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

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A B S T R A C T

Participatory mapping of indigenous lands and resources is increasingly seen as a precondition for securing legal recognition of indigenous land rights. But because participatory mapping might have unintended impacts on the functioning of rural communities, researchers have put a great effort in analyzing the effects of participatory mapping. In this article, we used a randomized evaluation to assess the effects of participatory mapping in conflicts with external actors and with neighbouring villages in the Tsimane' indigenous territory, Bolivian Amazon. We randomly assigned villages to a treatment and a control group, conducted participatory mapping with villages in the treatment group, and evaluated the effects of mapping village resources on the number of reported conflicts with and attitudes towards a) external actors and b) indigenous peoples from other villages. The exercise allows us to assess the effect of participatory mapping on conflicts while controlling for the political context. Results from our study indicate that conducting participatory mapping in randomly selected villages did not produce any effect of real or statistical significance on either 1) the number of conflicts with outsiders entering Tsimane' villages, 2) the number of conflicts with Tsimane' from other villages, 3) negative attitudes or opinions of outsiders, or 4) negative attitudes or opinion of Tsimane' from other villages. Our results suggest that some of the effects that have been attributed to participatory mapping are not the inevitable outcome of mapping *per se*; rather, they probably stem from other previous or ongoing processes that determine whether communities engage in mapping their lands and how they do so.

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Introduction

Emerging out of a broader interest in grass-roots participation (Chambers, 1997), over the last two decades participatory mapping projects have boomed (see for example Bernard, Barbosa, & Carvalho, 2011; Chapin, Lamb, & Threlkeld, 2005; Cronkleton, Albornoz, Barnes, Evans, & de Jong, 2010; Herlihy & Knapp, 2003; McCall & Minang, 2005; Roth, 2009; Sletto, 2009). Participatory mapping consists in a process through which professional and local researchers work closely with community members to gather information about the community's territory to generate maps that reflect communities' perceptions of the landscapes (Chapin et al.,

2005). Participatory mapping is typically assisted by the use of Geographic Information Systems (GIS), as the information retrieved in the field is geo-referenced and can be mapped and spatially analyzed with GIS software.

Researchers, indigenous peoples, and their advocates have used participatory mapping for a variety of purposes including recognizing land rights, land-use planning (i.e., demarcating traditional territories, protecting demarcated lands, managing traditional lands and resources), recording cultural and historical information, building community awareness, and resolving conflicts (see Chapin & Threlkeld, 2001; Cronkleton et al., 2010; Fox, 2002; Herlihy & Knapp, 2003; Mohamed & Ventura, 2000; Peluso, 1995; Poole, 1995; Rambaldi, Chambers, McCall, & Fox, 2006; Rocheleau, 1995). Participatory mapping has gained such widespread support that even organizations such as the World Bank have funded participatory mapping projects (Davis & Partridge, 1994; World Bank, 2002).

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Despite the growing popularity of participatory mapping and because researchers and activists involved in participatory mapping often seek to address issues of inequity by putting mapping at the service of local communities, the method has been subject to careful examination. Researchers working with participatory mapping have highlighted not only its potential positive effects, but also its potential —and unintended— negative effects, or what (Fox, Suryanata, Hershock, & Pramono, 2005) have called its "ironic effects". For example, despite its many potential useful applications, researchers have noticed that participatory mapping also risks becoming an elitist technology that enhances existing power structures (Chapin et al., 2005). It might also result in increased privatization of land, loss of indigenous conceptions of space, greater exposure of valuable natural resources, and increased taxation by the state (Bryant, 2002; Fox, 1998; Hodgson & Schroeder, 2001; Roth, 2009). Recent works on participatory mapping have also explored the limits of participation in such projects, questioned the social implications of technology transfers to indigenous communities, discussed the implications of establishing formal boundaries, and analyzed issues related to resource access and the reproduction of social inequalities —including gender inequalities— as well as other consequences of participatory mapping on the internal workings of the communities (Fox, 1998; Fox et al., 2005; Gordon, Gurdin, & Hale, 2003; Offen, 2003a, 2003b; Orlove, 1991, 1993; Peluso, 1995; Rocheleau, 2005; Rundstrom, 1995; Schroeder & Hodgson, 2002; Walker & Peters, 2001).

Among the effects of participatory mapping, several scholars have paid attention at how it relates to internal and external conflicts. Some authors have argued that participatory mapping can be used for managing internal competition over land and resources and for conflict resolution (Cronkleton et al., 2010; Harris & Weiner, 1998; Kyem, 2004, 2002; McCall & Minang, 2005; Weiner & Harris, 2003). For instance, in research in Cameroon, McCall and Minang (2005) found that inter-group dialogue was improved through the use of geographical information in participatory forums, leading towards conflict resolution. Similarly, in a project geared towards mapping resources in an extractive reserve in the Bolivian Amazon, Cronkleton et al. (2010) found that in the process of mapping their resources local residents gathered information to mediate competing claims, suggesting that —although mapping did not eliminate internal conflict— it provided a basis for initiating mediation processes.

Following an argument first prominently articulated by Obermeyer and Pinto in 1974 (Obermeyer & Pinto, 2008), other authors have argued that in certain circumstances participatory mapping can contribute to generate, deepen, or raise latent internal conflicts (Hodgson & Schroeder, 2001; Mwangi, 2007). Participatory mapping might intensify internal conflicts because it might bring to light overlapping uses of land and resources (Offen, 2003a, 2003b) or erode traditional ways of dealing with internal conflicts (Hale, 2006; Peluso, 1995; Vandergeest, 1996). Indeed, conflict over boundaries is a common feature of many participatory mapping exercises. For example, Mwangi (2007) documents distribution-based conflicts during the re-assignation of property boundaries within collective areas among the Massai (Tanzania). In another participatory mapping study in four Massai areas, Hodgson and Schroeder (2001) note the intensification of conflicts between villages. As long as boundaries remained flexible, conflicts could be minimized, but once boundaries were mapped, overlapping rights could not be overlooked and raised conflicts among neighbouring ethnic groups or villages in ways that did not exist before the mapping project began.

Some authors have also paid attention to the role of participatory mapping in increasing conflicts with external actors, such as protected areas managers, miners, loggers or oil extractors. As lands inhabited by indigenous peoples overlap with areas of high biodiversity (Sunderlin et al., 2005) and represent the last frontier of many raw materials and important minerals (Bedoya, 2004; Finer, Jenkins, Pimm, Keane, & Ross, 2008; Watson, 1996), many actors have claimed rights to occupy those lands or to use the resources in them (Orta & Finer, 2010; Peet & Watts, 2004; Zimmerer & Bassett, 2003). Participatory mapping has been often used to assist indigenous people's efforts to gain recognition to land-use rights or to protect themselves against land dispossession by encroachment or state authority. Researchers have documented that in those cases, participatory mapping might increase the number of conflicts with external actors (Peluso, 1995; Rundstrom, 2009), as the maps produced might challenge the maps made by state and corporate authorities. Some researchers have considered this second kind of conflicts (also known as socio-environmental conflicts) as motors that drive institutional transformations and promote democratic strengthening (Bebbington & Bebbington, 2009).

In this article we examine the relation between participatory mapping and internal and external conflicts. We do so by using an innovative approach based on a randomized evaluation of a participatory mapping project with the Tsimane' indigenous people in the Bolivian Amazon. The participatory mapping literature argues that mapping projects get caught up in local political or socio-economic entanglements that result in conflict (Fox, 2002). In other words, this literature suggests that 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 external conflicts than villages without such problems. The same villages might also be more likely to request and actively engage in participatory mapping because they see it as a tool to address their land problems. Similarly, practitioners are more likely to select villages with land tenure or encroachment problems for participatory mapping, as in those contexts results can be of immediate use. Observational studies might spot an association between a village's participation in a mapping project and the occurrence of external conflicts, but they cannot determine whether the mapping project itself increased the number of external conflicts or whether villages in a more conflicting situation were more prone (or more likely selected) to engage in participatory mapping.

Randomized evaluations, like the one presented here, allow one to determine the direction of causality (Banerjee & Duflo, 2009). Randomized evaluations measure the impact of an intervention by randomly allocating individuals to a "treatment" group, comprising individuals who participate in the project, and a "comparison" group, comprising individuals who do not participate in the project, at least for some period of time. The outcomes are then compared across treatment and comparison groups (Banerjee & Duflo, 2009). In development economics, this approach has gained increased recognition and has been used to evaluate all sorts of specific practical problems such as how to get teachers to come to schools more often, how to help farmers to save more, or how to convince parents to get their children immunized. This methodological approach, however, has never been used to evaluate participatory mapping.

Potential sources of conflict on Tsimane' lands

The Tsimane' are a native Amazonian society of hunter-gatherers and farmers in Bolivia. They number about 8000 people and live in more than 100 villages mostly settled in the province of Beni, Bolivia (Censo Indigena, 2001). The Tsimane' remained relatively isolated until the 1950s, when the opening of new roads facilitated the arrival of highland colonist farmers and the logging boom, putting them in continuous contact with other segments of Bolivian society, a process that transformed Tsimane' lands and

their land tenure system (Reyes-García et al., 2012). Nowadays, 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, Reyes-Garcia, Huanca, & Leonard, 2008). The Tsimane' also sell or barter agricultural and non-timber forest products in nearby towns or to travelling traders who come to their villages. Over the last decades, the Tsimane' have increasingly engaged in wage labour for forest concessions, illegal loggers, colonist farmers, and cattle ranchers operating in or within the vicinity of their territory (Godoy et al., 2005).

Traditionally, the Tsimane' lacked a system of individual land tenure (Godoy, Kirby, & Wilkie, 2001). Due to shared resource use and governance, land and natural resources probably fell under the broad category of common-property tenure, *sensu* (Ostrom, 1990, p. 1281). In 1979, the Tsimane' ancestral lands were affected by a colonization project that gave several hundreds of hectares to highland colonists farmers as private property (Pacheco, 2002). During the 1980s, the Bolivian government granted long-term forest concessions to several logging companies. Also during the 1980s, the government declared two protected areas (Pilón-Lajas Biosphere Reserve and Beni Biological Station) in part of the territory inhabited by the Tsimane' (Bottazzi, 2009). During the 1990s, the government also granted oil companies the right to prospect in the Tsimane' ancestral territory, although —to date— oil companies have not established themselves in the area (Gavalda, 2003). It was also in the 1990s, and following decentralization policies common in Latin America (Assies, 2006), that the Bolivian government started a land-titling process that recognized the Tsimane' rights to lands. Thus, in 1992, a presidential decree recognized Tsimane' communal property of part of the land they inhabited. The area was recognized as *Tierras Comunitarias de Origen* (TCO; Original Communitarian Lands) in 1996 (Bottazzi, 2009). During the same process, other Tsimane' villages were assigned to other TCOs, where they share land property with other indigenous groups. Some Tsimane' villages were not included in TCOs and thereby remained in other land tenure regimes (e.g., private land, forest concessions, protected areas) (Reyes-García et al., 2012).

The research presented here was conducted in villages within and around the Tsimane' TCO. The villages around the TCO were settled in land assigned to a commercial forest concession and in a neighbouring TCO. There are several potential sources of conflicts with external actors around these lands and their resources. First, throughout all Bolivia, the process of regularization of land titles has been slow and conflict-plagued. Moreover, due to its bureaucratic nature, land titling has only been completed when multilateral and international cooperation helped (Assies, 2006), not the case among the Tsimane'. Thus, despite the fact that the Tsimane' TCO was established in 1996, the actual process of land demarcation has yet to conclude. Before the Tsimane' TCO is completely demarcated, it needs to undergo a process of cadastral studies (*saneamiento*) to clarify the rights of third parties over land assigned to the Tsimane' TCO. Claimants who can prove the property or the use of the land before 1996 have priority to the land over indigenous peoples (Assies & Salman, 2000). Thus, from all the lands that were initially assigned, only lands that are not claimed by other actors will eventually remain as part of the TCO.

Second, the definition of land property for territories under forest concessions is another potential source of conflicts with external actors. Commercial forest concessions in the area expired in 2011, when the land was reverted to the state. The Tsimane' political organization, *Gran Consejo Tsimane'*, aspires to recover some of these lands for the Tsimane' TCO, partly to make up over land lost under the cadastral study. However, other actors have competing claims over that land. For example, the San Borja municipal government aspires to obtain a proportion of the forest

as municipal forest reserve, as it has been the case in other municipalities (Pacheco, de Jong, & Johnson, 2010). Lands could also be given to private owners who present adequate management plans for the land. Alternatively, under the 2006 agrarian reform, the land could be granted under collective ownerships to new smallholder settlements (often newly arrived highland settlers).

Third, the fact that TCOs refer only to land, leaving forest and underground resources regulated by other laws, is also a potential source of conflict over those resources. There have been several oil concessions overlapping the Tsimane' territory. In the 1990's, oil blocks in the Tsimane' territory were leased to REPSOL and PETROBRAS (Gavalda, 2003). Seismic lines were cut and several exploration wells were drilled. Nowadays there are no oil concessions in the Tsimane' territory, but rising oil prices and the TIPNIS road project have spurred the debate about a new wave of hydrocarbon activities expected to hit the region in the near future. In the same vein, as gold price rises, conflicts with illegal miners or gold mining concessions could be expected in the Tsimane' territory, where there have already been several booms of incursions looking to exploit the region's gold deposits.

Fourth, conflicts can also potentially arise for the use of natural resources. According to the Bolivian legislation, indigenous peoples have the right to hunt, clear forest land, and extract timber and non-timber forest products for consumption from their TCOs. Indigenous peoples can extract timber from their TCOs under approved forest management plans (Decreto N° 22611), except that most indigenous people cannot pay the costs of management plans. Over the years, a few urban-based Tsimane' have benefited from contracts with logging concessions and from informal agreements with illegal loggers to extract timber from the Tsimane' TCO (Bottazzi, 2009). Those contracts and agreements have reported some benefits to the Tsimane' elite, but have often been signed without the knowledge and consent of the communities, who did not benefit from them. Realizing this situation, and as in other parts of Bolivia (Pacheco et al., 2010), a growing number of Tsimane' have started 1) to sell timber in their communal land to illegal loggers, or 2) to engage in illegal logging themselves.

The new involvement in logging activities is not only a potential source of conflict with the legal and illegal loggers that encroach upon the Tsimane' TCO, but also a potential source of internal conflict. Although the Tsimane' territory is communally owned by the indigenous group, and not by specific villages, villages have informal internal boundaries. Villagers routinely trespass those 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., commercial wood, *Geonoma deversa* leaves for roofing thatch). New conflicts might arise from the commoditization of Tsimane' natural resources.

Methods

In this context, we approached the *Gran Consejo Tsimane'* to present them with the idea to conduct a participatory mapping of Tsimane' land use. The organization agreed with the project, as they aimed to use the information gathered to claim lands under forest concessions for their TCO. The participatory mapping project was conducted in coordination with the Tsimane' Amazonian Panel Study (http://www.tsimane.org/), a group of researchers working with the Tsimane' since 1999. In addition to the approval of the *Gran Consejo Tsimane'*, we also obtained consent from each village and participant.

Combining randomized evaluation and participatory mapping

We used a randomized evaluation to assess the effects of mapping village resources on the number of reported conflicts of

that village with a) external actors and b) Tsimane' from other villages. We also collected information on pathways variables, or variables that capture changes in the expected direction, but that might not necessarily lead to conflict, such as a change in people's attitudes towards outsiders. The research design included 32 villages settled in TCOs and neighbouring forest concessions (Fig. 1), which were randomly assigned to two groups: treatment ($n = 17$) and control ($n = 15$). Taking advantage of the fact that we were working with a large number of communities and we could not conduct the participatory mapping in all the communities at the same time, we could use this experimental design without falling into ethical pitfalls.

We started by conducting a baseline (or pre-intervention) survey (Table 1). The survey included questions on internal and external conflicts as well as on household and village characteristics. We then divided the villages between treatment and control. To make a random assignment of the intervention we first matched villages by total number of conflicts reported in the baseline survey. We then stratified villages 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 most resembled each other in number of conflicts while controlling for significant covariates.

The intervention consisted in the participatory mapping itself (Section 3.3), which took place during January–October 2008 for the treatment villages. During November–December 2008 we conducted a post-intervention survey, consisting of the same questions as those in the baseline survey. For the sake of equity, after the post-intervention survey (January–October 2009), we used the same protocol to conduct participatory mapping in villages assigned to the control group. Thus, at the end of the project, all participating villages had conducted the participatory mapping.

Once we had mapped the land of the communities assigned to both control and treatment groups, we produced a map representing villages' land and resource use. We then visited all the villages a third time and conducted a communal workshop where we gave a copy of the map produced, explained the map features, as well as the usefulness and perils of the map should it be misused by the community. We also gave copies of the map to the Tsimane' political organization and to Bolivian research institutions.

Pre- and post-intervention survey

We administered identical 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. We asked respondents to report the entrance of loggers into the village during the 30 days preceding the interview. If the answer was positive, we asked about the total number of conflicts with loggers during the same period. We also measured changes in peoples' attitudes towards outsiders entering their villages by asking
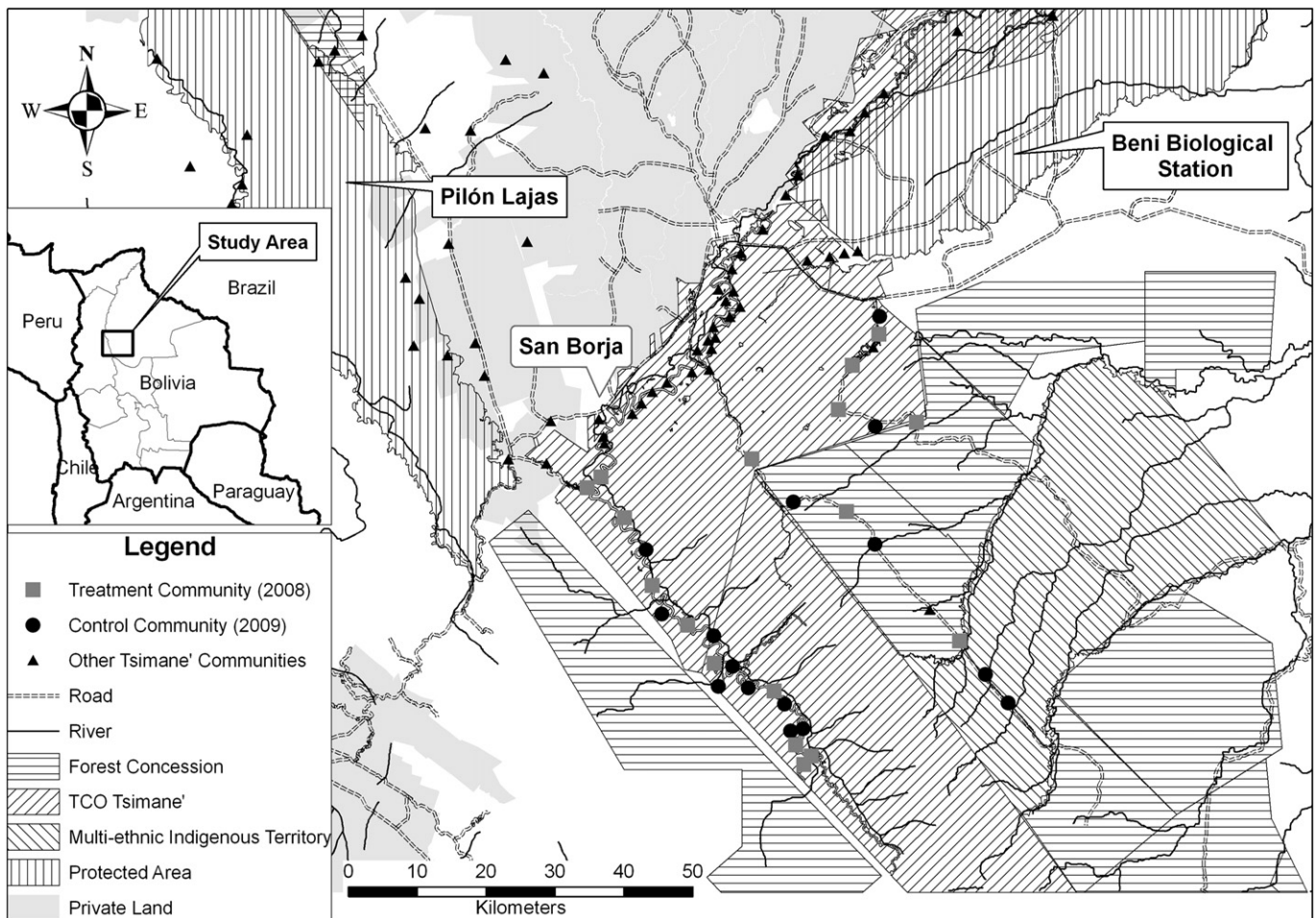

Fig. 1. Study site.

Table 1
Summary of research design.

A. Variables of interest		
External conflicts	Outcome: number of conflicts with	Loggers
		Highland colonist farmers
		Cattle ranchers
		Traders
	Pathway	Negative attitude towards outsiders
		Negative opinion towards outsiders
Internal conflicts	Outcome: number of conflicts with	Tsimane' from other villages
	Pathway	Negative attitude towards Tsimane'
		Negative opinion towards Tsimane'
Treatment		Participatory mapping
B. Schedule		
Baseline survey		September–December 2007
Intervention: Participatory mapping in treatment villages		January–October 2008
Post-intervention survey		November–December 2008
Follow up: Participatory mapping in control villages		January–October 2009
Returning information to the villages		May–July 2010
C. Sample size		
	Treatment	Control
Villages ($n = 32$ total)	17	15
Households ($n = 285$ total)	150	135

respondents their reactions to their entrance. We recorded the textual answers and later identified the answers in which the respondent mentioned actively rejecting the outsider (e.g., told the outsider to leave). Lastly, we asked respondents to give us their general opinion about the presence of traders (positive, indifferent, negative). We then repeated the questions for the other actors listed in Table 1.

The treatment: participatory mapping

The participatory mapping team was different than the team collecting survey data and was composed by two professional and four Tsimane' researchers. They used a protocol for participatory mapping based on Chapin and Threlkeld (2001) and Leake (2000). They strictly adhered to suggested guides of good practice (Rambaldi et al., 2006). The protocol included two visits to each village for data collection and one for returning the map. During the first visit the team conducted a communal workshop. After explaining the goals of the project and obtaining consent, researchers requested workshop participants to divided into groups and sketch maps that included (1) significant biophysical (e.g., ponds, streams) and human-made (e.g., paths, traditional houses) features; (2) land-use features (e.g., hunting camps, logging areas, palms patches); and (3) culturally important sites (e.g., sacred places, archaeological sites) in the lands that the community use on a regular basis. Over the days following the workshop, researchers and village guides covered the village territory on foot, taking GPS readings, and noting down relevant information regarding the features drawn on the sketch maps. After the first visit, data from sketch maps and GPS readings were processed in a GIS and the research team drew a preliminary map. The team visited each village a second time to fill in missing information and to correct inconsistencies.

On average, the participatory mapping workshop lasted 3 h and involved 10 men and 9 women. 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. 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. On average each villager had 7.6 potential contact days with the team conducting the participatory mapping.

Data analysis

For each of the surveys, we aggregated individual responses to construct variables measuring the total number of external and internal conflicts reported at the village level. We constructed variables for each actor (i.e., loggers, colonists, ranchers, traders, and Tsimane' from other villages). We also constructed an aggregated variable adding the number of reported of conflicts with all external actors over the 30 days before the interview. To assess whether there was an increase in negative attitudes that eventually might lead to conflict, we constructed four more variables. The variable *negative attitude* towards outsiders measured the percentage of respondents who reported actively rejecting traders, loggers, ranchers, and colonist farmers entering their village during the 30 days before the interview. The variable *negative opinion towards outsiders* measured the percentage of respondents who reported having a negative opinion of the same actors. The two variables were averaged by the number of informants in a village. Two similar variables were constructed to assess changes in attitudes and opinions of Tsimane' from other villages.

We analyzed the effect of participatory mapping on the reported number of internal and external conflicts using bivariate and multivariate statistics. To get a first estimate of the magnitude of the effects of the intervention, we calculated the mean and standard deviation of outcome and pathway variables for the treatment and control villages before and after the intervention. We also ran difference-in-difference estimations using multivariate techniques. The difference-in-difference estimation consisted in a set of Ordinary Least Square (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), and c) an interaction term (treatment*after). The multivariate estimation allows us to test the statistical significance of the tendencies observed. We ran the regressions using robust standard errors with clustering by village.

Results

Tsimane' external and internal conflicts

When considering both treatment and control villages and data collected during the pre- and post-intervention surveys ($n = 64$ villages), we found that at least one respondent in 91% of the villages reported the presence of traders, loggers, cattle ranchers, or colonist farmers during the 30 days before the day of the interview. Conflicts with external actors were reported in 67% of the villages: 31% of the villages reported conflict with loggers and 58% with traders. Less than 5% of the villages reported conflicts with ranchers and colonist farmers. On average, villagers reported 8.06 external conflicts/village on the 30 days before the interview, but there was a large variation (SD = 13.8) in the number of external conflicts reported (Table 2). Respondents reported conflicts with traders (an average of 5.3 conflicts were reported in each village) and loggers (2.4) more often than with other actors. Our data show that 11% of respondents reported actively rejecting the entrance of traders, loggers, ranchers, and colonist farmers, and 77% reported having a negative opinion about them.

Table 2
Definition and descriptive statistics of outcome variables. Variables aggregated at the village level ($n = 64$).

Variable	Definition	Mean	SD	Min	Max
Conflicts with and attitudes towards external actors					
Conflicts with loggers	Reported number of conflicts with loggers	2.4	5.4	0	30
Conflicts with colonists	Reported number of conflicts with highland colonist farmers	0.2	1.2	0	9
Conflicts with ranchers	Reported number of conflicts with cattle ranchers	0.05	0.3	0	2
Conflicts with traders	Reported number of conflicts with traders	5.3	9.6	0	47
External conflicts	Total number of conflicts with loggers, colonist farmers, ranchers, and traders.	8.06	13.8	0	77
Negative attitude outsiders	Percentage of respondents who reported actively rejecting loggers, colonist farmers, ranchers, and traders.	0.11	0.22	0	1
Negative opinion outsiders	Percentage of respondents who reported having a negative opinion of loggers, colonist farmers, ranchers, and traders.	0.77	0.57	0	2.2
Conflicts with and attitudes towards Tsimane' from other communities					
Conflicts with other Tsimane'	Reported number of conflicts with Tsimane' from other villages.	0.66	2.0	0	12
Negative attitude Tsimane'	Percentage of respondents who reported actively rejecting Tsimane' from other villages.	0.003	0.02	0	0.1
Negative opinion Tsimane'	Percentage of respondents who reported having a negative opinion of Tsimane' from other villages.	0.05	0.09	0	0.5

Note: All information refers to entrances to the village during the 30 days before the interview.

Respondents reported few conflicts with Tsimane' from other communities entering their territory, or an average of 0.7 conflicts/village. Negative attitudes towards Tsimane' from other villages were extremely rare, and only 5% of the respondents reported a negative opinion of Tsimane' from other villages.

Descriptive comparison of changes in the number of conflicts and attitudes

Table 3 shows the bivariate analysis for the variables that measured conflict with external actors entering Tsimane' villages

Table 3
Analysis of change in variables measuring conflicts with external actors. By actor, treatment, and year of survey ($n = 64 = 32$ villages*2 surveys).

[I] Time	[II] Groups:	[III]	[IV] Δ (Treatment − Control)
	Treatment N = 17	Control N = 15	
Conflicts with loggers			
Before Treatment	2.8 (±7.2)	2.2 (±5.05)	0.6
After Treatment	3.8 (±5.9)	0.33 (±1.29)	3.47
Δ (After − before)	1	−1.87	2.87
Conflicts with colonists			
Before Treatment	0 (±0)	0 (±0)	0
After Treatment	0.76 (±2.3)	0 (±0)	0.76
Δ (After − before)	0.76	0	0.76
Conflicts with ranchers			
Before Treatment	0.06 (±0.24)	0 (±0)	0.06
After Treatment	0.12 (±0.48)	0 (±0)	0.12
Δ (After − before)	0.06	0	0.06
Conflicts with traders			
Before Treatment	6.5 (±12.7)	6.8 (±10.5)	−0.3
After Treatment	2.76 (±3.56)	5.5 (±9.72)	−2.7
Δ (After − before)	−3.7	−1.3	−2.4

before and after the participatory mapping and for villages in the treatment and control groups. Between 2007 and 2008, conflicts with loggers, highland colonist farmers, and ranchers increased in the treatment but not in the control villages. During the same period, the average number of conflicts with traders decreased both in treatment and control villages. If we compare the variables before and after the intervention for both treatment and control groups, we find that, overall, the participatory mapping resulted in a net increase in the number of reported conflicts with loggers (2.87 conflicts/village more in villages receiving the treatment than in villages in the control group), and colonists (0.76), but in an overall decrease in the number of conflicts with traders entering Tsimane' villages (−2.4).

Table 4 depicts a similar analysis but using the variable that measures the total number of conflicts with external actors and with Tsimane' from other villages, as well as information form the pathway variables. We found an increase in the total number of conflicts with external actors (1.83 more conflicts/village were reported in treated than in control villages after the mapping). We also find a slight net increase in negative attitudes and opinions towards outsiders, but the real significance of the increase was low. Lastly, participatory mapping seemed to produce a net increase in the number of conflicts with Tsimane' from other villages (0.65), but no changes in attitudes and opinions towards them.

Difference-in-difference multivariate estimates

Table 5 presents results of the difference-in-difference multivariate estimate 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 test the robustness of our findings. Models reported in Columns [1]–[3] include controls: the coefficient reported in Column [1] is the result from a model including the number of people attending the workshop as a control; the coefficient reported in Column [2] comes from a model controlling for accessibility (i.e., a dummy for

Table 4
Analysis of change in variables measuring conflicts with and attitudes towards external actors (total) and Tsimane' from other villages. By treatment, and year of survey ($n = 64 = 32$ villages*2 surveys).

Time	Groups:		Δ (Treatment − Control)
	Treatment N = 17	Control N = 15	
Total external conflicts			
Before Treatment	9.35 (±19.21)	9.1 (±14.9)	0.25
After Treatment	7.88 (±10.07)	5.8 (±9.74)	2.08
Δ (After − before)	−1.47	−3.3	1.83
Negative attitude outsiders			
Before Treatment	0.16 (±0.28)	0.17 (±0.27)	−0.01
After Treatment	0.09 (±0.15)	0.03 (±0.10)	0.06
Δ (After − before)	−0.07	−0.14	0.07
Negative opinion outsiders			
Before Treatment	0.96 (±0.73)	0.80 (±0.50)	0.16
After Treatment	0.68 (±0.49)	0.61 (±0.48)	0.07
Δ (After − before)	−0.28	−0.19	−0.09
Conflicts with other Tsimane'			
Before Treatment	0.35 (±0.61)	1.7 (±3.6)	−1.35
After Treatment	0 (±0)	0.7 (±1.6)	−0.7
Δ (After − before)	−0.35	−1	0.65
Negative attitude other Tsimane'			
Before Treatment	0.01 (±0.03)	0 (±0)	0.01
After Treatment	0 (±0)	0 (±0)	0
Δ (After − before)	−0.01	0	−0.01
Negative opinion other Tsimane'			
Before Treatment	0.04 (±0.05)	0.06 (±0.10)	−0.02
After Treatment	0.02 (±0.04)	0.09 (±0.14)	−0.07
Δ (After − before)	−0.02	0.03	−0.05

Table 5
Difference-in-difference multivariate estimations: effect of intervention on outcome and pathway variables ($n = 64$).

Outcome and pathway variables	Robustness			
	[0]	[1]	[2]	[3]
Conflicts with and attitudes towards external actors				
[A] Conflicts with loggers	2.86 (2.35)	3.82 (2.73)	2.31 (2.07)	2.87 (3.32)
[B] Conflicts with colonists	0.76 (0.57)	0.97 (0.93)	0.23 (0.25)	0.76 (0.81)
[C] Conflicts with ranchers	0.06 (0.06)	−0.02 (0.06)	0.04 (0.06)	0.06 (0.08)
[D] Conflicts with traders	−2.37 (3.11)	−2.43 (2.86)	−1.93 (2.99)	−2.37 (4.40)
[E] Total external conflicts	1.83 (5.37)	2.79 (5.63)	1.00 (4.81)	1.80 (7.60)
[F] Negative attitude outsiders	0.07 (0.10)	0.05 (0.11)	0.05 (0.11)	0.07 (0.15)
[G] Negative opinion outsiders	−0.09 (0.19)	0.05 (0.27)	−0.12 (0.18)	−0.09 (0.28)
Conflicts with and attitudes towards Tsimane' from other communities				
[H] Conflicts with other Tsimane'	0.71 (1.10)	0.71 (1.11)	0.74 (1.14)	0.71 (1.56)
[I] Negative attitude Tsimane'	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)
[J] Negative opinion Tsimane'	−0.05 (0.05)	−0.07 (0.05)	−0.05 (0.05)	−0.05 (0.07)

Note: Outcome and pathway variables regressed against "treatment" and "after" binary dummy variables, and interaction of treatment*after. Coefficient reported (Standard Error in parenthesis) 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. Controls for [1] include the number of people attending the workshop, for [2] a dummy variable for year-round road access and the number of households in the village, and for [3] a full set of village dummy variables. * and **, significant at ≤5%, ≤1%. See Table 2 for definition of variables.

year-round road access to the village) and population density (i.e., number of households in the village); the coefficient reported in Column [3] comes from a model that includes a set of village dummy variables.

The single most important finding is that the intervention had no statistically significant effect on any of the outcome or pathway variables measured, neither for external actors not for Tsimane' from other villages. For example, although the participatory mapping seemed to be associated with a village level increase of 2.86 conflicts with loggers in the core model (Column [0]) and with a village level increase of 3.82 conflicts in the model controlling for participation in the workshop (Column [1]), the results were not statistically significant.

Participatory mapping did not show any significant association with the average number of people showing negative attitudes towards outsiders (line [F]) or towards Tsimane' from other villages [I]. Surprisingly, the intervention produced a decrease in the average number of people showing negative opinions towards outsiders and towards Tsimane' from other villages. Those results, however, are low in real terms and not statistically significant.

Discussion

Different authors, in different contexts, have found different effects of participatory mapping in internal conflicts and conflicts with external actors. Because participatory mapping does not occur in a social vacuum, it is possible that its relation to conflict is highly endogenous: villages with more land problems might be a more likely the target for mapping projects, but they might also experience more conflicts. The intricacies of social dynamics do not allow one to determine whether the mapping process —in itself— causes conflict, or whether conflict arises from some other, more complex dynamics. The use of an experimental research design, where only randomly selected villages participate in mapping, allows one to determine whether there is in fact a causal relation between participatory mapping and conflicts. Results from our study indicate that conducting participatory mapping in randomly selected villages did not produce any effect of statistical significance on either 1) the number of conflicts with outsiders entering Tsimane' villages, 2) the number of conflicts with Tsimane' from other villages, 3) negative attitudes towards or opinions of outsiders, or 4) negative attitudes towards or opinion of Tsimane' from other villages. Thus, our results suggest that conflicts are not the inevitable outcome of mapping *per se*. We explore potential methodological and theoretical reasons that might explain this finding.

We can think of at least three methodological caveats that might have flawed our experimental design, and that therefore might bias the results presented here. First, the time-lag between the participatory mapping and the post-intervention survey might have been too short to capture any change, as internal and external conflicts might appear only after a larger time span. Second, the participatory mapping intervention might have been too light to impact peoples' concepts on land and natural resources. 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 they call "functional participation", the second lowest step in a four-step ladder of participation steps. Lastly, it is also possible that we did not find any effect of our intervention because the post-intervention survey was conducted after the mapping process, but *before* giving the maps back to the communities. If the map itself, rather than the process of mapping, is what ignites change in peoples' attitudes, then our post-intervention survey could not capture any change. In sum, it is possible that the effects of participatory mapping projects might be evident only in a longer time span than what we could afford to measure due to budgetary and ethical issues (i.e., giving the map only to the treated communities), or that they are evident only after a much intense and politically-oriented intervention.

We also find an important theoretical argument in the literature on participatory mapping that might help explain the lack of effect of participatory mapping in internal or external conflicts. Fox (2002) has argued that true participatory mapping only occurs when the villagers claim and use the maps, as opposed to when villagers just help in making the maps. In our case, the lack of use of the maps is exemplified in the way our results were stored once the project ended. Although we put a great effort in returning the result of our work both to the Tsimane' representatives and to each village participating in the project, in a posterior visit to the area, we realized that many Tsimane' were unaware of our work. Even though maps had been returned to participants, during our posterior visit, we were questioned by some new leaders and by some villagers about the whereabouts of the maps. The maps had been stored in the leaders' houses and not discussed or otherwise used. So, if the argument advanced by Fox holds, and since Tsimane' villagers mostly participated in the mapping by helping to do the maps and guiding the team through their territory, it is no wonder that our intervention did not had any real effect, as it was not adequately adopted by Tsimane' villagers. But the intriguing question is why -despite all the threats and potential sources of conflicts with external actors around Tsimane' lands and their resources- Tsimane' villagers never engaged actively in the participatory mapping process?

A potential answer to that question lies in the participants' lack of awareness of immediate threats to the Tsimane' territory at the time when the participatory mapping was conducted. The loss of land and resources for Tsimane' livelihood and other consequences of overexploitation of natural resources are long-term and neither

evident, nor yet visible. As mentioned, the idea to conduct participatory mapping with Tsimane' villages was highly welcomed by Tsimane' political leaders. However, over the two years that lasted the execution of the project, we realized that most Tsimane' villagers were not always concerned about territorial rights. Furthermore, many were not aware of the threats to their territory. This low awareness can be explained by the fact that many threats to the Tsimane' territory are still hypothetical. For example, although encroachment of Tsimane' lands could occur if colonist farmers settle in the area limiting the Tsimane' TCO and previously given in forest concessions, the fact is this has not yet been the case. Then, low levels of awareness about potential threats to their territory might explain why Tsimane' villagers, although they were always helpful in the development of the project, never reached the stage of claiming the maps and using them to defend their lands. Kyem (2004) has highlighted the critical importance of selecting the right timing of a participatory mapping activity for a successful outcome of that process, as social interactions between actors evolve through time. In that sense, it is possible that the same project, with the same actors, but in a different moment (i.e., once some of the threats to the Tsimane' territory pass from being hypothetical to being real) might had had different results.

Conclusion

Results from our work support the argument – previously advanced in the participatory mapping literature – that mapping projects do not bring about conflicts *per se*. Rather, the process and the results of participatory mapping can help in conflict resolution or contribute to conflict generation or exacerbation depending on the political and socio-economic context in which they are conducted. Mapping never occurs in a social vacuum, it always affects and is affected by the broader political, economic, and cultural realm of which it is part, and the effects of mapping depend more on this broader context than in the tool itself. Consequently, as any other tool, participatory mapping is not inherently good or bad: it does not naturally produce or resolve conflicts. Rather, conflicts probably stem from other previous or ongoing processes that determine whether communities engage in mapping their lands and how they do so.

Acknowledgements

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