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Does participatory mapping increase conflict? A randomized experimental evaluation in the Bolivian Amazon

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Abstract

Researchers have argued that securing land tenure for indigenous peoples reduces deforestation and fosters the adoption of sustainable resource management. Because of the positive effects of land security, practitioners have proposed the use of participatory mapping to help indigenous populations claim legal recognition of their right to occupy their lands. But researchers have found that participatory mapping has other effects, such as an increase in conflicts. In this study, we test the effects of participatory mapping on the number of conflicts using an experimental research design. Research was conducted among 32 villages of a native Amazonian society in Bolivia. Villages were randomly assigned to treatment (n=17) and control (n=15) groups. The treatment consisted of participatory mapping. We used a survey instrument before and after the intervention to test whether the intervention increased conflicts and Tsimane' negative attitudes toward outsiders. Our results suggest that the intervention had virtually no effect on the variables measured, thus suggesting that participatory mapping does not seem to increase the capacity of indigenous peoples to respond to everyday entrances of outsiders in their territory.

Key words: cartography, Bolivian Amazon, Tsimane' indigenous peoples, Geographic Information Systems, experimental research

1.- **Introduction**

In the Amazon region, indigenous territories occupy an area larger than the area under protection in parks (Nepstad et al., 2002), but, to a higher degree than parks, indigenous territories suffer encroachment from extractive industries, extensive agriculture, and non-indigenous farmers (Picchi, 1991; Watson, 1996; Ballard and Banks, 2003; Hayes, 2007; Finer et al., 2008; Gray et al., 2008; Finer and Orta-Martínez, 2010). Researchers have argued that securing land tenure for indigenous peoples reduces deforestation and fosters the adoption and implementation of sustainable forest management (Deacon, 1999; Alston et al., 2000), whereas insecurity in land tenure fosters resource mismanagement and deforestation (Godoy et al., 1998; Finley-Brook, 2007; Oliveira et al., 2007). Because of the positive effects of land security, in the last two decades, practitioners have proposed the use of indigenous mapping to help indigenous populations demarcate their lands and claim legal rights to them (Leake, 2000; Herlihy and Knapp, 2003; Chapin et al., 2005; McCall and Minang, 2005).

Participatory mapping consists of a process through which professional researchers, local researchers, and community members work closely to gather information about the community's territory (Chapin et al., 2005). Participatory mapping is sometimes assisted by the use of GIS so that the information retrieved in the field can be made available as georeferenced maps. Participatory mapping "done by and for indigenous peoples to achieve political goals" (Chapin et al., 2005) is also called indigenous mapping. Research suggests that participatory mapping and land demarcation with traditional toponyms helps clarify the boundaries of the lands belonging to an ethnic group and links villagers to government policy makers. Participation in mapping seem to have encouraged some indigenous communities to demand title to lands (Toledo Maya Cultural Council, 1997; Leake, 2000; Herlihy, 2003;

Herlihy and Knapp, 2003), to defend and claim their rights to control natural resources (Smith, 2003; Brown, 2006), and to design conservation and resource management plans that are compatible with local practices (Mohamed and Ventura, 2000; McCall and Minang, 2005; Brown, 2006; Bauer, 2009).

Researchers have argued that, in addition to producing maps, when implemented with a stress on participation and with facilitation of discussions within communities, indigenous mapping empowers indigenous peoples in land and resource use rights against potential encroachers (Poole, 2003; Smith, 2003; Brown, 2006; Finley-Brook, 2007). Participatory mapping has gained such widespread support that even international organizations such as the World Bank have funded participatory mapping projects (Davis and Partridge, 1994; World Bank, 2002).

Despite the growing popularity of participatory mapping, researchers have emphasized that the process is not always politically useful (Bauer 2009) and risks becoming an elitist technology that enhances existing power structures (Chapin et al., 2005). Participatory mapping might even have unintended negative effects such as the increase in conflicts, increased privatization of land, loss of indigenous conceptions of space, and increased taxation by the state (Fox, 1998; Hodgson and Schroeder, 2001; Bryant, 2002; Roth, 2009). For example, reporting on a study in the Philippines, Bryant (2002) argues that the most significant and lasting contribution of participatory mapping projects conducted in the area by conservationist NGOs was to persuade indigenous peoples to internalize state control through self-regulation.

One often-mentioned negative effect of participatory mapping relates to the increase in conflicts. For example, Mwangi (2007) documents distribution-based conflicts during the re-assignation of property boundaries within collective areas among the Massai. In another participatory mapping study in four Massai areas (Tanzania),

Hodgson and Schroeder (2001) note the intensification of conflicts both between villages and with external actors. Political ecologists have provided at least three explanations for the apparent increase in conflicts generated by participatory mapping. Some authors have argued that participatory mapping might intensify conflicts because maps bring to light overlapping uses between actors without necessarily addressing power relations (Gordon et al., 2003; Finley-Brook and Offen, 2009). The process of delineating, mapping, and titling indigenous territories might also be conflictive, because the very process changes the desired outcomes of the actors. For example, territorial claims might be redrawn in relation to a neighbor's claim, resource concession, protected area, or other land allocation (Sletto, 2002a, 2002b; Offen, 2003). Finally, other authors have argued that participatory mapping informs and empowers indigenous peoples by bringing communities together and preparing them to deal with conflictive land tenure issues that involve neighboring groups or encroachment problems (Kyem, 2001; Corbett and Keller, 2005; Di Gessa, 2006).

Despite the claim, we do not know of any study that has tested whether participatory mapping systematically increases the number of conflicts. The few studies on the topic have been based on direct observations (Sletto, 2002b; Finley-Brook, 2007; Mwangi, 2007), which makes it hard to evaluate in an unbiased way whether participatory mapping in fact increases the number of conflicts. Here we contribute to assess the effects of participatory mapping on conflicts by reporting results of an experimental research. The research is based on a participatory mapping project conducted among the Tsimane', a native Amazonian society of foragers and farmers in Bolivia. The main goal of the project was to work with Tsimane' villages settled in the Territorio Indígena Tsimane' to produce high-quality digital maps of the territory they inhabit with the goal of helping them in the ongoing process of land demarcation. We

took advantage of the fact that we were working with a large number of villages and conducted the participatory mapping using an experimental research design that would allow us to estimate the unbiased effect of participatory mapping on conflicts.

2.- The Tsimane' and their land

At present, the Tsimane' number about 8,000 people and live in more than 100 villages mostly in the province of Beni, Bolivia. Like many native Amazonian societies, the Tsimane' are highly endogamous and practice cross-cousin marriage, meaning that a man marries his mother's brother's daughter or his father's sister's daughter (Huanca, 2008). The Tsimane' economy centers on hunting, fishing, and slash-and-burn farming, with cash cropping of rice becoming a dominant form of monetary income (Vadez et al., 2008). The Tsimane' also sell or barter agricultural and non-timber forest products (NTFPs) in nearby towns or with traveling traders who come to their villages. Over the last decades, the Tsimane' have increasingly engaged in wage labor for forest concessions, illegal loggers, colonist farmers, and cattle ranchers operating within or in the vicinity of their territory (Godoy et al., 2002).

The Tsimane' remained relatively isolated until the 1950s, when the arrival of highland colonist farmers, the opening of new roads, and the logging boom put them in continuous contact with other segments of Bolivian society, a process that transformed their lands and their land tenure system. Traditionally, the Tsimane' lacked a system of individual land tenure and considered land and natural resources common property (Godoy et al., 2001). In 1979, the Tsimane' ancestral lands were affected by a colonization project that gave several hundreds of hectares to highland colonists as private property (Pacheco, 2002). During the 1980s, the Bolivian government granted long-term commercial forest concessions to logging companies and established two

protected areas (Pilón-Lajas and Beni Biological Station) in the territory inhabited by the Tsimane' (Bottazzi, 2009). During the 1990s, the government also granted oil companies the right to prospect part of the Tsimane' ancestral territory, although oil companies never established themselves in that territory.

It was not until the 1990s that the Bolivian government started a land-titling process that recognized the Tsimane' claims to part of the land they had traditionally occupied (Chicchon, 1992). The Territorio Indígena Tsimane' was first recognized as Tsimane' communal land by a presidential decree in 1992 and later classified as Territorio Comunitario de Origen (TCO) in 1996 (Bottazzi, 2009). Despite the fact that the declaration occurred more than a decade ago, the actual process to establish the limits of the territory has yet to conclude. Before the land-titling process is concluded, Tsimane' lands need to undergo a process of cadastral studies [called "cleansing" (*saneamiento* in Spanish)]. This process gives priority over indigenous peoples to all other claimants that can prove use of the land before 1996 (except for forest concessions). Thus, from all the lands that appear as part of the territory initially classified as indigenous territory, only lands that are not claimed by other actors during the cadastral study will eventually remain in the hands of indigenous peoples (Stocks, 2005).

The research presented here was conducted in villages in the Tsimane' TCO and in villages in a territory designated as a commercial forest concession for the period 1981-2011. The Tsimane' settled in both types of land tenure systems have the right to hunt, clear land, and extract timber and non-timber forest products for consumption. Under approved management plans, the Tsimane' can extract timber from indigenous territories (Decreto Supremo Nº 22611). As we reported in a previous study, the Tsimane' living in both types of land tenure systems face encroachment and entrance by

many outsiders. Frequent encroachers include loggers, highland colonist farmers, and cattle ranchers, although the Tsimane' seem to express hostility only toward colonist farmers (Reyes-García et al., 2010).

3.- Methods

The study was conducted in coordination with researchers from the Tsimane' Amazonian Panel Study (TAPS, http://www.tsimane.org/), working with the Tsimane' since 1999. The idea to conduct participatory mapping came from the Tsimane' themselves, who on several occasions asked TAPS researchers to help them map their land. The Tsimane' argued that territorial maps would be useful to them in solving potential conflicts that might arise during the ongoing cadastral study. The Great Tsimane' Council (the Tsimane' umbrella government) approved the study, and we obtained consent from each village and participant. We used standard protocols (Leake, 2000; Chapin and Threlkeld, 2001), combined with GIS, GPS, and remote sensing, and guides to good practice (Rambaldi et al., 2006) to ensure that the study did not harm participating villages or individuals.

3.1.- The experimental research design

We followed a growing trend in development economics (Banerjee and Duflo, 2009) and used an experimental research design to evaluate the effects of participatory mapping on the number of conflicts in the area. Because participatory mapping involves a communal workshop and the mapping of communal territory, our unit of observation was the village. The experimental research design included 32 villages settled in the Territorio Indígena Tsimane' or neighboring forest concessions (Fig 1), which were randomly assigned to two groups: treatment (n=17) and control (n=15).

INSERT FIG 1 ABOUT HERE

To measure the effects of the intervention, we conducted a survey before and after the treatment in both treatment and control villages. The baseline or pre-intervention survey took place September-December 2007, the intervention took place January-October 2008, and the post-intervention survey took place November-December 2008. The surveys were conducted by a different team than the team who conducted the participatory mapping. The survey included questions on the number of conflicts with non-Tsimane' entering Tsimane' lands (the outcome variable). We also measured attitudes toward outsiders (i.e., negative opinion, neutral attitude, and negative attitudes toward outsiders) as pathway variables. By pathway variables we mean indicator variables of whether respondents changed their attitudes toward outsiders after the intervention.

To make a random assignment of the intervention, we matched villages by total number of conflicts with outsiders reported at baseline, stratified them by statistically significant covariates of number of conflicts (i.e., number of households in the village, road distance), and selected at random one village from each pair of villages that resembled each other most in number of conflicts while controlling for significant covariates.

For the sake of fairness, control villages received the treatment after we had collected data for the post-intervention survey (January-October 2009), so at the end of the project all participating villages had taken part in the participatory mapping. Table 1 contains a summary of the experimental research design.

INSERT TABLE 1 ABOUT HERE

3.2.- Pre- and post-intervention survey

In each village, we administered the pre- and post-intervention surveys to the male head (or the female if the male was absent) of 10 households randomly selected from a list provided by the highest-ranking authority in the village. In villages with fewer than 10 households, we interviewed all available household heads. Since the Tsimane' number about 8,000 (Censo Indígena, 2001) and the average household size is 6 persons (Godoy et al., 2009), we can estimate that the entire Tsimane' population contains about 1,329 households, of which we surveyed 285 (or about 21% of the total estimated).

To measure conflicts and attitudes toward outsiders, we asked every person in the sample three questions for each of the four most common types of outsiders who enter Tsimane' lands (i.e., traders, loggers, cattle ranchers, and colonist farmers) (Reyes-García et al., 2010). We first asked respondents to report the entrance of traders into the village during the 30 days preceding the interview. If the interviewee reported the entrance of traders, we asked about the respondent's reaction to the trader's entrance. We recorded the textual answers and later coded the answers as a) actively rejected (e.g., told the outsider to leave), b) passively accepted (e.g., did not interact), and c) engaged in economic or social activities (e.g., buying or selling products, chatting). Second, we asked respondents about the total number of conflicts with traders occurring in the village during the 30 days preceding the interview. Third, we asked respondents to give us their general opinion about the presence of traders, coded as 1) positive, 2) indifferent, or 3) negative. We then repeated the questions for loggers, cattle ranchers, and colonist farmers.

Because our unit of observation was the village, we aggregated responses at the village level. For each village we constructed four variables. Our main outcome variable was the *sum of village conflicts*, or the sum of the reported number of conflicts

with traders, loggers, ranchers, and colonist farmers occurring over the 30 days before the interview. We also constructed three pathway variables that captured village-level opinions and attitudes toward outsiders. The variable *negative opinion* measured the percentage of respondents who reported having a negative opinion of traders, loggers, ranchers, and colonist farmers entering their village during the 30 days before the interview (averaged by the number of informants in a village). The variables neutral attitude and negative attitude were constructed similarly using information from the question about the respondent's reaction to the outsider's entrance into the village.

3.3.- The intervention: Participatory mapping

A team composed by two researchers and four Tsimane' technicians led the participatory mapping. The team followed slightly modified, well-tested standard protocols for participatory mapping (Leake, 2000; Chapin and Threlkeld, 2001). Specifically, the protocol included two visits to each village for data collection. The two visits for data collection were stretched out over a period of four to eight months, depending on logistics. Before the study started, researchers and technicians agreed on the protocol for the visits. After training the technicians, the team rehearsed the delivery of the workshop to insure that they consistently conveyed the same message in the same way. The workshop was pilot-tested once in a village, revised, and then applied to all villages receiving the treatment.

On the first visit, the team conducted a communal workshop explaining the objectives and process of participatory mapping. Using local radios, the team announced their tentative arrival a few days in advance so people in the villages could plan ahead for the workshop. The team arrived at the village the day before the workshop and visited households to tell them about the place, time, and topic of the

workshop starting the following day. During the workshop, the team explained the goals of the project and what was expected from the village. Then, the research team divided participants into groups, provided groups with blank sheets of paper and pencils, and asked participants to sketch maps using three general types of information selected by members of the community where the workshop was pilot-tested. The information to be drawn on the maps included (1) significant physical features, natural and human-made (e.g., river, lakes, paths, houses); (2) land use features (e.g., hunting camps, logging areas, palms patches); and (3) culturally and historically important sites (e.g., sacred places, archaeological sites). Once the maps were finished, the team organized villagers to guide them to all the landmarks and resources they had drawn. Thus, over the days following the workshop, researchers, Tsimane' technicians, and village guides covered the village territory on foot, taking GPS readings of the features drawn on the maps. After the first visit, the data from sketch maps and GPS readings were processed and the team drew a preliminary map. The team visited each village a second time to fill in missing information and to correct inconsistencies detected when processing the data from the first visit. The second visit was shorter than the first one.

A third visit was conducted at the end of the project, once the team had finished participatory mapping on both control and treatment villages and drawn a map that showed the villages' traditional territory and land use. During the third visit, we gave each household in each village a copy of the map we had produced. In addition, we gave copies of the results to the Great Tsimane' Council.

McCall and Minang (2005) have characterized participatory mapping projects according to the level of local participation in the process. Our project probably falls into what these researchers call "functional participation" (Mccall and Minang, 2005), the second lowest step in a participation ladder with four steps. As mentioned, the

request to map the Tsimane' territory was originally made by some Tsimane' leaders, but otherwise we directed the process, from securing funding to deciding on the design, members of the team, schedule, and budget. We based our decisions on our own scientific framework and logistical possibilities, and we primarily executed our decisions without consultation with the local population (other than obtaining consent).

3.4.- Data analysis

Before analyzing data, we tested the randomness of the village's assignment to the treatment or control group. To do so, we ran an Ordinary Least Square (OLS) regression of the number of conflicts reported in a village (the outcome variable) against a dummy variable for the treatment using only information from the baseline or pre-intervention survey (2007).

We then analyzed the effect of the participatory mapping on the outcome and pathway variables using bivariate and multivariate techniques. We first calculated the mean and standard deviation of each of our outcome and pathway variables for the treatment and control villages before and after the intervention. The difference in the average number of conflicts before and after the intervention and between the treatment and control groups gave us a first estimate of the magnitude of the effects of the intervention.

Second, we ran difference-in-difference estimations using multivariate techniques. Specifically, the difference-in-difference regressions consisted on a set of OLS regressions of our outcome and pathway variables (one at a time) against a) a dummy for treatment (1=treatment; 0=control), b) a dummy for the time of the survey (1=after intervention; 0=before intervention), and c) an interaction term (treatment*after). The coefficient for the interaction of treatment*after should be

identical to the difference-in-difference estimation using bivariate techniques, and the *p* value indicates its statistical significance. We ran the regression using robust standard errors with clustering by village.

3.5.- Ethical issues related to the experimental design

Researchers have documented ethical issues related to the participatory mapping process (Abbot et al., 1998; Chapin et al., 2005; Bauer, 2009), so here we only discuss ethical issues as they relate to the randomization of this process. Initially, the team had concerns that the experimental research could produce inter- and intra-village conflicts (not only conflicts with outsiders). For example, although the Tsimane' territory is communally owned by the indigenous group, and not by specific villages, villages have informal internal boundaries. Villagers routinely trespass internal boundaries in daily activities such as hunting and gathering, but over the years we have observed inter-village conflicts when the trespassing involves collecting resources with a market value (e.g., wood). We were concerned that the participatory mapping would be understood as a process of village land demarcation and that villages conducting the participatory mapping first (i.e., treatment villages) would take advantage and claim the use of territory of other Tsimane' villages, thus opening the door to internal conflicts. To ensure that the experiment did not cause internal conflicts, during our interactions with villagers we emphasized the idea that we were mapping the land and resources of all the Tsimane', rather than the land and resources of a particular village, household, or individual.

3.6.- Potential biases

Our overall assessment is that the experiment worked well: the team was trained by practitioners who had conducted participatory mapping in other settings, the

indicators for the compliance of the intervention matched the expectations at the beginning of the project, and the population seemed to receive the project willingly. Despite this general assessment, we can think of two methodological issues that might challenge the validity of our results.

First, the intervention might have been flawed. For example, the prevalence of constant visiting and reciprocity in the Tsimane' society (Ellis, 1996) might have diluted the impact of the intervention. Because Tsimane' society is closely knit through marriage and blood ties, subjects in treatment villages could have shared the changes in attitudes arising from the intervention with subjects in control villages, thereby undermining the effect of the intervention. For example, some people in the control communities began asking for participatory mapping in 2008. Although they did not seem to mind waiting until 2009, their attitudes toward outsiders might have changed with just the information received. We did not ask about the frequency of contact between subjects in treatment and control villages, so we cannot test the bias generated by the spread of information about the intervention.

Similarly, the time-lag between the intervention and the post-intervention survey might have biased our estimates. The lag time between the intervention and the post-intervention survey ranged between six months (e.g., if a village ended the treatment in July 2008 and was visited again to carry out the post-intervention in December 2008) and just one month (e.g., if a village ended the treatment in October 2008 and had its post-intervention in November 2008). It is possible that we do not see strong effects partly because some villages experienced a long delay between the time they received the workshop and the post-intervention survey. Furthermore, raising awareness of land rights might require prolonged and repeated exposure before subjects can internalize and use the new knowledge. Hence, post-intervention effects might be evident in a

longer time span than what we could afford to measure due to budgetary and ethical issues. Given the limited resources for social science research and the ethical issues involved in conducting randomized experiments in social sciences, we believe it may be difficult to improve our experimental design.

4.- Results

4.1.- Randomness of assignment of intervention

Table 2 shows the results of our tests to assess the randomness of the assignment. The results suggest that in the pre-intervention period the treatment variable did not correlate with any of the outcome or pathway variables selected for the analysis. For example, since the *p* value of the association between the number of conflicts in a village and the treatment is close to one (p=0.96), one could assume that the assignment of the treatment has no association with the outcome. Similarly, the *p* values for the pathway variables are ≥0.25 suggesting that, at baseline, control and treatment villages resembled each other in the selected outcome and pathway variables.

INSERT TABLE 2 ABOUT HERE

4.2.- Compliance

On average, the participatory mapping workshop lasted three hours and involved 10 men and 10 women (Table 3). During the first visit, the team remained in the village an average of 5.8 days (SD=1.6), walking an average of 7.5 paths per village (SD=2.0) and collecting an average of 331 GPS readings/village (Table 3). The second visit lasted an average of 1.8 days/village, during which the team walked 2.2 paths/villages and took 35 GPS readings/village. In total, villagers had 7.6 potential contact days with the team during the intervention.

INSERT TABLE 3 ABOUT HERE

4.3.- Descriptive comparison of treatment and control groups.

Table 4 contains the definition and summary statistic for outcome and pathway variables. Villagers reported an average of 7.93 conflicts on the 30 days before the interview, although variation between villages was large (SD=13.8).

INSERT TABLE 4 ABOUT HERE

Over the two surveys, as many as 22 villages, or 34% of the sample, did not report any conflict. Because our outcome variable was censored, we ran a series of t-tests to examine whether land tenure type or road access helped explain censoring in the outcome variable at baseline. Neither land tenure type (indigenous territory or forest concession) nor road access explained censoring in the outcome variable at baseline at the 95% confidence level, suggesting that there was no self-selection in the sample.

Table 5 shows the difference-in-difference bivariate estimates for outcome and pathway variables for 2007 and 2008. The results shown in Table 5 suggest that between 2007 and 2008, the average number of conflicts reported decreased. The decrease was most pronounced in control than in treatment villages. The results in Table 5 also suggest that between the pre- and post- intervention surveys, some pathway variables improved and others worsened. If we compare the mean of pathway variables before and after the intervention for both treatment and control groups, we find a decrease in the number of people with negative opinions about outsiders. The number of people showing neutral attitudes toward the entrance of outsiders decreased in treatment villages but increased in control villages. Finally, we also found that the average number of people with negative attitudes toward outsiders decreased in both treatment and control villages.

INSERT TABLE 5 ABOUT HERE

4.4.- Difference-in-difference multivariate estimates

Table 6 presents difference-in-difference estimates of the effect of the treatment; cells show the coefficient for the interaction term (treatment*after). Column [0] shows the core model and the subsequent columns show variations to the core model to test the robustness of our findings. First, since our outcome variable is censored, we ran a Tobit model to control for censoring (Column [1]). Models reported in Columns [2]-[4] include controls: the coefficient reported in Column [2] is the result from a model including the number of people attending the workshop as a control; the coefficient reported in Column [3] comes from a model controlling for accessibility (i.e., a dummy for year-round access to the village) and population density (i.e., the number of households in the village); and the coefficient reported in Column [4] comes from a model that includes a set of village dummies variables.

INSERT TABLE 6 ABOUT HERE

The single most important finding is that the intervention had virtually no significant effect on the outcome or on the pathway variables measured. The intervention did not show any significant correlation with an increase in the number of conflicts with outsiders (line [A]). For example, participatory mapping was associated with a village level increase of 1.32 conflicts with outsiders in the core model (Column [0]) and with a village level increase of 3.48 conflicts in the model controlling for censoring (Column [1]), but the results were not statistically significant at the usual 95% confidence level.

Also, the intervention did not show any significant correlation with the average number of people showing negative attitudes towards outsiders (line [D]), although the association had the expected positive sign. Surprisingly, the intervention correlated with a decrease in the average number of people expressing negative opinions of outsiders and with a decrease of the number of people showing neutral attitudes toward

outsiders. For example, the intervention was associated with a decrease of 0.39 people showing neutral attitudes toward outsiders both in the core model and in the model controlling for year-round road access and the number of households in the village ($p=0.04$). Although statistically significant, the decline is low in real terms.

5.- Discussion and conclusion

At the beginning of this article, we noted that for the last few decades, different types of organizations have been supporting participatory mapping with the goal of empowering and helping indigenous peoples secure rights to their lands. We also explained that there have been many discussions about the uneasy mix of participatory community approaches and mapping and about the unintended consequences arising from participatory mapping. Our goal was to test one of the unintended consequences associated to participatory mapping: whether participatory mapping increased the number of conflicts with outsiders in villages taking part of the process.

Contrary to what has been argued (Sletto, 2002b; Finley-Brook, 2007; Mwangi, 2007), our study indicates that the participatory mapping intervention in randomly selected villages did not produce any effect of real and statistical significance on either the number of conflicts with non-Tsimane' entering Tsimane' lands (the outcome variable) or any of the pathway variables measured that might eventually give rise to conflicts (i.e., negative opinion, neutral attitude, and negative attitudes toward outsiders). None of the outcome and pathway variables measured increased or decreased in a meaningful and statistically significant way as a consequence of the treatment.

What explains the difference between our results and results from previous research? The explanation most likely lies in the use of an experimental research design. The level of participation of indigenous groups in participatory mapping is probably

highly endogenous: villages – or groups – suffering encroachment or other land problems might experience more conflicts than villages without such problems. But the same villages might also be more likely to request and actively engage in participatory mapping because they see participatory mapping as a tool to address their land problems. Similarly, practitioners are more likely to select villages with land tenure or encroachment problems to conduct participatory mapping projects than villages without such problems. Observational studies, as the ones reporting an increase in conflicts derived from participatory mapping, might spot an association between a village's participation in mapping and conflicts, but they cannot determine whether mapping increased the number of conflicts or whether villages in a more conflictive situation were more prone (or more likely selected) to engage in participatory mapping. Thus, researchers who have raised concerns about the conflictive potential of participatory mapping might, in fact, have reached their conclusion based on an increase in conflicts due to other political or socioeconomic processes.

Contrary, in this study, we used an experimental research design that randomly assigned villages with and without conflicts with outsiders to a treatment and a control group. The exercise allowed us to assess the unbiased effect of participatory mapping on conflicts. Our results suggest that the unintended effects of mapping (or at least some of them) are not the inevitable outcome of mapping *per se*; rather, they seem to stem from other previous or ongoing processes that determine whether communities engage in mapping their lands and how they do so.

We conclude by discussing some implications of our findings for the use of participatory mapping with indigenous peoples. The increase in the number of conflicts, although a negative outcome at first sight, has also been interpreted as a sign of empowerment. Researchers have argued that indigenous peoples who participate in

mapping processes might develop a growing awareness of their rights and decide to take a more active role in the defense of their lands and natural resources. This often includes conflicts arising from challenging outsiders who enter their lands for illicit uses (Kyem, 2001; Corbett and Keller, 2005; Di Gessa, 2006). The results of our study do not lend support to the idea that participatory mapping contributes, *per se* and in the sense just mentioned, to empower indigenous peoples on their defense of land and natural resources. Participatory mapping might produce georeferenced maps that capture the local knowledge of people, and those maps, if appropriately done, can be used in land demarcation processes. But participatory mapping does not seem to increase the capacity of indigenous peoples to respond to everyday entrances of outsiders in their territory.

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Figure 1: Study site

Table 1. Summary of experimental design

A. Variables of main interest		
Outcome	Number of conflicts with outsiders	
Pathways	1) Negative opinion of outsiders, 2) Passive attitude towards outsiders, 3) Negative attitudes towards outsiders	
Intervention	Participatory mapping	
B. Schedule		
Baseline survey	September-December 2007	
Intervention: Participatory mapping in treatment villages	January - September 2008	
Post-intervention survey	October-December 2008	
Follow up: Participatory mapping in control villages	January - September 2009	
C. Sample size		
	Treatment 1	***Control***
Villages (n=32 total)	17	15
Households (n=285 total)	150	135

Table 2. Randomness of assignment: Regression of outcome and pathway variables (in 2007) on village binary dummy variable for treatment (treatment=1; control=0; n=32).

Dependent variables:		**Coefficient**	**Standard Error**	***p***
Outcome:				
Sum of village conflicts		0.352	6.14	0.96
Pathway:				
Negative opinion		0.240	0.215	0.27
Passive attitude		0.213	0.182	0.25
Negative attitude		-0.033	0.084	0.70

Table 3. Adult attendance at workshops and intensity of mapping at treatment villages (n=17)

Topic	Mean	Std.Dev	Min	Max
Workshop duration, in hours	2.9	1.1	1.5	6
Number of men at the start of the workshop	10.2	6.0	4	27
Number of women at the start of the workshop	9.9	5.1	3	18
Number of men three hours after the start of the workshop	4.4	5.6	0	15
Number of women three hours after the start of the workshop	2.6	3.2	0	8
Number of days of permanence in village, 1st visit	5.8	1.6	2	8
Number of paths walked, 1st visit	7.5	2	2	11
Number of GPS readings taken, 1st visit	331	135	26	542
Number of days of permanence in village, 2nd visit	1.8	1.3	0	5
Number of paths walked, 2nd visit	2.2	1.9	0	6
Number of GPS readings taken, 2nd visit	34.8	37.7	0	125

Table 4. Definition and descriptive statistics of outcome variables (n=64)

Variable	Definition	Mean	SD	Min	Max	Censoring (%)
Outcome variable						
Open conflicts	Sum of the number of open conflicts with traders, loggers, ranchers, and colonist farmers occurring the 30 days before the interview.	7.93	13.8	0	77	22 (34%)
Pathway variables						
Negative opinion	Percentage of respondents who reported having a negative opinion of traders, loggers, ranchers, and colonist farmers entering their village during the 30 days before the interview. Averaged by the number of informants in a village	0.70	0.54	0	2	11 (17%)
Passive attitude	Percentage of respondents who reported no interaction with traders, loggers, ranchers, and colonist farmers entering their village during the 30 days before the interview. Averaged by the number of informants in a village	0.55	0.49	0	1.9	8 (12%)
Negative attitude	Percentage of respondents who reported actively rejecting traders, loggers, ranchers, and colonist farmers entering their village during the 30 days before the interview. Averaged by the number of informants in a village	0.10	0.19	0	0.9	42 (65%)

Table 5. Descriptive statistics of outcome variables by treatment and year of survey (n=64=32 villages * 2 surveys)

[I]	[II]	[III]	[IV]
Time	Groups:		Δ (Treatment- control)
	Treatment N=17	Control N=15	
Outcome: *Sum of village conflicts*			
Before Treatment	9.35 (±19.21)	9 (±14.94)	0.35
After Treatment	7.47 (±9.62)	5.8 (±9.74)	1.67
Δ (After-before)	-1.88	-3.2	1.32
Pathway 1: *Negative opinion*			
Before Treatment	0.92 (±0.68)	0.68 (±0.51)	0.24
After Treatment	0.62 (±0.43)	0.54 (±0.49)	0.08
Δ (After-before)	-0.30	-0.14	-0.16
Pathway 2: *Passive attitude*			
Before Treatment	0.68 (±0.63)	0.47 (±0.34)	0.21
After Treatment	0.44 (±0.52)	0.62 (±0.38)	-0.18
Δ (After-before)	-0.24	0.15	-0.39
Pathway 3: *Negative attitude*			
Before Treatment	0.13 (±0.23)	0.16 (±0.25)	-0.03
After Treatment	0.08 (±0.13)	0.03 (±0.10)	0.05
Δ (After-before)	-0.05	-0.13	0.08

Table 6. Difference-in-difference estimations: Effect of intervention on outcome and pathway variables (n=64)

	Dependent variables:	**Controls**				
		[0]	**[1]**	**[2]**	**[3]**	**[4]**
[A]	***Open conflicts***	1.32 (5.29)	3.48 (9.79)	2.35 (5.60)	0.64 (4.72)	1.32 (7.49)
[B]	***Negative opinion***	-0.16 (0.19)	-0.18 (0.31)	-0.03 (0.25)	-0.18 (0.16)	-0.16 (0.26)
[C]	***Passive attitude***	-0.39* (0.19)	-0.51 (0.27)	-0.46 (0.24)	-0.40* (0.19)	-0.39 (0.26)
[D]	***Negative attitude***	0.08 (0.09)	0.41 (0.27)	0.07 (0.10)	0.07 (0.10)	0.09 (0.13)

Note: Dependent variable regressed against "treatment" and "after" binary dummy variables, and interaction of treatment*after. Coefficient reported is for difference-in-difference coefficient (treatment*after). Treatment=1 if village received treatment; treatment=0 if village was control. After=1 if year==2008 (after intervention); after=0 if year=2007 (before intervention). [0] Raw model, see Table 5. [1] Tobit model to control for left-censoring. Controls for [2] include the number of people attending the workshop, for [3] a dummy variable for year-round road access and the number of households in the village, and for [4] a full set of village dummy variables. * and **, significant at ≤5%, ≤1%. See Table 4 for definition of variables.

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Figure(s)

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