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ARTISANAL AND SMALL-SCALE MINING (ASM) GOVERNANCE AND CUSTOMARY TENURE INSTITUTIONS: PRACTICES AND OUTCOMES IN GUINEA[1]

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1 The views and opinions expressed in this paper are those of the authors and not necessarily the views and opinions of the United States Agency for International Development (USAID).

Abstract
There are ongoing attempts across African societies to superimpose modern legal institutions onto community institutions. In Guinea, attempts are underway to bring artisanal and small-scale diamond mining in line with a formal regulation and parcel allocation system. Artisanal and small-scale mining (ASM) in Guinea's Forécariah and Kindia regions is currently governed by customary governance structures and deeply rooted customary institutions for land and property rights management. Thus far, formal structures have failed to replace or integrate with customary institutions. Identifying how to achieve complementarity between an informal and formal system that are defined by deep cultural and structural tensions requires a solid understanding of customary institutions (Ensminger 1995). The overarching objective of this paper is to inform policy prescriptions for interventions that achieve greater overlap and integration between formal and informal institutions. To this end, the paper has two research goals. First, the study seeks to provide policy planners with a deeper understanding of the customary institutions and systems governing ASM in Guinea's Forécariah and Kindia regions. Based on the empirical results, the paper seeks to provide concrete policy recommendations for promoting greater complementarity. Empirical data on ASM of this scope and scale is uncommon, especially in Guinea, therefoe, this analysis presents a unique contribution to literature around tenure security, resource contestations and land governance for mining communities and the ASM sector in Sub-Saharan Africa. The analysis can also provide a broader contribution to research surrounding resource expropriation and environmental protection in areas with a history of strong but informal customary governance.

Key Words
Artisanal and small-scale mining (ASM), customary tenure, subsurface rights, land governance, Kimberley Process Certification Scheme

1. INTRODUCTION

Artisanal and small-scale mining (ASM) is an important, if often-overlooked, means of income generation for individuals living in developing countries that are rich in resources such as gold, gemstones, and other minerals (Hilson 2009). The economic role of ASM can range across contexts from a specialized pursuit for individual actors looking to "strike it rich" to a widespread secondary or even primary local economic activity that is critical in addressing rural poverty in conjunction with subsistence agriculture. ASM can be an important means of coping with unemployment and of lessening rural to urban migration pressures. Aside from the jobs that ASM directly provides to diggers, washers, surveillants, Masters and mine bosses, it is estimated that six support jobs are created for every one job in the ASM sector, including taxi drivers, cooks, and other support services. In Guinea alone, it is estimated that 300,000 people work directly in ASM and another 1.5 million people benefit from this economic activity.

Despite the potential livelihood benefits, the ASM sector also presents local and national challenges for countries with these natural resources. Locally, concerns arise about environmental degradation, crime, drug use, prostitution and conflict with the host community. Nationally, to avoid lost revenues due to an export ban, governments must ensure ASM sector compliance with the Kimberley Process Certification Scheme (KPCS), which requires mine-to-export traceability systems in order to certify diamond exports as conflict-free. The potential revenues for governments through formalization of ASM, combined with international ethical concerns about labor standards, safety, and the danger of ASM's use to fund rebel groups and gangs, produce strong incentives for national governments and international donors to prioritize programs that bring the sector in line with KPCS standards.

Nevertheless, achieving KPCS compliance represents a significant task for many governments for two main reasons. First, there is a large resource and capacity burden on states to ensure that the ASM sector adheres to the formal registration, licensing and traceability requirements required by KPCS. Nyame and Blocher (2010) summarize the multitude of government activities and limitations that contribute to the persistence of an informal ASM sector, including "unfavorable government policies, the cumbersome and bureaucratic nature of registration procedures, large-scale mining encumbering large tracts of land at the expense of ASM…and structural adjustment programs undertaken by governments in the sub-region" (47), because of increases in poverty and

unemployment that followed these structural adjustment reforms (Mohammed Banchirigah 2006, Hilson and McQuilken 2104) .

Second, artisanal mining of diamonds throughout Sub-Saharan Africa often occurs within a complex land tenure system typified by overlapping statutory and customary regimes (Nyame and Blocher 2010, Freudenberger et al. 2015). Therefore, resource and capacity challenges are further exacerbated by attempts to build this new formal system on a fundamentally different and entrenched informal system (Ensminger 1997). The simple act of "absorbing" customary practices into law through formalization is not sufficient to produce a working synthesis of the two regimes. Too often, pushes for legalization ignore that "miners must be able to *see incentives* for registering [production] in order for the policy to be effective and equitable," (Spiegel 2012, 199). This complexity is compounded by the heterogeneity of miners operating in the area, since miners are often young and transient actors without a formal role in traditional governance.

An evolving example of ASM formalization is found in the Forécariah and Kindia prefectures in the Guinée-Maritime region of Guinea (Figure 1). There, the state has begun to exercise sub-surface rights in diamond mining areas, but customary land tenure processes dictate access, use, and management of land and natural resources. However, the state has limited capacity for parceling ASM sites and issuing licenses to miners—in 2014, just 14 licenses were issued in Forecariah prefecture—producing an environment of competing regimes for managing mining sites (Freudenberger et al. 2015, USAID 2014b). The Ministry of Mines and Geology has simply lacked the staff, the budget, and the tools to oversee production in all of Guinea's diamond mining areas (USAID 2014b). In other areas of Guinea, threats by the state to customary land governance institutions' control of ASM have produced conflicts over land access and compensation (USAID 2014). Overall, Guinea's experience illustrates the two main challenges to ASM formalization—weak state capacity combined with conflicts that arise from attempts to overlay the formal system onto deeply entrenched customary institutions.

This paper is motivated by two primary objectives. First, it draws on primary data collected across a large sample of households and mining sector representatives—the first and largest study of its kind in this region—to help clarify the complex tenure regime that governs artisanal mining of diamonds in Guinea, providing insight to donors and implementing partners about when statutory

versus customary systems are applied and enforced. In particular, this analysis draws on baseline data from two large-N quantitative surveys of households (N=2,165) and of individuals involved in the ASM sector as miners, overseers, or Customary Land Owners (CLOs) (N=916) collected for an impact evaluation of the Property Rights and Artisanal Diamond Development Project II (PRADD II) project in Forécariah and Kindia prefectures. Data from these surveys is supplemented by a smaller survey of CLOs in each community (N=108) and qualitative data from focus group discussions and key informant interviews. Focus group data was collected from women, youth, ethnic minorities, and miners, and key informants included CLOs and plantation owners. This supplemental data details shifting attitudes and outcomes regarding the security, governance, and condition of land and water resources, as well as perceptions about ASM and the legality of diamond production in mining communities.

Secondly, through an in-depth case study and empirical analysis of the PRADD baseline data, this paper explores avenues for improving ASM governance and outcomes by investigating the potential for overlap and integration between the informal and formal systems in Forecariah and Kindia. We focus on a discussion of the real and potential benefits of each system, as well as the points of overlap that might best pave the way for a hybrid model that improves ASM livelihoods and outcomes. Specifically, the study investigates whether and how customary institutions heighten social gains and mitigate the social and environmental impacts of mining, with the goal of exploring potential areas where ASM formalization can bolster the well-being of receiving miners and communities.

The paper is structured as follows—Section 2 presents descriptive findings about the current ASM context of low uptake of the formal mining system in the study area. Then, Section 3 details the prevalent customary controls on mining and land allocation. Section 4 explores the possibility for formalization to help communities surrounding ASM sites to secure greater social benefits and mitigate environmental costs of mining. Finally, Section 5 provides discussion about challenges encountered in creating a hybrid system of ASM management, and Section 6 concludes the paper.

2. PARCELIZATION AND THE KIMBERLEY PROCESS

For the first research objective, this and the following section describe the application of customary versus statutory tenure systems for use, access, and management rights to mining sites,

as well as the comparative status of tenure rights for miners, landowners, and farmers. Examining the routine mining practices in these areas elucidates the degree of application of statutory tenure systems and the extent to which the customary and statutory systems have evolved to accommodate each other.

Accounting for more than 90% of the country's exports, mining of gems, metals and other minerals is critical for Guinea's economic growth and sustainable development (Bermudez-Lugo 2012). The government of Guinea faces internal and external incentives to formalize the country's ASM sector through parcelization and licensing. Internally, claiming subsurface mineral rights is an opportunity for the government of Guinea to generate revenue from permits and from taxes when diamonds are sold on official markets.

The Kimberley Process Certification Scheme (KPCS) is the main external incentive driving the government of Guinea to exert greater control over the ASM sector. Ratified in 2002, the KPCS is an international certification scheme designed to prevent conflict diamonds from entering legitimate trade on world markets by establishing standards and requirements for monitoring the internal chain of custody of diamonds (USAID, 2014a). KP participants must certify diamond shipments as conflict free, establish mine to export traceability systems, implement national legislation and institutions pertaining to diamond mining, employ internal controls, and commit to transparency and exchange of statistical data (USAID, 2014b). Guinea has struggled to meet the obligations of the KPCS, and the nation was cited in 2009 in a KP Administrative Decision for abnormally high export figures in 2007-2008 that were inconsistent with the country's formal diamond production capacity. At that time the country was requested to follow an action plan for strengthening internal controls on production and monitoring (Chirico, 2012).

Despite this pressure, thus far, uptake of the formal system has been in Forecariah and Kindia prefectures. Diamond mining in these prefectures occurs in the Atlantic-draining Konkouré River basin. Artisanal miners use open pit methods to dig for diamonds primarily with hand tools and no mechanized tools or equipment, except for some use of water pumps powered by small generators (USAID, 2015).

However, Forecariah and Kindia are far from the most important diamond-producing regions in Guinea (Figure 1). The regions are estimated to contain only 4% of the country's current annual diamond production capacity. In contrast, the most important region for diamond production is the forest region of Kerouane prefecture, which is the location of the Banankoro diamond mining area, accounts for 69% of current diamond production capacity and is the only one of Guinea's diamond regions where industrial production occurs. Forecariah was actually found to have the lowest gravel grade of all diamond regions in Guinea (0.08 ct/m^3, [2] compared to 0.20 ct/m^3 in Kerouane) (Chirico, 2012). Diamond mining is often a secondary or tertiary economic activity for local inhabitants, as they are primarily engaged in subsistence agriculture, but there is also some migration to these areas for mining from other parts of Guinea and from Sierra Leone (USAID, 2015).

The Ministry of Mines and Geology (*Ministère des Mines et de la Géologie*, MMG) began work to formalize ASM activities in Forécariah in 2013 (USAID 2014b). By 2014, the MMG had parceled approximately 130 active and inactive mines across Forécariah, but very few parcels were purchased. Each parcel is one hectare and requires the user to purchase an artisanal mining permit (USAID 2015). Thus far, only 14 parcels have been purchased, and most of these are by external actors (Ibid.). This first parceling project was criticized for lack of consideration of geological data indicating the probable presence of alluvial diamonds when selecting land to parcel. To enable more effective parceling of the area, the United States Geological Survey (USGS) conducted a test project in the area to map diamondiferous sites through high-resolution aerial mapping.[3] The MMG plans to continue conducting parceling operations across the entire watershed of Forécariah to improve regulation and control over small-scale diamond mining, (USAID 2014a).[4]

These trends are reflected in our households (N=2,165), miner (N=916) and Community Land Owner (N=108) survey data collected in 2014 as part of the baseline data collection for the PRADD II impact evaluation in Forécariah and Kindia prefectures. According to miner survey data, formal mapping of mining sites by the governments is rare, and has occurred in 9% (152) of mining sites

2 Carats (ct) per cubic meter (m3).

3 http://www.usaidlandtenure.net/sites/default/files/USAID_Land_Tenure_PRADD-II_Guinea_Snapshot_August_2014_0.pdf

4 Personal correspondence with PRADD: As of August 2014, there are a total of 130 parcels. MMG conducted additional parceling operation in 2014, and 14 of these parcels have been purchased.

used by miner survey respondents in the last year. Of these mapped sites, 34% (45) require a formal license or mining permit. On their current worksite, 11% of miners (93) were required to acquire some type of documentation, but only 1% (11) was required to attain a formal mining license. Five of the miners surveyed are holders of any of these permits. Only 4% (34) of miners have ever registered their production, and only seven miners have kept a document of registration or sale of their production.

According to data collected during the CLO survey, 30% (32) of CLOs have a mining site on their customary land. Ten of these mines (31%) have been formally mapped, and of those that have been mapped, half have formal permit or license (5). The CLO is the holder of the license in three of these cases.

Relatedly, knowledge and awareness of policies and laws—such as the Kimberley Process, the National Mining Law, and the Land Code—is low. Only eight percent (74) of respondents to the miner survey have heard of the Kimberly Process (KP). Among the miners who are aware of the KP, the most common method for learning about the process was radio (36%, 27), followed by neighbors, friends, and family (20%, 15), NGO and donor information session (19%, 14) and mine bosses and owners (18%, 13).[5]Among the miners who have heard of the KP, most miners correctly identified that the KP regulates diamonds (N=56) and correctly identified Guinea as a participating country in the KP (51). Some also stated they knew the primary purpose of the Kimberly Process Certificate Scheme (17).

There is slightly greater, though still low, awareness of the National Mining Law, which regulates mining rights, as 11% of miner survey respondents (102) have heard of this law. Like the KP, the most common process for leaning about the National Mining Law is the radio (39%, 40), followed by neighbors, friends, and family (25%, 26), mine bosses and owners (13%, 13), and government officials (11%, 11).[6] Miners are also better informed about the National Mining Law than the Kimberly Process. Most miners who have heard of the law correctly identified that the National Mining Law recognizes the right to compensation for interrupted land use (91%, 91), correctly

5 Less common sources for learning about the KP are newspapers (4%, 3), community leaders (4%, 3), and government officials (1%, 1).

6 Less common sources are newspapers (7%, 7), community leaders (5%, 5), and NGO information sessions (2%, 2).

agreed that mining rights do not extinguish property rights (86%, 84), and correctly identified that no right to prospect or operate is valid without consent of the landowner (83%, 88).

Ten percent (88) of miners are familiar with the Land Code, primarily through radio (56%, 52). Government officials (14%, 12), neighbors and friends (14%, 13), and community leaders (9%, 8) are also common sources.[7] Seventy-seven percent (60) of miners correctly identified that obtaining official documentation for property can be done only through the Land Registry.

Only three CLOs had heard of the Kimberley Process, and four had heard of the national mining law. Slightly more CLOs (10) have heard of the Land Code. Given the low awareness of the National Mining Law and the Land Code, it is unsurprising that 94% of CLOs (101) said that they are 'not at all familiar' with the LAND registry process, and none have certified land through the process.

A need for the Property Rights and Artisanal Diamond Development Project II (PRADD II) [8] project funded by USAID was identified in Forecariah (Figure 2) because of the almost entirely informal nature of current ASM activities in the prefecture. PRADD II is designed to support Guinea's (and other diamond-producing states') compliance with the Kimberley Process Certification Scheme by improving awareness, strengthening internal control systems, and promoting systems that increase the volume of rough diamonds that enter the legal supply chain. Additional aims of the PRADD II program are to improve the governance of surface and sub-surface resources—including the primary property rights of landowners and the secondary land rights of miners—reduce land and natural resource conflict, improve the livelihoods of artisanal miners, and support vulnerable communities by strengthening tenure security.

3. ASM GOVERNANCE AND CUSTOMARY TENURE INSTITUTIONS

As in much of Sub-Saharan Africa, the ASM sector in Guinea largely operates informally, outside of government mapping or licensing. Rather than the government of Guinea, local Customary Land

7 Newspapers (5%, 4), NGOs (2%, 2), and mine bosses and owners (2%, 2) are less common.

8 Piloted in the Central African Republic in 2007 and launched in Liberia in 2010, the Property Rights and Artisanal Diamond Development (PRADD) project is the first and largest development program focused on the Kimberley Process and artisanal diamond mining challenges. PRADD II is an expansion of the PRADD project that began in September 2013 in Guinea and Côte d'Ivoire, supported by the United States Agency for International Development (USAID).

Owners (CLOs) most often organize, control, and monitor artisanal diamond mining. This section describes the prominence of customary practices for regulating access to mining sites.

Analysis of household and miner survey data indicates that the customary tenure system remains the predominant means for gaining authorization to mine a site in these areas. According to the ASM survey, miners predominantly rely on authorization from the CLO (90%, 794) to mine a site. This is largely an informal process that does not require miners to obtain a formal license to use the mining site. CLOs are the descendants from the villages' founding families and have customary authority to grant permission for diamond mining on their land. Indeed, most mines are owned by CLOs (93%, 1,634), but 32% of sites lack any ownership documentation (550). Titles are most rare, and exist on only 7% (119) of sites. The land is borrowed, rented, or leased for 38% (669) of sites. CLOs rarely have formal title on their customary land in general. Among villages included in the CLO survey, it was reported that any customary land was converted into titled land in approximately half of the villages (47%, 51). However, even though the other lands were reported as titled, villages often lacked legal documents.

Focus group discussions confirm that the process of allocating land for mining is primarily the role of village elders and CLOs. Similar to the process that outsiders wishing to acquire land for farming must follow, outsiders wishing to acquire land for mining must approach village elders and land owners with the traditional cola nuts offering. One respondent explains, "In the diamond case there is only one rule. This is the same for [all] the world, including foreigners. This means that there are no specific rules for foreigners. If the alien finds the diamond, it is for him; since he bought the plot of 4m2 with landowners [for] 50,000 GNF. If [there is a] diamond discovery, he pays the deposit [to the] landowner called f*arlè* in Soussou; that means an obligation. Unfortunately, no fleeing the scene without giving anything to landowners," (Focus group (adults), Forecariah, October 21, 2014). Respondents also noted that while outsiders must pay for each pit acquired, village natives can often acquire pits without paying. Additionally, in exchange for their land, customary land owners are often granted the "right to shovel", meaning that as land owners they are entitled to part of the profits from any diamonds found. However, cases of non-compliance with such agreements are commonly mentioned.

CLOs authorize mining on plots between 16 and 25m^2 for the cost of 35,000–50,000 GNF (mean 44,507 GNF, sd=7,475), approximately \$4.55-6.50[9]. Payments to the government to obtain a license are substantially higher on average than these payments to CLOs, since government payments average 386,046 GNF (sd=750,512, N=55), or \$50. Respondents to the household survey who are involved in mining were asked to estimate the cost of mining a pit without a formal permit on the site where they currently work. The reported cost of mining a pit on a site without a formal mining permit varies between Forecariah and Kindia. The average cost is higher in Kindia (298,601 GNF, sd=698,235) relative to Forecariah (46,677 GNF, sd=14,226).

From the CLO survey data, it appears that CLOs sometimes, but not always, also make decisions at mining sites. Twenty-one of the 32 CLOs who have mining sites on their customary land participate in at least some decisions about who can mine, how to mine, how to restore land, the sale of stones, or prospecting costs. Ten CLOs indicated that they participate in no decisions. Fourteen of these CLOs who participate in mining decisions have control over one or all of these operational decisions.

4. ANALYSIS OF BENEFITS, COSTS AND PRE-EXISTING DISTRIBUTION GENERATED BY LOCAL INSTITUTIONS.

Why do we see little uptake in parcelization for ASM in Guinea? If the issue is a lack of incentives to adopt the formal system, what components of customary tenure institutions (positively) influence the social and environmental effects of mining? This section investigates whether and how customary institutions heighten social gains and mitigate the social and environmental impacts of mining, with the goal of exploring how ASM formalization can bolster the well-being of receiving communities.

For this second objective, paper applies a mixed effects regression approach that examines social and environmental outcomes for households and miners clustered at villages and mining sites to investigate whether and how customary tenure institutions influence the social and environmental effects of mining. To do so, this analysis uses customary land use rules and perceptions of tenure security within the customary system as proxies for land governance. Outcomes of interest include restoration of mined-out sites, uptake of smarter mining techniques, and perceptions of the local

9 At \$1=7,699.95 GNF

impacts of mining, including the ability to earn a living, mining safety, and the overall tenor of the mining sector's influence on the surrounding community. We draw on the mining survey to test the role of various institutional and governance factors in contributing to the likelihood of miners undertaking remediation efforts and/or uptake of smarter mining techniques. We draw on household data to test the role of customary institutional factors on eliciting livelihood benefits from mining.

4.1. Tension between formal and informal systems—why no uptake?

As it currently functions, the informal system benefits many of the actors involved. It eliminates the transaction costs of obtaining a permit and avoids losing time and resources interfacing with a weak state. Additionally, agricultural production in Africa is kin-based and highly "risky". In an setting characterized by risks in both the formal mining system and the agricultural production system, the customary lineage system offers significant benefits: (1) kinfolk (2) cooperate in labor, (3) cooperate in risk management (4) cooperate in investment (5) high level of trust (6) high level of cooperation (7) short run access to land for subsistence and (8) long run inheritance of land. Finally, abandoning the current system could potentially have unacceptable distributional consequences for CLOs as payments for mining authorization are redirected toward government authorities.

Formal *and* informal rules that are culturally derived shape economic choice and behavior. As Ensminger (1997) notes, assessments of costs and benefits of a system are "filtered through the calculus of kinship," and "Property rights changes that violate this complex of complementary interdependencies are doomed to fail," (165). Informal social institutions are important because they govern day to day behavior by (1) define codes of conduct (2) behavioral norms (3) rules of engagement on a daily basis. Crucially, informal social institutions are *key to enforcement, which is required for economic performance*. North states that this is also the case in developed economies. North (1990) points to the strength of informal constraints—because our daily interactions are shaped by norms and social conventions. North (1990, p.36) "underlying these informal constraints are formal rules, but these are seldom the obvious and immediate source of choice in daily interactions.

4.1.1. Formal sector challenges

The customary system circumvents a cumbersome and potentially corrupt bureaucracy. Lack of awareness, expense, and a slow and complicated process to acquire a permit are all serious obstacles identified by a majority of miners. Most miners 'agree' or 'strongly agree' with the statement 'I do not know how to get a license' (89%, 789). Three-quarters of miners (75%, 668) agree it is very difficult to gather all of the documents, and the same percentage (74%, 657) agree that the process of gaining a license is very slow. Another 65% (N=577) agree that the price for the license is too high, and 26% N= (239) are "neutral" about the price, which suggests they may not be aware of what a license costs. Corruption is also a concern, and 62% (N=547) of miners agree that there is bribery involved in obtaining the license. Logistical obstacles to licensing are compounded by lack of trust in the Mining Ministry. One in ten (9%, N=194) respondents to the household survey had little or no trust in officials from the Mining Ministry.

4.1.2. Local control advantages

Local control over mining activities provides some assurance that some benefits and profits remain local. Government administration raises the specter that communities will lose control over where and when mining occurs on their customary land. More non-local operators could mean more extraction of benefits/profits that leave the area, instead of going to host communities. This is especially true if large mining companies are allowed to operate in the area. Large mining companies also employ comparatively very few workers. The legitimacy enjoyed by strong customary institutions in mining areas could ensure that host communities maximize the social benefits of mining on their traditional land and enact strong protections that mitigate environmental degradation and social challenges arising from mining-related migration.

4.1.3. Successes of the customary system

In at least three ways, the current customary system for land is working well, as evidences by low numbers of conflicts, high perception of fairness, and low perceived risk of land expropriation.

First, the customary system effectively distributes land, and land conflicts are rare. In the past year, 8 CLOs (7%) report having conflicts between members of the same households in their village. None of this conflicts resulted in violence or the destruction of property, and all conflicts have been resolved. Half (50%, 4) of the CLO's believe that both the frequency and intensity of conflicts

between members of the same household have remained the same, and the remaining 50% are divided between increasing and decreasing. A similarly low number of CLOs report conflicts occurring between households in their village (7%, 7). All but 1 conflict have been resolved (.17, sd=.41). 86% (6) of CLOs report that conflicts between households have either remained the same or decreased compared to 3 years ago. Accordingly, only 43 plots held by households surveyed (1%) were the subject of a land conflict in the last two years.

Disputes with other villages are the most common type of conflict, but still only one in 10 CLOs report a dispute with another village (9%, 10) in the past year. Like village level conflicts, the most common source of conflicts are boundaries (.78, sd=.44) and land allocation (.6, sd=.52). Conflicts with other villages also included conflicts over tree cutting (.11, sd=.33) and grazing (.1, sd=.32). 0.12 of conflicts (sd=.35) resulted in violence or destruction of property. 0.56 (sd=.53) of conflicts have been resolved. 80% (8) of CLOs believe that the intensity of conflicts with other villages have decreased.

The least common type of conflict is conflicts with investors. Only two villages report having any conflicts with investors. Neither conflict resulted in the destruction of property, though one of the conflicts remained unresolved. 90% (9) of CLOs believe that the frequency of conflicts with investors was decreased.

Second, nearly all respondents believe that their community land rules are fair. 80% of respondents (1,712) “strongly agree” that rules about community land are fair, and an additional 18% (388) “agree”. Similarly high numbers of respondents believe their community rules about land use and management are clear and well-known. 93% of respondents (1833) “strongly agree,” and an additional 4% (89) “agree” that the land use and management rules are clear. Decisions about customary land allocation are perceived as fair at even higher rates than rules about community land in general. 94% of respondents (1830) “strongly agree” that decisions about customary land allocation are fair, and additional 5% (90) “agree” they are fair.

Punishments for land management violations appear to be implemented consistently. If a community member was caught mining from a pit that did not belong to him or her, 88% of respondents (1883) report that the offender would likely be punished.

Third, community members trust that their land is secure in the current system. In spite of the rarity of land documentation, households rarely report their plots are at risk of encroachment, either presently or in the future. Of plots that are reported to be at risk of encroachment, losing land to members of the extended family is the most likely scenario (8%, 345 in 1-2 years, and 9%, 354, in the next 5 years). Government authorities and investors are perceived as less of a threat to tenure security than family members, contrary to worries about mines and other investments increasing the rates of encroachment. Only 5% of plots (N=4112) are believed to be at risk of local government authorities taking the plot of land without the household's permission. Costs of the current system. There is even less fear from private investors than from other parties; HHs respondent that they think it somewhat or very likely that a private investor will take their plot of land without permission for just 4% (182) of plots.

Households strongly agree that the boundaries of their farmland are clear and respected by people in their village (87%, 1883). An additional 11% "agree" and just 2% do not agree (5). Households are similarly confident that government officials or investors cannot take any of their land without negotiation and fair compensation. 75% (1591) "strongly agree" their land cannot be taken, and another 18% "agree" (379). 5% disagree (115).

Following Ostrom (1990), control of property rights by local communities presents several notable advantages for the preservation of valuable communal resources, such as more information, more cooperation, and less disputes. However, if the indigenous system can not handle pressures due to exogenous shocks like rising land values, then the system of local control will fail to protect the valuable resource from which the community derives its livelihood.

4.2. So, why change what isn't broken? Costs of the current system and potential benefits of the formal system

Why do we need to change a system that doesn't appear to be broken? Ensminger (1997) notes, "The real policy question for Africa are when to leave customary systems to accommodate these changes and how to intervene if customary systems appear to no longer guarantee tenure security?" (180). Indeed, the very survival of a strong customary system in Forécariah and Kindia indicates these prefectures' peripheral status when considering push factors toward exclusivity in property rights such as potential financial returns and land pressure. However, several internal and external

forces lead the contemporary transition in these prefectures towards artisanal mining formalization, such as (1) International factors (KP process) pushing for more formal rules; (2) the potential for pressure from other industries, including extractive industries and a railroad project in Forécariah; (3) a move of the government toward parcelization and its need to protect local citizens; (4) demographic and economic pressures impacting inheritance systems; and (5) an attendant move toward greater individual/exclusive regimes with increasing land value—generally driven by commercialization and population pressures—which increases the incentive to privatize the gains from investment.

4.2.1. Mining's image problem

Mining is often perceived negatively by host communities and their CLOs. Roughly half of CLOs believe that ASM has a 'negative' or 'very negative' influence (14), but roughly half believe ASM has 'positive' or 'very positive' impacts (13). The most common positive benefits observed include better jobs (9), rents to land owners (8), increases in trade (8), and better roads (6). The negative impacts of ASM are more numerous. CLOs believe that ASM has caused food prices to increase (15) and that ASM increases migration (13). Less prevalent negative effects include increased conflict (9), increased drug use (7), increased crime (5), and increased fights over women (5).

Even though CLOs are divided about the impact of ASM on their community, they do grant use of land to insiders and outsiders for mining purposes despite mixed feelings about mining. CLOs were asked how they would prioritize five land uses in allocating land, from 'most likely to reallocate land' (1) to 'least likely to reallocate land' (5). Agricultural uses were the most important priority for the CLOs, with an average of about two on the scale (1.8, sd=1.4), followed by plantations (2.7, sd=1.3). Surprisingly, mining was the least desirable land activity overall (3.5, sd=1.7), even more so than leaving the land fallow (3.1, sd=1.3) or for pasture or other non-agricultural use (3.1, sd=1.5). However, the assessment of the desirability of allocation of land for mining was bimodal: while 49% of CLOs (53) said it was very unlikely that they would allocate land to mining, 22% of CLOs (24) did indicate that they would be very likely to allocate land for mining purposes. The comparative status of tenure rights for miners, landowners and farmers is difficult to discern.

Only 37% of households surveyed (728) indicated that the influence of ASM on their community is 'positive' or 'very positive'. The most common benefits that household survey respondents see from ASM is jobs (27%, 591) and improved roads (15%, 328). Main concerns about the influence of ASM on the host community are rising food costs (33%, 704), increased migration (30%, 654), crime (19%, 419) and drug use (19%, 406). In the qualitative data, respondents do recognize the benefit derived from increased economic activity brought by mining. One woman observed, "[The main benefit of ASM is] development of small businesses which reported substantial income to [our community's] women. I was selling fish and rice. With this trade, I have gained a lot. Also, I helped my husband to build a building. I can say that we have benefited from the exploitation of [our community's] diamond," (Focus group (women), Kindia, November 7, 2014).

Many participants ultimately feel that the negative impacts of mining ultimately outweigh the benefits, however. One woman reflected, "I know the artisanal mining sector has more negative effects than positive. In addition to the abuse of alcohol and marijuana, conflicts do not end. Added to this is the lack of benefit derived by the District of diamond mining. Then farmland was destroyed. The holes are not closed. The population ignores the profit from diamond mining. In our mosques, the miners are the first to benefit from the blessings of the Imams (leader of prayer at the mosque) at the expense of our own children. Also when the diamond is found, they return home," (Focus group, Forecariah, October 21, 2014).

Another focus group respondent exclaimed, "I ignore the advantages that the artisanal mining sector could bring to our community. I know with this sector the abduction of women increases. This sector destroys cultivable lands. When diggers arrive in a locality they make holes that they never close back. That prevents farmers to work. Another inconvenience that I can quote is the rise of foods price and other necessary goods. That is what provokes hunger in the village because the majority of the inhabitants are not implicated in the extraction of diamond... As another inconvenience, you must quote the destruction of the low grounds, the decreases of the farming man power…The artisanal mining sector provokes the pollution of rivers through the deposit of gravels on their bed, without mentioning that woods are cut in [an] abusive way. Cultivable lands as far as low grounds are destroyed. Mining exploitation starves the village. It destroys soils and

provokes prices increase, theft of fruits and plants and crime. With this sector, pity[10] disappear[s] in the village and increase[s] the suffering of the population." (Focus Group, Fansiga, DATE).

One important follows out of this in this last quote is that communities that have no experience with mining still have a negative perception of mining's effects, indicating that stigma around the mining sector precedes its arrival in these prefectures. When considering current challenges faced by ASM communities, it is important to disentangle stereotypes about mining from descriptions of negative outcomes experienced by communities.

4.2.2. Mining conflicts and diamond rushes

The formal system may be better able to prevent mining conflicts. Currently the incidence of mining conflicts is higher than other disagreements. The incidence of conflicts is higher at mining sites than other areas, since 27% (245) of miners reported a conflict at their mining site in the last two years. Of the miners who experienced a conflict, half (49%, 119) experienced one conflict, while the other half experienced two or more conflicts during this time. As in other areas, most conflicts at mining sites are about boundaries (60%, 267). Other common topics of conflict are theft of stones (13%, 56) and mining rights (6%, 29). Diggers and washers are the most common actors involved in a conflict (61%, 273), followed by laborers (37%, 167). Customary landowners were a party in only 8% (37) of conflicts, while surveillants and masters were involved in about 15% of conflicts, each (71 and 63, respectively). Some conflicts in this context did escalate, as 17% of disputes involved violence or destruction of property by one or more parties. Most of these recent conflicts are now resolved, and only 2% (7) are ongoing. The master or mine boss was the most common actor to help resolve the conflict (39%, 176). Customary land owners were involved in the resolution of 17% of conflicts (78). Most miners are satisfied with the resolution achieved. In 91% of conflicts (398), the respondent believed that the resolution of the conflict was fair.

Conversations surrounding mining-related conflicts in the FGDs reveal that the belief that mining activities lead to increased disputes and violence is common. Groups of women in particular express perceptions of fear and violence regarding mining conflicts, as one group of women said, "When there is fighting in the mining camp, this scares because they use even shovels, pickaxe

10 The use of the word 'pity' is understood as meaning empathy.

during the fight. They are often recorded in cases of serious injury or sprains which may lead them to the hospital," (Women's focus group, Forecariah, October 29, 2014).

Accordingly, the primary perceived benefit of mining permits appears to be their ability to protect miners from expropriation and conflicts. Almost all miners believe having a permit will protect their pits from being taken (89%, 819). Large majorities—between 85% and 95% of miners—believe that mining permits will protect them from conflicts with a variety of people, including the police (91%, 814), farmers (86%, 769), other miners (92%, 816), other diggers or washers (87%, 779), and the land owner (90%, 806).

A formal ASM system could also help communities prevent diamond rushes. Mark Freudenberger has compared the baseline situation in PRADD countries to the state of California during the 19th century gold rush, citing similar speculation and lack of government regulation.[11] Indeed, 29% of CLOs (31) indicate knowledge of at least one diamond rush in the past year.

4.2.3. Community benefits and transparency

A formal system could ensure greater monetary benefits and greater transparency in how monetary benefits from granting permission to mine are spent. Only 11% of respondents (227) report a single meeting in the past year about land rights, land allocation, land conflict, or the resolution of land disputes. Considerably less transparent than land rules and decision making is decision making about how fines and fees are spent. Only a small percentage of local governments collect fees or fines from outsider's use of community land, such as mining or farming. Of the 5% of respondents (115) who reported such fees were collected, 77% (93) are not aware of how this money is spent, and 78% (93) did not believe the money is spent in ways that benefit the needs of everyone in their community. Thus transitioning away from a system where CLOs negotiate mining arrangements on behalf of the community could create openings for more members of the community to participate in negotiations.

This need for inclusivity is an important point, as communities are not monolithic. Greater openness in mining operations allows for the acknowledgement of competing community priorities and local power dynamics (Spiegel 2012). This space does not exist in a system where CLOs have

11 http://www.brilliantearth.com/news/brilliant-earth-interviews-artisanal-diamond-mining-expert/

the final say. Currently, 54% of household survey respondents (1,173) said that no one can ever appeal a ruling by a CLO that they disagree with, and only 5% (102) said that people can always do this.

Accordingly, some members of the community will make out better in a formalized system, such as town members who mine (assuming the higher price received for diamond found makes up for having to buy government permit, since "locals" often now can mine for free) and even town members who do not participate in mining if they benefit from better environmental conditions or greater monetary benefits to the community as a whole. Others may perceive a formal a net loss the transition to a formal system, such as CLOs who do not currently share benefits with the community.

It may also be possible to get higher price for diamonds in formal system, as 87% (782) of miners believe having a permit will help them get a higher price for their diamonds. CLOs currently lose out when miners who have found a large diamond leave without paying the CLO the negotiated percentage, as elucidated by one qualitative respondent: "Those who earn small stones, sometimes give some money to the landowner. When the stone is large, the miners tend to leave without informing the landowner," (Focus group, Forecariah, October 21, 2014).

4.2.4. Environmental degradation

Restoration of mined out sites and adoption of smarter mining techniques is currently rare. 92% (788) of miners believe it is important to restore mined-out sites, however, 69% (635) of miners report never refilling a mining pit in the past year. Only 18% (169) of miners report they 'always' or 'frequently' refill mining pits.

Customary rules requiring restoration are uneven, so communities could benefit from a law about this. In the household survey, rules requiring restoration are reported by less than a quarter of respondents (20%, 427). Where rules exist, they are not followed consistently. Over half of respondents report that no miners obey rules about restoring mined-out sites (65%, 762), and just 20% of respondents believe all or most miners obey the rules (20%, 238). Punishment is also enforced unevenly. Overall, 69% of respondents (806) claim no people are ever punished for

breaking rules about mining site restoration, and only a quarter of respondents believe that rule breakers are always punished (25%, 295).

Similarly, in the miner survey, only a quarter (25%, 224) of miners report that their village has rules that require restoring mined-out sites. In villages where rules do exist, 43% (96) of miners believe that all or most miners obey the rules. Miners have varying interpretations of how rules are enforced. While 38% of miners (87) report that people who do not follow these rules are always punished, 40% of miners (91) report that people who do not follow the rules are never punished.

Discussions in the qualitative data confirm the high environmental cost of ASM activity and the challenge of enforcing restoration requirements. One woman emphasized the high likelihood that land will be unsuitable for cultivation after mining activities have concluded, "They [the miners] destroyed my field of agriculture and the money that I received in return was largely insignificant. I built a small house and latrines," (Focus group (women), Kindia, November 7, 2014).

Youth in Kindia explain, "Money that we receive after the selling of our diamond cannot allow us to restore the holes, we cannot do it with the hand, you must fuel a bulldozer to do it. As such, we do not have this means to restore more of 100 pits. It is also difficult to engage, for example, 5 people to close back these holes. There are bosses, when they find [a] diamond, [they] disappear without leaving the trace. They go either to (…)[12] or on another mining site. And workers who he maintained benefit only of crumbs to feed their family," (Focus group, October 28, 2014).

Women also stressed that open pits are dangerous to children and livestock, particularly when they are filled with rain water. In more than one village, children had drowned after falling into unrestored sites. One group of women explained, "We know nothing of the advantage that pulls the diamond but on its way there are large holes where it was dug, that makes our children and animals in danger. Also all our [swampland for agriculture][13] [is] now useless because [there] are holes everywhere… From diamond we only know the damage it causes. These are the holes where our children may fall at any time," (Focus Group, Kindia, November 23, 2014).

12 Mining site name has been removed to protect the anonymity of participants.
13 Originally translated as "shallows for culture".

Smarter mining techniques are another way to mitigate negative environmental impacts of ASM, but their practice is not currently commonplace in Forcariah and Kindia. A stronger presence by the Ministry of Mines in these areas could hasten the adoption of these practices. Less than half of miners have heard of the trenching method of mining (45%, 405).

4.3. Testing the benefits of customary controls

To best address the costs of the customary system while cultivating buy-in from customary leaders and community members who are generally satisfied with their customary system, scholars and policy makers have underscored the need for policy that situates programming within the community's customary system of land governance, a task that requires deep knowledge of land practices and authority structures in the program area. To explore the opportunities for customary elements of mining administration to help communities capture mining benefits and mitigate negative outcomes, we test the ability of indicators of strong customary land governance to predict positive social and environmental outcomes from mining.

Random effects logit models were generated from 1) household and 2) mining survey data to predict binary social and environmental outcomes, clustered at the village and mine site level, respectively. After running tests on the proportional-odds assumption with ordinal variables, it was determined that the ordinal data fails this assumption and a binary logit model is more appropriate.

Control variables across both models include socio-economic status (SES), education, migration, whether the respondent has ever worked as a digger or a washer on a mining site, and prefecture. Additional control variables in the household survey model are an index of perceived tenure security, ethnicity and age (Table 1). Additional control variables in the miner survey model are years of experience in ASM and participation in other livelihood activities besides mining (Table 2). Key independent variables common to all models are 1) the existence of rules requiring restoration of mined out sites, 2) perception of how often these rules are followed by miners, and 3) perception of how often rule breakers are punished. We expect stronger customary contexts to have local rules about mining site restoration and to levy punishments when these rules are ignored, thus incentivizing more miners to follow the rules. Other independent variables in the household survey model are indicators of the importance of customary institutions in land issues, how often

rule breakers from specific groups are punished, and satisfaction with the customary land allocation and management system. The final independent variable in the miner survey model is an index of perceptions of the benefits (or lack thereof) of obtaining a mining license.

4.3.1. Results

4.3.1.1. Household Survey Models

Table 3 presents the results of the models measuring associations between customary governance institutions and social outcomes and attitudes about diamond mining. Each model explores logit prediction of a different outcome variable, except Models D and E are different specifications for the same outcome variable, whether or not the respondent believes that mining can cause environmental problems. Key independent variables of interest are experience working as a digger or washer in ASM, a tenure security index of perception of likelihood of different land expropriation scenarios, perception of rule fairness, likelihood of punishment for breaking rules, and main traditional authorities responsible for punishing rule breakers. While each of these variables is a significant predictor of at least one outcome of interest, they are not significant across the board. However, together these variables can be understood as likely indicators of the strength of a community's customary system of land governance.

4.3.1.2. Miner—Survey Models

Logit models were also prepared from miner survey data to test whether similar measures of customary system strength are predictive of better environmental outcomes at mining sites (Table 4). Outcomes of interest include the use of smarter mining techniques, restorations of mined out sites, including pit refilling, tree replanting, and stream restoration. An additional model explores the effect of stronger customary institutions on the perception of benefits to formal licensing. Key independent variables include experience working as a digger or washer and the existence of land rules, as in the models described above. An additional independent variable that differs from the household model is an index formed of eight questions that ask the respondent’s perception of the usefulness of mining permits to prevent conflicts and negative outcomes and to produce positive outcomes. In general, the existence of rules and the permit perception index are both highly significant variables.

5. POLICY RECOMMENDATIONS—ACHIEVE COMPLEMENTARITY BETWEEN INFORMAL AND FORMAL SYSTEMS

The core policy/development question that follows from this analysis is how to achieve complementarity between informal and formal institutions? In fact, "The fit between formal and informal institutions is key to the former's success," (Ensminger, 165). Some requirements for uptake and success of the formal system include: (1) that gains outweigh the transaction costs and (2) sufficient fit between customary tenure/social norms and new rights regime to lend legitimacy to enforcement. In addition to complementarity, there is the issue of the security of the property rights and whether security is promoted.

There is already some evidence of movement toward a hybrid system or tension between the systems. This phenomenon can be observed in the variation in survey responses about customary and government actors' authority to make decisions about land management and transfer. 20% of respondents (426) to the household survey indicated that local government authorities would be the most likely to punish someone caught mining a pit on someone else's site and an additional 8% (168) said that the local committee would do this, compared to 28% (606) who said the CLO would play this role and 29% (626) who chose village elders.

Similarly, 20% of survey respondents (442) said that they would approach the Local government authorities *first* if someone was encroaching their farm, though a larger percentage (50%, 1,073) said that they would first seek out their village elders. Furthermore, 51% of survey respondents (1,105) affirmed that local government authorities would help neighbors resolve a boundary dispute (compared to 29%, N=617, for the CLO, and 74%, N=1,597, for elders).

With respect to land transfer, CLOs were asked who in their community has the authority to sell their community's customary land. Unsurprisingly, CLOs are the most common and have authority to sell customary land in 93% of villages (100). Village elders have the authority in 34% (37) of villages, the District Head has authority in 17% (18) of villages, and the District Council has authority in 25% of villages (27). The national government only has authority to sell customary land in two villages. However, less than 10% of villages have sold customary land to someone outside the village in the past five years (10).

Guinea's Mining Code provides an important foundation for regulating ASM activities on customary land. The law clarifies explicitly, "A mining right does not extinguish a property right. No right to prospect or operate is valid without the consent of the landowner or its successors, with regard to activities involving the surface or affecting it," and "Property rights shall be exercised throughout the term of the operation through the collection of compensation," (100). However, compensation is required only to redress the "disturbance of enjoyment suffered by such occupant" during mining activities. It is not required to include a stake in mineral discoveries on the parcel. Additionally, the law allows expropriation of land held by a third party, such as a CLO, for "public utility…in the absence of consent from the landowner or its successors," a stipulation that potentially allows disenfranchisement of ASM communities by the government (101).

6. CONCLUSION

The potential revenues for governments through formalization of the sector, combined with international ethical concerns about labor standards, safety, and the danger of ASM's use to fund rebel groups and gangs, produce strong incentives for national governments and international donors to prioritize programs that subdivide mining areas into parcels that can be licensed out to miners for exploitation.

However, ASM currently takes place in Forécariah and Kindia within a wholly informal system. In other areas of Guinea, threats by the state to customary land governance institutions' control of ASM have produced conflicts over land access and compensation (USAID 2014). ASM formalization programs can lessen the likelihood of such disputes by understanding and working through customary structures. This requires the creation of a hybrid system, wherein the government exercises its subsurface rights to parcel and license land for mining while ensuring that the customary holders of surface rights are compensated for their loss of use of the land and share in the benefits when diamonds are found on a site. Furthermore, the legitimacy enjoyed by strong customary institutions in these areas could ensure that host communities maximize the social benefits of mining on their traditional land and enact strong protections that mitigate environmental degradation and social challenges arising from mining-related migration.

These results could be of larger interest to development practitioners and researchers, given their consideration of how enforceable communal governance of land can facilitate environmental

protection. This inquiry is also potentially of interest in contexts where ambiguity about the relationship between informal and formal land tenure systems has led to concerns about expropriation of community resources without adequate localized compensation.

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Tables

Table 1. Household Survey Summary Statistics

Variable Name	Variable Descriptions	Mean	SD	N
Dependent Variables				
Earn a living mining	0=No, 1=Yes: Respondent does not think people can earn a living/support their families mining	0.57	0.49	1,987
Mining is dangerous	0=No, 1=Yes: Respondent thinks diamond mining is dangerous	0.74	0.44	1,981
ASM positive influence	0=No, 1=Yes: Respondent thinks ASM has a positive influence on community	0.37	0.48	1,989
Mining causes environmental problems	0=No, 1=Yes: Respondent thinks mining can cause environmental problems	0.91	0.29	2,146
Restoring mined out sites is important	0=No, 1=Yes: Respondent thinks restoring mined out sites is important	0.9	0.3	2,126
ASM increases trade	0=No, 1=Yes: Respondent thinks ASM increases trade	0.13	0.34	1,995
ASM improves roads	0=No, 1=Yes: Respondent thinks ASM improves roads	0.16	0.37	1,996
Independent Variables				
Socio-economic status	0=No, 1=Yes: Respondent falls in lowest quantile of asset holdings	0.25	0.43	2,165
Ethnicity	1=Soussou; 0=Other	0.84	0.37	2,140
Education	0=No, 1=Yes: One or more members in respondent's household any formal education	0.51	0.5	2,165
Migration	0=No, 1=Yes: Respondent born in village	0.83	0.38	2,161
Age	Continuous; respondnet age in completed years	46	16	2,164
Digger or washer	0=No, 1=Yes: Respondent has worked as digger or washer	0.2	0.4	2,165
Prefecture	1=Forecariah; 0=Kindia	0.5	0.5	2,165
Tenure security	Mean of six scale variables about perception of likelihood of land expropriation where 1=Very likely and 5=Very unlikely	4.44	0.92	2,128
Rules are fair	0=No, 1=Yes: Respondent 'strongly agrees' land governance rules are fair	0.8	0.4	2,144
Youth who break rules are punished	1=Always/frequently/sometimes/rarely; 2=Never; 3= NA (this doesn't occur)	2.19	0.71	2,151
Elders punish rule breaker	0=No, 1=Yes: Respondent selects elders as most likely actor to punish rule breaker	0.56	0.5	2,165
CLO punish rule breaker	0=No, 1=Yes: Respondent selects CLO as most likely actor to punish rule breaker	0.33	0.47	2,165
Elders or CLO punish rule breaker	0=No, 1=Yes: Respondent selects elders or CLO as most likely actor to punish rule breaker	0.57	0.5	2,165
Customary rules	Scale generated from mean of three variables about perception of rule fairness, where 2=Agree, 1=Somewhat agree and 0=Disagreee	1.67	0.69	2,165
Village dependence/exposure to mining	Percentage of respondents in village who have worked as digger or washer	0.2	0.19	2,165

Table 1. Miner Survey Summary Statistics

Variable Name	Variable Descriptions	Mean	SD	N
Dependent Variables				
Smarter mining techniques	0=No, 1=Yes: Respondent has practiced trenching method	0.33	0.47	880
Refill pit	0=No, 1=Yes: Respondent has refilled a pit in the last year	0.3	0.46	902
License benefit	0=No, 1=Yes: "It would not benefit me to have a license"	0.46	0.5	886
Replant trees	0=No, 1=Yes: Respondent has replanted trees in the last year	0.11	0.31	896
Restore stream	0=No, 1=Yes: Respondent has restored a stream in the last year	0.07	0.26	892
Independent Variables				
Socio-economic status	0=No, 1=Yes: Respondent falls in lowest quantile of asset holdings	0.24	0.43	916
Years of mining experience	Number of years respondent has worked/been involved with diamond mining	9	8	869
Education	0=No, 1=Yes: Respondent has any formal education	0.48	0.5	910
Other livelihood activities	0=No, 1=Yes: Respondent is engaged in other livelihood activities	0.53	0.5	908
Migration	0=No, 1=Yes: Respondent born in village	0.47	0.5	910
Digger or washer	0=No, 1=Yes: Respondent has worked as digger or washer	0.84	0.37	916
Prefecture	1=Forecariah; 0=Kindia	0.58	0.49	916
Rules	0=No, 1=Yes: There are rulesin this village that require restoring mined out sites	0.25	0.43	897
Permit perception	Principle component index of eight scale variables about perception of mining permits, where 1=Strongly agree, 2=Agree and 3=Neutral or disagree	0	2.4	845

Table 3. Household Survey Model Results

VARIABLES	Model A Earn a living mining	Model B Mining is dangerous	Model C ASM positive influence	Model D Mining causes environmental problems	Model E Mining causes environmental problems	Model F Restoring mined out sites is important	Model G ASM increases trade	Model H ASM improves roads
Socio-economic status	0.130 (0.131)	-0.141 (0.156)	0.0599 (0.134)	0.127 (0.227)	0.109 (0.229)	-0.0879 (0.201)	0.176 (0.142)	0.0981 (0.166)
Ethnicity	-0.334** (0/152)	-0.0392 (0.238)	-0.0435 (0.230)	-0.0722 (0.327)	-0.122 (0.344)	0.139 (0.291)	0.355 (0.318)	0.575** (0.292)
Education	-0.211* (0.119)	0.249** (0.123)	0.184 (0.127)	0.142 (0.198)	0.176 (0.197)	0.411** (0.171)	0.372** (0.171)	0.294* (0.156)
Migration	0.168 (0.167)	0.137 (0.156)	0.394* (0.233)	0.345 (0.232)	0.272 (0.241)	0.0994 (0.224)	-0.409* (0.214)	0.223 (0.216)
Age	-0.00513 (0.00390)	0.00441 (0.00421)	-0.00499 (0.00422)	0.00101 (0.00660)	0.000807 (0.00647)	-0.00177 (0.G12	-0.00636 (0.00559)	0.00381 (0.00494)
Digger or washer	-0.571*** (0.147)	-0.726*** (0.152)	0.337 (0.213)	-0.398 (0.254)	-0.392 (0.259)	0.0855 (0.349)	-0.225 (0.190)	0.341* (0.175)
Prefecture	-0.101 (0.215)	-0.632** (0.293)	0.168 (0.227)	-1.399*** (0.243)	-1.363*** (0.244)	1.276*** (0.231)	-0.484* (0.285)	0.791*** (0.278)
Tenure security	-0.108 (0.0969)	0.0821 (0.0828)	-0.275*** (0.104)	0.0805 (0.0877)	0.105 (0.0890)	0.222* (0.126)	0.295** (0.131)	0.338*** (0.119)
Rules are fair	0.440*** (0.155)	0.395** (0.162)	0.210 (0.166)	-0.281 (0.214)	-0.269 (0.213)	0.0225 (0.247)	-0.0188 (0.221)	-0.0322 (0.283)
2.k10_bin	-0.800*** (0.217)	0.138 (0.180)	-0.262 (0.267)	-0.386 (0.354)	-0.402 (0.355)	0.452 (0.429)	-1.299*** (0.359)	-0.687** (0.312)
3.k10_bin	-0.0274 (0.239)	0.730*** (0.273)	-0.658** (0.261)	-0.757** (0.383)	-0.739* (0.383)	-0.760*** (0.282)	-0.669** (0.273)	-0.518* (0.298)
Elders punish rule breaker	-0.267* (0.147)	0.0442 (0.136)	0.694*** (0.165)	-0.174 (0.166)		0.362* (0.209)	0.501** (0.195)	0.404** (0.159)
CLO punish rule breaker	0.309** (0.145)	0.479*** (0.133)	0.394** (0.153)	0.207 (0.233)		0.848*** (0.278)	0.697*** (0.252)	0.419** (0.195)
Customary rules	-0.103 (0.105)	0.421*** (0.119)	0.723*** (0.125)	0.227 (0.215)	0.217 (0.214)	-0.202 (0.169)	0.000815 (0.171)	0.351* (0.198)
Village dependence/exposure to mining	0.676 (0.537)	1.762*** (0.496)	2.235*** (0.524)	-0.197 (0.638)	-0.120 (0.659)	1.766** (0.837)	1.313** (0.660)	-0.928 (0.727)
Elder or CLO punishes rule breacher					0.439** (0.183)			
Constant	1.533*** (0.481)	-0.967 (0.627)	-1.712*** (0.603)	2.985*** (0.615)	2.682*** (0.623)	0.233 (0.777)	-2.914*** (0.779)	-5.011*** (0.694)
Observations	1,925	1,919	1,927	2,083	2,083	2,070	1,933	1,934

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Miner Survey Model Results

	Marginal Effects	Model A	Model B	Model C	Model D	Model E	Model F	Model G	Model H	Model I	Model J
VARIABLES	**Permit perception**	**Smarter mining techniques**	**Smarter mining techniques**	**Refill pit**	**Refill pit**	**License benefit**	**License benefit**	**Replant trees**	**Replant trees**	**Restore stream**	**Restore stream**
Socio-economic status	-0.0272 (0.189)	0.238 (0.185)	0.238 (0.171)	-0.174 (0.204)	-0.174 (0.210)	-0.0882 (0.174)	-0.0882 (0.158)	-0.140 (0.298)	-0.140 (0.391)	-0.191 (0.354)	-0.191 (0.344)
Years of mining experience	-0.0579*** (0.0105)	0.0388*** (0.0105)	0.0388*** (0.0126)	0.0106 (0.0112)	0.0106 (0.00694)	-0.0307*** (0.0104)	-0.0307 (0.0190)	0.000109 (0.0166)	0.000109 (0.0139)	0.00105 (0.0190)	0.00105 (0.0184)
Education	-0.472*** (0.164)	0.192 (0.164)	0.192 (0.226)	0.210 (0.177)	0.210 (0.179)	-0.342** (0.152)	-0.342 (0.236)	0.733*** (0.273)	0.733*** (0.255)	0.528* (0.319)	0.528 (0.333)
Other livelihood activities	0.00134 (0.194)	0.421** (0.195)	0.421 (0.275)	0.0885 (0.209)	0.0885 (0.166)	-0.472*** (0.179)	-0.472* (0.257)	-0.765** (0.333)	-0.765*** (0.233)	0.114 (0.393)	0.114 (0.438)
Migration	-1.378*** (0.193)	-0.392* (0.202)	-0.392 (0.273)	-0.202 (0.220)	-0.202 (0.211)	0.447** (0.186)	0.447 (0.289)	-0.325 (0.335)	-0.325 (0.364)	-0.451 (0.385)	-0.451 (0.360)
Digger or washer	-0.0761 (0.233)	0.515** (0.240)	0.515** (0.257)	0.120 (0.250)	0.120 (0.233)	-0.351 (0.215)	-0.351* (0.194)	0.669 (0.419)	0.669 (0.447)	0.437 (0.448)	0.437 (0.440)
Prefecture	-0.500** (0.215)	-0.308 (0.217)	-0.308 (0.473)	0.145 (0.237)	0.145 (0.284)	0.170 (0.200)	0.170 (0.320)	-0.651* (0.360)	-0.651* (0.392)	-0.812* (0.430)	-0.812* (0.472)
Rules	-0.878*** (0.216)	0.0736 (0.212)	0.0736 (0.202)	2.105*** (0.227)	2.105*** (0.272)	-0.501** (0.205)	-0.501** (0.214)	2.021*** (0.323)	2.021*** (0.317)	2.028*** (0.379)	2.028*** (0.426)
Permit perception		-0.167*** (0.0384)	-0.167*** (0.0533)	0.0651* (0.0391)	0.0651 (0.0859)	0.0237 (0.0331)	0.0237 (0.128)	0.0270 (0.0597)	0.0270 (0.0614)	-0.0121 (0.0725)	-0.0121 (0.0453)
Constant	1.964*** (0.357)	-1.593*** (0.369)	-1.593*** (0.496)	-1.834*** (0.396)	-1.834*** (0.334)	0.659* (0.338)	0.659 (0.622)	-3.111*** (0.605)	-3.111*** (0.484)	-3.648*** (0.696)	-3.648*** (0.737)
Observations	777	757	757	776	776	768	768	772	772	771	771
R-squared	0.139										

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figures

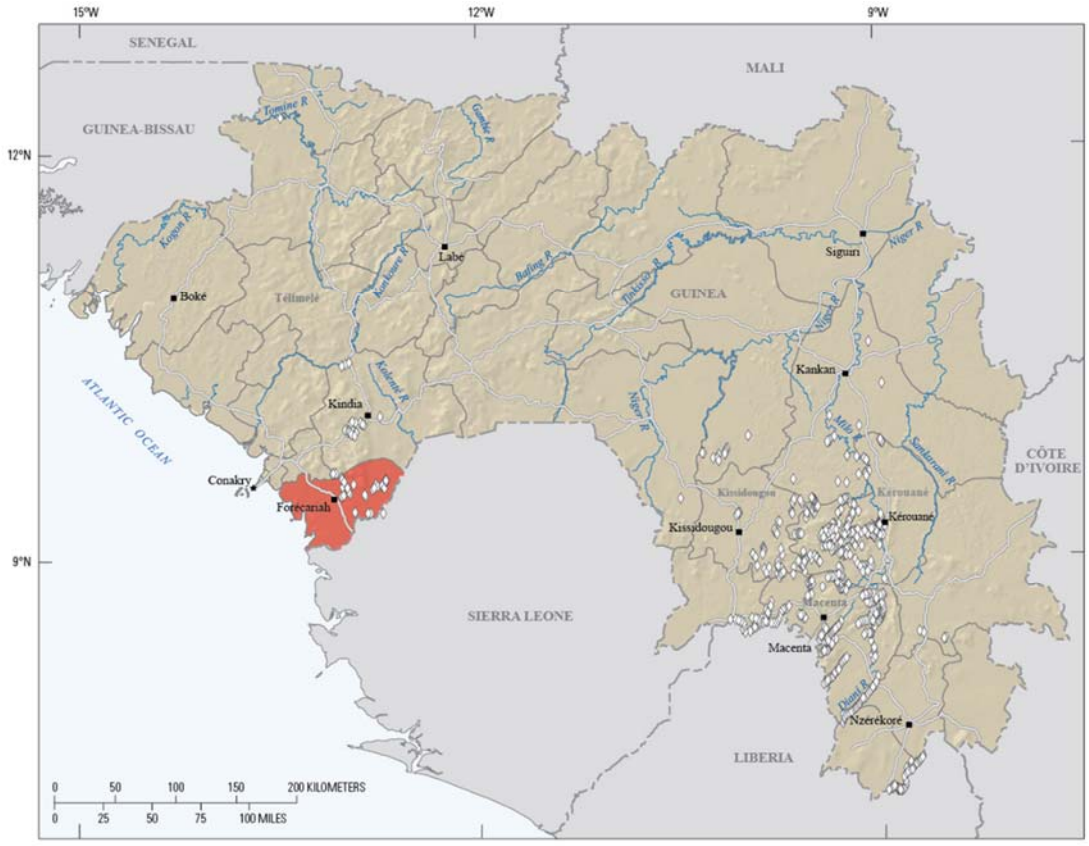

FIGURE 1. Diamond occurrences in Guinea (Chirico, et al.,. 2012)

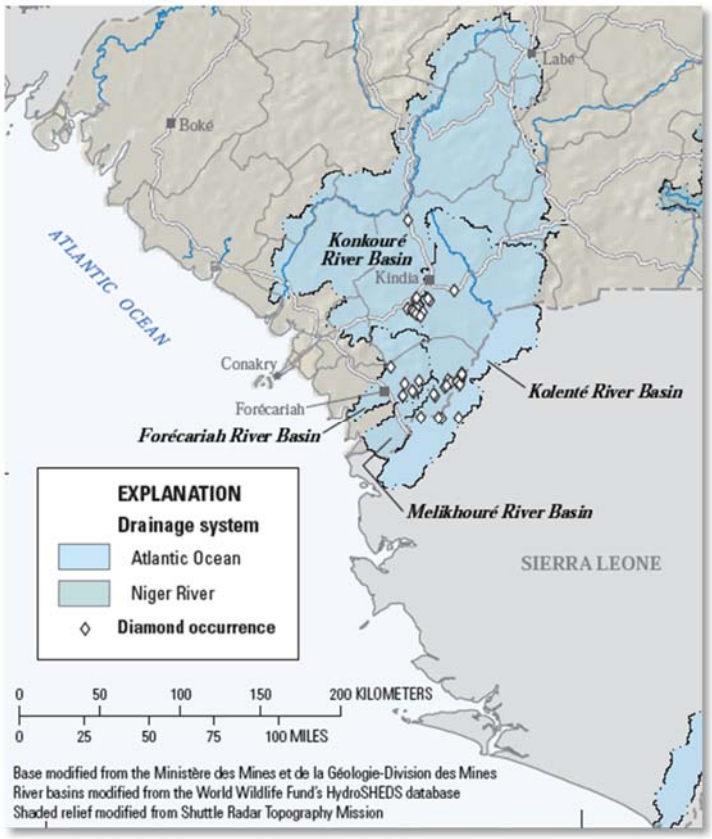

FIGURE 2. Treatment and control areas (Chirico, et al., 2012)