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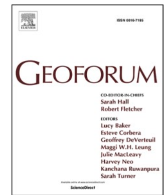

Adaptation sovereignty: situated responses to environmental change

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ABSTRACT

This paper investigates Indigenous illegal artisanal and small-scale gold mining (ASGM) and its motivations in Madre de Dios, Peru, through the lens of resource sovereignty and adaptation. It proposes and applies a new framework of adaptation sovereignty to examine responses to socio-environmental change — in this case, change caused by ASGM on Indigenous territories conducted by external, non-Indigenous miners. This study addresses a critical gap in the literature regarding Indigenous communities who experience external ASGM on their lands while engaging in the same activity.

The authors draw on semi-structured interviews, informal discussions, participant observation, and observations of mining activities in three Indigenous communities to illustrate how Indigenous community ASGM emerges as a strategy rooted in self-determination and territorial presence, enabling communities to remain on their lands despite disruptions to traditional livelihoods caused by external ASGM. It argues that ASGM functions as both a survival strategy and an enactment of territorial belonging and authority under constrained and contested conditions.

This paper responds to calls for a better understanding of the motivations underlying illegal ASGM in the Amazon rainforest. It introduces adaptation sovereignty as a conceptual framework that centres sovereignty while making analytically visible contradictions of adaptation, including the tension between ASGM as a means of maintaining community presence and its role in degrading the ecological conditions that support that presence. The paper further examines community aspirations for a better future and analyses how external interventions and conceptions of Indigeneity shape the possibilities, limits, and repercussions of adaptation sovereignty.

1. Introduction

Artisanal and small-scale gold mining (ASGM) is an important livelihood source for millions of people worldwide, but it also contributes to ecosystem degradation through deforestation and mercury pollution (Fisher et al., 2023). In the Amazonian region of Madre de Dios, Peru, ASGM has shaped Indigenous territories by disrupting traditional resource use and undermining Indigenous authority over land and resources. While some Indigenous communities in the region also participate in ASGM, how they experience, interpret, and navigate extraction remains poorly understood.

This paper investigates Indigenous illegal artisanal and small-scale gold mining (ASGM) activity and motivation through the perspectives of resource sovereignty and adaptation. We inquire: How does Indigenous community ASGM, in the absence of state recognition, function as both an adaptation strategy and an assertion of resource sovereignty, and what are the implications for policy and practice?

To answer these questions, this study utilised geospatially informed qualitative research, including semi-structured interviews and observation, in three Indigenous communities in Madre de Dios, Peru, that are affected by external ASGM and engaged in ASGM on their titled land. We propose and apply a new framework of "adaptation sovereignty" to examine responses to environmental change – in this case, change caused by external non-Indigenous ASGM on Indigenous lands. We approach this work from the perspective that resources act as conduits for struggles over sovereignty and territory rather than solely as drivers of conflict (Anthias, 2018). We situate research findings within discussions of how narrow conceptions of Indigeneity have constrained perceptions of Indigeneity, extraction, and the environment.

Within and beyond the study area of Madre de Dios, there is a lack of literature on the perspectives of Indigenous people and communities who experience externally driven ASGM on their territories while

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concurrently engaging in the same activity. There is therefore a need to understand the effects of and motivations for ASGM within these groups. For example, Indigenous communities have been positioned as “deciding” to engage in illegal mining within and around their territories (e.g., Damonte, 2021), while their experiences of mining and the overarching context under which they undertake mining remain unexamined.

This is particularly relevant as Indigenous peoples are often ‘trapped’ within preconceived expectations of Indigeneity (Cattelino, 2010), particularly regarding environmental issues, which can complicate resource extraction. Therefore, while this paper recognises the detrimental socio-environmental impacts of ASGM in the study area and acknowledges that questions remain about the long-term effects of extraction (Anthias, 2018), we also aim to build on the work of Arsel et al. (2019) and Peruvian scholar Pinedo (2017), who contest the prevailing notion that community attitudes towards and relationships with extraction are predominantly negative.

We structure this paper as follows: Section 2 provides an overview of the case study context and ASGM in Madre de Dios. Section 3 reviews relevant literature and introduces the adaptation sovereignty framework. Section 4 summarises the research site selection and data collection methodology. Sections 5 – 8 present research results organised according to our framework of adaptation sovereignty. In Section 5, we analyse Indigenous community ASGM, referred to as community ASGM, as an adaptation, and in Section 6 as an expression of sovereignty. In Section 7, we examine community visions of a better future, followed by Section 8, where we analyse the sociopolitical restrictions and repercussions of community ASGM involvement. Section 9 concludes the paper.

2. Case Study Context: Indigenous Communities and ASGM in Madre de Dios, Peru

Peru ranks as the ninth-largest gold producer worldwide and the foremost in Central and South America (World Gold Council, 2024). In the Amazonian region of Madre de Dios, Peru, gold is extracted through Artisanal and Small-Scale Mining (ASM) methods, rather than through Large-Scale Mining (LSM) operations prevalent in other regions of the country (Espin, 2023). While there is no one definition of ASM, it is generally characterised by labour-intensive mineral extraction using manual or low-tech methods and is conducted primarily in rural and remote areas of the Global South (Rupprecht, 2017; Zvarivadza, 2018).

ASGM in the Madre de Dios region has historically been characterised by geographically dispersed and inefficient operations, minimal planning, substandard miner safety, and environmental degradation (Espin and Perz, 2021). These challenges have reflected broader national and international patterns in ASGM. In 2002, the Peruvian Government initiated a formalisation effort through the Law of Formalisation and Promotion of Small-scale and Artisanal Mining (Law 27651). ASGM activity has fluctuated along with gold prices, with major price surges in the 1980 s and again post-2007 (Espin and Perz, 2021). Since 2002, more than 70 ASGM regulatory documents and measures have been issued, often featuring inconsistent definitions of illegality and informality (Espin and Perz, 2021). Legal ambiguities and loopholes have led to uneven policy application and enforcement (Duff and Downs, 2019).

Madre de Dios has attracted international attention as an ASGM hotspot due to its significant levels of illegal mining as well as gold-associated criminality and human rights abuses. A substantial portion of the region’s ASGM occurs within a government-designated area, the “Small-scale and Artisanal Mining Zone in the department of Madre de Dios”, established in 2010 (Finer and Mamani, 2023). However, within this corridor, mining may be legal, informal, or illegal, influenced by various and often conflicting factors. Conversely, it is illegal to mine in protected areas, Indigenous territories, and natural watercourses, such as rivers (Finer and Mamani, 2023). Despite this illegality, members of at least ten Indigenous communities, just under a third of the total Indigenous communities in the region, have adopted mining extraction on their land (Damonte, 2021). This Indigenous participation in mining diverges from the official stance of the regional Indigenous federation, FENAMAD, and highlights a scenario that was neither considered nor accounted for in the country’s ASGM formalisation plan (Damonte, 2021).

The delineation of the mining corridor and legal mining concessions in the region has also led to overlapping land-use rights, a well-known issue in Madre de Dios (Rodriguez-Ward et al., 2018). Despite Indigenous land titles predating the mining corridor and legal concessions, and formal prohibition of ASGM on Indigenous territories, government-approved mining concessions have been granted within community territory (Fig. 1). As a result, non-Indigenous miners operate on Indigenous territories both with and without legal authorisation, depending on their relationship to these concessions. In contrast, Indigenous community members themselves often operate illegally, as ASGM is prohibited on Indigenous territories and formalisation processes are financially inaccessible.

3. Review of Relevant Literature

3.1. Indigeneity and Resource Sovereignty in Latin America

Since the early 2000 s, governments across Latin America have intensified extraction and resource-centred development (Svampa, 2019), which has heightened extractive pressures on local and Indigenous communities. This has conflicted with territorial sovereignty, which Indigenous movements have long articulated as central to their autonomy, livelihoods, historical identity, and social reproduction (Andreucci et al., 2023). Despite emphasis on Free, Prior, and Informed Consent (FPIC) for Indigenous peoples, consultation has often been substituted for consent, and Indigenous authority over territory and subsoil resources has been limited (Riofrancos, 2020, 2021). It is against this backdrop that Indigenous responses to extraction take shape, including resistance, participation, or negotiation.

Debates on extraction in Indigenous contexts have increasingly examined how Indigeneity is framed within resource politics. For example, Anthias (2018) argues that Indigenous-led extraction challenges “essentializing tropes of indigeneity, forcing us to acknowledge that indigenous peoples may seek to participate in and benefit from an extractivist development model” (ibid: 149), while others emphasise that Indigenous communities may choose to employ “extractive sovereignty” (Bieberstein and Evren, 2024). Those who participate in extractive activities, however, often run up against the “double-bind of need-based sovereignty” (Cattelino, 2010: 254), wherein:

> Indigenous sovereigns…require[s] economic resources to exercise sovereignty…however, once they exercise economic power, the legitimacy of indigenous sovereignty and citizenship is challenged within settler society.

Across these contexts, concepts of Indigeneity shape how communities navigate, participate in, and respond to extraction. Bonet (2019) argues that Indigeneity is often produced through dominant narratives that position Indigenous peoples as both vulnerable and resistant, ultimately constraining permissible economic practices. Similarly, Li’s (2000) conceptualisation of Indigeneity as a relational positioning emerging from “historically sedimented practices, landscapes…and struggle” (ibid: 2–3) helps illuminate Indigenous participation in extraction as a situated response to both opportunity and constraint. Furthermore, Li’s concern that certain sites and experiences of Indigeneity are “privileged while others are overlooked” (ibid: 3) in practice can be argued to mirror the underrepresentation of Indigenous extraction in the literature.

These territorial dynamics and relational views of Indigeneity closely align with literature on resource sovereignty, which emphasises how

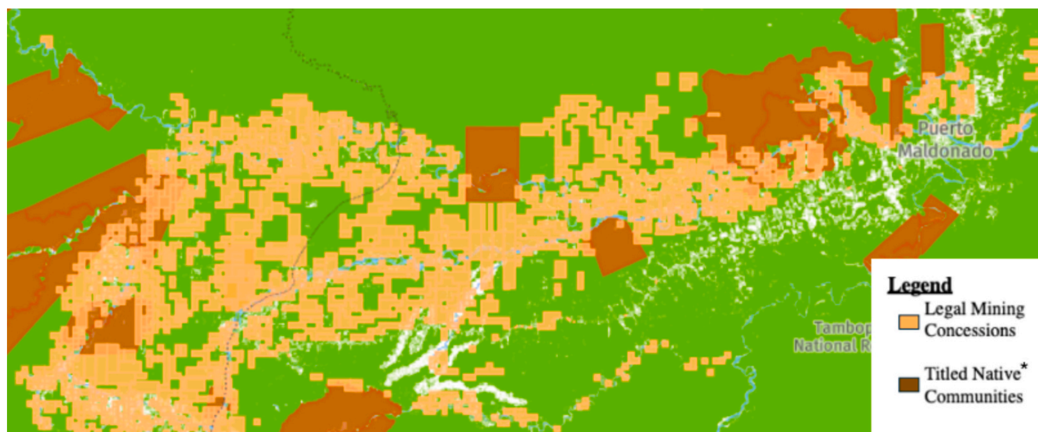

Fig. 1. Study Area Map data from Global Forest Watch (https://www.globalforestwatch.org/map/), accessed 9 January 2025. Basemap imagery provided by Planet-NICFI (www.planet.com/nicfi) via Global Forest Watch. *Although the legal land titles use the term "Native Community" (*Comunidad Nativa*), we use the term Indigenous throughout this paper in line with international norms. *Indígena* is also a term commonly used by community members.

sovereignty is enacted through territorial practice rather than legal authority. In defining resource sovereignty, we adopt Powell's (2018) and McNeish's (2017) shift from traditional juridical conceptualisations of sovereignty as a state's control over defined territory toward a perspective of resource sovereignty as "an emergent process traceable in territorial practice" (Powell, 2018: 115) that "capture[s] the complex material and social dynamics of resource claims" (McNeish, 2017: 1135). McNeish (2017) suggests that the efficacy of resource sovereignty as a framework lies in its recognition of the interrelation between territorial claims, economic development, and the "cultural and epistemological expressions of identity and relationships to landscapes and resources" (ibid: 1135), aligning with the above relationality and positionality of Indigeneity, particularly vis-á-vis extraction.

Peruvian scholar Merino Acuña (2015, 2019, 2022) further explores the construction and complexity of resource sovereignty in Indigenous contexts. In his work on Indigenous self-determination and territoriality in Peru, Merino Acuña (2015) finds that Indigenous territorial management, often aimed at cultural preservation, does not eliminate contradictions between these aims and the socio-environmental harms caused by resource extraction. This work is complemented by Navajo Nation scholar Curley (2023), who posits that contradictions in Indigenous societies' relationships with resources are underexamined and undervalued by researchers and academics. He argues that support for extractive projects may stem from an aspiration for self-determination.

In this paper, we employ sovereignty as an umbrella concept, referring to the enactment of authority, territorial belonging, and decision-making through everyday practices rather than through judicial authority, within which claims to self-determination and expressions of autonomy are articulated and negotiated. An important feature of gold mining in Madre de Dios, Peru, is that mining is often conducted in and around Indigenous land by external actors, both legally and illegally, without community consent. This research seeks to analyse the lived experience and practices of resource sovereignty that are frequently obscured by rigid, state-based legal definitions (Powell, 2018). This approach is especially beneficial for enhancing the examination of resource conflicts in Indigenous contexts and at intersections of legal and illegal ASGM.

In the next subsection, we examine adaptation, which also forms an important theoretical basis for our analysis of responses to extraction.

3.2. Adaptation to Shifting Socio-Environmental Conditions

In this paper, we explore adaptation as a lens through which to examine human responses and adjustments to shifting socio-environmental conditions. Although now frequently associated with climate change, the term adaptation has historical usage that predates this context and retains broader relevance today.

Early hazards research used the concept of "adjustment" that was "systematic or unsystematic, rational or irrational" (White, 1945: 46) to describe human behavioural responses to natural hazards. Steward (1955) employed the term "cultural adaptation" to characterise human subsistence practices that shift and calibrate "cultural cores" to changes in the natural environment. Denevan (1983) argues that the rationale of "the climate became drier; migration occurred to a wetter climate; ergo, the drought caused the migration" (ibid: 405) neglects significant human agency; a more precise interpretation, he asserts, is that the climate became drier, necessitating new survival adaptations, with migration to a wetter climate as the selected option. In this paper, we align with this critique and with Geertz's (1963) earlier emphasis on the necessity of analysing a group's perspectives on their adaptations and shifts in response to their surroundings, which introduced an interpretive dimension to the field.

Recent adaptation literature (e.g., Schipper, 2020; Eriksen et al., 2021) has increasingly examined maladaptation, which occurs when adaptation strategies not only fail to achieve their intended aims but also worsen vulnerability. This literature highlights factors beyond climate, such as unequal power dynamics, that shape whether adaptation tips into maladaptation. This emphasis on power and structural constraints resonates with our approach, which understands responses to environmental change as expressions of adaptive capacity shaped by social, political, economic, and biophysical factors (Smit and Wandel, 2006).

The next section introduces the concept of adaptation sovereignty, which situates adaptation within contested land and resource claims, ASGM-driven environmental degradation, and Indigenous assertions of self-determination.

3.3. Adaptation Sovereignty: A Framework

The preceding literature on resource sovereignty and adaptation reveals an analytical limitation: existing approaches have not theorised how a single, everyday practice can simultaneously adjust to socio-environmental change, contribute to it, and function as an enactment of territorial authority under constraint. This paper addresses this gap by proposing "adaptation sovereignty" as an analytical framework.

Adaptation sovereignty conceptualises the mutual shaping of adaptation and sovereignty by examining adaptive practices under constrained conditions as enactments of self-determination. It captures how practices can serve as both survival strategies (i.e., a means to meet basic needs, particularly under constraint) and expressions of agency, while simultaneously exacerbating environmental harm that may undermine

those same needs and values. In examining what is being adapted to and what methods are being used to adapt, the framework centres adaptation as a practice through which sovereignty is enacted or reworked under constrained and contested conditions. Crucially, adaptation sovereignty is practice-based and recognises that adaptations may move beyond survival strategies to represent political claims, historical or cultural connections, and community-defined understandings of continuity, among other dynamics.

As discussed in Section 3.1, resource sovereignty examines how authority is enacted through lived, material, and territorial practice (McNeish, 2017; Powell, 2018). However, it speaks less to why communities adopt certain practices, particularly environmentally harmful ones. In contrast, adaptation explains adjustment under stress and recognises that such adjustments may ultimately be harmful (Denevan, 1983; Smit and Wandel, 2006). In this paper, their integration enables analysis of how environmentally harmful resource practices can emerge as both adaptations and assertions of territorial authority under constrained conditions, rather than being evaluated solely or primarily in terms of vulnerability reduction. In these instances, environmental concerns are complicated when sovereignty is taken seriously (Powell, 2018). We incorporate futures thinking (e.g., Cheok et al., 2025) into this framework to explore complexities between future visions and present resource sovereignty and adaptive practices.

Building on Section 3.2, we expand the concept of adaptation beyond responses to "change[s] in the physical environment" (Denevan, 1983: 401) to include responses aimed at "better cop[ing] with, manag[ing], or adjust[ing] to some changing condition, stress, hazard, risk or opportunity" (Smit and Wandel, 2006: 282) in the non-physical environment. Within this approach, actions or practices need not yield the most rational or "optimal" solutions to qualify as adaptations (Denevan, 1983). This concept builds on examinations of the potential negative outcomes of adaptation strategies while centring sovereignty. This distinction reflects our focus on adaptation as everyday practice rather than as planned intervention, where maladaptation is often assessed.

The goal of the adaptation sovereignty framework is not to resolve such contradictions, but to render their interacting dimensions visible. In doing so, it serves as a foundation for examining pathways toward improved socio-environmental outcomes that recognise the challenges of local contexts and local visions for the future.

This framework rests on four primary analytical steps for examining adaptation to changing socio-environmental conditions under constrained and contested circumstances.

1. The first step examines the resource practice in question through an adaptation lens, analysing how community members perceive the changing socio-environmental conditions and how the practice seeks to overcome associated stress.
2. The second step analyses the practice through the lens of resource sovereignty to understand motivations beyond survival and clarifies how the practice is experienced and interpreted by the study community.
3. The third step examines participants' visions for the future in relation to the adaptive practice and the changing conditions it responds to, revealing how they experience and evaluate the adaptation and how they imagine alternative pathways.
4. The fourth step situates the adaptive practice within external framings, such as state, policy, and academic narratives, to show how these shape the practice itself and its consequences.

The framework's focus on agency and self-determination serves to counteract an exclusive emphasis on vulnerability-reduction or damage-centred research (Tuck, 2009), wherein "oppression singularly defines a community" (Tuck 2009: 413), and join Powell (2024: 73) to diverge from discourse that "engages in tropes of ruin and loss" within Indigenous and other communities grappling with resource extraction. This paper and the adaptation sovereignty framework underscore and seek to examine the interstice between environmental change and adaptation, wherein frequently overlooked agency and decision-making manifest as expressions of sovereignty. While applied here to examine ASGM within an Indigenous context, the framework is not limited to either context. It can be applied to investigate responses to diverse environmental changes across populations.

4. Methods

4.1. Sampling and Data Collection

This paper is based on semi-structured interviews with leaders and members of three Indigenous communities, informal discussions among community members, a review of pertinent literature and policy documents, participant observation, and observation of mining activities. The three study communities are anonymised in this paper to protect participant and broader community identities. Fieldwork and data collection took place between June and December 2024. The lead author's ethnographic research between 2013 and 2016 in multiple Indigenous communities in the region informed the present study and aided case study selection and data collection.

To select the case study communities, this research utilised secondary data sources, geospatial analysis, and primary qualitative data collection to identify titled Indigenous communities impacted by external mining on their territories while also participating in ASGM. We found that within and immediately surrounding the mining corridor of Madre de Dios, nine titled Indigenous communities have land overlapped by legal mining concessions. The first author then conducted qualitative scoping analysis at the onset of fieldwork to identify communities with active ASGM participation, assess logistical feasibility of research in each community, and request visitor permission from community Presidents.

This led to the selection of three communities experiencing externally-led ASGM on their lands while participating in the same activity. The selected communities are historically of the Shipibo-Konibo and Ese Eja ethnicities but were described by participants as multiethnic with other Indigenous Amazonian ethnicities. There is significant social integration between the three selected communities, and many community members have lived in or often travel between them.

Purposive sampling (Etikan et al., 2016) was employed to interview Indigenous community leaders as key informants, and convenience sampling (ibid) was employed to interview community members. The frequent mobility of community members necessitated this non-probability sampling approach; miners often work on the river for 24–72 h consecutively, with workers alternating sleep, and many community members regularly travel between the three communities, the city of Puerto Maldonado, and surrounding areas. Consequently, convenience sampling was considered the most effective strategy for engaging participants, fostering trust, and addressing potentially sensitive subjects, such as illegal mining. Interviewees varied in age, gender, community affiliation, and occupation (mining versus other sectors).

A total of 26 semi-structured interviews were conducted between June and December 2024: seven participants from each of the first two study communities and 12 from the third community. This included interviews with three community leaders, one from each community, and four participants from the third study community who were living in the region's capital city. Interviews averaged 30–40 min. Spanish is the predominant language spoken, and all interviews and conversations were conducted in Spanish by the lead author and first co-author, the latter of whom is a member of one of the study communities. The sample reached thematic saturation (Guest et al., 2006), meaning that no new themes or insights emerged from interviews. This indicated the reliability of the analysis and that additional interviews would be unlikely to improve the study's validity, therefore posing an unnecessary participant burden.

Participant observation (Hurst, 2023) in daily life, including

attending sports games and participating in multi-community gatherings on Sunday afternoons, as well as observing gold mining in and around the communities, was used to build trust with participants and improve understanding of the study topics. Due to safety concerns related to illegal mining in the area by armed, non-Indigenous miners and their guards, the lead author's ability to conduct interviews and participant observation was limited to daytime visits accompanied by an Indigenous research assistant from one of the study communities. The safety concerns that led to daytime visits rather than longer stays in each community were raised by the regional Indigenous federation (Federacion Nativa del Rio Madre de Dios y Afluentes, FENAMAD) and participants. While this altered the research approach to some extent, it was necessary to ensure the safety of the lead researcher, field assistant, and participants.

4.2. Data Analysis

Thematic analysis was conducted on semi-structured interview data, employing both manual coding and NVivo software. An inductive coding approach facilitated the organic emergence of themes from the data, rather than relying on pre-existing frameworks. Codes were developed iteratively and refined throughout the process, with a focus on survival, agency, land relations, and environmental change. The objective was to keep the analysis rooted in participant narratives while creating a nuanced thematic framework that captured the study's complexity.

5. Environmental Change and ASGM as Adaptation

5.1. The erosion of traditional resource sovereignty

"Before the miners came, we lived beautifully…" (Interviewee 10, July 2024).

Following the first step of the analytical framework outlined above, this section examines the changing socio-environmental conditions to which communities are adapting before analysing ASGM as an adaptive practice within these conditions. Community leaders and members were asked in semi-structured interviews and informal conversations about how mining had impacted the community. While each participant, regardless of age, reported witnessing significant changes, older adults and elders in particular provided a rich background on community life before the reported arrival of external miners in the 1990s. Before this, communities relied primarily on natural resource subsistence (the direct provisioning of food or materials), including hunting and gathering game and plants from the forest, fishing, and cultivating yucca, plantain, and other crops (Interviewees 4, 9, 10, 12, July 2024). This aligns with academic findings; a regional ethnobotanical study conducted in the early 2000s that examined five Indigenous communities, including one of the communities included in our study, found that Indigenous subsistence livelihoods were highly dependent on forest resources (Lawrence et al., 2005).

While families possessed their own residences and *chacras* (small plots to cultivate yucca and other crops), land use was described as fluid and partially communal. For example, Brazil nuts were deemed communal, and harvesting was a shared, seasonal activity in which families were permitted to harvest from others' lands (Interviewees 14 and 15, July 2024). Brazil nuts and other foraged plants and crops provided modest cash income.

Several elders also recounted the practice of gold mining before the influx of external miners (Interviewees 10, 18, 21, July 2024). Participants described panning for gold using simple tools such as pans and shovels, in stark contrast to the machinery and mercury utilised today (Interviewee 25, December 2024).

Interview data illustrate how resource sovereignty, conceptualised as everyday territorial practises (Powell, 2018) and resource claims (McNeish, 2017), was expressed and practised through land use prior to the arrival of non-Indigenous miners. Although adaptations, such as the transition from bows and arrows to shotguns, occurred over time, subsistence strategies remained closely aligned with historical hunting, gathering, and small-scale agricultural practices (Interviewee 25, December 2024). This highlights how resource practices in Madre de Dios are embedded in Indigenous histories of land use, which shape communities' understanding of subsequent incursions by external miners.

The onset and escalation of external ASGM initiated a significant transformation in the resource utilisation and subsistence strategies of the study communities. Interviewees emphasised that their capacity to engage in small-scale agriculture was hindered as portions of community land were disrupted by miners seeking gold, while agricultural plants "stopped growing" on other parts (Interviewee 7, June 2024; Interviewee 22, September 2024). As one community member articulated:

> Mining has impacted the environment substantially…it leaves us without trees, without animals…Now one can no longer grow hectares of *plátano*, cultivate oranges and mandarins. Now you can no longer find forest fruits, *caimito del monte*, that kind of thing. No, everything is stone and sand. In a few words, it is a desert. There is no longer jungle, and this is the largest impact that mining has had on the community (Interviewee 22, September 2024).

Interviewees indicated that these issues have worsened over time, and community insights can be triangulated with existing research regarding the effects of ASGM on local ecosystems. Before the 2000s, deforestation in Madre de Dios was predominantly caused by agricultural expansion (Markham and Sangermano, 2018). This trend shifted in the 2000s, when ASGM emerged as a significant contributor to land change; by 2007, ASGM became the principal driver of land change in Madre de Dios (Scullion et al., 2014).

One interviewee stated that, although fish remain present in lakes and rivers, their numbers have diminished since the arrival of non-Indigenous miners and that wildlife has retreated into the forest due to mining activities and associated impacts: "It's not how it used to be. Now, there are many people, lots of noise, and many motors" (Interviewee 23, September 2024). Community members reported the need to venture further into the forest to hunt, rendering the practice increasingly challenging (Interviewee 4, July 2024). In all, sole or primary reliance on traditional livelihood practices has become unviable, a change attributed by community members to the encroachment of external miners and associated environmental change. This significant shift has necessitated individual and community adaptation.

5.2. From Green to Gold: ASGM as Adaptation

In the study context, non-Indigenous small-scale mining activity was found to constitute an ongoing threat to resource sovereignty, whereby external actors undermine local authority over territory and resource use (McNeish, 2017). Communities' descriptions of invasion and dispossession on their titled lands underscore Bonet's (2019) and Li's (2000) arguments that Indigenous identity and land relations are situated within existing power structures that shape who and what becomes (in)visible and (il)legitimate.

With respect to the broader environmental effects of mining, existing literature has centred primarily on mercury pollution from ASGM (e.g., Ashe, 2012; Langeland et al., 2017; Martinez et al., 2018; Koenigsmark et al., 2021; Barocas et al., 2023), with a focus on mercury accumulation in and risk to humans and the broader ecosystem. For example, a 2018 study (Markham and Sangermano, 2018) found that large portions of the Madre de Dios River, including the study area, were highly vulnerable to mercury (Hg) pollution and that mercury posed a threat to biodiversity in the landscape.

Study participants, however, shared different environmental concerns. Community members expressed strong concern about the impact of external ASGM on deforestation and the trash left by miners.

Respondents also reported that they had been educated by the local Indigenous federation about mercury's harmful effects and told not to eat fish due to high levels of mercury. However, almost all participants expressed disbelief that the mercury used in mining affected the environment or human health. Additionally, fish are a primary food source for the study communities, and multiple participants described fishing as an important cultural connection to their ancestors (Interviewee 4, 12, 13, July 2024).

In addition to the direct environmental impacts of ASGM at the ecosystem level, community members frequently highlighted the effects that external miners have had on the social fabric of their communities. Significant changes reported include a shift toward individualistic land use and ownership models, and a transition to greater economic participation and interest. One community elder shared that "the external miners opened our eyes to *la plata* [money]" (Interviewee 10, July 2024).

The communities have also had to manage complex power dynamics and opportunities arising from external, non-Indigenous miners. For example, while community members and leaders portrayed both legal and illegal miners as invaders of their territory, some have also profited economically by renting out a portion of their family land for mining (Interviewee 4, July 2024). Nevertheless, the language used by communities to refer to non-Indigenous miners — *foráneos* (outsider/foreigner, but often used within a national context), *colonos* (settlers/colonisers), *invasores* (invaders), and *tercera personas* (directly translated to 'third persons') — is illustrative of their ongoing insider–outsider dynamics.

The shifting conditions described can be understood as socio-environmental changes requiring adaptive responses, aligning with the perspective that adaptations arise under conditions of stress rather than optimal choice. These accounts show how the erosion of traditional resource use reflects both environmental degradation and a loss of territorial sovereignty, creating conditions to which community members must respond and adapt.

Evidence indicates that while it is commonplace for subsistence communities to adjust to gradual environmental changes, it is significantly more challenging to adapt to abrupt shifts (Venugopal et al., 2018). Interview and conversational data suggest that household- and community-level ASGM has emerged in response to survival challenges posed by externally led ASGM and its impact on the community and local natural resources since the late 1990s, aligning with concepts of adaptation (Denevan, 1983; Smit and Wandel, 2006).

A sentiment echoed across community miners, succinctly stated by one, was "If we don't mine one week, we don't eat" (Interviewee 9, July 2024). This situates mining as an adaptation strategy under constrained conditions, and one employed for subsistence purposes rather than wealth accumulation or developmental aims. This is consistent with Smit and Wandel's (2006) discussions on how significant impacts—in this case, external ASGM—can shift environmental conditions beyond the limit of former coping ranges, requiring substantial adaptation to enable survival. These findings also coincide with Arsel et al.'s (2019) "Maria's Paradox", in which the authors find that extraction may be supported not out of choice or ignorance of the consequences, but because current conditions leave communities with few viable options. Underlying this analysis are arguments made by White (1945), Denevan (1983), and Burton et al. (1978) that responses need not be positive, ideal, or viable in the long-term to be considered adaptations.

Data from interviews and informal discussions also strongly indicated that ASGM has developed as a means not merely to survive but to sustain residence on community land. For instance, one community member currently residing in the city recounted that she and her family had to vacate their community due to their inability to mine (Interviewee 14, July 2024). She elaborated that her family lacked the financial resources to rent the necessary mining equipment and did not possess family land that external miners sought to exploit. This would have enabled them to receive a modest payment that could be utilised to rent mining equipment, a practice she noted as prevalent. She stated, "Everyone who can mine, does, and everyone who mines stays in the community", further explaining that her family had no means of sustenance without the ability to mine (Interviewee 14, July 2024). Her husband addressed the deterioration of social connections as community members of elevated social standing or age appropriated desirable parcels of communal land for mining purposes (Interviewee 15, July 2024). Despite this, he articulated a sense of alienation from his culture since their departure and a strong desire to return to their community.

Community residents who were not miners articulated their indirect dependence on gold mining to sustain their presence in the area. One participant managed to mine sufficient resources to purchase a boat, and now transports external miners and community members (Interviewee 10, July 2024). One community miner used her profits to pay for her teenage children to train as eco-guides because "there is no work in the community" (Interviewee 7, July 2024). She underscored the importance of community presence, sharing that her children could earn income while still living in the community for most of the year.

In this context, ASGM functions not only as a survival strategy but also as a practice of territorial presence, aligning with conceptualisations of resource sovereignty by McNeish (2017) as the enactment of everyday practices. The effort to remain on community land aligns with the assertion that "maintaining a relationship to the land is at the heart of Indigenous peoples' struggles" (Goeman, 2015: 71) and that Indigenous leaders have "long pursued their land bases as an existential necessity" (Dennison 2024: 119).

This section has illustrated how community ASGM operates as an adaptation under constrained socio-environmental conditions to enable survival and physical presence on community land, significant to Indigenous cultural and territorial belonging. This directly links ASGM to broader struggles over identity and place — even though ASGM itself is not considered a historical practice linked to community land, culture, or identity. In this context, ASGM emerges as an embodied paradox: both a driver of the need for adaptation and the means through which Indigenous communities adapt to ASGM-driven environmental change.

We now turn to the next phase of analysis using the adaptation sovereignty framework to further examine ASGM motivations and communities' interpretations of this adaptation (Geertz, 1963), particularly important given the paradoxical role of ASGM in the study context.

6. Beyond Survival: Sovereignty as a Motivational Factor in ASGM

Following step two of the adaptation sovereignty framework, this section analyses local practices through the lens of resource sovereignty, which directly pertains to issues of land and territory (McNeish, 2021). Critically, this leads to a deeper understanding of agency, even within constrained circumstances, and helps to answer why ASGM has been the option used to adapt to environmental change (Denevan, 1983). We therefore examine how ASGM is driven not just by the necessity for survival but also by local aspirations for self-determination, territorial claims, and experiences of encroachment by external miners.

A connection between external ASGM, community ASGM motivation, and (a desire for) sovereignty was frequently discussed by community miners, wherein community ASGM was often described as a response to external ASGM. For instance, when asked about her motivation for mining, one respondent succinctly stated, "We work in mining because we see others taking the gold from here" (Interviewee 7, June 2024), articulating ASGM participation as a response to territorial dispossession and assertion of presence and authority. Upon further inquiry, she proceeded to elaborate that:

> The difficulty that we have here today, more than anything, is that we hardly work in agriculture anymore. Because they [legal and illegal miners] have invaded the community. They come and invade

> us because they're after mining, right? Like we aren't going to see it? We have the right, and more so because we are from the community. We should work in mining. We work here, whereas the others come here, invade us, take the gold out, the riches, and leave. But we stay (Interviewee 7, June 2024).

Another participant proposed that his and the community's mining activities were a reaction to external mining but simultaneously distinct from it:

> The *tercera personas* take the riches from the community, *toda la riqueza*, so some community members also mine. But the community members take way less gold, it's only a bit to live and to pay for the children's school or studies, *para vivir* (Interviewee 18, July 2024).

Such statements reflect what Powell (2018) and McNeish (2017) describe as resource sovereignty, wherein everyday resource practices become material enactments of belonging and authority. These quotes illustrate the sentiments of invasion and neglect by external miners, bordering on abandonment, which frequently emerged during interviews and informal discussions. Findings suggest that community mining is employed as a manifestation of sovereignty, self-determination, and "material (mineral) power" (Powell, 2018) in response to perceived encroachment by external entities and substantial changes in the accessibility of natural resources. In this case, sovereignty is enacted through the territorial practice of mining rather than the communities' legal authority, which participants described as being disregarded by both external miners and the state.

Community miners characterised their ASGM as less intensive than that of external miners, while also asserting it as a crucial element in safeguarding their territory. One community miner stated that her presence had deterred external miners from extracting resources from her family's land and other community territory:

> The outsiders who come to work…They disrupt the land, and they leave. And we all stay. Look, I live in this part [gestures to her house and the trees surrounding it]. Look! It is not destroyed because I live here. If I hadn't lived here, everything would have been destroyed. That's why it is good. We are working with what they have already left. We are protecting the last thing that is left (Interviewee 7, June 2024).

This aligns with arguments made by Anthias (2018) that Indigenous responses to extraction go beyond resistance to include heterogeneous and pragmatic avenues of action; here, community engagement in ASGM is framed as a strategy of territorial protection and preservation enacted through continued presence, complicating binaries between extraction and environmental protection. While Arsel et al.'s (2019) "Maria's Paradox" highlights the tensions between extractive harm and necessity, the present findings suggest an additional dimension—one in which Indigenous ASGM becomes intertwined with community defense, revealing how adaptation and sovereignty can converge under constrained conditions.

Furthermore, these remarks reinforce the research finding of significant levels of support for, or understanding of, community ASGM for survival and sovereignty among both community miners and non-miners. Factors that may help to explain this include the perception of community ASGM as less intensive or detrimental and community presence — supported directly or indirectly by community mining — as protective. These accounts underscore Li's (2000) argument that Indigeneity is articulated relationally and strategically in response to external pressures, rather than through adherence to externally imposed expectations of authenticity.

Although collected data indicate relatively low levels of conflict regarding community mining, it is important to note that such conflict may indeed exist. However, findings suggest that external mining was perceived as a significantly larger and more urgent issue at the time of data collection.

Together, these findings demonstrate how ASGM operates as both a subsistence activity and a continually reconstituted enactment of resource sovereignty, enabling community members to assert territorial belonging and resist dispossession within a restrictive and harmful extractive landscape. This parallels Curley's (2023) analysis of reservation economies "shaped and limited by colonial forces" where extraction "becomes a pathway toward development and self determination" (ibid: 63–64). This resource sovereignty is not an inherent state but arises from practices and negotiations, with self-determination and authority manifesting even in restrictive and dynamic contexts.

In light of the challenges faced by these communities, the subsequent section examines participants' visions for a better future to illuminate their perceptions of mining as a long-term adaptation strategy and form of sovereignty, alongside broader aspirations beyond ASGM.

7. Visions for the Future

Although socioecological vulnerability is a matter of urgency, research focused solely on revealing the cumulative harms faced by Indigenous peoples or others may inadvertently reinforce and pathologise this suffering (Tuck 2009; Powell, 2024). By investigating communities' aspirations and visions for a better future, the third step in the adaptation sovereignty framework seeks to utilise the "epistemological shift" of desire to uncover "that which has been hidden or what happens behind our backs" (Tuck 2009: 419-20). Furthermore, while mining may serve as a strategy for community members to "stay in place", it is crucial to examine how ASGM transforms the nature of that place, as well as how communities experience these changes and imagine a better future.

Previous research has revealed a lack of understanding regarding the wellbeing and future aspirations of local populations in Madre de Dios (Torre-Marin et al., 2021). We therefore asked participants about their hopes and desires for a better future, changes that they would make if there were no restrictions, as well as what a better future would look like. The four predominant themes concerning a better future, articulated by over fifty percent of participants, were desires for the advancement in sustainable agriculture and livelihoods, promotion of sustainable, decriminalised community mining, shifts in external mining, including the revocation of state concessions, and enhanced social connectedness within and between communities. These themes indicate that community members envision a more sustainable future that combines pre-mining resource practices with regulated community mining and a transition or reduction in externally driven mining activities.

Theme One: Advancement in sustainable agriculture and livelihoods

Interviewees demonstrated a pronounced interest in diversifying their income and sustenance practices, moving away from exclusive dependence on ASGM. This encompassed initiatives such as freshwater aquaculture, traditional weaving, and ecotourism, which were identified as economically and culturally significant opportunities (Interviewee 1, 12, 13, June-July 2024), as well as the management and harvesting of the palm fruit aguaje:

> We can grow *aguaje*[1] instead of cutting trees. There is lots of money in *aguaje*. I want to grow *aguaje* so my kids, the next generation, won't die of hunger and will have money. It takes eight years to grow *aguajales*. Agriculture for the future… (Interviewee 10, July 2024).

The focus on economic diversification, sustainable practices, and

[1] Aguaje (*Mauritia flexuosa)* is a palm fruit native to the Amazon rainforest. It is commonly eaten fresh or made into juices and desserts. It is culturally important for many Indigenous Amazonian communities and known for its multiple health benefits.

cultural connectedness underscores the centrality of adaptation sovereignty, wherein community members envision integrating traditional activities into future livelihoods rooted in long-term autonomy and sustainability. It also illustrates the significant tension between community goals surrounding sustainability and current mining practices, the latter of which is discussed below.

Theme Two: Promotion of sustainable, decriminalised community mining

Most participants expressed support for continued community mining in conjunction with agriculture and sustainable economic practices but often did not regard mining as the optimal choice. For example, one interviewee suggested that a percentage of community mining profits could be used to improve the community, but then stated that, "mining is good for now, to live, but if you can do something else, like agriculture, it is better" (Interviewee 18, July 2024).

The desire for an alternative lifestyle in the community signifies a perception of the prevailing mining circumstances as an adaptation, yet not necessarily regarded as the singular, optimal, or most preferable one. This is underscored by the almost paradoxical remarks of Interviewee 18 (July 2024), who expressed robust support for mining and minutes later asserted that agriculture or "something else" would be superior. These internal tensions reflect that extractive practices chosen under constraint can simultaneously address vulnerability and exacerbate it, echoing arguments made by Denevan (1983), Arsel et al. (2019), and Curley (2023).

While community miners expressed disbelief that mercury pollution from mining was harmful, they exhibited interest in mitigating other environmental repercussions of ASGM. For instance, one miner expressed a strong desire to "mine better" yet lamented the absence of external assistance to do so. Instead, "all they do is try to suppress the mining and not encourage you to make improvements" (Interviewee 19, September 2024). This statement underscores a recurring theme among miners; frustration with law enforcement's application of mining regulations against them on communal Indigenous land.

The aspirations demonstrated above indicate pursuit of and challenges to adaptive sovereignty, in which individuals and communities hold autonomy over their lives and livelihoods. These visions reveal how communities seek means of living that align with their historical practices, current circumstances, sovereignty, and self-determination, rather than solely historical or imposed external models. Fig. 2 visualises a core contradiction of adaptation sovereignty in the study context, highlighting how community ASGM simultaneously sustains territorial presence while undermining communities' capacity to inhabit their land.

The overarching tension mapped in Fig. 2 is produced through multiple, interconnected processes documented in this paper, including the loss of traditional livelihoods, leasing of community lands, the need for income to maintain community presence, and externally-led ASGM on community territory—the latter of which we now examine in relation to community goals.

Fig. 2. Central Tension in Community ASGM.

Theme Three: Shifts in external mining practices

As has been explored throughout this paper, community ASGM was found to be highly connected to externally led ASGM and its impacts. Shifts in external mining practices were highlighted as necessary by the majority of participants and are needed to begin to resolve the tension between community ASGM and community presence, as presented in Fig. 2.

Most participants criticised external miners, along with legal mining concessions authorised by the state, and expressed a desire for the legal mining concessions to be withdrawn. Specifically, participants expressed a desire for the removal of all external miners (Interviewee 7, June 2024), the reduction in harm to the ecosystem from external ASGM (Interviewee 22, September 2024), and for external miners, particularly illegal miners, to listen to and respect the authority of communities and their leaders over their land (Interviewee 1, June 2024). Other participants expressed negative views of state concessions but were unwilling to discuss their desires in relation to external miners themselves, which was interpreted as possibly related to safety concerns.

A minority of interviewees provided examples that indicated intracommunity conflict regarding external miners. One interviewee expressed disdain that past leaders had been bribed by illegal miners and the need for community leaders to "be strong" to avoid this (Interviewee 18, July 2024). Another, who did not wish to be recorded or provide his name for safety reasons, expressed worry and fear about external miners on community land (Interviewee 26, December 2024). He shared that he could no longer live well in his community because of the harm that mining had caused to the forest and the land, the loud explosions that occur when the police blow up the motors of illegal miners, and his fear of being robbed by external miners.

These accounts and their urgent expression underscore that mining represents a loss of territorial control that communities are struggling to regain, despite having legal rights to their territories. Concurrently, there are also indications that internal community divisions that may facilitate external mining on community land, highlighting the significance of the fourth theme identified regarding a better future: enhanced social cohesion within and among communities.

Theme Four: Enhance social connectedness within and between communities

Although only a minority of participants explicitly discussed community divisions, the majority indirectly referenced social conflict and diminished cohesion through recurrent discussions about the necessity and aspiration "to unite" within and among communities:

> How beautiful it was…the community used to be united. But mining changed everything. We used to have community meetings, and everyone would come. Now, most don't go unless it will impact their money (Interviewee 14, July 2024).

This frequent emphasis across participants suggests that, despite internal divisions implied or explicitly mentioned, previous social practices and degrees of social cohesion are both a desired outcome for the future and a strategy for achieving other community objectives.

The community visions explored in this section are grounded in Indigenous understandings of continuity and self-determined development, which themselves are adaptive and reflect both historical practices and present-day livelihood strategies. Central to these future aspirations, including sustainable livelihoods and enhanced social cohesion, is realigning future community land relations in part with historical practice. This echoes Dennison's (2024) assertion that "Land is often at the core of Indigenous identity and who we are planning to be in the future" (ibid*:* 119). These aspirations reveal distinct desires, objectives, and potential strategies to remain on their land while ameliorating or transcending the current negative feedback loop between ASGM and environmental degradation. Nevertheless, challenges remain and will be

elaborated upon in the subsequent section.

8. Constraints on Community Extraction and Visions for the Future

While community visions are strongly rooted in self-determination, they are also influenced—sometimes supported, sometimes constrained—by broader social, political, and environmental factors, which we now examine as the final step in the adaptation sovereignty framework.

Community members voiced fears about the future of their status as recognised, titled Indigenous communities because of their mining practices and the environmental destruction caused by mining. An acute awareness that Indigenous peoples must conform to preconceived expectations to remain recognised or gain recognition (Cattelino, 2010) was expressed by research participants, one of whom shared fear of her community's land title being revoked because the community doesn't "live how it used to" and is "too integrated" into the economy and culture of the nearby city, Puerto Maldonado (Interviewee 13, July 2024). This was also linked to a sharp decline in the communities' native language skills; as another participant shared, "If you don't have your language, you lose your title" (Interviewee 12, July 2024). These concerns reflect Li's (2000) concept of the "tribal slot", in which pre-set criteria or expectations of authenticity shape how Indigeneity is recognised. Such fears highlight the precarious conditions under which Indigeneity is validated by external actors; amid existing power imbalances, these conditions actively narrow the range of adaptive practices considered legitimate, influencing how communities navigate extraction and adaptation.

As Povinelli (2002) argues, Indigenous peoples are positioned to "fail" at Indigeneity because they are required to be different yet cannot achieve that difference—a dynamic that constrains the political and economic pathways available to them. This is partly because "if indigenous peoples are fully understandable, then they are not truly different" (Cattelino, 2010: 237), which then calls into question their Indigenous-based rights. Community members expressed fear of mining repercussions that contradicted communities' visions for the future, partly due to preconceived narratives about Indigenous peoples and conservation that—whether portrayed positively or negatively—are often used by external entities to serve their own interests (Rose, 2014). At the same time, as demonstrated throughout this paper, the study communities are challenged by, and continue to navigate, the harm that ASGM inflicts on the local ecosystem and on their ability to survive and remain on their land.

Although there is interest in external support, interview data align with existing findings that conflict may arise when support is shaped by external agendas rather than community goals. An example of this comes from discussions with participants about an NGO project that reportedly offered community miners payment to stop mining and switch to sustainable livelihoods such as agriculture. One participant (Interviewee 18, July 2024) expressed appreciation because he perceived agriculture as a better livelihood option. Others (Interviewees 4, 14, 15, July 2024) criticised the project for *requiring* the replacement of mining rather than providing greater autonomy to community members. These participants expressed frustration that the project exclusively supported community miners; those unable to mine or already practising (or struggling with) other livelihood options were ineligible. Participants shared that this contributed to community conflict and inequality, because community members who couldn't afford to mine weren't eligible for livelihood support (Interviewees 14, 15, July 2024).

Although brief, this example echoes existing findings on external interventions. For example, Riofrancos (2021) observes that consultation frameworks may fail to respect Indigenous values or decision-making power and contribute to misaligned external interventions, and Huambachano and Cooper (2021) argue that external interventions often "fall short" by failing to consider community contexts and demanding goods and services that may not align with community goals.

Our research suggests that tensions between community aspirations and external interventions may reflect structural mismatches between externally defined goals and locally grounded adaptation strategies. At the same time, tensions exist between community goals and current adaptation strategies. The tension between community objectives and scepticism towards mercury underscores the importance of interpretive approaches to engagement that take both community needs and goals seriously alongside scientific evidence. In light of this, external actors could align with what Merino Acuña (2022) calls a "nation-building" approach, wherein Indigenous Nations and communities "hold the authority and responsibility for management, applying their own protocols, institutions, cultural values, and sustainable economies with the support—not the imposition—of Western conservation" (ibid: 97) on their lands.

This section has demonstrated that adaptation sovereignty in the study context is continually shaped by unequal power relations that constrain which adaptive practices are rendered legitimate. In this sense, adaptation sovereignty emerges not as a static outcome but as an ongoing negotiation shaped by external and internal limits and goals.

9. Conclusion

This paper investigates the motivations behind Indigenous illegal gold mining in the Amazon rainforest, examines the aspirations of communities in Madre de Dios, Peru, and analyses the formal and informal means through which Indigenous communities exercise agency. The analysis reveals that the three study communities in Madre de Dios use ASGM as a form of adaptation sovereignty: a strategy rooted in self-determination and a connection to land that enables continued territorial presence despite disruptions to traditional livelihoods caused by externally led ASGM. The case study also emphasises how identity—in this case, Indigeneity—shapes adaptive responses, territorial strategies, and the significance attributed to participating in ASGM.

Findings indicate that adaptive practices undertaken under constrained conditions may simultaneously address livelihood needs, assert territorial authority, and generate socio-environmental harm. Policies or interventions that evaluate such practices solely through the lens of illegality or environmental degradation risk overlooking their role in sustaining community livelihoods, presence, and self-determination. Our findings underscore the importance of interpretive approaches that take both community needs and goals seriously, alongside scientific evidence, to avoid exacerbating conflict or dispossession. This approach reframes policy and scientific engagement from eliminating harmful activities to grappling with the conditions that underlie why those activities are chosen or necessary.

This paper introduces the concept of adaptation sovereignty to explore the reasoning, agency, and constraints behind responses to environmental change, as well as local aspirations for the future. It does not aim to resolve the tension between ASGM as a means of maintaining community presence and its role in degrading the ecological conditions that support that presence in the study context. Instead, it makes this lived contradiction analytically visible, emphasising the intricate knowledge that local communities possess in navigating complex and contested environmental change. Adaptation sovereignty advances existing debates by moving beyond adaptation and maladaptation binaries to uncover the ways that adaptive practices can simultaneously sustain livelihoods, generate environmental harm, and enact territorial authority, thereby linking adaptation with sovereignty and self-determination.

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CRediT authorship contribution statement

Lena Easton-Calabria: Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Javier Pacaya Álvarez:** Writing – review & editing, Methodology, Investigation. **Constance McDermott:** Writing – review & editing, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The data that has been used is confidential.

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