

LIVELIHOOD VULNERABILITY TO UNCONTROLLED FIRES
AMONG CAMPESINO COMMUNITIES IN THE NORTHERN BOLIVIAN AMAZON

by

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A thesis submitted
in partial fulfillment of the requirements
for the degree of Master of Science
(Natural Resources and Environment)
at the University of Michigan
August 2014

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Abstract

The effects of climate change have now reached all parts of the world, and for many people, climate-related stressors add an additional layer onto the complex environmental, social, and economic factors already contributing to their vulnerability. Rural communities that rely to a great extent on local ecosystems for their livelihoods may be greatly affected by seemingly minor alterations in climatic conditions, which then catalyze other environmental changes. In the northern Bolivian Amazon, climate change, land cover change, and fire use in land management are interacting synergistically across multiple scales to generate an elevated risk of uncontrolled fires. This study explores how uncontrolled fires have affected the livelihoods of one group of actors in this region, campesinos, and the implications for ecosystem-based development interventions. It also touches on how campesino communities, civil society organizations, and the Bolivian forest and land management agency, ABT, have responded to the elevated risk of uncontrolled fires.

I carried out a total of 43 semi-structured interviews with residents of five campesino communities in the department of Pando, Bolivia, from May to August, 2013. Focus group discussions, participatory mapping, and household surveys in the focal communities, as well as interviews with local civil society organization staff, served as supplementary sources of information. Residents of four of the five focal communities reported that they had experienced uncontrolled fires at least once between 2003 and 2013. In three of the communities, some residents had experienced significant damage to annual crops, agroforestry systems, wild cacao, or Brazil nut trees.

The effects of uncontrolled fires have implications for ecosystem-based development interventions that are being carried out in rural communities throughout the northern Bolivian Amazon. Local civil society organizations, supported by international donors, are promoting the development of agroforestry systems, commercialization of cultivated and wild cacao, and increase of Brazil nut harvesting income, among other interventions. Because these productive systems are susceptible to uncontrolled fires, the increasing incidence of fires in the region has the potential to derail these interventions over the short or medium term. There are already indications that without additional fire adaptation measures, agroforestry systems are no longer appropriate in some communities.

Separate interventions by civil society and the ABT to reduce and control the use of fire as a land management tool have mainly focused on campesino communities. Given that uncontrolled fires are caused by multi-scaled factors ranging from global climate to regional land use patterns to local fire use practices, I suggest that campesino communities have limited agency and may not be the most appropriate actors to target for such interventions. Other local actors, particularly owners of large cattle ranches, appear to contribute much more to uncontrolled fires, including fires that spread to community land, and may therefore represent a higher priority target for fire mitigation interventions.

Acknowledgements

This research was possible thanks to financial support from the School of Natural Resources and Environment, Rackham Graduate School, and the Tinker Foundation.

The warm welcome and collaboration I received from members of Los Mandarinos, Palestina, Petronila, San Antonio del Maty and Trinchera was more than I could have asked for—mil gracias. As this work continues to develop I hope that it will accomplish my goal of benefiting these and other rural communities in the northern Bolivian Amazon.

I am deeply grateful for the support of Diego Pacheco at the Universidad de La Cordillera, and the staff of CIPCA-Cobija, especially Ramiro Chávez and Gilda Ticona. I am certain that without your guidance this project would not have been possible in its current form, and would not have evolved in the rich and rewarding ways it has.

My advisors at the School of Natural Resources and Environment, formal and informal, had a tremendous influence on my scholarly development at Michigan and the development of this thesis. I sincerely thank Rebecca Hardin, Arun Agrawal, Maria Carmen Lemos, Bilal Butt, and Pete Newton, for your ideas, patience and support throughout this process.

To my fellow SNRE students, friends, and especially the residents of 432: you were essential in making this crazy ride somewhat manageable, an incredible experience of intellectual growth, and ultimately a lot of fun.

And most importantly, quietly cheering me on as they have throughout all of my improbable adventures, my family has been the foundation of my support from start to fin....

Glossary

Autoridad de Fiscalización y Control Social de Bosques y Tierra (ABT) – Authority for the Monitoring and Management of Forests and Land, a Bolivian government agency

barraca – a large forested estate, established for rubber tapping and later for Brazil nut harvesting, owned by an individual, family, or company

barraquero – an owner of a barraca

campesino – (specific to the northern Bolivian Amazon) a person, usually of mestizo heritage, who pursues an extractivist or agroextractivist livelihood, usually combining forest product harvesting and small-scale agriculture

campesino community – an independent community composed primarily of campesino members

Centro de Investigación y Promoción del Campesinado (CIPCA) – Center for the Investigation and Advancement of Rural Peoples, a Bolivian civil society organization

chaco – a swidden (slash-and-burn) agricultural plot, typically 0.5-2 hectares

habilito – the provision of credit to forest product harvesters, which may be in the form of food or other household goods, to be repaid through the sale of forest commodities to the creditor

Herencia – a Bolivian civil society organization

Instituto Nacional de Reforma Agraria (INRA) – the National Institute of Agrarian Reform, a Bolivian government agency

patrón – an owner of a barraca

Programa Amazonía Sin Fuego (PASF) – Amazon Without Fire Program, a project financed by the Italian Embassy in Bolivia and Brazil

trabajador empatronado – a barraca estate worker, usually indebted to the patrón

zafra – the harvest season for a particular product, but usually used with specific reference to the Brazil nut harvest, which typically lasts mid-December to March

Note on Spanish and scientific name notation: Throughout the text, Spanish terms are introduced with their English translation and subsequently used interchangeably. Scientific names of plants are italicized according to standard convention.

Forest Commodities and Natural Resource Control in the Production of Socioeconomic Vulnerability

You load sixteen tons, what do you get?
Another day older and deeper in debt
Saint Peter don't you call me 'cause I can't go
I owe my soul to the company store.

- "Sixteen tons," Merle Travis, 1946

Preface

The morning sun was just starting to filter through the trees when I arrived. Doña Maria Elena¹ was already moving about the yard feeding the chickens. She pulled out a wooden bench on their swept dirt patio and made sure I was comfortable. Don Severino emerged from the house and greeted me warmly. *The old body doesn't like getting up in the chill of the morning*, he said, pulling his worn jacket closer around him. In unhurried, gravelly Spanish, he began to describe some of the changes he has observed in his northern Amazonian community during the 15 or 16 years he has lived here.

San Antonio del Maty is one of the older campesino communities, founded in 1976 by a former worker on the rubber estate. Before moving there, Don Severino was a rubber tapper on a nearby forest estate managed by a patrón, a large landowner. *In those days, people didn't know money here*, he explained. They just received a "check" from the patrón, which was exchanged for food and other goods at the company store. Those years were difficult: rubber tapping starts at 4 am and is grueling and dangerous work, and life was tightly circumscribed by the boundaries of the rubber estate and the rules of the patrón.

Life today in the free community of Maty is also very difficult, Don Severino observes. *The crisis is bad this year, and we have large unpaid accounts with the businessmen who buy our Brazil nuts*. The crisis is that food in the house has mostly run out, they have no cash, and not enough food production from their one hectare agricultural plot. The Brazil nut harvest, which provides the vast majority of the family's income for the year, is still five months away. *Sometimes people are left with nothing. When the Brazil nut harvest ends, everything runs out*.

Introduction

This chapter uses a political economy perspective on accumulation by dispossession, commodification, and state control over natural resources to address two main questions. 1) How was campesino livelihood vulnerability produced historically in the northern Bolivian Amazon? 2) What factors perpetuate socioeconomic vulnerability today in independent campesino communities? While acknowledging that there were differences between the experiences of workers on the rubber estates in the region, and that there are sometimes large differences

¹ Names changed to preserve anonymity.

between campesino households and communities currently (Zenteno et al. 2012), there appear to be similar experiences that have been broadly shared. These common experiences have much to tell us about why and how conditions of vulnerability were produced and perpetuated through campesino livelihoods.

I propose that two factors have played a central role in the historical and present production of socioeconomic vulnerability among campesinos in the northern Bolivian Amazon: 1) the degree of orientation of the campesino economy toward commodity production, and 2) the amount of control over land and natural resources that campesinos have been permitted by the elites and central government of Bolivia. Both factors can be understood, to a large extent, in the context of accumulation by dispossession, which has taken various forms over the years.

Livelihood vulnerability is a dynamic condition with multiple causes and manifestations (Bebbington 1999, Brooks 2003). It is important to understand how campesino communities in the northern Bolivian Amazon came to be vulnerable historically, considering political, economic, and social factors, in order to more fully grasp how and why they are vulnerable today. This understanding is particularly important in the context of newly emerging challenges for campesino livelihoods, such as an increase in climate-related hazards. If the factors contributing to vulnerability are incompletely understood, interventions aimed at reducing vulnerability will likely be less effective. This case, though focused on a small geographic region, illustrates particular conditions leading to the social production of vulnerability that have many parallels in other historically oppressed and currently vulnerable peasant and agroextractivist communities. It is useful to recognize these parallels to inform broader dialogue about the root causes of poverty and livelihood insecurity.

The chapter is organized into three main sections. I begin by introducing key terms and the conceptual frames employed. The second section discusses the production of livelihood vulnerability in the rubber era, roughly from 1860 to 1985, and draws primarily from secondary sources. The third section focuses on factors contributing to socioeconomic vulnerability in independent campesino communities in the last three decades up to the present. Unless otherwise indicated, this section draws on primary data from individual interviews, focus group discussions, or household economic surveys conducted in five campesino communities (see Appendix A for detailed methods).

Concepts of Livelihood and Vulnerability; Processes of Control and Commodification

Before proceeding, I will clarify the terms campesino, livelihood, and vulnerability.

“Campesino” is a Spanish word typically understood to mean peasant farmer, and thus is linked, semantically, to processes of forest conversion. However, in the northern Amazon region of Bolivia, people who identify as campesinos often focus more on extracting forest products than agricultural activities.

Livelihood is a term I use narrowly to refer to the material means of obtaining food, shelter, and other basic necessities, through monetary or non-monetary means. For the purpose of narrowing the scope of my analysis of vulnerability, I avoid the broad conceptualization of livelihoods as composed of capabilities or entitlements (e.g. Bebbington 1999, Sen 1999). Campesinos’ livelihoods in independent communities today are, in general, mostly based on harvesting Brazil

nuts and sometimes timber for monetary income, as well as other forest products for food, traditional medicines, and housing material (Zenteno et al. 2012, Henkemans 2001). The chaco, an agricultural plot created by cutting and burning primary or secondary forest, is also an important component of the livelihoods of most campesinos in the region. Chacos are typically planted with rice, yuca (manioc), plantain, and corn, mostly for subsistence. A smaller number of households have developed agroforestry systems, or keep cattle, as additional sources of food and income.

Vulnerability has been defined in many ways by different disciplines (Eakin and Luers 2006). Adger (2006, 268) defines vulnerability as “the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt.” The conceptualization of vulnerability developed by Bohle et al. (1994) is more comprehensive: “an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of potential harmful perturbations” (37). In this case, it is useful to think about the vulnerability of households and communities as a state or condition, in which temporal variability is an important consideration (Bohle et al. 1994); some aspects may persist long term while other aspects may change frequently. I examine campesino vulnerability in terms of livelihood vulnerability, the concrete manifestations of which are mainly food insecurity and income insecurity, which are closely connected in many instances. I define food insecurity as having a shortage or absence of food in the household at least occasionally, either due to insufficient food production or inability to purchase enough (in contrast to food security, which Bohle (1994) defines as having “a high command over food through markets and distribution systems and sufficient assets and wealth”). Similarly, I define income insecurity as having insufficient and/or erratic and unpredictable inflows of cash into the household.

The theory of accumulation by dispossession encompasses both the processes of natural resource control and commodification that I propose have played a central role in the historical and present production of campesino vulnerability. “A wide range of processes...includ[ing] the commodification and privatization of land and the forceful expulsion of peasant populations; the conversion of various forms of property rights (common, collective, state, etc.) into exclusive private property rights; the suppression of rights to the commons; the commodification of labour power...appropriation of assets (including natural resources)...the slave trade...and ultimately the credit system” can constitute tactics of accumulation by dispossession according to Harvey (2003, 145). Fairhead, Leach and Scoones (2012) describe accumulation by dispossession as “class-based processes in which ownership of capital (assets of value) become concentrated (accumulated) in the hands of those already holding capital” (243). Harvey (2003) also emphasizes that the state is always a major player in facilitating or carrying out accumulation by dispossession. The state can include a government or its agencies, or any other actors who hold significant power, such as wealthy elites. Accumulation can be accomplished through the physical appropriation of land and natural resources, or more subtly, through regulating how people can access and benefit from these resources.

Commodities are things produced “for sale on the market” (Polanyi 1944, 75). Being a commodity is not an intrinsic characteristic of an object, though some material properties can facilitate commodification. Through the process termed commodification, there occurs a “shift

towards economic production increasingly motivated by or for exchange” rather than just as an “outlet for surplus production” (Prudham 2009, 125). Thus, commodification can be understood as a process in which “production for use is systematically displaced by production for exchange; social consumption and reproduction increasingly relies on purchased commodities; new classes of goods and services are made available in the commodity-form; and money plays an increasing role in mediating exchange as a common currency of value” (Prudham 2009, 125).

In this case, it will become clear not only that several products from the Amazonian forests were highly commodified (for example, rubber, timber and Brazil nuts), but also that the campesino economy, initially through coerced production and consumption of commodities, became commodified. Below, I explore how the abovementioned concepts and processes map onto historical and current experiences in the northern Bolivian Amazon.

The Rubber Era: 1860 to 1985

Elite Control over Land and Natural Resource Access

The forests of the northern Bolivian Amazon region were, prior to “exploration” in the 1800s, the home of at least six different indigenous groups (Assies 2002). By the mid-1800s, colonists from Bolivia and Brazil began exploring the region in search of *Cinchona* bark for the production of quinine (Stoian 1999). *Cinchona* bark harvesting was relatively short-lived, but by 1850-1860 the new arrivals had begun to establish rubber estates, called barracas (Henkemans 2001). According to one account by a barraca owner, because the majority of indigenous peoples were “hostile” to those who arrived to expropriate their land, a genocide was carried out against them: “a killing without mercy in the search for rubber lands where the only obstacle to their exploitation was the savage man, who had to be killed by all possible means” (quoted in Assies 2002, 93). Some indigenous people who were not killed by the new colonists were conscripted as workers or slave laborers on the newly formed barracas.

This time period marks an era of massive accumulation of land, natural resources, and the wealth of human resources by the colonist elite. The new arrivals claimed land by navigating along the rivers and placing markers on the banks, the land behind which was then understood to be theirs. They became known as barraqueros or patrones (estate owners), and eventually gained de facto ownership of vast areas of the Bolivian Amazon region. At one point, the most dominant family controlled three quarters of the land in the region (Assies 2002). The barraqueros originally did not have title to the land (Romanoff 1992), but after the massacre and displacement of indigenous peoples, there were few left to contest their land claims. The barraqueros’ growing economic and political power served to reinforce the legitimacy and enforceability of their land claims in the absence of de jure land tenure granted by the government. During these first decades of the rubber boom, the central government of Bolivia had little influence in the northern Amazon region, and because rubber was such an important source of export revenue (representing nearly half of the state’s income from exports at the turn of the century (Henkemans 2001)), the central government likely saw no incentive to exert control over the barraca system. Therefore the colonists were given free rein to develop an exploitative system of land tenure and labor.

Commodity Production and the Livelihoods of Estate Workers

The claiming of vast tracts of forestland in Bolivia's northern Amazon was motivated by the potential for profits from the trade in local natural resources, primarily non-timber forest products. The mid-1800s represented the beginning of the commodification of wild rubber, which was later followed by other forest commodities. Indeed, in spite of the relative isolation of the region with respect to the rest of Bolivia, the economy of the northern Amazon region at this time was completely oriented toward the international export of forest commodities, mainly via Brazil. By 1880, Stoian (1999) considers that the northern Amazon region of Bolivia was "fully integrated into the world economy," with forest commodities being exported and food and other products being imported from abroad.

In order to obtain latex from the wild rubber trees of the northern Amazon, the barraqueros required large amounts of labor, mainly rubber-tappers and boatmen to transport the rubber through the river systems to the main cities of Riberalta and Guarayamerin. When the "rubber rush" began, some formally educated people, mostly from southeastern department of Santa Cruz, arrived of their own accord and took salaried positions to help manage the barracas (Assies 2002). The local indigenous people were few and uncooperative, so the emerging estate owners turned to coercively conscripted labor from other regions of Bolivia. Indigenous people who had been converted to Christianity in the Moxos plains region of Beni department, just south of the focal region, were the target of much forced labor conscription, as were peasants in Santa Cruz. The manipulative technique of acquiring labor for the barracas became known as the *enganche* (being hooked); men were deceived into signing a contract, then put in chains and shipped north to the barracas (Assies 2002). Once there, the barraqueros provided them with the necessary equipment for tapping the wild rubber and an initial food supply, which served as the initial debt that would keep men and their families tied to the barracas, often under conditions amounting to slavery.

The livelihoods of the men that had been brought into the northern Amazon region to work on the rubber estates in the late 1800s and early 1900s were bolted to the markets of the commodities they were forced to produce and consume. *Trabajadores empatronados* (rubber estate workers) were, during the early period of the rubber boom, not allowed to produce their own food in swidden agricultural plots or, according to Henkemans (2001), by hunting. The prohibition of autonomous food production helped establish the system of *habilito* on the rubber estates. In this system, campesinos working for a patron "sold" the rubber (and later also Brazil nuts) that they harvested to him in exchange for vouchers for food, drink, and basic household necessities. Because the food and other products at the patron's store were so expensive (in part due to high transportation costs, and in part because the patron had a monopoly on essential goods), and he paid so little for the large volumes of forest commodities harvested, the *trabajadores empatronados* had to take out loans from the patron in order to buy food (Henkemans 2001, Romanoff 1992). Thus, many estate workers found themselves in a perpetual cycle of debt and repayment. A study conducted in 1984 across 22 barracas in the northern Bolivian Amazon region showed that 96% of estate workers were in debt to their patrones (Romanoff 1992). In addition the accounts were heritable, so not even the children of *trabajadores empatronados* could escape the debt (Assies 2002). This debt peonage bound the workers to the barracas for many years.

In addition to livelihood vulnerability generated by the *habilito* system, *trabajadores empatronados* were also exposed to the vicissitudes of the international markets for the commodities they were producing. Commodity production in the Bolivian Amazon has been marked by a series of crises in which the exchange value of the commodity crashed and suddenly the producers whose “income” depended on this commodity were left without alternatives. *Cinchona* bark, rubber, *asaí* (*Euterpe* spp.) palm hearts and Brazil nuts are all commodities that have experienced boom and bust cycles in the northern Amazon region of Bolivia. The first period of the Amazonian rubber boom was from 1880 to 1913 (Assies 2002, Romanoff 1992). The international price of rubber again rose during World War II, and afterward was mediocre, but stayed high enough (given price supports in neighboring Acre, Brazil) to make rubber tapping cost-effective for *patrones* making use of the *barraca* system until 1985. Brazil nuts began to be harvested for commercial trade beginning in the 1920s or 1930s (Assies 2002, Henkemans 2001), and became an important secondary source of income to *barracas*, at times outstripping rubber in income generated.

Whenever the international price of rubber or Brazil nuts fell, the estate workers received a lower price. Whenever the price of food increased, *barraqueros* passed the difference on to the workers. According to Romanoff (1992), when the selling price of forest commodities was highest, the estate workers could afford to buy imported food so they did not grow their own even once the prohibition was lifted. Once they had run out of credit, they were not able to buy enough food and did not have any of their own to fall back on, so experienced worse food insecurity than when the price of rubber or Brazil nuts was low.

In the later years of the rubber era, particularly after the rubber market crash of 1920, it became more common for the *patrones* to allow communal *chacos* to be made by the estate workers (Henkemans 2001). However, food insecurity, high prices of food, and malnutrition remained severe problems for *trabajadores empatronados*. Romanoff’s 1984 survey found that 70% of households residing on *barracas* experienced a lack of sufficient food for children and adults. Among children residing on *barracas*, 22% were found to be malnourished (Romanoff 1992). Henkemans (2001) writes that “price fluctuations and livelihood insecurity that went along with the boom and bust periods of the rubber market” shaped the lives of rubber tappers throughout the rubber era in this region (50). The fact that they were forced into debt peonage to produce forest commodities, and had no control over the land they lived on or autonomous access to natural resources contributed greatly to the vulnerable condition of the estate workers’ livelihoods.

Independent Communities: 1985 to the Present

The first independent communities in the northern Bolivian Amazon were founded by former *trabajadores empatronados* in the late 1920s, when a bust in the rubber market led some owners to abandon their estates (Henkemans 2001). The estates were then taken over by the workers, who then came to consider themselves *campesinos*. Each successive crisis in the rubber trade produced additional hardship for the estate workers, but also in some cases an opportunity to escape the *barraca* system. Independent communities became more common after World War II, when the international price of rubber declined to pre-war levels. However, independent communities proliferated to a much greater extent after the floor fell out of the rubber market in 1985. In this section I focus on this more recent period from 1985 to the present.

Commodity Orientation of the Campesino Economy

A main source of vulnerability in many campesinos' livelihoods today is the continued reliance on the sale of raw commodities as a source of monetary income (Pacheco et al. 2009). Wild rubber no longer commands a good price on the international market, though it has risen somewhat in the last couple of years, leading some to return to rubber tapping. Brazil nuts, harvested from wild trees, are now the predominant forest commodity. Each campesino community in the northern Bolivian Amazon (and each household) has a different livelihood profile, but harvesting Brazil nuts is almost ubiquitous. People in many communities also gain significant income from legally or illegally selling timber, mostly for domestic or Brazilian markets. Although most campesino households today grow or obtain from community forests some portion of their own food, their reliance on one or two forest commodities for monetary income is problematic for at least a couple of reasons.

Fluctuations in the selling price of commodities can make financial futures difficult to predict. Similar to most commodities sold on the world market, the price of Brazil nuts can vary significantly from year to year, and even within a single Brazil nut harvest season (Pacheco et al. 2009). Therefore, campesinos may have a good idea of how many bags of Brazil nuts they can collect in a season, but the price may be double or a small fraction of what it was the previous year, making financial security difficult. In addition, because Brazil nuts are harvested from wild trees, which are subject to interannual climatic and other variations, the Brazil nut trees do not produce the same amount each year. Some years are particularly bountiful, whereas others are thin.²

Community rules that discourage migration for work, coupled with the strong seasonal variability of income, are also important in contributing to income insecurity. Brazil nuts are usually harvested from mid-December to the end of March every year. These are months of tremendously hard work and bounty for many campesino families. During the rest of the year, most households have few, or very minor, income-generating opportunities within their communities, and either have to make do with what they earned during the Brazil nut harvest (zafra) or leave the community to work elsewhere. Most of my focal communities had internal rules prohibiting adult members from leaving for extended periods except to study or serve the community in a campesino organization, so this tightly curtails income-generation options that are not based directly on local natural resources. The characteristics of the Brazil nut tree, and the dearth of alternative income sources, lead to livelihood vulnerability attributable to the seasonality of work and income.

Another source of livelihood vulnerability for many campesino households is the perpetuation of accumulation through exploitative systems of debt. The system of *habilito*, originally established on the barracas, remains closely tied with the sale of Brazil nuts in the present although it may take a somewhat less coercive form (Cano Cardona et al. 2014). Today, campesinos mostly sell their Brazil nuts to middle men who visit the communities before and during the harvest. These

² Many interviewees also explained that the production of Brazil nuts has declined noticeably compared with a decade or two ago. This may be because there are fewer accessible trees than before, due to forest clearing around communities and harvesting of Brazil nut trees for timber, and/or because of climate-associated factors such as changes in the rainfall regime or increasing incidence of uncontrolled fires.

middle men, many of whom the community members have a relationship with, provide loans to campesinos who run out of money and supplies before the zafra. These loans are typically provided in overpriced food. The debt is then repaid in bags of Brazil nuts when the harvest takes place. This reduces, quite significantly for many households, the earnings they can generate from Brazil nut sales.

State Control over Natural Resource Access

Also within the scope of accumulation by dispossession, and closely tied to the process of commodification of natural resources, is the reassertion of state control over campesino use of land and forest resources. The central government of Bolivia, perhaps pressured by the elites controlling domestic industry, has been the key player in this recentralization.

Starting in the 1990s, the state took several steps to devolve control over land and natural resources, as well as decision making, to campesino and indigenous communities. The government supported land tenure reform and land redistribution to indigenous and campesino communities through the 1996 Law of the National Institute of Agrarian Reform (INRA 2010). Forestry Law 1700 of 1996 was also hailed as a progressive step to decentralize control over timber resources to indigenous and campesino communities (León et al. 2012). The land tenure reform effort has been fairly effective in the northern Bolivian Amazon; many campesino and indigenous communities have been able to attain formal ownership rights to large tracts of land. In the northernmost department of Pando, the process has been particularly successful; it is the only department to have officially completed the process of saneamiento (regularization) of land titles, with most campesino families formally in a community being allocated close to 500 ha each (INRA 2010). This is a remarkable departure from the extremely concentrated land ownership structure of the previous 140 years or so, in which colonist elites controlled the majority the land (Assies 2002).

While the decentralization of land tenure has been a positive development for many campesinos, there has not been concomitant devolution of control over access to some natural resources. The case of timber is particularly illustrative. The northern Amazon region contains a few highly valued timber species, including mahogany, tropical cedar, and tumi (Henkemans 2001), and many less sought-after species. The Forestry Law of 1996 was at least nominally aimed at granting campesino and indigenous communities more control over timber on communal lands. However, in practice this law has not been supportive of autonomous natural resource decision-making at the community level, and has also focused mainly on managing forests for timber harvesting rather than other uses (León et al. 2012). For example, there is a long bureaucratic and technical process involved in obtaining a permit from the Authority for the Monitoring and Management of Forests and Land (ABT, a central government agency) for timber harvesting on community lands. This process is effectively a barrier to timber harvesting for many communities (Ribot et al. 2006).

In addition to legal control over timber harvesting, community members are not allowed to harvest timber from their forests for commercial purposes; if they would like to sell timber legally, they must contract with a private logging company. Not only does this remove control over the actual logging process from the hands of the community, it reduces potential income because they are effectively forced to sell standing trees—the commodity in its most raw form—

to the logging companies. Thus the community is not able to capture any added value. If they were permitted to fell and saw their own logs into boards, they could receive significantly greater economic benefits, including a much higher return per tree and employment opportunities for community members.

In addition, the skidders and other heavy equipment used by logging companies do extensive damage to moist forests of the Bolivian Amazon (Jackson et al. 2002). The machinery typically leaves forests tangled with thorny invasive plants, with plant species important to the community crushed, forest trails impassable, and Brazil nuts inaccessible to harvesters. Forests selectively logged with heavy machinery take much more time to recover than forests that are selectively logged with chain saws and low-impact extraction methods. The reasoning provided by the ABT for the no-chainsaw rule is that if community members were allowed to harvest timber to sell, there would be no way for the government to control this practice and everyone would be cutting and selling wood illegally. An alternative perspective is that this control over timber harvesting in community forests is an effective way for the state to aid logging companies in the accumulation of capital through the dispossession of the natural wealth of community forests. Ribot, Agrawal and Larson (2006) write with regard to forest management in Bolivia, “the central government’s priority appears to be large-scale concessionaires” (1875).

Central government control over use of forest resources, through the Forestry Law of 1996, has contributed to the vulnerability of campesino livelihoods in at least two ways. First, by reducing the potential for community income and employment through timber harvesting. Second, because the machinery used for commercial harvesting reduces the potential income and food sources for campesinos from the logged areas of forest.

Interactions of Socioeconomic and Biophysical Vulnerability

This chapter illustrates two principal mechanisms that have contributed to the production of socioeconomic vulnerability among rubber estate workers in the northern Bolivian Amazon, and later, campesinos in independent communities. Commodification of forest resources, and government and elite control over access to these resources, are tactics of accumulation by dispossession that have been important in generating livelihood vulnerability. I make generalizations about the historical and current lived experiences of campesinos in the region, but I represent as accurately as possible key aspects of a widely shared experience, based on written histories and primary research.

Livelihood vulnerability is a dynamic condition influenced by many factors, which can be categorized as social or biophysical (Brooks 2003). I have focused on a small subset of the social factors here, leaving aside important aspects such as level of access to education and health care, gender and cultural norms, and the characteristics of the environment in which people live. I conclude the chapter by employing the concept of “double exposure” to explore how particular socioeconomic and biophysical sources of vulnerability may overlap and intersect in campesino communities of the northern Bolivian Amazon.

O’Brien and Leichenko’s (2000) theory of double exposure “refers to cases where a particular region, sector, ecosystem or social group is confronted by the impacts of both climate change and economic globalization” (227). They emphasize that it is important to consider these two

processes together because their interaction may result in different “winners” and “losers” than might be expected when considered individually.

In the northern Bolivian Amazon, long-term processes of economic globalization have provided the opportunity (positive or negative) for most campesino households to obtain a large portion of their income from forest commodities sold internationally. Historical development pathways in the region have entrenched extractivist economies among campesino communities, and because other economic activities have not been developed, extracting forest products—primarily Brazil nuts and timber—remains one of few options for income generation. Sale of these commodities can be lucrative, however, and campesinos with access to productive forests and markets can have significantly higher annual incomes than rural residents in other parts of the country without these resources (Czaplicki Cabezas 2011).

The sustainability of forest product harvesting is another issue. The literature is divided over the question of whether Brazil nut collecting at current intensities is sustainable over the long term (Peres et al. 2003, Zuidema and Boot 2002). Some harvesters argue that the high value of Brazil nuts on the global market has led people to collect every last fruit they can find, leaving little for natural regeneration. For timber, considering the pace of extraction and extent of impacts on forests, selective timber harvesting seems to be an unsustainable activity in the medium term (Jackson et al. 2002). The most prized species such as mahogany have already been exhausted, and loggers have turned to taking a larger number of species and individuals per hectare of forest, leading to increasing forest impoverishment and degradation.

Forest commodities sold on the global market can generate substantial income for producers, but their very success may lead to an uncertain future. To this situation climate change is contributing new stresses to the ecosystems on which these globalized extractive economies are based. Climate-related stressors and hazards that are now developing include changes in temperature and rainfall regime, reduced forest humidity, flooding, droughts, and uncontrolled fires. All of these can negatively affect forests where Brazil nuts and timber are harvested.

If some campesinos can be considered at least partial “winners” from globalization (which is of course variable between individuals and dependent on one’s perspective), the following discussion of climate-related uncontrolled fires will demonstrate that they are almost certainly “losers” from climate change. As O’Brien and Leichenko (2000) point out, understanding the joint effects of globalization and climate change can provide important lessons for policy and adaptation strategies.

Keeping in mind the historical and socioeconomic factors that contribute to livelihood vulnerability in the northern Bolivian Amazon, the next chapter addresses some of the impacts of and responses to uncontrolled fires, as well as their implications for ecosystem-based development.

Livelihood Vulnerability to Uncontrolled Fires and Community, Civil Society and State Responses

“Global climate change presents a challenge to future livelihood strategies, especially for those social groups which are currently vulnerable. Relatively modest adverse changes in resources or economies imply critical shifts in food security for these communities. Any strategy envisaged as feasible for coping with future climate change must be rooted in a full understanding of the complex structure and causes of present-day vulnerability.”
(Bohle et al. 1994, 37)

Introduction

In less-industrialized countries, many rural communities rely to a great extent on local ecosystems for their livelihoods (Andrade Pérez et al. 2010). The combined effects of climate change and conversion or degradation of ecosystems may constitute critical sources of vulnerability for these communities (Locatelli et al. 2010), especially in the context of other social and economic stressors (O’Brien and Leichenko 2000). In the northern Bolivian Amazon³, rural communities derive close to half of their income and subsistence on average from forest products alone (Czaplicki Cabezas 2013⁴, Zenteno et al. 2012). People with lower incomes also tend to earn proportionally more from non-timber forest products (NTFPs) in this region (Zenteno et al. 2012). Their livelihoods are therefore very sensitive to environmental changes. Though in-depth research is lacking, initial assessments of the socioeconomic effects of climate variability and change in this region indicate that there is significant cause for concern (Nordgren Ballivián 2011, Rojas Quiroga et al. 2013). One important change is a dramatic increase in fires that escape control and are destructive to local ecosystems and livelihoods. Uncontrolled fires have been a challenge for decades in other regions of the Amazon, but northern Bolivia has only seen a marked increase since around 2003 (Fuentes Nay 2013). Accelerating climate change, land cover change, and fire use in land management are interacting synergistically to generate an elevated risk of uncontrolled fires (Cochrane and Barber 2009, Nepstad et al. 2001).

Numerous studies have addressed the extent, causes and environmental effects of land cover change and forest degradation in the Amazon (Matricardi et al. 2013, Monteiro Brando et al. 2014, Nepstad et al. 1999), including in Bolivia’s northern Amazon (Marsik et al. 2011, Muller et al. 2012). Research is also being conducted to explore how climate change will influence the region’s biota (Andersen 2009, Asner and Alencar 2010). Much less attention has been paid to the effects of these phenomena on local people and the adaptation options available to them. In the northern Bolivian Amazon, major events such as the catastrophic flooding in early 2014 have garnered attention, but the slowly emerging and cumulative effects of other climate-related hazards have apparently produced little response (Nixon 2012) from government and civil

³ The northern Bolivian Amazon encompasses all of Pando department and parts of La Paz (Abel Iturralde and Franz Tamayo provinces) and Beni departments (Ballivián, Vaca Diez and Yacuma provinces) (Fuentes Nay 2013), in total around 220,000 square kilometers.

⁴ This study only included communities that have participated in interventions by the Center for the Investigation and Advancement of Rural Peoples; results may not be representative of the population.

society organizations. As a result, research and interventions addressing local adaptation to climate change in the northern Bolivian Amazon lag far behind that in other parts of Bolivia (LIDEMA 2010), and neglect important internal variations within this region, which also have implications for adaptive strategies in forested regions of neighboring countries.

This chapter seeks to delineate some of the ways the livelihoods of campesinos are vulnerable to the climate-related hazard of uncontrolled fires in the northern Amazonian department (equivalent to a state) of Pando. In this region, campesinos are non-indigenous, primarily rural residents whose livelihoods typically center on harvesting products from the forest and small-scale agriculture (Henkemans 2001).⁵ The chapter also presents a critical review of ecosystem-based development and fire control interventions implemented to date, in light of the new challenges posed by uncontrolled fires in the region. I point out potential disconnects between campesino experiences of uncontrolled fires and the interventions being pursued in their communities by civil society organizations and the Bolivian forest and land management agency, ABT. I suggest that these interventions to promote ecosystem-based development and control fire use may not adequately reflect changes occurring within the social-ecological system, or take into account the multi-scaled nature of the factors contributing to uncontrolled fire in campesino communities, including the matrix of neighboring cattle production.

In what follows, after a summary of my methods and study sites, the second section defines uncontrolled fires and outlines the relationships between climate, land cover, and fire in the Amazon. Third, I describe the effects of uncontrolled fires on key productive systems that form the basis of livelihoods in the northern Bolivian Amazon, followed by a fourth section on community-level effects and responses. Fifth, I outline some of the fire use reduction and control interventions by civil society and the state. In the sixth section, I discuss implications of an increase in uncontrolled fires for sustainable development and ecosystem-based adaptation interventions. I conclude with thoughts about potential broader implications of a shift to a regime of more frequent and extensive uncontrolled fires.

Methods and Study Sites

This study focused on five campesino communities in Pando department, northern Bolivia: Los Mandarinos, Palestina, Petronila, San Antonio del Maty, and Trinchera (see Figure 1). These communities are made up of 10-35 households, with several more families arriving temporarily for the Brazil nut harvest each year. The land is communally owned, though each community has its own norms and rules (ranging from internally recognized private parcels to communally accessed land and natural resources). The land area pertaining to the focal communities ranges from 7,181 ha to 16,237 ha. The vast majority of land cover within these communities is a mix of upland and lowland moist forest, though selective logging has been widespread, and there are at least 100 hectares of planted pasture in the community of Trinchera.

Each focal community is developing an Integrated Forest and Land Management Plan (PGIBT) with support from the Center for the Investigation and Advancement of Rural Peoples (CIPCA) in Cobija, Pando. I helped facilitate the diagnostic phase of this process, which included focus

⁵ Of course the campesino identity in Pando is politically charged, multifaceted, and evolving. Some people who identify as campesinos spend significant amounts of time working or studying in urban areas.

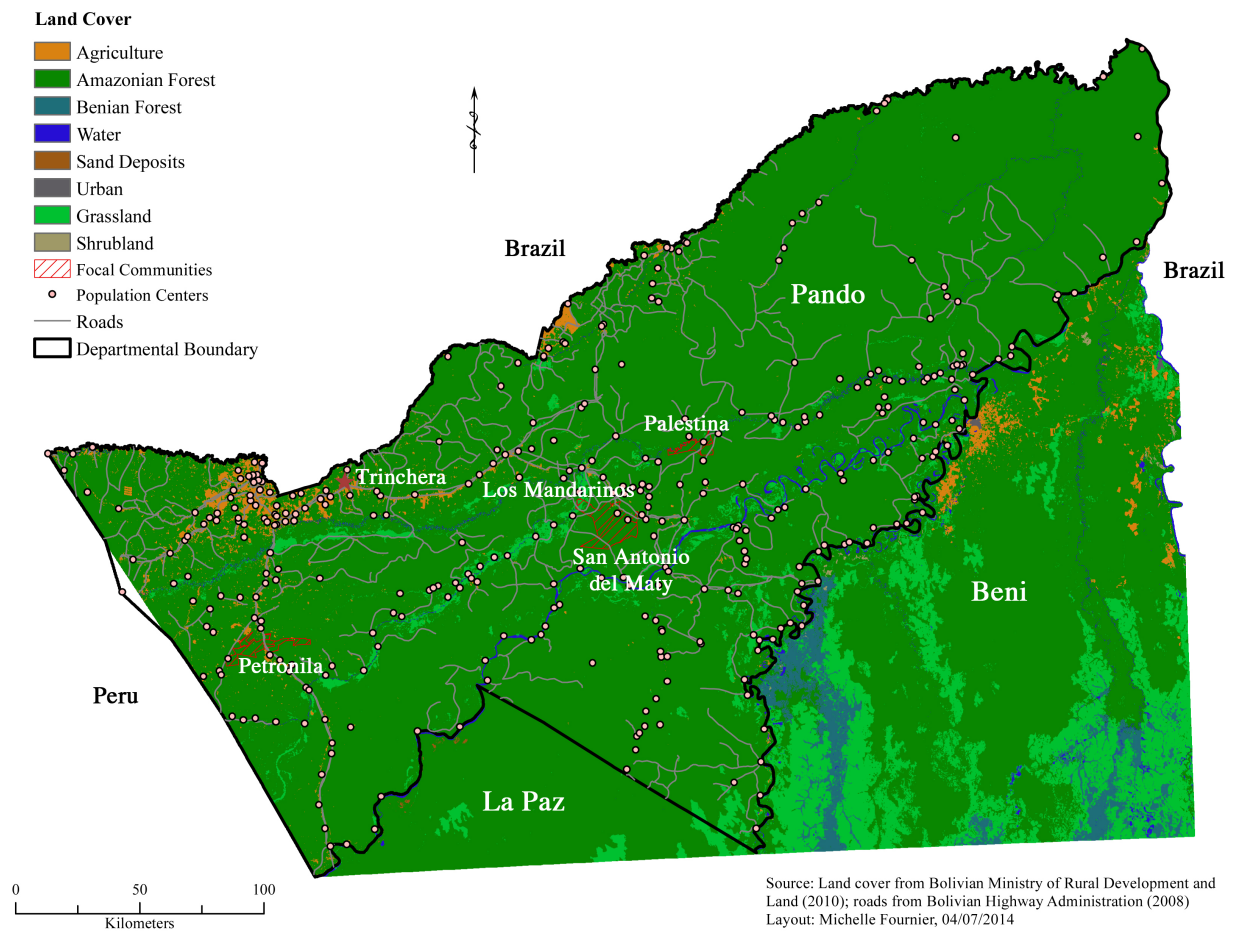


Figure 1. Land cover in the northern Bolivian Amazon as of 2010, with settlements and focal communities in Pando identified. About 94% of Pando department’s land cover is classified as forest (Herencia 2011; although much of it has been selectively logged). Note: Los Mandarinos and San Antonio del Maty are adjacent so appear as one shape; shapefile of Trinchera was not available.

group discussions and participatory mapping to explore climate- and non-climate-related hazards in the communities, as well as household surveys about livelihood strategies. Separately, I then conducted 43 semi-structured interviews (with a total of 55 campesinos; 20 women and 35 men), in Spanish, to gain a more in-depth understanding of the effects of climate-related hazards on local livelihoods, and residents’ responses in the five focal communities. Additional interviews with local civil society organization staff provided information on interventions being carried out. Fieldwork was carried out between May and August 2013.

The focus on uncontrolled fire emerged from inductively coded interview responses: of the various climate-related hazards residents are experiencing, uncontrolled fires were overall perceived to represent the most significant and immediate threat to livelihoods. Unless otherwise indicated, findings are from primary data. Individuals’ names have been omitted to preserve their anonymity. See Appendix A for a more detailed description of methods.

Climate-Land Cover-Fire Connections in Amazon Forests

From the perspective of most campesinos with whom I spoke, fire is both an essential component of current agricultural practices and a potential hazard. This view is shared by peasants who practice swidden agriculture in other areas, such as the caboclos in eastern Amazonia (Carmenta et al. 2013). My informants differentiated between intentionally set fires that burn the intended area (“quemadas”), and fires that are uncontrolled, burning areas that were not intended to be burned (“quemazón,” or more formally, “incendio”). A normal agricultural burn can become an uncontrolled fire given the right conditions.

Local people may or may not perceive uncontrolled fires as problematic or negative. In east Kalimantan, Indonesia—another region that has experienced extensive fires in recent decades—this perception depends on what is burned and when (Chokkalingam et al. 2005). Given the differing perspectives I encountered, I use the term uncontrolled fires—often referred to in the literature as “accidental fires”—to mean any fires that extend beyond the area or substrate intended to be burned, whether or not they “spread to proportions that are perceived harmful to a population and/or ecosystem” (Sorrensen 2009).

Tropical moist broadleaf forests, such as those covering much of the Amazon region, are generally considered fire-sensitive ecosystems because most species are not adapted to this type of disturbance (Cochrane and Barber 2009, Uhl and Kauffman 1990). Natural fires (for example, set by lightning) hardly ever occur in undisturbed moist forests of the Amazon (Cochrane 2003). In this ecological context, extensive uncontrolled fires alter forest ecosystem composition and structure, endanger human health and safety, and diminish environmental services such as food provisioning and carbon storage important to people from local to global scales (Cochrane 2003).

On the other hand, burning forest to facilitate cultivation in the Amazon basin appears to be a practice that dates to the pre-Columbian era (Piperno 1990). Archeological evidence for anthropogenic fires seems to point to the use of fire in even the wettest areas of the basin (Arroyo-Kalin 2012). The use of fire as a tool for forest clearing in Amazonia may precede the colonial period, but fire use over large areas only became common in the 1970s (Cochrane and Barber 2009). Fire use is so prevalent because it is an inexpensive and accessible land management tool to clear forest for agriculture or ranching, or to improve forage on existing pastures—particularly in areas where labor and capital to undertake more intensive management practices may be scarce (Nepstad et al. 2001).

In spite of the anthropogenic ignition sources, uncontrolled fires in the Amazon are a climate-related hazard because there are strong climatic influences over whether a typical burn becomes a runaway conflagration. Global climate patterns, especially temperature and rainfall amount and timing, are particularly important. Drought in the Amazon region—when seasonal rains are delayed or greatly reduced—creates dramatically more favorable conditions for fires to spread (Asner and Alencar 2010, Monteiro Brando et al. 2014). Strong El Niño/Southern Oscillation (ENSO) events can cause drought throughout the Amazon basin; this appears to have been one of the catalysts for the massive fires of 1997/1998. However, there are other potential causes of drought, as in 2005, a non-ENSO year that also saw tens of thousands of square kilometers burn in Amazonia (Cots Torelles and Cardona Pons 2006). Climate change projections for the

Amazon basin are still very uncertain, but warmer temperatures and a longer dry season (IPCC 2014) could exacerbate droughts.

Climate is also partially determined at the local level, particularly within Amazonia, and land cover/use plays a critical role. The moist broadleaf forests of this region generate much of the rainfall for their local area, so conversion of forest to other land covers reduces rainfall and moisture in remaining forests and cleared areas. Selective logging within forests is also considered to contribute to forest drying and fire risk, by opening up the canopy allowing increased sun penetration and evapotranspiration, and reduced humidity, as well as generating additional fuel for fires (Uhl and Kauffman 1990). The combination of selective logging and fires does much greater damage to forests than logging alone (Gerwing 2002). In the northern Bolivian Amazon, one study demonstrated that the combination of selective logging and fires in forests increases the mortality rate of trees and reduces recruitment (Pinto and Alvarado 2007).

Once an area of forest in Amazonia burns, it becomes more susceptible to future fires through similar mechanisms to logging (Gerwing 2002). Additionally, smoke from fires can inhibit rainfall (Nepstad et al. 2001). Positive feedback loops between climate change, land cover/use change, and fire are enhancing the risk of and damage from uncontrolled fires in this region (Nepstad et al. 2001). Given these trends, the severity, extent and frequency of uncontrolled fires in Amazonia is expected to increase unless more substantial actions are taken to break out of the system's self-reinforcing feedbacks.

Uncontrolled Fire Effects on Productive Systems

Widespread fire use in the northern Bolivian Amazon began to increase noticeably starting around 2003, with the first widespread uncontrolled fires occurring in 2005 (Cots Torelles and Cardona Pons 2006). Uncontrolled fires are beginning to pose challenges to livelihoods in some campesino communities in the region, especially because of livelihoods' heavy reliance on local ecosystems.

Forest product extraction and trade forms the basis of the local economy today, with Brazil nut and timber harvesting representing key sources of income for rural communities (Zenteno et al. 2012). Palm fruits, wild cacao, game animals, fish, medicinal plants, and housing materials are also commonly harvested from community forests, mainly for household consumption. Shifting cultivation in forests provide crops mainly for subsistence, and some households have also begun to implement agroforestry systems. The land area communities devote to cattle ranching is increasing, but still occupies on average less than 10% of community land (Zenteno et al. 2014).

Residents of four out of five focal communities reported experiencing uncontrolled fire in their community, either during the previous dry season or during the ten previous years (the earliest year mentioned with an uncontrolled fire was 2003). An important contrast discussed in the next section is the community of Palestina, where residents agreed that uncontrolled fires do not represent a threat to their livelihoods. In communities that do experience uncontrolled fires, they have not affected residents' livelihoods in the same ways or to the same extent, though residents in all five focal communities for the most part utilize the same productive systems.

Uncontrolled fires were reported to have a range of impacts on the productive systems that constitute the principal sources of income and food for the focal communities (Table 1). Below, I highlight uncontrolled fire impacts on livelihood activities that have been promoted through interventions by civil society organizations in the northern Bolivian Amazon region: creation of agroforestry systems, improved commercialization of Brazil nuts, and development of other non-timber forest products such as wild cacao.

Table 1. Primary impacts of uncontrolled fires on the productive systems that principally contribute to campesino livelihoods in northern Bolivia, according to experiences in the five focal communities. Note: cattle are kept only in Trinchera, and by one family in Petronila.

Productive system	Impacts of uncontrolled fires	Temporal range of impact
Annual crops	Crops in swidden agriculture plots can be killed by a single fire	Plots are typically cultivated for 1-3 years
Agroforestry systems	Annual, perennial and woody species can be killed by a single fire	Most species require at least 4-5 years to begin production; mature systems can produce for decades
Cattle ranching	No impacts mentioned (though in other regions of the Amazon significant damages to fencing and grazing have been reported (Nepstad et al. 2001))	
Brazil nuts	<ul style="list-style-type: none"> - Brazil nut trees are easily damaged or killed by direct exposure to fire - After a forest fire the trees flower but may not produce fruit; or the fruits may not mature properly, falling before they are fully formed - Brazil nut production can be reduced in areas adjacent to burned forest 	One fire can potentially reduce harvests for two years because of the tree's reproductive phenology; longer-term effects are not known
Timber	Uncontrolled fires can kill tree species valuable for timber and other species used for construction in communities; even low-intensity fires in closed-canopy moist forest not previously exposed to fire can kill 22-44% of trees greater than 10 cm DBH (Cochrane 2003, Holdsworth and Uhl 1997)	Species valuable for timber require several decades to reach harvestable size
Other non-timber forest products	<ul style="list-style-type: none"> - Wild cacao plants can be killed - Palms are generally resistant to fires, but intense fires that penetrate the roots can kill them - Game animals may be killed or driven away, but few impacts mentioned 	Variable according to species

Agroforestry Systems

In Pando, agroforestry systems are diversified annual/perennial/woody plantings usually cultivated under partial shade of forest trees, and may include dozens of different species that can provide sustenance and income. Cacao and annatto (urucú) are two species that had been planted in relatively large numbers by some households in the focal communities.

The 2012 fires in Mandarininos destroyed agroforestry plots that had been planted four years earlier. One family had more than 2 ha planted, and was able to save about 1 ha by making an impromptu fire break. Another family lost their whole plot of cacao, almost 2 ha. In Trinchera, a family's 1 ha agroforestry plot was destroyed in 2006 or 2007 when their neighbor in the community set fire to his cattle pasture and it spread to their plot. Some species had just been starting to produce, and they all died.

Some people who had lost all or part of their agroforestry systems to uncontrolled fires said that they no longer have a desire to establish them. Incipient systems require several years of care—planting saplings, continually cutting back surrounding vegetation, carrying water to irrigate in the dry season—before the trees start to produce in significant quantities, and it is considered too much work given the risk of losing it all in one fire. In addition to the lost time and effort, the loss of these diversified production systems represents a material loss of food and income, for families that may experience high levels of insecurity on both fronts.

Brazil Nut

Brazil nut (castaña or almendra in Spanish) is harvested from wild trees in the forests of the northern Bolivian Amazon as well as parts of Brazil and Peru. After a long development period, the mature capsules fall to the ground, where people collect and cut them open, extracting the seeds. Once mature, Brazil nut trees are among the tallest in the forest. However, they are easily damaged by fire, subsequently “drying out” as in Mandarininos in 2012, when an uncontrolled fire burned an area designated for agriculture in the community. In addition to the potential for fires to kill the trees, their fruit production can also be affected. A Petronila resident observed that after a fire, Brazil nut trees flower but do not produce fruit. A resident of San Antonio del Maty explained that sometimes after fires, the Brazil nut fruits do not mature properly, falling to the ground when they are still small.

Uncontrolled fires can apparently reduce Brazil nut production even in areas that do not burn directly but which are adjacent to forests with uncontrolled fires. In 2005, Trinchera experienced fires in about 200 ha of upland primary forest (bosque alto) in the community. One family's area of forest was spared from the fires, although areas of forest on either side burned, but the next year the Brazil nut production was very poor. Their parcel of forest, about 250 ha, usually produces 90-100 sacks (a sack holds 70-75 kg of in-shell nuts) of Brazil nuts in a harvest, but they were only able to collect 33 sacks in 2006. This was the worst harvest they had experienced in 26 years of harvesting from that parcel.

The characteristics of the Brazil nut tree help explain these experiences. The year of lag time between the fire in adjacent forest and the poor harvest reflects the Brazil nut's reproductive phenology; it takes up to 14 months between flowering and the fall of the mature fruits (Ortiz 2002). In addition, Brazil nut trees are self-incompatible; animal pollination is essential to

produce fruit. In experiments, Brazil nut production was reduced by 90% or more when pollinators were excluded compared with when they were not (Klein et al. 2007). The pollinators are primarily medium- and large-sized bees (Motta Maués 2002), which may be prevented from visiting Brazil nut flowers due to smoke (Ortiz 2002). The main flowering period of the Brazil nut occurs during the driest months of the year, from August to November (Motta Maués 2002), which coincides with the primary period when land is burned, August to October (Fuentes Nay 2013). It appears that fire within and adjacent to forests could significantly reduce Brazil nut production through direct tree death and reduced pollination, but further empirical evidence is needed.

Other Non-Timber Forest Products

A community member in San Antonio del Maty has access to a large area of lowland forest (bosque bajo) which contained an abundance of wild cacao trees, but much of this area burned in 2012, killing the cacao. In the lowland forest there are also various palm species that are an important source of food and income for his family. The palms, which have protected meristems (Cochrane and Barber 2009), resisted the fire. But another community member in Maty asserted that palms dry out and die if fires penetrate their roots.

Hunting and/or fishing in community forests range in importance for community members' livelihoods from not very important to extremely important. However, I heard little about how uncontrolled fires affect these resources. Preliminary studies indicate that fire can have "widespread and severe" impacts on wildlife in the Amazon, mainly through loss of habitat (Cochrane and Barber 2009).

Uncontrolled Fire Effects and Responses Across Communities

Among the five focal communities, the effects of uncontrolled fire on a community or household's most important productive systems range from negligible to large. At one end of the spectrum is the community of Palestina, in which no informants felt that uncontrolled fires pose a hazard to their livelihoods. This may be explained by the land cover and land use within and surrounding the community. Palestina is almost completely forested, with the only land cover change being the creation of about 10 ha of swidden agricultural plots (chacos) per year, which subsequently regenerate to second growth forest. Neighboring properties are also almost completely forested. The very small area of forest conversion, combined with a low level of disturbance of forested areas (the community was selectively logged in the past but not within the last 10 years), likely contributes to a local microclimate and ecosystem resistant to burning. In addition, community members and surrounding residents make very limited use of fire as a land management tool. One of the borders of the community is a significant river (Rio Orthon), and the community contains many lakes, so it may also naturally be less susceptible to uncontrolled fires than other communities.

The community of Petronila falls close to the low end of the impact spectrum as well. Uncontrolled fires burned about 20 ha of the community in 2010, and people clearly recognize the threat fires pose to the forests and productive systems such as Brazil nuts and timber. But because of the small land area affected within the community to date, uncontrolled fires have not had a significant effect on peoples' livelihoods. Land use change within the community has been minor (only one family keeps cattle), though selective logging has occurred. One neighboring

property is a private cattle ranch, but otherwise the community is surrounded primarily by forested land.

Toward the more severe end of the impact spectrum are communities like Los Mandarinos, San Antonio del Maty, and Trinchera. Some households in these three communities lost not only significant investments of time and effort, but also food security and potential income, when their chacos or agroforestry systems were destroyed in uncontrolled fires. In Maty some also have reduced opportunities for future collection and sale of wild cacao, after a fire swept through an area of lowland forest rich in these plants. In Trinchera, at least two households lost about two-thirds of their typical income from Brazil nut harvesting after an uncontrolled fire in 2005 burned forest adjacent to theirs. These communities are located along the main road that connects Cobija to Riberalta, along which the bulk of land cover change in Pando has occurred (Marsik et al. 2011), mainly due to rapid expansion of cattle ranching. Several households in Trinchera also keep cattle on a total of 100 ha or more of pasture.

Only within the last few years have uncontrolled fires become a significant concern in Los Mandarinos, San Antonio del Maty and Trinchera. These fires are also periodic, not occurring every year. Though there has not been much time to develop strong community institutions around fire management, some communities have or are developing fire use norms to reduce the risk of intentional burns of chacos within communities becoming uncontrolled fires (Table 2). However, so far they appear to be implementing few strategies for adapting to an environment with a greater risk of uncontrolled fires. Fire breaks to protect important resources (rather than mitigate fire spread) appear to be uncommon, and are generally considered too much work. Similar fire control norms were observed among caboclo smallholders in the eastern Brazilian Amazon (Carmenta et al. 2013). Abandonment of the most affected productive systems, especially agroforestry systems, seems to be the most common adaptive response.

Table 2. Principal impacts of uncontrolled fires in each community, as perceived by community informants, and their mitigation and adaptation responses.

Community	Primary impacts of uncontrolled fires	Responses to fires / secondary impacts
Los Mandarinos	<ul style="list-style-type: none"> - Losses of part or all of agroforestry systems - Losses of swidden agricultural plots - Loss of few Brazil nut trees 	<ul style="list-style-type: none"> - In process of developing stronger community norms for fire management (mutual assistance for agricultural burning, fire breaks) - Lack of interest to (re)establish agroforestry systems
Palestina	<ul style="list-style-type: none"> - Minimal impact - Reduced fruiting of Brazil nut trees observed after fire 	<ul style="list-style-type: none"> - None mentioned
Petronila	<ul style="list-style-type: none"> - Forest degradation (mainly growth of undesirable/invasive species) - Reduced Brazil nut production, loss of timber species and palms, but only in a small area within the community 	<ul style="list-style-type: none"> - Greater care in swidden agriculture plot burning - Make fire breaks only if fire spread seems imminent

San Antonio del Maty	<ul style="list-style-type: none"> - Loss of agroforestry systems, cacao plantings - Loss of Brazil nut trees in one area (fire subsequent to flood damage) - Loss of wild cacao 	<ul style="list-style-type: none"> - Community norm to wait until the first rains in August before burning agriculture plots - Limited use of fire breaks
Trinchera	<ul style="list-style-type: none"> - Reduced Brazil nut production following uncontrolled fire in adjacent area of forest - Forest degradation - Loss of agroforestry plots 	<ul style="list-style-type: none"> - Community norm to wait until the first rains in August before burning agriculture plots - No use of fire breaks

Civil Society and Government Responses: Fire Use Reduction and Control

With increasing recognition of the threat posed by uncontrolled fires in the Bolivian Amazon, civil society organizations and the Bolivian forest and land management agency, ABT, have stepped up efforts over the last few years to control and reduce the use of fire as a land management tool. These interventions appear to have primarily targeted campesino communities.

The Amazon Without Fire Program (PASF) in Pando was a three-year project funded by the Italian Embassy, which worked with 95 communities in the department (Pers. comm. Naja Vargas, Program Coordinator in Pando, 06/2013). Starting in 2010, they offered technical assistance on conducting controlled burns, supported the development of community fire brigades, and promoted agroforestry systems and other agricultural practices that do not necessitate the use of fire (Arancibia Rivero and Cuellar 2012, Santín 2012).

On the part of the state, the ABT requires permits for all forest clearing and burning, and can levy fines for fires outside the permitted area. According to residents in some focal communities, the ABT's increased efforts in the department since 2010 to control land cover change may be leading to somewhat lower risk of uncontrolled fires.⁶ The threat of fines from ABT for catalyzing uncontrolled fires was commonly cited as an important motivating factor in taking greater precaution when burning chacos.

However, it does not appear that interventions exclusively at the scale of smallholders will be effective in reducing the incidence of uncontrolled fires (Carmenta et al. 2013). These fires are caused by complex interactions of social and biophysical factors at multiple scales (Sorrensen 2009). It also does not appear that campesino communities are the most important actors to target for fire mitigation. According to interviewees who have experienced uncontrolled fires in their communities, fires often originate on neighboring private properties, usually associated with

⁶ However, the ABT's tightened control over land use has also had significant negative impacts on livelihoods and food security in some communities. For example in 2012, no one in Los Mandarinos received authorization from ABT for creating their chacos, and almost everyone chose to forego agricultural production for the year rather than face potential fines by the ABT. In other communities, such as Trinchera, some families' permits arrived too late in the year to make a chaco.

cattle pasture burns. Or, as in the case of Mandarininos in 2012, a burn within a community can merge with a neighbor's pasture burn to create a large, destructive fire.

In general, private landowners who engage in cattle ranching appear to be much more important contributors to uncontrolled fires in the northern Bolivian Amazon than campesino communities, both through direct fire use and through biophysical feedbacks associated with land cover change (Nepstad et al. 2001). In the Bolivian lowlands (including the northern Amazon), cattle ranching and mechanized agriculture were responsible for the most land-use change as of 2004 (Killeen et al. 2008, Muller et al. 2012). In the northern Amazon, mechanized agriculture has gained little purchase, but cattle ranching has been expanding rapidly: from 1990 to 2004, the cattle population expanded at an average of 4.0% annually, twice the national average (Pacheco et al. 2009). Anecdotal evidence indicates that by far the greatest extent of cattle ranching occurs on large private landholdings in this region (though some campesino communities have also created extensive pastures).

Furthermore, although large landholders have received little explicit attention among studies of fire anywhere (Carmenta et al. 2011), signs point to them being key agents of fire use in Bolivia and the northern Amazon in particular. National-level data from the ABT in 2010 illustrate that 85% of the land area authorized for deforestation/burning (32,305 ha) was titled to private landowners, while 10% (3,801 ha) was titled to campesino communities (Rocha Rojo 2011). In Pando, remotely sensed fire "hot spots" showed that while campesino communities covered 40.2% of the department's land area, 37.9% of the total area burned from 2005 to 2012 was within this area (Fuentes Nay 2013). In contrast, 4.7% of the land area was titled to private owners but 17.0% of the burned area of the department occurred on this land. A similar study in Bella Flor municipality, Pando, found that that land ownership was the second most important determinant of fire frequency (after days of precipitation), with fire incidence being highest within and close to private cattle ranches (*haciendas ganaderas*) (Villarpando Vargas 2010). Of course, hot spot data do not indicate whether fires were intentional or uncontrolled, or who set them; fires cross property lines. What they do indicate, however, is that fire use is much more common on individual property, particularly cattle ranches, in Pando.

Current fire reduction and control interventions do not seem to be taking into full account the interrelationships between local climate change, land cover change, and fire. While campesinos do have agency in their application of fire, they have only partial control over the frequency, areal extent, and severity of uncontrolled fires in their communities. Apart from the main causes of uncontrolled fires, a potential reason that PASF and ABT fire use abatement interventions have focused on campesino communities is that private landowners with large ranches lie outside the typical locus of intervention of civil society organizations and beyond the power of the state.

Implications for Ecosystem-Based Development

To improve rural livelihoods as well as conserve the region's forests, civil society organizations with the support of international donors have since the 1980s pursued various interventions, including support for community forest management and commercialization of NTFPs in the northern Bolivian Amazon (Zenteno et al. 2012). Among resource-poor farmers in less-industrialized countries, forest product harvesting and agroforestry systems are promoted to diversify income sources, attempting to spread risk and reduce vulnerability to market and

climate shocks (Matocha et al. 2012). I refer to these interventions, which seek to promote economically and environmentally sustainable development, as ecosystem-based development, more commonly called ecosystem-based adaptation (EBA). Current interventions by civil society organizations focused on sustainable development of natural resources and agricultural systems in campesino communities include promotion of agroforestry systems, development of Brazil nut management plans, and native cocoa commercialization.

Agroforestry system development has been supported since at least the early 2000s. The Center for the Investigation and Advancement of Rural Peoples (CIPCA), Herencia, and the Amazon Without Fire Program (PASF) have promoted development of diversified production of food crops and commercially valuable products such as native cocoa, timber, and certain fruits together under partial tree cover. CIPCA has financed the establishment of greenhouses in various communities for seedling production, and has provided training to individuals interested in developing agroforestry systems.

More recently, CIPCA and other civil society organizations have supported some communities such as San Antonio del Maty to complete formal management plans of Brazil nut trees in their community. Completing a management plan allows community members better market access and a more favorable price for their Brazil nuts, according to community members. Efforts to certify Brazil nuts as organic have similarly sought to achieve a more favorable sale price for producers.

A third intervention that CIPCA was expanding to communities in Pando (already established in the Riberalta area) during the study period was the development of associations of agroforestry producers for the commercialization of native cocoa (cacao criollo) from planted and wild sources. The goal of supporting cacao production is to diversify and increase income sources, reducing reliance on Brazil nuts and timber.

A challenge that is now emerging for these interventions, however, is a dramatic increase in the frequency and extent of uncontrolled fires in the region. As residents' experiences in my focal communities illustrate, agroforestry systems, wild cacao, and Brazil nut trees are susceptible to uncontrolled fires in this region. The biophysical conditions around which these interventions were designed are changing, and it is possible that over the short or medium term, they may no longer be appropriate in communities with a high risk of uncontrolled fires. For forest-based adaptation and other development interventions to be effective, they need to be sensitive to the interconnected parts of the social-ecological system, as well as the different time horizons over which these parts may change (Locatelli et al. 2010). Interventions also need to be responsive to the local repercussions of environmental (as well as social and economic) dynamics at higher scales. This has been recognized in the literature, but implementation can be complicated.

Most vulnerable so far are agroforestry systems and cacao plantings. In communities like Los Mandarininos, San Antonio del Maty and Trinchera, it appears that agroforestry systems as currently implemented are already not a viable development option, either because they are being destroyed by uncontrolled fires or because of the threat of such fires. Investing several years of work and care into an agroforestry system or cacao planting with the risk of losing it all in one day to an uncontrolled fire is not an attractive prospect. Perennial and woody species in

agroforestry systems require a much larger initial start up cost than annual crops, and when they are lost, represent a more significant loss of investment (Sorrensen 2003). The vulnerability of agroforestry systems to fire has long been recognized in the Brazilian Amazon (Nepstad et al. 2001, Sorrensen 2003), but this challenge has only begun to emerge over the past few years in the northern Bolivian Amazon.

The forest-based production systems of wild cacao and Brazil nut trees in community forests are also vulnerable to fires. Though the areal extent of damage to these resources in the focal communities appears to be relatively small so far, the dynamics of fires in Amazonian forest are such that successive fires build on each other in a positive feedback loop (Nepstad et al. 2001). Given the apparent shift in the northern Bolivian Amazon to a fire regime of greater frequency and extent over the past decade (Fuentes Nay 2013), uncontrolled fires' impacts on livelihoods and development have the potential to become increasingly widespread among rural communities.

Broader Repercussions

Though this case study focuses on the experiences of a small number of people in five rural communities in Pando, Bolivia, they share similar ecosystems, land use trends, and climate-related hazards such as uncontrolled fires with the broader Amazon region, especially neighboring Acre and Rondônia states in Brazil, and Madre de Dios in Peru. In addition to regional relevance, the repercussions of widespread uncontrolled fires in rural areas would also almost certainly be felt strongly in urban areas as well. For example, Brazil nuts are not only a critically important source of income for many rural communities, but also rural-urban migrants and urban inhabitants of northern Bolivia (Pacheco et al. 2009) and adjacent areas of Brazil and Peru. Although a formal estimate has not been made, Ortiz (2002) guessed the Brazil nut harvest and trade “may easily account for several hundred thousand people” across the three countries. Brazil nut shelling facilities in Riberalta and Cobija, Bolivia, employ thousands of people, most of them women. If Brazil nut production were to decline due to more widespread and frequent uncontrolled fires, a significant part of the economic foundation of the region, as well as incentive to conserve primary forests, would be undermined.

I also underscore that uncontrolled fires are just one of several climate-related hazards and other kinds of stressors campesinos are facing in the region. Flooding, drought and changes in the rainfall regime (timing and amount of rain) are other climate-related hazards that residents are experiencing in the focal communities. Uncontrolled fires can also exacerbate other hazards already being experienced; for example, uncontrolled fires are most likely to occur in times of drought, when agriculture systems are already stressed and non-timber forest products may be less abundant.

Campesino communities in the northern Bolivian Amazon, like their counterparts around the world, are experiencing multiple stressors, of which uncontrolled fires and other climate-related hazards are just one aspect (Eriksen et al. 2011). On a day-to-day basis these non-climate stressors normally represented a greater concern for most campesinos with whom I spoke than uncontrolled fires and other climate-related hazards. The impacts of uncontrolled fires should be considered in the context of the many other environmental, social and economic challenges that rural residents are experiencing.

Conclusions

The majority of campesino communities and households in the northern Bolivian Amazon, especially in Pando department, derive their livelihoods primarily from forested land in their communities. Brazil nuts, timber, other non-timber forest products, small-scale swidden agriculture, and less commonly, agroforestry systems and cattle ranching, provide the majority of household income and food. Within this context, uncontrolled fires are emerging as a significant climate-related hazard in the region. Discussions with members of five campesino communities in Pando revealed that most of the productive systems that form the basis of their livelihoods are susceptible to uncontrolled fires. Furthermore, ecosystem-based development interventions being carried out by civil society organizations in campesino communities, including implementation of agroforestry systems, development of cacao commercialization, and completion of Brazil nut management plans, are also at risk either over the short or medium term.

To date, it appears that few local institutions have developed within the study communities to mitigate or adapt to uncontrolled fires beyond traditional fire management practices. At higher institutional levels, interventions by civil society organizations and the Bolivian forest management agency, ABT, seem to have primarily focused fire use reduction and control efforts on campesino communities. However, other local actors such as private landowners with large cattle ranches are likely contributing much more to the problem of uncontrolled fires, including fires that spread to community land. Furthermore, uncontrolled fires are caused by factors at multiple scales, ranging from global climate patterns to regional land cover and land use, to local fire use practices; campesino communities have limited agency and may not be the most appropriate actors to target for such interventions.

Current interventions focused on ecosystem-based development, and fire use reduction and control in campesino communities, seem to reflect a lack of recognition of the changing biophysical conditions in the region and the nested scales through which the hazard of uncontrolled fires is manifested. The multi-scalar nature of the risk and impacts of uncontrolled fires suggests that a more regional and multi-actor approach than has been pursued to date could be beneficial to reducing the vulnerability of rural communities to uncontrolled fires.

Recommendations

Campesino Households and Communities

1. Factor the risk of uncontrolled fires into land use planning. Recognize that timber harvesting, creation or expansion of pastures, and other activities involving forest conversion or degradation, greatly increase the risk of uncontrolled fires. Consider fire hazard when choosing the location of agricultural systems.
2. Adjust community norms and rules pertaining to fire use and mitigation strategies to changing climatic conditions. Uncontrolled fires can occur any year, but the risk is particularly high during times of drought. Having more stringent regulations regarding fire use and mitigation strategies in dry periods could reduce the risk of uncontrolled fire.
3. Demand fair compensation for damages to community assets from fires originating on a neighboring property. Know and make use of the protocol to submit a claim of damages.

Civil Society Organizations

1. Consider uncontrolled fire hazard and adaptation strategies in intervention planning and implementation. Prior to the proposal of any ecosystem-based development intervention, discussions with community members should include climate-related hazards the community is experiencing. If uncontrolled fires are a challenge in the community or on neighboring properties, the susceptibility of the productive system to be developed through the intervention should be discussed with community members. If the intervention is deemed appropriate, discussions and implementation of strategies to adapt the intervention to an environment of uncontrolled fire risk could be beneficial. In particular, agroforestry system development should be coupled with practices that reduce risk of fire damage, such as fire-resistant planting design and location, and creation and maintenance of fire breaks.
2. Couple interventions to reduce the use of fire as an agricultural tool (mitigating risk) in campesino communities with strategies to adapt to the risk of uncontrolled fires, recognizing that individual communities have only limited control over uncontrolled fire risk. For example, establishing communication protocols with neighboring landowners about the timing and extent of fire use, as well as the escape of burns, could allow for greater preparation and damage reduction in the event of uncontrolled fires.

ABT and Policymakers

1. Focus on actors and land uses that contribute most to uncontrolled fires. Fire use reduction and control efforts should be based on the biophysical factors at multiple scales that contribute to uncontrolled fires, including land cover and land use at the regional or departmental level. Actors whose land cover/land use contributes more to the risk of uncontrolled fires, especially those

engaged in medium- and large-scale cattle ranching and other activities that require forest conversion, should be priority targets.

2. Granting of logging concessions, and the harvesting practices that are permitted, should take into account the long-term risk of uncontrolled fire in the area. Selective logging, particularly when carried out with heavy machinery, greatly increases the risk of uncontrolled fires, as well as the intensity of fires when they do occur.

3. Adjust fire use and control requirements in accordance with climatic conditions. Recognizing that the risk of uncontrolled fires is exponentially higher during droughts, greater sensitivity of ABT's fire use policies to interannual climate variations could lead to improved compliance.⁷ Information about current levels of risk associated with regional climate, as well as required fire control measures, should be clearly communicated to rural residents.

⁷ Adapted from Carmenta et al. (2013).

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Appendix A: Detailed Methods

The questions that initially guided my investigation were: 1) In what ways are campesino productive systems vulnerable to climate-related hazards, and how severe are the risks, according to their perception? 2) What practices and institutions have been or are being developed among different stakeholders to help adapt to climate-related hazards? For both, I tried to understand whether there was perception of change—if or how vulnerabilities and adaptive responses have changed and are changing over time.

Fieldwork was carried out for three months between May and August 2013. I focused on five campesino communities in Bolivia's northernmost department, Pando: Los Mandarinos, Palestina, and San Antonio del Maty (Puerto Rico municipality); Petronila (Filadelfia municipality); and Trinchera (Porvenir municipality). These communities are made up of about 10-35 households, with several more families arriving for the Brazil nut harvest. The land is communally owned, though each community has its own norms and rules with respect to land and natural resource access. The area of land pertaining to the focal communities ranges from 7,181 ha to 16,237 ha. Like most campesino communities in Pando, my focal communities have formal title to their land except for Trinchera, which was in the process of obtaining its title during the study period.

The five study communities receive support from the Center for the Investigation and Advancement of Rural Peoples (CIPCA) in Cobija, Pando. Each community is developing a Integrated Forest and Land Management Plan (PGIBT). Along with CIPCA staff, I helped facilitate the diagnostic phase of this process in the communities, which included focus group discussions and participatory mapping to explore climate- and non-climate-related hazards that community members are experiencing, along with household surveys about livelihood strategies. Separately, I then conducted 43 semi-structured interviews (with a total of 55 people; 20 women and 35 men), in Spanish, to gain a more in-depth understanding of the effects of climate-related hazards on local livelihoods, and responses. Spanish is the first language of residents in all communities except for Trinchera, where Portuguese is generally preferred, but the majority were also fluent in Spanish. As many families have moved into the communities within the last few years, I prioritized interviewing long-term residents rather than select community members at random.

To complement individual interviews, I participated in or observed community life as much as possible, including attending several relevant community meetings. I also attended three workshops focused on natural resource management in Pando, which included the Campesino Federation, ABT, and other government and civil society organizations. I interviewed staff at various civil society organizations in Pando (Amazon Without Fire Program, Autapo Foundation, CIOEC-Pando, CIPCA) and La Paz (CIPCA, Cordillera Foundation, Environmental Defense League (LIDEMA)) to gain their perspectives.

My focus on uncontrolled fire emerged after fieldwork, through inductively coding campesino interview responses. Of the various climate-related hazards residents reported experiencing, uncontrolled fires were overall perceived to represent the most significant and immediate threat to livelihoods.