



Perceptions of Local Vulnerability and the Relative Importance of Climate Change in Rural Ecuador

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Published online: 22 July 2020

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Abstract

Rural, natural resource dependent communities are especially vulnerable to climate change, and their input is critical in developing solutions, but the study of risk perception within and among vulnerable communities remains underdeveloped. Our multi-disciplinary research team used a mixed-methods approach to document, analyze, and conceptualize the interacting factors that shape vulnerability and to explore community members' perceptions of the role and relative importance of climate change compared to other factors in three rural communities in Ecuador. Economic instability, lack of access to basic services, and environmental degradation are perceived as greater threats to community well being than increasing seasonal variability and flooding. Programs and policies directed at climate change adaptation should integrate climate and non-climate related stressors. Our findings also point to a greater need for collaboration across public health, poverty alleviation, and environmental management fields through practical research targeting assistance to vulnerable populations.

Keywords Well being · Vulnerability · Riparian flooding · Marginality · Climate change · Climate adaptation · Esmeraldas · Ecuador

Introduction

The impacts of global climate are felt differently among individuals and communities based on their geography and capacity to cope with or adapt to climatic stressors they experience (Adger and Kelly 1999; Frick-Trzebitzky *et al.* 2017). These capacities are in turn determined by underlying sociopolitical

systems and historical power differentials. In broad terms, vulnerability to climate change, although defined differently across disciplines (Bohle *et al.* 1994; Brien *et al.* 2004; Kelly and Adger 2000; Wisner 2004), is produced at the intersection of geography, individual endowments, and institutional and structural capacities and priorities. As a result, it has been argued that solutions to climate change require interventions to address both specific climatic risks and generic structural deficits, such as lack of income, education, or political power (Lemos *et al.* 2016).

A related approach within vulnerability research focuses on the need to recognize and harness local understandings of vulnerability and adaptive capacity as a tool for climate-change planning (Webler *et al.* 2016). These approaches emphasize, often through participatory risk assessment or risk mapping (van Aalst *et al.* 2008), the unique experiences faced by communities while also seeking commonalities across systems that can provide insight or represent leverage points for intervention. However, they have also been criticized for a tendency to focus on climatic risks (Antwi-Agyei *et al.* 2016) rather than exploring the interaction between specific and generic sources of vulnerability. Lack of financial, human, or political resources may reduce the capacity of a community to develop or maintain climate-specific infrastructure,

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s10745-020-00165-1>) contains supplementary material, which is available to authorized users.

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resulting in a vicious cycle where the financial and human costs of climatic shocks increase. Communities without effective preventive infrastructure are also more dependent on short-term responses, such as the provision of food donations and drinking water. This can strengthen systems of political clientelism (Lemos *et al.* 2016) further diminishing the community's political power.

Our study explores changing perceptions of climate change urgency relative to other stressors among communities in rural Ecuador. Since a community-level orientation may fail to capture individual experiences (Malin and Ryder 2018), we also explore how perceptions of risk vary within communities based on relative wealth, gender, and age. We follow the participatory approach of Antwi-Agyei *et al.* (2016) to better understand how climatic- and non-climatic stressors are prioritized by community members recently impacted by flooding, and how these stressors may interact to produce vulnerability. We focus on the Esmeraldas region of Ecuador, a province that is among the parts of the country most likely to be impacted by climate change (Fernandez *et al.* 2015; UN-Habitat 2009). Esmeraldas is home to coastal and riparian communities who are physically exposed to climatic risks, primarily in the form of landslides and flooding (Luque *et al.* 2013). A significant proportion of the population's livelihoods are dependent on the availability of natural resources (INEC 2010), which increases their sensitivity to climate events (Bennett and Dearden 2013; Bunce *et al.* 2010; McDowell and Hess 2012).

The economic and political history of Esmeraldas province has led to economic and structural inequalities that compound vulnerability of its residents. The rich natural resource base of the region has been exploited over the centuries, beginning with intensive gold mining in the 1500s (Sánchez 2015; Whitten 1998, 1986). In a population where 43.9% of all residents identify as Afro-Ecuadorian and 2.8% as Indigenous (INEC 2010), processes stemming from colonialism, including ideals of whiteness or 'mestizaje,' have historically given rise to exclusionary policies through structural racism (Rapoport Center 2009). Esmeraldas is also characterized by extraordinary species richness and endemism (Myers *et al.*, 2000; Naughton-Treves *et al.* 2006; Sierra 1999; Sierra and Stallings 1998) and, in the 1980s, very rapid deforestation drew the attention of the international conservation community (Ferrin *et al.* 2016; Rudel 2000). As a result, the province became the focus of major global and national initiatives targeted towards environmental protection and climate change (Luque *et al.* 2013; Rapoport Center 2009) resulting in innovative programs that directly impacted both urban residents and rural smallholder communities. To halt the encroachment of extractive industries, Ecuadorian governmental agencies, environmental non-governmental organizations, and international financial donors developed collaborative agendas that recognized the need for poverty alleviation and rural

development in the context of sustainable forestry (Rival 2003). This coincided with a political shift towards 'neoliberal multiculturalism,' described as a concession of strategically conceived cultural rights while strengthening the interests of national and transnational capital (Muteba Rahier 2018). This led to an increase in policies specifically targeting Indigenous and Afro-Ecuadorian populations by international development and global governance institutions (Fontaine 2012) and, given their 'traditional relationship' to the land, granted rural Afro-Ecuadorians political status similar to Indigenous groups in the region, making them eligible for similar collective rights (Fontaine 2012).

Consequently, programs were designed to help rural Esmeraldeño communities, especially those located in the buffer zone of the Cotachachi-Cayapas reserve, to obtain legal title to historically contested communal lands (Project SUBIR 1991–2002) (Rapoport Center 2009; Rival 2003; USAID 2012), to increase local Afro-Ecuadorian and Indigenous Chachi representation and negotiating power (Rival 2003), and to develop participatory community forest management and sustainable forestry in coordination with logging companies, the ministry of the environment, and other stakeholders (Rudel 2000). Since 2009, the Ministry of the Environment of Ecuador has operated the Socio Bosque (Forest Partner) program, a payment for ecosystem services strategy to conserve native forests and other ecosystems, reduce deforestation, and simultaneously improve the well-being of communities living in these areas. Through Socio Bosque, communities sign a voluntary 20-year conservation agreement and receive an annual per-hectare incentive payment in return for maintaining forest cover on communal lands. To accomplish this, community members are also taught not to log, farm, or hunt commercially in the protected area (Mohebalian and Aguilar 2016). This program is a key pillar of Ecuador's participation in the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program (Collen *et al.* 2016). An additional notable program was implemented in 2009 in the city of Esmeraldas (capital of the province), when it was selected to participate in UN-Habitat's Cities and Climate Change Initiative designed to help cities in developing countries build adaptive capacity to address climate change. Through this program the provincial government mobilized international concerns around climate change to justify the need for investments in public infrastructure, improvements in institutional capacity, and poverty reduction (Luque *et al.* 2013).

With this in mind, our cross-sectional, qualitative study consisted of three related, complementary activities combined with survey results on household-level experiences of recent flood impact. Consistent with our concerns for more multidimensional data, we combine transdisciplinary methods to explore gender, generational, and ethnolinguistic variations within and across the communities, and closely ranked common concerns among them. Our research questions are:

1) How do community members recently impacted by flooding define well being?

2) What is the relative importance of climate and climate change in relation to the other stressors identified by community members, and how do community members perceive interactions between stressors related to climate change and other stressors?

Research Sites

We selected our three research sites on the basis of key ecological and ethnographic criteria regarding experiences of and responses to climate vulnerability: Trinidad, Guadual, and San Miguel, which lie along the Cayapas River, within the buffer zone of the Cotacachi-Cayapas Ecological Reserve, participate in the Socio Bosque program, and are accessible only by river (Carlton *et al.* 2014). San Miguel and Guadual are in Atahualpa Parrish and Trinidad is in Telembí Parish. San Miguel and Trinidad are predominantly Afro-Ecuadorian, while Guadual is predominantly a Chachi Indigenous community.

As is common in riverine and coastal communities worldwide, all three communities are accustomed and adapted to seasonal flooding patterns. During the winter months of December to late May, floods of 0.5 to 3 m, typically of short duration (a few hours or days) are common (Tauzer *et al.* 2019). In late 2016 and early 2017 there was an unusually severe seasonal flooding (Masoero 2016; Schumer 2015). Damages to crops and livestock were estimated at around US\$814,000. A maximum rainfall at the rain station in Esmeraldas city recorded 244.5 mm in 24 h compared to an average of 89 mm/24 h (Masoero 2016) and a state of emergency was declared in January 2017. This severe flooding is consistent with intensifying patterns of precipitation related to the El Niño Southern Oscillation (ENSO) (IPCC 2014; Morán-Tejeda *et al.* 2015), increasing the predicted likelihood of extreme weather events in the region (Bennett and Dearden 2013).

Methods

Vulnerability research is transdisciplinary both in its historical origins and in its practice (Davis 2008). In contrast with multi- and interdisciplinary perspectives aimed at encouraging scientists to become conversant with concepts and practices of other fields, a convergence approach promotes the development of a shared theoretical and methodological space (Kulkarni *et al.* 2017; Wilson 2019). This is essential to bridge divides between niche areas of expertise, engage effectively with decision-makers across sectors, and best take advantage of opportunities to influence policies. Our team, comprised of

researchers trained in anthropology, epidemiology, and the environmental sciences, chose an integrative, mixed-methods approach to address our research questions from multiple, complementary perspectives.

To ground our conceptual approach within the national political context as well as make it relevant to the participants, we also organized our overall study design and analysis around the concept of ‘buen vivir’ (well being), derived from the Quechua concept of ‘sumak kawsay’ describing a harmonious way of life that is “community-centric, ecologically balanced, and culturally sensitive” (Balch 2013; Zimmerer 2012). Although political definitions of ‘buen vivir’ remain vague, the concept has been introduced into the Ecuadorian constitution (Asamblea Constituyente del Ecuador 2008; Guardiola and García-Quero 2014). Attempts to define and operationalize ‘buen vivir’ guide political discussion and influence policy (Lalander 2016; Merino 2016). We investigated its relationship to local definitions of well being and stressors and/or factors locally perceived as threats to well being, an approach supported by definitions of vulnerability that emphasize the capacity of individuals and communities to cope with and adapt to external stress on their well being (Adger and Kelly 1999), as well as the “interface between exposure to the physical threats to human well being and capacity of people and communities to cope with those threats” (UNEP 2003).

We combined focus group discussions (FGDs), structured interviews, free listing, and limited survey data to facilitate understanding of the lived experiences of our three study communities. Surveys, free-listing, and structured interviews were conducted from March to June of 2017, and focus groups were completed in June 2017. In the two predominantly Afro-Ecuadorian communities, all data collection was conducted in Spanish, while in Guadual, all data collection was conducted in Chapalaá with a local translator.

Focus Group Discussions (FGDs)

We held two FGDs in each community. Participants whom we considered to hold leadership positions were sent letters in advance describing the planned activities, inviting them to participate, and asking them to invite other residents to participate. On arrival we confirmed community member participation and invited further individuals if this was necessary to ensure equal distribution by age and gender. In total, 37 women and 30 men participated. The smallest group included seven individuals, and the largest 15. Two trained Ecuadorian facilitators who have worked in the region for over a decade, accompanied by one or more note-takers, conducted the focus groups. Separate FGDs were held by gender to ensure equal participation. Within each FGD, specific activities were conducted in separate breakout sessions for older (>40, approximately the median age of the population) and younger (<40)

participants. All focus group discussions were recorded with the consent of the participants, and detailed notes were taken.

The FGD guide (Supplemental Materials – Appendix 1) was developed through a review of the literature and reviewed by the full study team before data collection. Given that our objective was to identify and better understand interactions between perceived risks and stressors (specifically climatic and non-climatic stressors), we worded questions broadly to avoid prompting for specific responses. As noted, to ensure that the questions were universally understood, vulnerability was framed as an impact to community well being, while stressors and risk were framed as problems, worries, or threats to well being. In five of the six FGDs, respondents did not mention climate or weather-related concerns until prompted by the interviewer.

Structured Interviews

We conducted interviews with a total of 13 individuals (three in Timbire, five in San Miguel, and five Guadual) who we considered to hold leadership positions. These included current and former community presidents, presidents of local indigenous groups, teachers, and health professionals. These individuals were asked to describe problems the community had faced or was currently facing, and what was being done to address them. Subsequently, interviewees were questioned about whether specific activities related to flooding had been considered, such as the construction of retention walls, or relocation of homes. Interviews were not audio-recorded, and analysis was based on interview notes.

Free Listing

We developed a free list prompt to elicit information related to change and risk (framed as problems or worries). One individual per household completed the free listing exercise from 25 randomly selected households in San Miguel and Guadual, and every household in Trinidad, we were able to interview 22 of 24 households, a total of 42 women and 30 men. Men were over-represented in Guadual relative to San Miguel and Trinidad, in part due to distinct cultural conventions. Chachi household heads were more often men, while Afro-Ecuadorian household heads were more often women. The prompt asked the respondent to list all the problems affecting people in their community. Due to the low literacy rate of the population, free listing was conducted orally. Participants were asked to name items as they occurred to them, and then further prompted, both non-specifically and by reading back previously listed items, until they could not add anything else. As in the FGDs, if climate related concepts had not been mentioned in the initial free list, participants were prompted to describe any climate-related problems affecting their

community, and this was noted on the transcript of responses (22 instances (30.6%)).

Household Survey on Flood Impacts

We also asked the free list respondents to answer survey questions on household demographics, socioeconomic status (e.g., household building materials, livelihood strategies, assets), and flood damages in the past year. Household wealth was assessed using 16 variables related to key household durable assets and components of the dwelling structure to construct a household wealth index using multiple correspondence analysis (Filmer and Pritchett 2001). We divided the index scores to indicate households with wealth below the median and households at or above the median. Household food insecurity was measured using the Household Food Insecurity Access Score (HFIAS), a nine-item scale developed and validated by the United Nations Food and Agriculture Organization for use in low- and middle-income countries (Coates *et al.* 2007). ‘Severe crop loss due to flooding’ was defined as any crop loss from which the family had taken three or more months to recover.

Analyses

We analyzed FGD transcripts and field team notes with qualitative data analysis software NVivo (Ltd 2018). A codebook was developed based both on a priori research questions and on themes that arose during data collection (Supplemental Materials - Appendix 2). Codes were applied, and two coders performed iterative re-coding based on themes that emerged during coding. This grounded theory-based approach encourages unbiased development of the results (Charmaz 2006). Following final coding, we ran queries to identify salient and representative quotes on broad themes. We consolidated data from free list prompts by recoding similar but differently worded responses into broader categories.

We tabulated survey data and calculated summary statistics including mean and standard deviation of continuous, normally distributed variables, median and interquartile range of non-normally distributed continuous variables, and percentages of binary variables. We used chi-squared and ANOVA tests to compare differences in the proportion of key variables (age, sex, percentage of households that had experienced flood damages in the past year) among communities.

Local Definitions of Well Being

To address the first research question and understand local definitions of well being, we relied on FGD. We used the following conversational prompts: “What makes your community unique?” “What do you like and not like about living here?” and “What does ‘living well’ mean to you?”

Threats to Well Being

To address the second research question and identify threats to well being and the relative importance of climate and climate change in relation to other stressors, we relied on a complementary combination of FGDs, structured interviews, and free listing data. To determine the relative importance of stressors, we examined data from the FGD ranking exercise. In the free listing data, we excluded responses generated after prompting for information related to weather were excluded, and calculated the Smith Salience Statistic (S), which accounts for the frequency that an item is mentioned across all lists and the order in which the item is mentioned in lists (Smith 1993). Smith's statistic may take values from 0 to 1, where higher values denote higher salience.

To understand whether the relative rankings of these stressors were consistent across genders, ages, and communities, we linked survey data on gender, age, and wealth, to free-listing data, and examined similarities in the rank ordering of responses between subgroups (by community, men versus women, younger versus older, and wealthier versus less wealthy). We used Spearman correlation coefficients to test consistency in the rank ordering of responses. We completed salience analysis using the 'AnthroTools' package (Purzycki and Jamieson-Lane 2017) in R statistical software version 3.4.1.

Perceived Interactions between Stressors

To further investigate the second research question by exploring perceived interactions between stressors related to climate and other stressors, we used FGD, free listing, and survey data. We used FGD data again to directly address perceptions of interactions among factors. In the free listing data, we assessed the extent to which specific stressors were co-mentioned as an indirect measure of perceived association. To accomplish this, we generated a bipartite network. Participants were indirectly linked to one another when they reported the same responses during free listing, and responses were indirectly connected when listed by the same participants. We then used a Stochastic Block Model to identify groups of responses that tended to be co-mentioned (Hric *et al.* 2017), and simultaneously, groups of participants with similar free lists using the 'blockcluster' package (Leger 2016), also in R.

Social Programs

To understand the role of social programs, we relied on FGD and structured interview data. This theme emerged during FGD and interviews without specific prompting.

Results

Throughout this section we integrate free listing, FGD, and structured interview results according to identified themes.

Study Population

There were 23 to 35 total households in each community (Table 1). Each community had access to intermittent electricity, a communal telephone line, and rudimentary sanitation through latrines. All three communities had an elementary school; however, high school students had to travel by boat to other communities. Trash management services were not available in any community. Only Trinidad had a piped water system; however, this was not functioning at the time of the study. None of the three communities had a functioning health clinic.

The main economic activities of represented households were agriculture and small business entrepreneurship. Agriculture included a combination of subsistence farming and small-scale commodity crop production (most often cacao). However, the proportion of crops raised for sale versus consumption varied by household, with 52.0% of respondents in San Miguel, 77.3% in Trinidad, and 84.0% in Guadual reporting income from agriculture. Guadual had the greatest proportion of respondents who were severely food insecure, followed by Trinidad (Table 1).

Over a third of free listing participants (36.1%) reported that their household had experienced non-agricultural flood loss in the past year (typically damage to houses or personal items). Among households engaged in agriculture, 41.7% reported a crop loss due to flooding, and 23.3% reported a severe crop loss. There were no differences in gender, age, or household wealth score between those who reported a flood loss and those who did not (data not shown).

Local Definitions of Well Being

Respondents agreed that 'buen vivir' encompasses a few key elements, including: a dignified home equipped with basic facilities, access to food (in sufficient quantity and quality), and clean, safe water, as well as living in harmony and tranquility both within the familial unit and among neighbors, described by one respondent as "having respect for one another, living in unity, being understanding, and (living) in solidarity with one another." Notably, most respondents described "living with dignity" as something unachievable because they lack necessities like potable water, and because the requirements for well being are precarious and often outside individual or community control.

A man from Guadual also defined "buen vivir" as "having 'lushi' [money in the Chachi language Chapalaá]. And I don't mean, having money just to have it, no. I have to have farms

Table 1 Characteristics of Free-listing Respondents

	San Miguel	Guadual	Trinidad	<i>P</i> value (chi2/ANOVA)	Overall
Households	33	35	24	–	92
Individuals	136	220	96	–	452
Households participating in free-listing	25	25	22	–	72
Respondent = female	72.0%	24.0%	81.8%	<0.001	58.3%
Respondent > 40 years old	40.0%	32.0%	40.9%	0.779	37.5%
Mean years of education	7.1 (3.8)	8.0 (3.8)	5.6 (3.8)	0.113	7.0 (3.9)
Household wealth index > =median	44.0%	60.0%	45.5%	0.463	50.0%
Sources of household income					
Income = agriculture	52.0%	84.0%	77.3%	0.033	70.8%
Income = small business	16.0%	4.0%	0.0%	0.076	6.9%
Income = BDH	60.0%	72.0%	69.2%	0.656	66.7%
Household food security (HFIAS)					
Food secure	40.0%	24.0%	45.5%	0.153	36.1%
Mildly insecure	4.0%	0.0%	0.0%		2.8%
Moderately insecure	24.0%	20.0%	4.6%		15.3%
Severely insecure	32.0%	56.0%	50.0%		45.8%
Primary source of drinking water					
Rain water	80.0%	64.0%	100.0%	0.008	80.6%
Creek water	20.0%	36.0%	0.0%		19.4%
Other					
Any non-crop losses due to flooding in past 12mo	40.0%	40.0%	27.3%	0.585	36.1%
Among HHs with a farm (<i>N</i> = 60)					
Any crop loss due to flooding	45.0%	45.5%	33.0%	0.692	41.7%
Severe crop loss due to flooding	10.0%	36.4%	22.2%	0.130	23.3%
Sells less of crop	25.0%	9.1%	38.9%	0.084	23.3%
Sells half or more of crops	75.0%	90.9%	61.1%		76.7%

and I have to have crops, so that I can have money. If I have my farm, then I don't have to worry more about my family, right?"

Solidarity was perceived by many respondents as important for achieving well being. Respondents indicated that, if the community works together one and is organized, it will be able to fight more effectively for what it wants and needs. Organization was perceived as a way of providing a platform to voice community concerns at a political level and as an important component for community development. A woman from San Miguel explained, "(Community organization) is a key element for (social) guarantees, right? That they give us that on a social level, and then we should also have something on a political level (...) to have an impact."

Threats to Well Being

Non-climate threats: Underlying specific stressors described by community members were foundational concerns about water quality and food security. All three study communities

have traditionally relied upon the Cayapas river for consumption, with one woman from San Miguel noting that, in the past, "you would drink the water, and you wouldn't get sick, the water was good!" However, in recent years, participants reported stomach cramps and diarrhea after drinking the water, and rashes and skin blemishes after bathing. Despite the perception that it is unfit for human consumption, community members still drink river water, especially in times of drought Fig. 1.

Participants also discussed decreasing food security due to a loss of traditional foods including river fish, shrimp, and wild game. Traditional fishing methods with baskets, line and hook, and nets, were no longer effective. A man from Trinidad said, "everyone grabbed fish with a wire, with baskets and fishhooks, and now, nothing – not even the net traps. Nothing, nothing comes." Participants also noted that the fish they did catch were frequently 'contaminated' by unusual growths and lumps, making them unfit for consumption. On the loss of wild meat, one woman from San Miguel mentioned that "[the animals] have completely gone far away."

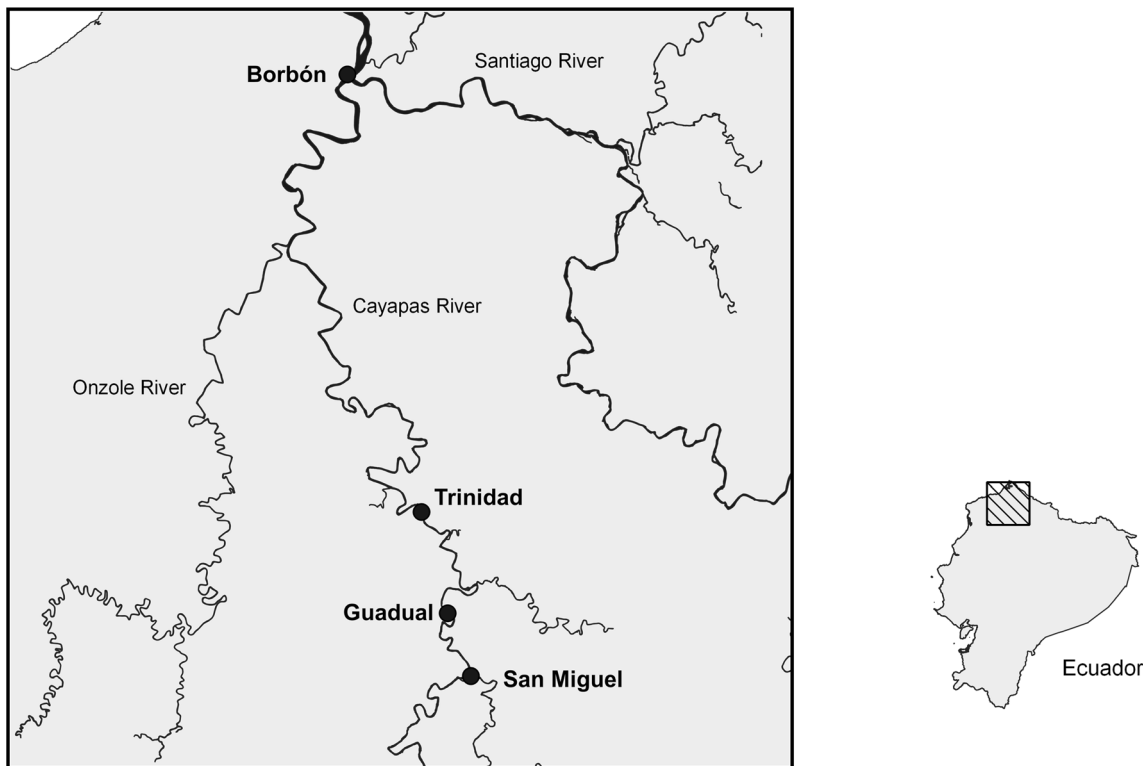


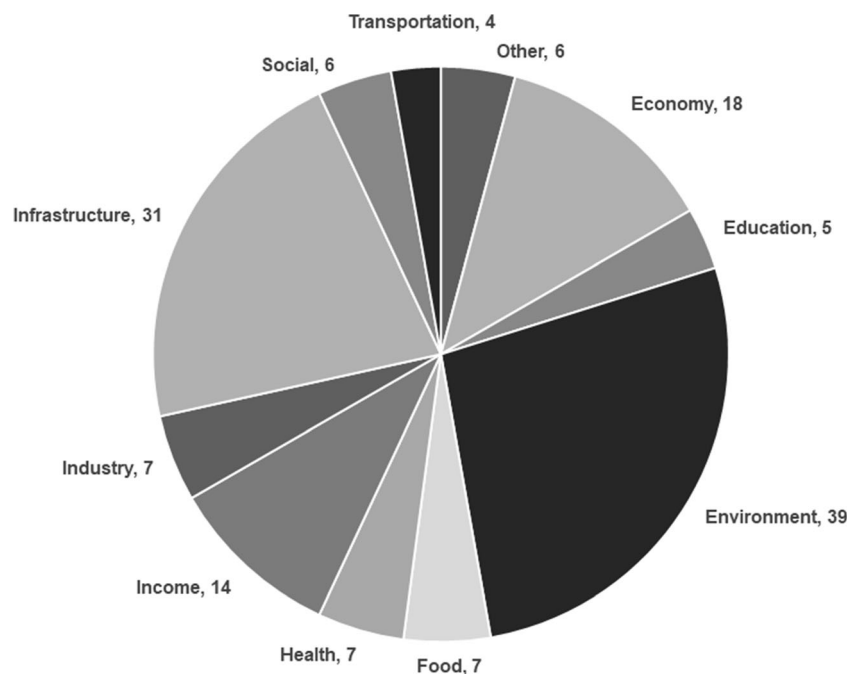
Fig. 1 Map of the three study villages. The three study communities, Trinidad, Guadual, and San Miguel, are each located along the Cayapas river, 2-3 hours by boat from the population center of Borbón.

Prioritized stressors were related to economic dependence (e.g., unemployment and a lack of fair market prices for their crops), environmental degradation associated with extractive industry, and the need for improved access to basic services (Fig. 2). Some differences in the ranking of issues were noted by gender, as women tended to prioritize access to basic

services, especially water, while men tended to emphasize issues related to employment and agriculture.

Interviews with community leaders supported these priorities. Most significant ongoing activities described were intended to improve community infrastructure. These included efforts to build or improve schools, health posts, access to

Fig. 2 Themes mentioned in the focus group discussion (FGD) vulnerability matrix exercise. Shown here are the frequency of themes mentioned during the vulnerability matrix exercise. The ‘other’ category here includes themes of land, security, climate, and culture.



electricity, and, most frequently, potable water systems. Social issues were also frequently discussed in Guadual, the Chachi community, where leaders remarked on problems of domestic violence and underage pregnancy, among others. Community leaders also reported successes in improving community-run hotels and schools and in improving transportation by purchasing community boats. San Miguel and Guadual described a successful effort, coordinated between several communities, to evict illegal miners and loggers from the area. Leaders in San Miguel also described having successfully negotiated a payment dispute with the Socio Bosque program.

Climate threats: Although flooding is regarded as a challenge, it was consistently ranked as a lower priority concern. Losses of durable assets were reported, for example a man in San Miguel said that, “last year, in April, the river rose the most... my mother lost many things because she didn’t expect the flooding to reach her home.” Climate variability was also described, where the summer and winter seasons were primarily distinguished by rainfall rather than temperature, as temperature is relatively stable throughout the year. A man in Guadual noting that “rains were stronger now than in the past,” and that summers were more intense: “It’s been many years since I saw a summer like this one... the estuary dried up completely.” A woman from San Miguel also noted increasing instability in seasonal patterns: “a problem is that now they’ve given us climate change and we don’t know what month [is] really summer and what month is winter, or rather, it varies.” This instability had negatively impacted agriculture: “with the changing climate we have, there’s a lot of drought and too much winter and a loss of production.”

When specifically asked about efforts that had been made to ameliorate flooding, leaders in Guadual reported plans to construct a retention wall, while leaders in San Miguel reported having considered moving part of the community to higher ground. Neither was carried out. All three communities organized ‘mingas’ to clean up the community following flooding, and no community or government institution had provided support for farmers who had lost crops.

Analysis of free listing data suggest that access to potable water is the most salient problem listed overall (across the three communities) ($S = 0.31$), followed by flooding ($S = 0.25$), river contamination ($S = 0.14$), and trash ($S = 0.13$). Both free listing and FGDs suggest differences in the concerns expressed between communities as well as by sex (Fig. 3). Similar to what was observed in FGDs, the lack of potable water was the most salient problem for women ($S = 0.43$), while flooding resulting in crop destruction was more often prioritized by men ($S = 0.27$) (Supplemental Figs. 1a–1c).

Perceived Interactions among Stressors

Water quality and food security were often referenced in describing how problems interacted or compounded one

another. Logging and mining operations indirectly contributed to food insecurity. A man from Trinidad commented, “Look, the worst that we have now, is from when the heavy machinery was brought in (for) the gold mines. (Since then), you don’t get any fish from the river...” To purchase replacements for these lost sources of food, respondents said they relied more heavily on cash crops as well as employment in the same extractive industries. One man in San Miguel described the moment he realized that his family’s ancestral lands, previously used for multiple subsistence crops, had been planted with cacao:

“People used to say that cacao damaged the earth, that if you planted cacao, the green plantain trees wouldn’t produce anything (...) They planted everything (else) because cacao killed the plantains. So when I came (later) and I went to our field and I saw that cacao had been planted, tears came to my eyes, I cried.”¹

This increasing economic dependence on industry was further exacerbated by the vicissitudes of market demand for cacao, unreasonably low prices demanded by intermediary buyers, and limited access to larger buyers due to the lack of road access. A man in Trinidad explained, “we plant chocolate and when it’s (time) for the harvest, they pay us 25 cents per pound... we can’t take out the product if we can’t sell it.” It is notable that although FGD participants explicitly discussed these interactions among economic, social, and environmental issues, climatic variability and flooding were less frequently linked to this more tightly entangled group of other concerns.

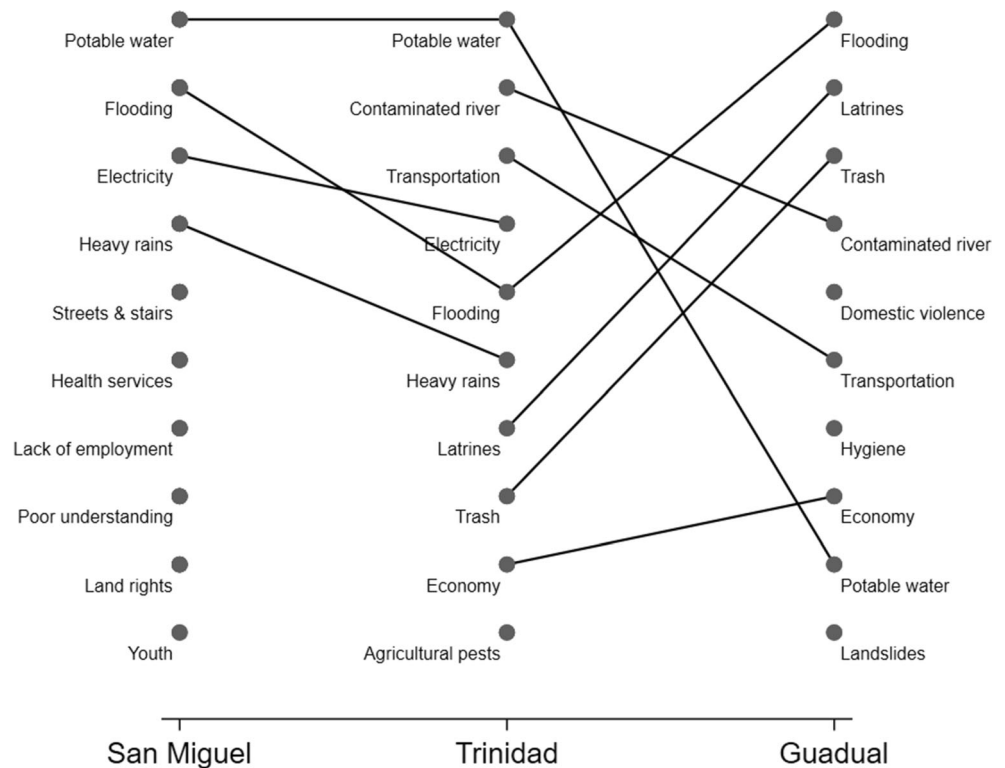
Free listing results also suggested that certain problems were more likely to be co-mentioned, suggesting that respondents cognitively related these issues (Fig. 4). We describe these groupings broadly as ‘flooding and potable water’ (notably, these two items formed a separate group), ‘contamination and trash’, and ‘other responses.’

Role of Social Programs

Discussions of social programs were markedly gendered. Two-thirds of households received income through the Bono de Desarrollo Humano (BDH) national cash transfer program (Table 1). During focus groups, women discussed participation in BDH, a conditional program for which eligibility is based on household poverty as well as the presence of school-age children or elderly or disabled persons (Rinehart and McGuire 2017). In the focus groups conducted with men, the Socio Bosque program was discussed primarily in the

¹ Although intensive cacao production can wear out soil, properly managed cacao crops, inter-cropped with plantain, may provide greater income and greater economic stability than cacao alone (Franzen and Borgerhoff Mulder 2007).

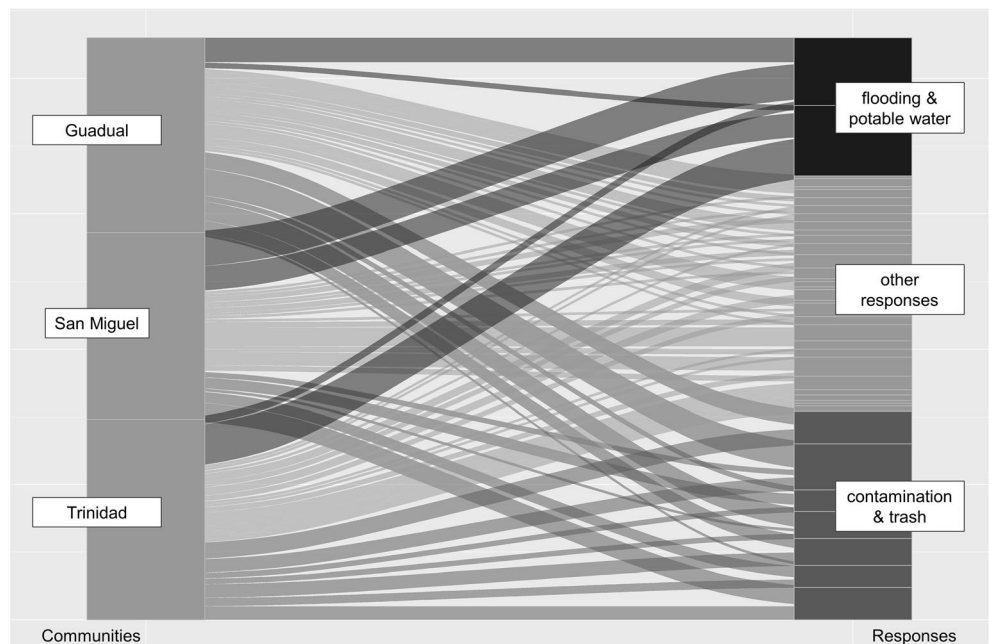
Fig. 3 Saliency ranking from free-listing exercise. Shown here are the ranking of salient issues, by community. There was no evidence of correlation in the ranking of issues between the 3 communities (Spearman’s rho=0.04 (p=0.8131), 0.12 (p=0.4714), 0.27 (p=0.1009) between Guadual and San Miguel, Guadual and Trinidad, San Miguel and Trinidad, respectively).



context of training in ecologically safe practices, such as fishing without the use of pesticides. Men also felt that the Socio Bosque program had helped them to strengthen inter-community networks. A man in San Miguel noted, “as a park guard in the Cotacachi Cayapas ecological reserve, the important thing is coordination, as well as having a plan... we aren’t

thinking only of San Miguel, but that all communities need to develop a strong organization.” In interviews with community leaders, Socio Bosque was also described as a key project involved in many ongoing community activities, either through its role in providing organizational support or as a potential source of funding for proposed projects.

Fig. 4 Community network structure of respondents and responses from free-listing exercise. Shown here are stressors reported in the free-listing exercise (right side), linked to the identification codes of the individuals who listed them (left side) The size of the boxes corresponds with the number of the stressors listed (right side) or the total number of responses the participant provided (left side). The three shades on the right side indicate responses that were more likely to be listed together: flooding and potable water (group 1), contamination and trash (group 3), and other responses (group 2).



Discussion

Individuals living in our three rural coastal Ecuadorian study communities emphasized that well being implied dignity, food security, and water quality. Over a third of households had experienced losses due to flooding in the past year, and almost a quarter of households engaged in agriculture reported a severe flood-related crop loss. However, unfulfilled fundamental necessities, economic instability, and changes in the local ecosystem resulting from environmental degradation were perceived as much greater immediate threats to community well being than climate-related factors.

Participants tended to describe flooding as a consequence of deforestation and a cause of crop failure and food insecurity. The degradation of local ecologies by extractive industries such as palm oil plantations, mining, and logging, with resultant negative impacts on local food and water systems, have also been reported in many other parts of the world (Abood *et al.* 2015; Laurance *et al.* 2018; Papworth *et al.* 2017). In this context, climate change may act as a catalyst, accelerating the pace of negative feedbacks between increased resource extraction by miners and loggers, declining fish and animal populations, and increased household dependence on employment through the same extractive industries or the sale of cash crops to maintain food security.

Most of the issues participants reported confronting were described as *modifiable*, with participants describing their own role and the role of the government and other organizations in exacerbating or ameliorating a negative cycle of economic dependency on extractive industry. In contrast, although increased flooding was regarded as human-made and sometimes described using the term ‘climate change,’ most discussion did not reference local causes and proposed solutions tended to be specific (e.g., construction of a retention wall, shifting the community to a new location) rather than generic. In a setting where communities are both accustomed to, and experienced in, responding to seasonal flooding, the gradual intensification of these patterns was recognized but not prioritized. It might be argued that, in this context, climate change represents a form of ‘slow violence,’ which “occurs gradually and out of sight, dispersed across time and space, typically not viewed as violence at all” (Nixon 2011). However, this perspective risks a de-emphasis of the critical perspective of community members themselves.

For over three decades, the international conservation community has treated poverty reduction as an important element of projects to protect biodiversity in Esmeraldas (Rival 2003; Walker 2004). The shift from ‘loss of biodiversity’ to concerns over ‘climate change’ is a more recent and broader change in the conversation between international researchers and implementers and community members. The attitudes expressed here echo those of Indigenous community members in other parts of the world, for whom climate change

narratives are enmeshed in histories of dealing with outsiders (Marino and Schweitzer 2016) and for whom climate change may provide access to political power that can then be negotiated or redirected to address other local concerns. Communities have ‘adapted’ to systems of structural disadvantage (Oliver-Smith 2016) by learning to use the programmatic levers available to them as advantageously as possible.

The gendered implementation and impact of two ongoing social support programs, BDH and Socio Bosque (Rosa da Conceição 2018), reinforce this conclusion. The BDH program is a poverty-alleviation program that provides conditional cash transfer at the household level to families and pregnant women, while Socio Bosque provides payment for ecosystem services, works with communities rather than individuals, and was largely discussed by men. It has been argued that cash-transfer programs like BDH indirectly strengthen resilience to extreme weather events by increasing the capacity of households to obtain preventive infrastructure and to respond to immediate disasters (Asfaw and Davis 2018), while Socio Bosque is the centerpiece for Ecuador’s climate change mitigation policy as well as a mechanism to promote local climate adaptation (Kongsager *et al.* 2016). Our results suggest that men value Socio Bosque for its role in ecosystem protection and for the complementary social and political power that the program affords - a power that was leveraged to support locally prioritized infrastructure projects. The BDH program is valued by women for the support it provides in sustaining households. These differences also highlight the extent to which, even among the geographically isolated rural populations described here, community is not the only unit of identity.

Our approach to data collection and analysis had a few notable features. During data collection, we framed ‘*buen vivir*’ as a proxy for vulnerability. This connection aligns with definitions of vulnerability focused on well being (Nagy *et al.* 2018; UNEP 2003) and allows otherwise theoretical concepts to be communicated within a locally meaningful framework. Participant responses highlight the contested meanings of ‘*buen vivir*,’ indicating its linkages to worldviews struggling to assert themselves against or in relation to incursions of extractive industries. However, they also underscore sovereignty-based challenges that limit its being fully embraced socially and render ‘*buen vivir*’ instead as one more way to express the opposite of poverty.

The study also had several limitations. Survey data were not systematically collected from FGD participants, so we are unable to compare the age, education, and wealth of these individuals with those who participated in the free listing activity. We separated the free listing activity from survey questions about flood impacts so that these were applied at different times and, whenever possible, on different days. Nevertheless, our study consent form described an interest in flooding as a motivation for the research, which may have

caused respondents who completed the free listing activity after completing the survey to be more likely to mention flooding. Participants who mentioned flooding also enumerated specific flood damages, including which of their crops had been damaged and how long it had taken them to overcome this loss. Therefore, the frequency of flooding damages described here should be interpreted as maximum estimates. Secondly, there were no specific instructions to ensure even participation of men and women in the survey, despite distinct cultural norms. Thus, the results from the two Afro-Ecuadorian communities Trinidad and San Miguel were skewed towards women's responses, while the results from the Chachi community of Guadual were skewed towards men's responses.

While the National Ecuadorian Climate Adaptation Strategy and the Policy for 'buen vivir' recognizes that climate change needs to be addressed (Ecuador 2012; Secretaria Nacional de Planificación y Desarrollo (Senplades) 2013), specific strategies or actions aiming to reduce generic vulnerabilities in Esmeraldas are not mentioned. In contrast, the participants in our study tended to prioritize generic stressors such as environmental and economic challenges, and a lack of basic services. Climatic factors were also identified as important, but secondary, concerns. To bring these two perspectives into alignment, effective policies directed at climate change adaptation should take a holistic assessment approach that integrates analyses of climate and non-climate related stressors.

Acknowledgements We wish to thank Dr. Maria Lemos, Ing. Luvin Alberto Oviedo Racines, UTELVT students Sabrina Tenorio and Luis Rodriguez, and study participants for their collaboration.

Data Availability The datasets during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Compliance with Ethical Standards

Conflict of Interest The authors declare they have no conflicts of interest.

Financial Support This research was funded by the University of Michigan Graham Institute for Sustainability and the University of Michigan School for Environment and Sustainability.

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