 1-5 KM	-0.364 (0.306)	-0.645 (0.490)
Distance- 5-10 KM	-0.310 (0.509)	-0.00648 (0.718)
Distance- > 10 KM	-0.00413 (0.617)	-0.849 (0.893)
Number of Visits Per Week	0.129 (0.0795)	-0.0564 (0.104)
Pastoralist	0.566* (0.314)	0.446 (0.397)
Constant	-2.812*** (0.954)	-9.971*** (2.550)
Observations	922	922

Standard errors in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . All models include fixed effects for regional blocks.

Appendix C3 Table 3: Actions Against Littering Behavior on Treatment Groups and Individual Attributes, Logit Model