

RESEARCH ARTICLE

Polygons

The politics of mathematical abstractions in contemporary Peruvian Amazonia

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Funding information

Wenner-Gren Foundation; Social Science Research Council; National Science Foundation; Explorer's Club

Abstract

Anthropologists have extensively examined the material politics of bureaucratic rule and technical expertise. But ethnographic analysis must also attend to the politics of mathematical abstractions that cannot be reduced to any specific kind of materiality. A key site to appreciate such politics is the georeferentiation of Indigenous property polygons in Peru's Amazonian region of Loreto. In the context of climate change and biodiversity loss, both the Peruvian state and Indigenous communities have pinned their hopes on mathematically stabilizing Indigenous property polygons. But these hopes are haunted by the confusing accumulations of informal attempts to make sense of these territories over time. To appreciate these accumulations, the state engineer (*ingeniero*) can serve as a privileged prism. Thinking through polygons provides an opportunity to interrogate emerging forms of Indigenous territoriality in Amazonia, as well as the contentious politics of mathematical abstractions in contemporary global environmental governance.

KEYWORDS

accumulations, climate change, engineers, georeferentiation, Loreto, mathematical abstractions, polygons, Peruvian Amazonia, rain forest governance

"I am sure you must all be wondering, 'Why have I been summoned to the city if my Indigenous community already has a property title?'" With these words, Segundo began his PowerPoint presentation in front of dozens of Indigenous chiefs from all over Loreto, Peru's largest Amazonian region (see Figure 1).¹ Segundo, a senior topographer in Loreto's Regional Agrarian Bureau (Dirección Regional Agraria), was in charge of a small office in Loreto's capital city of Iquitos that was tasked with conducting Indigenous land titling and maintaining Indigenous land records in the region. Seated in small school desks aligned in front of the podium, the meeting's attendees wore traditional adornments that emphasized the ceremonial and political importance that they attributed to this moment. As Segundo talked about property titles, most of the attendees, firmly holding yellowed files in their laps, started whispering to each other. "Well, ladies and gentlemen," Segundo said, "the truth is, your property titles do not have the information that is currently required by law. What we need to do now is amend them *rectificar* with a GPS [global positioning system]." As he took a pause, a few clerks from the

Regional Agrarian Bureau and I rushed into the audience to distribute informational brochures to the Indigenous attendees, who suspiciously watched Segundo's PowerPoint presentation. "Today," Segundo continued, "you cannot ask for a logging permit if your property title does not have precise geographic coordinates. You cannot receive annual payments if you were to enroll in a forest conservation program. If you do not have geographic coordinates, you cannot do many things. You need them for everything."

Segundo's emphatic speech echoes a larger epistemic shift in the governance of Amazonian rain forests, which, in the last two decades, have emerged as key strategic sites for biodiversity conservation and carbon sequestration. As a result, vast technocratic investments are being made to reconstitute them as spaces of fine-grained technical legibility, so that the state can cope with emerging planetary demands for environmental transparency and accountability. Thus, while Loreto and other Amazonian regions have historically been at the margins of state infrastructures of technical legibility, the converging crisis of climate change and biodiversity

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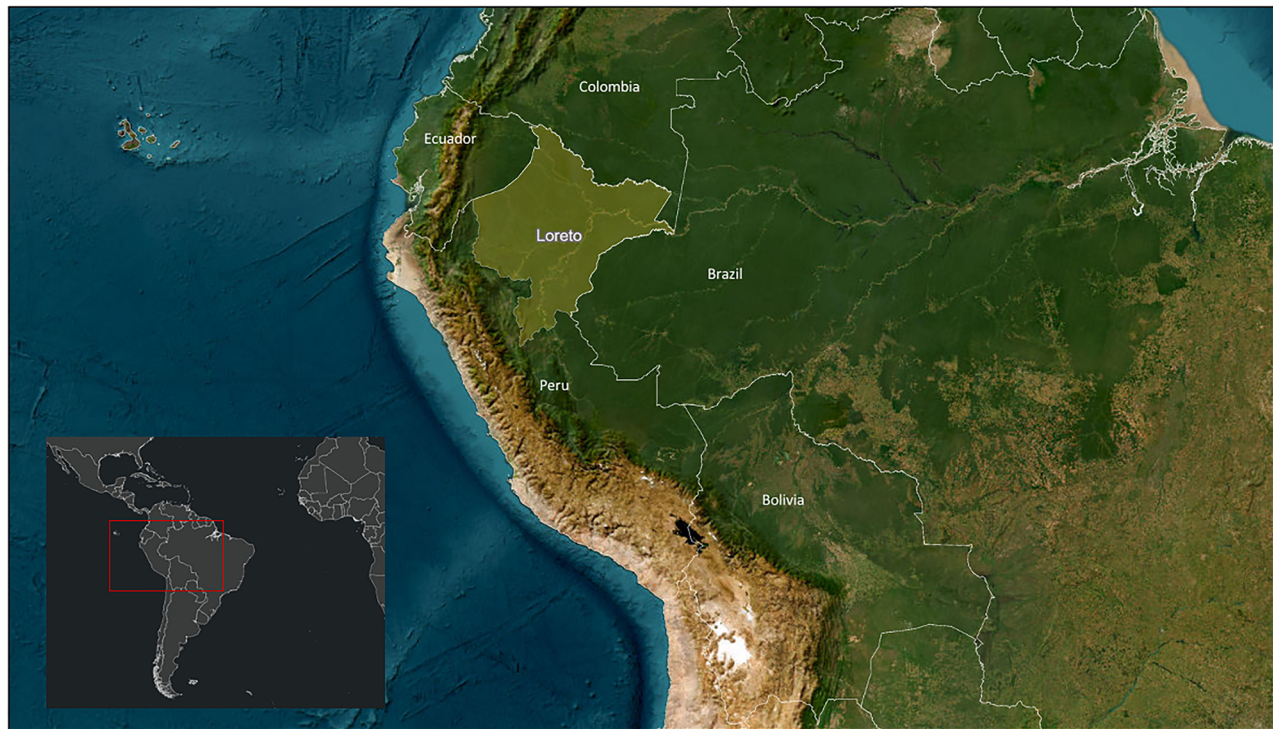


FIGURE 1 Peru's Loreto region. (Eduardo Romero Dianderas) [This figure appears in color in the online issue]

loss are now pushing forward novel technocratic reforms that enable the state to govern tropical rain forests according to precise, comprehensive, and centralized bodies of technical information. In this context, Indigenous stewardship has been internationally recognized as a fundamental ingredient in the conservation of tropical rain forests (Blackman & Veit, 2018; Schleicher et al., 2017). And so, the titling of Indigenous lands has emerged as a key ethical and environmental technology in the fight against climate change and biodiversity loss.

In Loreto, these global conditions have changed how Indigenous lands are legally recognized and demarcated. From being a neglected state affair that was pushed forward only by Indigenous organizations and their allies, recent years have seen a surge in foreign aid funds, technological innovations, and administrative reforms to support the creation of centralized, comprehensive, and consistent Indigenous land property records (Huamani Mujica, 2021; Monterroso et al., 2017, p. 25). Behind these investments is the drive to legally recognize the hundreds of Indigenous communities (*comunidades nativas*) that exist today in the region by recording their precise areas and boundaries in global geographic coordinates (mainly as defined by the Universal Transverse Mercator system, or UTM). This process, technically known as georeferentiation, has become possible thanks to GPS, which has been increasingly used in land surveying over the last two decades (Rankin, 2016). Today, GPS carries the promise of bringing clarity and predictability to the management of rural property in different parts of the Global South (Campbell, 2015, p. 148; Hetherington, 2012; Krupa, 2015, p. 103).

This promise of technical precision and stability has turned georeferentiation into a fundamental asset for the hundreds of Indigenous communities that exist today all across Loreto. Once precise geographic coordinates are granted to an Indigenous property title, georeferentiation becomes a means to authoritatively define an Indigenous territory's boundaries. This is a particularly dramatic question in Loreto, where the boundaries of Indigenous communities can often extend inland for several kilometers amid landscapes fraught with dense vegetation, muddy terrains, and sinuous streams. In this context, georeferentiation allows Indigenous peoples to legally expose the invasion of their lands by loggers, oil companies, or colonizers, even in the most remote areas of the tropical rain forest. Similarly, georeferentiation is a key technical requirement for Indigenous communities interested in gaining access to a variety of state-regulated endeavors, from logging to participating in carbon markets. And since all property is to be inscribed by reference to the same mathematical plane, it (theoretically) prevents controversy, dissent, and manipulation. Thus, in the age of climate change and biodiversity loss, Indigenous property georeferentiation has become a fundamental ingredient for securing Indigenous participation, territorial defense, and economic well-being in Peru's emerging regimes of tropical rain forest governance.

Yet georeferentiation does not operate on specific material artifacts, such as the property titles held by the Indigenous chiefs watching Segundo's PowerPoint presentation. Rather, it aims to stabilize elusive kinds of mathematical abstractions that incessantly oscillate between such property registers and the more-than-human Indigenous territories that they seek to

demarcate: the property polygons of Indigenous communities. Property polygons are complex mathematical abstractions that aim to establish the precise geometrical dimensions of property rights on the surface of the earth. They typically come to life in property titles through a coordination of elements that span various numerical and visual registers, including the technical notation of vertex angles, lateral distances, and visual geometries that describe bidimensional self-enclosed spaces, usually contextualized around neighboring landmarks that guide the interpretation of their location. Their history is arguably as old as surveying itself, but as new bureaucratic architectures based on professional topography and centralized state property records have expanded across the world since the early 19th century, they have gained increasing prominence as quintessential elements in fiscal, territorial, and juridical forms of state technocratic governance (Edney, 2019; Kain & Baigent, 1992).

Technocratic reformers hope that, by means of georeferentiation, Indigenous property polygons can be fully stabilized in the plane of mathematical reference of global geographic coordinates. And yet, as Segundo's speech suggests, the question remains: How to "amend" the hundreds of property polygons traced on paper before GPS devices became common in Loreto at the turn of the 21st century? For most of the 20th century, the region lacked fine-grained geodetic networks (IGN, 2016, p. 142), so polygons were calculated, drawn, and delivered to Indigenous communities without reference to geographic coordinates of any kind. Instead, they were put together through the arduous but arguably inaccurate calculative labor of classical topography, with theodolites, measuring rods, and compasses, a craft that many senior topographers in Loreto described to me as working *al ojímetro* (to the eye meter). Accordingly, these old polygons loosely index location by tracing straight lines and establishing lateral distances and angles near locally known rivers and creeks. Retrospectively, many topographers and technocrats pejoratively referred to these old polygons as merely "referential" drawings that needed to be georeferenced on the ground with GPS devices. But this is far from a trivial technical matter. For how to "amend" such "referential" mathematical abstractions has become a complex political question with fundamental implications for Indigenous peoples and state institutions in contemporary Loreto.

Drawing on 24 months of fieldwork and participation in several Indigenous land-titling brigades across Loreto, I describe the turbulent processes by which state engineers are using GPS to georeference old polygons—originally traced in paper-based Indigenous property titles—and are thus officially remapping their angles, distances, and areas. By thinking through polygons, I show that mathematical abstractions can become productive terrains of anthropological inquiry. In recent years, anthropologists have interrogated the politics of bureaucratic rule and technical expertise at the level of their materiality, showing how attention to the material composition of administrative documents, property titles, or maps can unveil subtle political relations that quite often go unnoticed if we take such artifacts for granted (Campbell, 2014; Feldman, 2008; Hetherington, 2011; Hull, 2012; Riles, 1998). While these studies have been very productive, I contend that ethnographic

analysis must also attend to the politics of mathematical abstractions, which, by definition, cannot be reduced to any specific form of materiality. To those who would attend this kind of politics, georeferentiation offers a privileged site of study. As polygons transit from the merely "referential" to the georeferenced, georeferentiation processes reveal not only material struggles over specific kinds of digital or paper media, but also mathematical struggles over the stabilization of geometrical abstractions such as angles, lines, distances, and areas. Such struggles unfold over terrains of political engagement that cut across several different domains of experience, ultimately bringing us into the abstract realm of geometrical speculation. Thus, when state land surveyors perform official acts of georeferentiation in the field, they work neither by strictly following the angles and lines recorded on the original property map, nor by tracing the physical boundary marks that they can find in the landscape. Rather, they undertake a speculative process in which maps and landscapes compete as material points of reference for stabilizing an elusive mathematical abstraction that exceeds them both. In this sense, georeferentiation involves a mode of political struggle over geometrical abstractions such as angles, lines, distances, and areas, abstractions that participate in but ultimately transcend their specific material instantiations in either paper property titles, digital databases, or more-than-human landscapes.

In Loreto, these struggles have become particularly salient because old paper-based Indigenous property polygons do not make sense as mathematical objects. They are, literally, impossible things—not only because they only vaguely refer to their locations in Amazonian landscapes (which themselves continually change according to abrupt shifts among rivers and creeks), but also because property polygons are constituted as stable geometries by various numerical and visual elements that often contradict each other. As a result, the question of how to "amend" old polygons becomes undecidable when conflicting interests lead to irreconcilable interpretations over how best to bring Indigenous territories into the mathematical plane of reference of global geographic coordinates. In this context, different "amended" versions of the very same polygon can come to circulate and collide with each other across state institutions, Indigenous towns, and the boundary paths opened by Indigenous peoples in the rain forest.

Following such polygonal instabilities also allows us to critically examine emerging forms of Indigenous territoriality in contemporary Peruvian Amazonia. In the last four decades, a robust body of literature has analyzed Indigenous territorialities as modes of intimate praxis that result from long-term Indigenous engagements with more-than-human landscapes in Amazonia. This literature has extensively documented how Indigenous territorialities emanate from shifting and intensely affective relationships with the nonhuman world. And thus it has shown how these relationships are irreducible to the instrumental principles of fixity, boundedness, and bidimensionality that are conventionally associated with modern property regimes (Surrallés & García Hierro, 2004; Surrallés, 2009; Varese, 2005). While I subscribe to the analytical purchase and political importance of this literature, the resulting opposition between Indigenous territories and modern

property forms underplays how Indigenous territorialities are intimately embroiled today in the political modes of praxis and imagination cultivated through the technical tracing of property polygons in Amazonia. Thus, Indigenous territories are not fully exterior to the polygons that register them, since many contemporary controversies over Indigenous territories are already heavily permeated by the unruly hermeneutical productivities afforded by property polygons. Polygons, therefore, constitute a privileged terrain where Indigenous territorial rights are settled and unsettled in contemporary Peruvian Amazonia.

In what follows, I trace the unpredictable productivities associated with these impossible mathematical objects as they manifest across paper and digital documents, bureaucratic planning activities, and Indigenous controversies over land in Loreto. Across these various sites of inquiry, I do not take polygons as immediately clear and self-consistent mathematical objects. Rather, I focus on the modes of erasure and confusion that result from the various kinds of unruly material accumulations on which polygons are defined and argued about in Loreto. I offer the *ingeniero* (engineer) as the mediating figure through which to appreciate the effects of these various forms of accumulation. In the riverine and Indigenous worlds of Loreto, the title of *ingeniero* indexes an unstable mixture of moral deference, epistemic authority, and political power that is normally associated with urban and lettered workers, whose presence in Indigenous communities is often brief and, many times, untraceable. I myself was repeatedly called an *ingeniero* despite all my attempts to clarify my true profession (a clarification that only brought to life the even more startling title of *ingeniero antropólogo*).

As *ingenieros* come and go to and from Indigenous communities, they leave material traces of their attempts to make sense of old polygons. And as time passes and memory recedes, these traces take on lives of their own, their interpretation becoming undisciplined and tactical, thanks to lack of regular state oversight and access to telecommunication networks. Thinking through the traces left by *ingenieros* allows us to think about the combined hermeneutical effects of different kinds of accumulations in Loreto: accumulations of paper documents that deposit themselves in the yellowed files of Indigenous chiefs, accumulations of fluvial sediments that redraw the contours of rivers and streams, and accumulations of vegetal life that erase boundaries traced with machetes through the rain forest. By following the erasures and confusions of such unruly material accumulations, we can begin to appreciate how the mathematical stabilization of Indigenous property polygons becomes a contentious terrain of political struggle as Amazonia enters the age of climate change and biodiversity loss.

MAKING IMPOSSIBLE POLYGONS

Polygons started to perfuse the Indigenous worlds of Loreto in the mid-1970s, when the left-wing military government of Juan Velasco Alvarado established the first legal framework in which Indigenous lands could be titled in the form of Indigenous communities (Varese, 2018). Since the mid-20th century,

primary schools and churches had gradually expanded along the main rivers of Loreto; this accelerated the development of permanent riverine settlements that understood themselves as Indigenous communities with relatively stable territories. But in the mid-1970s the notion that sedentary settlements were bounded to a fixed and exclusive territory was still a fairly foreign idea in most of Peruvian Amazonia (Chirif & García, 2007, p. 158; García Hierro & Surrallés, 2009, p. 13). When the first Indigenous Community Act was approved by the government in 1974, Indigenous life in the Peruvian Amazon was defined by seasonal movement, dispersion across vast stretches of the lowlands, and change that mimicked the shifting rivers and creeks that organize space in Loreto. In this sense, Indigenous life was not contained within the fixed lines traced by topographers, but unfolded along the shifting lines traced by water and sediment. Thus, to some degree at least, property polygons performed the very institutions that they sought to legally recognize: Indigenous territories that could be represented as fixed and bounded areas in space. Yet, as state topographers measured and traced the boundary lines that were to constitute Indigenous property polygons, the lines became relatively speculative entities whose legibility and importance decreased as one moved from the inhabited banks of the main riverways to the depths of the rain forest.

The lines were speculative, in part, owing to the technical conditions in which Loreto's Indigenous property polygons were traced during the late 20th century. From 1975, when Indigenous lands started to be titled in Peruvian Amazonia, to the early years of the 21st century, when GPS devices started to be extensively used in the region, hundreds of Indigenous property maps in Loreto were assembled following what is often called classical topography. Senior *ingenieros* I talked to explained to me how their work before the advent of GPS required them to travel long distances by boat into Indigenous villages in need of collective property titles. After talking to local leaders and listing possible neighboring properties, they would identify a visible point of origin—the confluence of a creek and a main river, for instance—from which they would measure the angle and the distance of a line toward a new point. Using measuring rods, compasses, and theodolites, they made a list of angles and distances that would follow the contours of adjacent rivers and creeks where Indigenous villages were almost always situated. Critically, this activity would be restricted to “frontal points,” that is, the perimeter of the property polygon that abuts navigable waterways (see Figure 2).

Days or weeks later, on some drawing desk back in the city, the polygon would come to life. Mapmakers would use the *ingenieros'* angles and distances to draw the new property polygon on parchment, calculating its remaining inland vertexes, or “center points.” This multisited process depended on a chain of notational references that exhibited all sorts of frictions: haste, the natural gravitational deviations of compasses, the instability of the grounds on which theodolites stood. Location, here, was possible only by analogical reference to locally known waterways and their meandering shapes, since for most of the 20th century there were no national geodetic grids available in Peruvian Amazonia to triangulate coordinates of latitude and longitude (IGN, 2016, p. 142). So as rivers eroded and



FIGURE 2 Working in the Peruvian Amazon, an engineer (*ingeniero*) measures an Indigenous property polygon on the ground with classical topography, before GPS technologies were available. Undated photograph from the mid-1990s. (Centro para el Desarrollo del Indígena Amazónico) [This figure appears in color in the online issue]

withdrew their banks, which the ingenieros had striven to describe with angles and straight lines, their technical notations suffered the unpredictable whims of Amazonia's hydrological rhythms, thus complicating its future topographic interpretation.

At the turn of the century, GPS devices and geographic information system (GIS) software became widely available in Peruvian Amazonia and gradually displaced the use of classical topography. As a result, it became technically possible to locate the contours of old Indigenous property polygons by stitching them directly from the ground onto the mathematical plane of reference of global geographic coordinates. Even though official protocols on georeferencing old Indigenous property polygons would not be established for another two decades, state regulations on rain forest-related activities in Loreto increasingly required geographic coordinates from Indigenous communities as early as the first decade of the 21st century. Thus, if an Indigenous community asked for a logging permit, or if a participatory reforestation project needed to demarcate intervention plots in an Indigenous territory, geographic coordinates were to be included in technical planning documents. As a result, old Indigenous property maps across Loreto were pervasively, albeit unofficially, georeferenced. As ingenieros working in various institutions strove to make sense of these old maps to locate polygonal vertexes and lateral sides in the rain forest with their GPS, they left behind written agreements, communal acts, and even printed maps that would dwell in Indigenous communities long before their departure.

Crucially, it was Indigenous organizations and allied NGOs, rather than state ingenieros, who launched the earliest, most systematic, and most comprehensive attempts to unofficially

georeference the polygons of old paper-based Indigenous property maps in the spirit of securing Indigenous territorial integrity across Peruvian Amazonia (Smith et al., 2003). These initiatives were born out of a broader global enthusiasm in the late 1990s with the possibility of putting emerging GPS technologies at the service of Indigenous territorial struggles (Smith, 1994). In pursuing this much more comprehensive process, however, these initiatives soon realized that the geometrical figures and written notations in old Indigenous property maps, including their area and surrounding hydrography, as well as their angles, distances, and overall shape, were often self-contradictory and utterly incompatible with the property documentation of neighboring Indigenous communities.

This was shown to me one day by Segundo while we spoke in his office. Handing over an old Indigenous property map on his desk, he said,

Look at the area and hydrography in this property map, for instance. How should you amend it? The map says that this polygon has a total area of 2,430 hectares and that it comprises the area between these two creeks, which you can see drawn over here. But if I keep the original hectare area, there is no way that the polygon can exist across the whole space between these two creeks. And if I extend the polygon across the space between these two creeks, then its area increases fourfold.

In other cases, Segundo told me, if one were to digitally redraw a property polygon in GIS software by following its geometrical instructions (“go for 2,100 meters at an 80-degree angle

from point 1 to point 2, then go for 4,235 meters at a 214-degree angle until point 3,” and so on), then one would end up drawing an unclosed shape. On yet other occasions, two Indigenous communities adjacent to each other would each have registered in their property maps different angles for the boundary line that they supposedly shared. When, say, there was a valuable cluster of timber trees in a disputed area created by these discrepant vertex angles, the result was an impossible juridical conflict. Both communities could make irreconcilable claims on the same portion of land while ardently waving officially stamped and legally endorsed property maps.

As a result, georeferentiation would require serious geometrical amendments to their perimeters, areas, geometrical instructions, and hydrological contexts. The question was, of course, how to make such amendments. Geometrical decisions—like which lateral line to extend to close up a polygon, which angle to widen, and whether to stick to the area or to the geometrical shape of the titled area—became inextricably political questions, especially when expanding investments in logging, oil, and conservation projects were adding new pressures to the riverine worlds of Peruvian Amazonia.

In time, Indigenous organizations and their allies managed to create an impressively complete archive of georeferenced Indigenous property polygons that, for over 20 years, achieved a semi-official status in Peru. Intensely circulating throughout state offices, NGO projects, and academic reports, these activist cadastres are perhaps one of the most valuable and successful artifacts created through the alliance of Indigenous organizations and the environmental movement in Peru. As a state technocrat with a long career in Peru's Amazonian titling institutions, Segundo resented how such “political” georeferentiations had come to be taken as official by everyone in the country, including institutions of the Peruvian state itself. For him, this *de facto* recognition of politically motivated work undermined what he envisioned as a truly technocratic register of Indigenous property polygons in Loreto. Granted, technical concessions were necessary in the traditionally underfunded institutions of Indigenous land titling that existed until the recent past. But as the pressures of climate change and biodiversity loss create the conditions for the large-scale official georeferentiation of Indigenous communities in the region, Segundo calls for a kind of state centralization that would displace the contentious authority of unofficial georeferentiations across Loreto.

By the time the Peruvian state finally issued protocols on georeferencing old paper-based Indigenous property polygons in 2017, however, unofficial georeferentiations produced by ingenieros working for Indigenous organizations, environmental NGOs, and many other public and private institutions had been accumulating across state offices, NGO databases, and Indigenous towns for more than two decades. GIS technicians working with Indigenous communities told me that, in some cases, they had to deal with up to four different versions of the same Indigenous property polygon when they were conducting their projects. Such accumulations emanated from the diverging criteria by which different ingenieros would pursue

unofficial georeferentiations. Some would proceed by prioritizing the angles, distances, and areas recorded in old property maps, whereas others (e.g., those working for Indigenous organizations) would tend to disregard maps altogether and focus instead on local boundary agreements and hydrography. Some ingenieros would merely take one or two relevant geographic coordinates near the riverbanks and then project the entire shape of polygons on GIS software, whereas others (e.g., those working in state-led titling projects) would record the shape of polygons by walking over their entire perimeter in the rain forest. While all these acts of georeferentiations drew on very different points of material reference, and thus produced radically different “amended” versions of the very same polygon, they all converged in the shared epistemic belief that it is possible to stabilize elusive mathematical abstractions by fixing their angles, distances, lines, and areas in the plane of mathematical reference of global geographic coordinates.

For Segundo, it was inexcusable that such confusion had been produced by the unruly accumulation of unofficial georeferentiations. “Georeferentiation should be conducted on the basis of what the Indigenous communities themselves *have always ancestrally agreed upon*. These are all unofficial sources,” he had told me a few days before his PowerPoint presentation in front of the Indigenous chiefs. Invoking ancestral Indigenous territoriality, which he viewed as radically external to the confusions of informal georeferentiations, Segundo longed for an ultimate referent that could yield itself to the hopes of unequivocal technical precision and centralized authority incarnated in the Regional Agrarian Bureau. But Segundo also left something aside: that Indigenous territorial claims were already heavily mediated by the accumulations of the very same polygonal amendments that he sought to displace.

THE UNRULINESS OF YELLOWED FILES

As soon as Segundo finished his PowerPoint presentation in front of the Indigenous chiefs, he opened the floor for questions. The chief of the Buenos Aires Indigenous community, on the Ucayali River, rose from his chair and took the stage.

Good morning, ingeniero. I just wanted to bring to your attention the quarrel we currently have with our brothers of the neighboring community of Tigrillo. You see, our boundary has always been the Paujil Creek, but when some ingenieros came from Iquitos a few years ago for a reforestation program, *they moved it a bit* into our territory, beyond Paujil. That is an ongoing problem we have with the community of Tigrillo, ingeniero, because the Paujil Creek has always been our boundary, but now they say it is entirely within their territory.

Segundo interjected and asked the chief of Tigrillo, also present at the meeting, about the matter. “Brother, what do you have to say?” Segundo said. “Do you know where your boundary is?”

The chief of Tigrillo replied, “Our ancestors knew where it was, ingeniero. But the line has been lost ever since. The forest reclaimed it, but a couple of ingenieros came a few years ago. They saw our map and told us our line was actually beyond the Paujil Creek.”

Segundo groaned with exhaustion. “My friends,” he said, “if Paujil has always been your ancestral boundary, it does not matter what some ingenieros said. You are the ones who know your territory.”

Later that day, Segundo explained to me that this was actually a recurrent issue in Loreto: once ingenieros were assigned the task of locating the precise boundaries of an old Indigenous property polygon, they would georeference the polygon’s frontal points and angles by walking in the rain forest with their GPS devices. On some occasions, they would take the boundary to be not the sinuous creek that lay between two communities, but the straight topographic line that had been traced in the original paper map in a rough attempt to follow the creek. Confusion thus resulted from the technical limitations immanent in classical topography, which relied on geometric descriptions that reduced property polygons to as few numbered points and straight lines as possible. In time, the divergence between both lines would only get worse as river channels changed, moving water bodies in and out of the abstract polygonal reductions drawn in old property maps. And once new ingenieros tried to make sense of these old drawings with their GPS devices, disagreements would arise over the real boundary between the two communities.

These interpretive confusions were further complicated by questions of authority. “Besides, my friends,” Segundo began again, “please remember that any plotted maps that ingenieros from Iquitos might make are not official if the Regional Agrarian Bureau does not issue them. They might craft them for the sake of their projects, but they do not have official value. Who were these ingenieros? Do you remember?”

The chief of Tigrillo replied, “They worked for the regional government, ingeniero.”

“But do you remember what project it was?” Segundo said.

“No, ingeniero.”

This confusion between official and unofficial georeferenciations was only encouraged by a double erasure over time: the erasure of boundary lines that would come to be reclaimed by the rain forest, and the erasure in memory of the names and institutional affiliations of ingenieros performing unofficial georeferenciations. The haunting presence of both erasures evokes the particular rhythms that perfuse regional life in Loreto. As a vast and densely forested region, Loreto is connected almost exclusively by fluvial transportation; trips from the capital city of Iquitos to many Indigenous communities take many hours or even days by boat. Telecommunications are almost completely absent from most Indigenous communities. And interactions between state representatives and Indigenous communities are irregular and unpredictable. Quite often, the only traces that state representatives leave behind after their visits are various documents, many of which are related to the boundaries of Indigenous communities.

As I came to learn, the yellowed files that the Indigenous chiefs held in their laps during Segundo’s PowerPoint

presentation contained the material traces of unruly polygonal amendments. Some were printed digital maps that had no official value but were still cherished by Indigenous chiefs as evidence their territories’ extent. Others left traces only in the form of communal assembly acts describing georeferenciation, undertaken by all sorts of visitors, from NGO technicians to foresters from Loreto’s regional government to independent consultants hired by logging companies or by the communities themselves. Overall, most people had trouble remembering specific names and affiliations. What came to the fore was the generic and blurred image of the ingeniero, a trace-making figure who mediated the papers that accumulated in these yellowed files, only to recede into partial oblivion.

When confronted with these yellowed files, Segundo insisted on returning to an Indigenous territoriality that was external to and unpolluted by such unruly paper accumulations. “Please, my friends, remember that we are only updating *what you have always ancestrally agreed upon*,” he said. “What we want to do now is to have a register of what has always been the case. This is not about gaining more land.” Despite this warning, the quarrel between Buenos Aires and Tigrillo reveals the elusiveness of calls for ancestrality. It shows how the accumulation of ingenieros’ material traces yields a kind of hermeneutical artillery that, though unofficial, can be stored, retrieved, and activated to pursue tactical arguments about territorial control. The paper accumulations reveal the patchy terrain of erasures and confusions on which polygons are defined and argued about today, foreclosing any uncontested path to stabilize property polygons as they are brought to the mathematical plane of global geographic coordinates.

As an extensive anthropological literature has shown, modern state documents create distinctions between the state and its citizens through their very process of circulation (Feldman, 2008; Hull, 2012; Latour, 1999). Modern conceptions of political authority are thus intimately attached to control over the production, distribution, and archiving of documents, which constitutes a form of public trust and technical legitimacy that is essential to contemporary state formations. Because of this, modern state documents are expected to be governed by strict, coordinated, and centralized protocols that guarantee the stability of the technical objects that they help delineate and manage. This, indeed, is the political affect that invigorates Segundo as he insists that georeferenciation be recentralized in Loreto’s Regional Agrarian Bureau. But just as ubiquitous as this centralizing pulse may be, so are the disruptive effects of their dispersions and proliferations, as a rich ethnography of documentation has suggested over the last decades (Campbell, 2015; Das, 2004; Hetherington, 2011; Hull, 2012; Tarlo, 2003).

As we relate this literature to the dialogue between Segundo and the Indigenous chiefs, what matters is to understand what leads Segundo to question the content in the chiefs’ yellowed files. Segundo rejects the traces left behind by these unruly acts of polygonal amendment at a moment when Indigenous property polygons are to be mathematically stabilized and lodged in state public records, which are subject to environmental transparency and bureaucratic accountability. The forces haunting such technocratic aspirations are, of course,

the paper accumulations that lie within the yellowed files of his interlocutors, waiting to be activated as polygons initiate their official transit from the confusing surfaces of paper property maps to the apparent mathematical smoothness of global geographic coordinates.

WHO OWNS SHIRINGAYOC?

Three weeks after Segundo's PowerPoint presentation, we left Iquitos for the upper basin of the Moray River. It was 5 a.m. on a Sunday, and the mist of the early morning was just clearing from the canopy of the trees at the riverbanks. I had been appointed to join the technical field brigade that was to embark on a two-month trip up and down the Moray and Ucayali rivers, georeferencing old Indigenous property polygons in both basins. Heavily equipped with computers, printers, paper files, and GPS devices, the brigade was composed of five members. Gerardo, our youngest member, was a Limeño geographic engineer in charge of analyzing preexisting topographic information in both river basins and drawing digital polygons; these would be submitted for deliberation by the Indigenous communities. Dairon, the team's field technician, worked as Gerardo's right hand. Then there was Roberto, a senior anthropologist who was fondly known in the region; more than two decades earlier, he had participated in the original demarcation of these Indigenous communities with theodolites and compasses. The brigade's last member, in addition to myself, was Maicol, an agronomist from the Agrarian Regional Bureau.

With each passing meander, we moved farther away from Iquitos. The canopy thickened, and the river became less predictable as sandbanks and whirlpools occasionally challenged Anderson, our skillful boat captain. On the motorboat, jokes and card games went hand in hand with grumpy discussions about the messiness of available documentation. Seated in the floor of our vessel, Gerardo tirelessly analyzed a geodatabase provided by Segundo containing the state's provisional Indigenous property polygons for this area. By analyzing their superimpositions and misalignments, along with the adjacent courses of rivers and creeks, he tried to make sense of whether they reflected actual Indigenous rights on the ground or whether they resulted from speculative translations born of the clumsy scanning and digital redrawing of old paper property maps in Iquitos. Sometimes, Gerardo would dictate the supposed geographic coordinates of a polygon's frontal points to Dairon so that he could enter them in his GPS device and see where they landed in the navigator's map. "It lands in the middle of nowhere, my friend," Dairon would reply with a playful smile. Gerardo would call these "floating points." He knew they had to be wrong. Yet he failed to know *how* they were wrong. Was it because the physical river had moved? Because the cartography used in the titling process was wrong? Or perhaps there was a flaw in the downloaded cartography on Dairon's GPS device?

Our brigade's methodology was fairly simple, or so it seemed. We would spend three to four days working with each Indigenous community, establishing the boundaries of their territories, which involved, quite often, settling quarrels with their

neighbors. If that goal was achieved, we would make our way through the rain forest with smaller boats or machetes until reaching the agreed-on locations, where we would install plastic milestones and take GPS points, which would then be consecrated in signed agreements between the parties. Each process would begin when we arrived at the community's main town, usually in the early afternoon. Roberto, an already-cherished character throughout the basin, would be received with care by the authorities, who would find us a roof in town to settle our tents for a few days. After having beers, playing soccer, and conducting other social activities, people would go take a bath in the river at sunset, and a general assembly of the Indigenous community would ensue in the evening. These assemblies would begin in quite patterned ways. Maicol would first introduce us in his capacity as the Agrarian Regional Bureau's official representative, exhorting people to take advantage of this lifetime opportunity and noting that "coming all the way up here is costly, and there may not be more chances like this for a long time." Then Roberto would speak, joyfully explaining what we had come to do and praising the "almost exact precision" of the new GPS technologies and computation. Gerardo would then follow. As a young man still in his 20s, he would address his generational cohort. "Just as your fathers left a property title for your community," he might say, "you can now leave something too for your kids."

Three weeks after we left Iquitos, the brigade headed toward the Pucayacu River, a remote tributary of the Moray River, where we were to work with two communities that had reportedly quarreled over their boundaries for several years: Cinco Hermanos and Nuevo Testamento. After navigating all day, we finally arrived at the town of Cinco Hermanos around 5 p.m. and were immediately received at the main port by Víctor, the Cinco Hermanos chief. Once the *comuneros* (townspeople) returned from their gardens and sunset arrived, we gathered in the Cinco Hermanos communal saloon to discuss our activities for the upcoming days (see Figure 3). People started to come, flashlights in hand, greeting us and taking a seat on the floor as the sound of crickets invaded the darkness of the surrounding night.

"Could I take a look at your property map, chief?" asked Gerardo, as he stared at his computer at an improvised desk people had prepared for him.

"Yes, ingeniero, here you go," Víctor said, as he removed a moldy parchment from a yellowed file.

Gerardo reviewed the document and said, "Chief, this is a preliminary map made by the PETT project [which used to title Indigenous communities in Loreto a few decades ago]. This is not your official property map. Don't you have it?"

"This is what we have, ingeniero," Víctor replied. "But look, here is our boundary line. You can see it right here on the map. Right now we have an issue with our brothers from Nuevo Testamento because they have made a *trocha* [a machete-made path through the rain forest] over there. They say that this *trocha* is our boundary line, but the elders here have always told us it is further downstream."

At the core of Víctor's words was a concern about which community owned the Shiringayoc Creek and, perhaps most importantly, its mouth at the Pucayacu River. Víctor continued,



FIGURE 3 In August 2019, Víctor (left), a chief of the Indigenous Cinco Hermanos community, and Gerardo, an engineer, discuss the community's property map at dusk in the village's communal saloon. (Eduardo Romero Dianderas) [This figure appears in color in the online issue]

The thing is, ingeniero, Shiringayoc is the only source of food for the families who live here in Cinco Hermanos. It is where we hunt our game and where people take care of their gardens. In the rainy season, everything else is flooded here. If Nuevo Testamento owns the mouth, then who knows? They might charge us to take products out of the creek.

Víctor's concern was echoed by Dairon, who whispered to me as Víctor kept explaining his position to Gerardo. "The mouth of a creek is really important," Dairon whispered,

because *most small creeks do not appear in official charts*. We just do not know how they go around as they move upstream, and thus, we cannot know, unless we were to spend days surveying the area, at which point a creek stops being in one property polygon and enters another one.

Legally, this should not be an issue, because waterways are technically not owned by anyone under Peruvian legislation. But since creeks decisively mark the spatial and economic experience of people in rural Amazonia, they become fundamental units of territorial control as Indigenous communities dispute and settle boundaries with each other.

Importantly, the quarrel between these two Indigenous communities was framed by Víctor not in terms of Shiringayoc itself, but of an abstract parallel line running east to west that

had no regard for the sinuous courses of both the Pucayacu River and the Shiringayoc Creek. Thus, if what was at stake for Víctor was the territorial control over a hydrographic being in the landscape, the *political terrain* on which these stakes came to be expressed was a mathematical one: the course of a line that neither he nor the people of Nuevo Testamento could experience directly, but which could only be precariously instantiated as a drawn trace on a map (for Víctor), or as a trocha in the rain forest (for Nuevo Testamento). As Cinco Hermanos and Nuevo Testamento argued over which material point of reference should be used to establish an abstract parallel line, a dispute unfolded across the materialities of maps and landscapes, one that was nonetheless irreducible to either.

Gerardo continued, "OK, so Cinco Hermanos was titled in '97 and Nuevo Testamento in '94, right? And you are saying they moved the line upstream without consultation?"

"That is correct, ingeniero," said Víctor. "They have opened a trocha at the right margin of the river. And if you extend that line to the left margin, Shiringayoc's mouth would end up in Nuevo Testamento's land. That is not right. Our land actually ends in a line downstream, in a point known as the San Pedro estate, where an old man from Nuevo Testamento manages a small agricultural post." Víctor smiled at the supportive comments of his fellow comuneros.

"Gosh," Gerardo said, "it seems that the ingenieros who made this map apparently did not know about Shiringayoc, chief. And the Nuevo Testamento property map actually does not give us a lot of information."

Growing frustrated, Víctor replied, “But 90 percent of this creek is in our territory, ingeniero. My idea would be that perhaps we could set the line right at the mouth of Shiringayoc.”

At this point, Gerardo realized that the San Pedro estate mentioned by Víctor did not appear in the property map of Cinco Hermanos, but in Nuevo Testamento’s map it actually showed as a point *within* the territory of Cinco Hermanos. “I do not understand, Víctor,” Gerardo said. “So you are saying that San Pedro is within the territory of your neighbor Nuevo Testamento. Is that correct?”

“Yes, ingeniero,” Víctor said.

“But here it says otherwise,” Gerardo said. “Are you sure that San Pedro is not within your land?”

“No, ingeniero. That estate has always been of an old man who lives in Nuevo Testamento. That is our boundary.”

“Gosh, Nuevo Testamento’s property map is a piece of garbage,” exclaimed Gerardo, visibly irritated. Suddenly, a young comunero named William spoke up.

“Ingenieros, first of all, good night,” William began, “and in the name of everyone here, thank you for visiting our community. Let me tell you. Those guys from Nuevo Testamento have moved the boundary upstream four times. First, it was at San Pedro. Then they said it was the mouth of Shiringayoc. Then they said it was in a place called Lagarto. And now they say it is that trocha they have opened without consultation. They came with an ingeniero from Iquitos a few years ago, and he told them that his GPS marked it there.”

Roberto rose from his chair. “My friends,” Roberto said, “I do not know who might have come. But I want to remind you all once again that what an ingeniero might say is not an official statement unless Loreto’s Agrarian Regional Bureau sanctions it. They need to validate the process.”

People nodded as Roberto spoke, but confusion ensued as we met with Nuevo Testamento representatives the next morning. It was around 6 a.m., and the brigade, along with Víctor and a few other men from Cinco Hermanos, had come downstream in a boat. In accord with a previous agreement the brigade had made on our way to Cinco Hermanos, Jairo, the young chief of Nuevo Testamento, had come upstream to meet us near the area in dispute along with a few other of his fellow comuneros. An intense rain had started, and Jairo and the others rapidly took refuge in our roofed motorboat, where, after a round of warm greetings, we began to talk about where to set up the boundary posts and take the GPS points to georeference their boundary. Jairo began.

“Gentlemen,” he said, “when I took charge of this role last year, my predecessor gave me the community’s property documents and told me that *this* line [the trocha] is the point where our land ends. I remember that when I was a teenager, an ingeniero came to our town and took my father and some other folks to show them that boundary.”

“You are talking about the ingeniero Villar,” replied Don Gilberto, a man in his 60s and a longtime comunero of Nuevo Testamento. “I remember having gone with the ingeniero Villar to that point about five years ago. He went there and entered the map’s coordinates in his GPS and told us and the people of Cinco Hermanos that our boundary was right there, at the trocha.”

“But is there a signed agreement that I can see?” Gerardo asked, as he tried to cover the papers from the intruding rain.

“No, ingeniero,” said Jairo. “But I have a map here in my bag.” With Don Gilberto’s help, he handed over a parchment. When Gerardo saw it, he grew impatient.

“My brothers,” he said, “this property map does not have geographic coordinates. When your property map came out, GPS technology did not even exist. I do not understand how that ingeniero might have told you that he was entering geographic coordinates in his GPS.” As Gerardo said this, a timid laughter erupted among some of the people in the boat. “These maps cannot be read with GPS. They only give you angles and distances,” he concluded.

“So, ingeniero,” said Don Gilberto, “what are you trying to tell us? I do not understand. If Nuevo Testamento’s property map is the earliest, then it should prevail, shouldn’t it?”

“It is not that simple,” said Gerardo. “We need to consider hydrography and context. And you need to take an agreement. It is not like I can come here and tell you ‘here it is.’ I find it very weird that a state ingeniero might come here and that there is no record of that in Iquitos. We do not even know if he came in the name of the Agrarian Regional Bureau!”

At this point, Don Gilberto’s facial expression changed. “You know what happens, ingeniero? That is the problem. Ingenieros come here, but they do not make their maps here. They come and take their points and then make their maps as they think it is. Not as it really is.”

Don Gilberto’s frustration emerged from the confusion caused by the vague traces left behind by ingenieros. Yet it was precisely the accumulation of vague material traces that mediated these debates, blocking the disputants’ access to an unmediated territory, akin to what Segundo had referred to as what *you have always ancestrally agreed on*. As the hours wore on and we slowly reached an agreement seated on the floor of the motorboat, I started to sketch a timeline of how the successive amendments of the boundary line had unfolded (a timeline that was certainly complicated by the multiple erasures in peoples’ memory and in the rain forest). I learned, for instance, that some people remembered quarrels about this line as far back as 1996, when Cinco Hermanos was not even a legally demarcated community. A group of Spanish priests who used to work in Cinco Hermanos in the 1990s were the first who examined the Cinco Hermanos property map and told people that their boundary line was probably around the San Pedro estate. A few years later, the ingeniero Villar came to Nuevo Testamento when the community was preparing to participate in a state-led conservation program that would pay the community in exchange for forest conservation. These programs depended on precise geographic coordinates and a fixed counting of hectares, so a provisional georeferentiation was conducted by the ingeniero Villar even when the legal framework for it would not exist until 2017.

Crucially, Villar had come to the field with a version of Nuevo Testamento’s polygon to guide his georeferentiation, a version that was unsanctioned by the Regional Agrarian Bureau. As Jairo opened his yellowed file, he pulled out a printed map in full color and showed it to me. It was a version of Nuevo Testamento’s polygon produced by an activist

environmental NGO about a decade earlier. Thus, contrary to Segundo's desires to suppress the legitimacy of unofficial georeferentiations, this particular version of Nuevo Testamento's polygon had made its way back to the place it referred to via a state ingeniero, functioning not as a mere register of an unmediated territory but as an epistemic and political artifact that participated in the mathematical stabilization of what the territory was. Effectively, the abstract parallel line proposed as a boundary in this unofficial version of Nuevo Testamento's polygon moved the boundary upward in the map, a few meanders upstream from what Nuevo Testamento's original paper-based property map apparently registers, if we take its hydrography at face value.

As the clock struck noon and the rain receded, agreements were finally taken. Shiringayoc's mouth was to remain within Nuevo Testamento's polygon, and we were to project Nuevo Testamento's trocha line to the left margin of the Pucayacu River. This time, at least, Nuevo Testamento had won the mathematical battle. Yet a "good neighbor agreement" was demanded by Cinco Hermanos so that their comuneros could have full liberty to enter through the mouth of the creek upstream. Once the agreement was signed, Víctor insistently asked the brigade to place boundary posts at the points where Shiringayoc and other minor water bodies crossed the invisible boundary line into Cinco Hermanos territory. After long walks and difficult trips in small boats, anxieties mounted about the visibility and conservation of these boundary posts. "This area is easily flooded in the rainy season, ingeniero. Let's place the posts over here. In this high ground, please," Víctor said as we arrived at the place where, according to Dairon's GPS, the now agreed-on boundary line crossed over the banks of the Shiringayoc. "Perhaps, ingeniero, when I am gone one day, the new leaders will not know that this is the point [where the boundary line crosses Shiringayoc]," said Víctor. "Perhaps Nuevo Testamento will forget about our good neighbor agreement. That is why I would like to have a fully signed act and a picture, so I can share it with my fellow comuneros."

After this requirement was met, there ensued a debate within the brigade itself. "Be careful with what you say or sign, Gerardo," recommended Dairon. "If you are not careful with what you do now, they are going to be saying that 'the ingeniero Gerardo did this and told me this and that.'" And so indeed, amid Víctor's fears about the erasures of time across the registers of missing documents and flooded boundary posts, and the brigade's fears about producing yet one more piece of unsettling artillery in local quarrels over boundary lines, another piece of paper was finally added to Víctor's yellowed file.

THE POLITICS OF MATHEMATICAL ABSTRACTIONS

I would like to end by considering Dairon's meditations on the ways Indigenous property polygons are stabilized and destabilized in contemporary Loreto. As we walked through a semiflooded terrain in the company of authorities from two neighboring Indigenous communities, Dairon and I talked about the vicissitudes of georeferencing polygons in Amazonia

as we struggled to pull our boots out of the thick mud without losing our equilibrium. Drawing on his long experience as a freelance surveyor in Amazonia, Dairon was somehow less constrained by Segundo's institutional imperatives. He acknowledged Indigenous property polygons as immanently unstable entities. "Ultimately, my friend, the amendment of these property titles will never end," he said. "Next year a flood will come, and a town will resettle further upstream. The milestone that you might have put over here, perhaps the river will have taken it. You might have a line to work with on your computer. But you will always have to keep on amending." As the whole group gathered to have a snack, Dairon pursued this point even further. "Isn't it true, gentlemen? When you are gone for good, your children might say, 'Oh, I do not want my boundary post to be here! I want it to be there!' Perhaps this big *aguajito* [a swamp tree that grows in Amazonia] that we are using here as a localizer will not be here anymore."

"You are right, ingeniero," our hosts responded.

Dairon's observations contrast with how others envision the georeferentiation of Indigenous property polygons today, that is, as a novel technocratic reform that seeks to stabilize boundaries in the context of climate change and biodiversity loss. Across the world, property polygons have conventionally been seen as offering a sense of political and geometrical versatility that springs from their (ideal) mathematical self-consistency, their fixity in time and space, and the calculational and analytical capacities they provide for state administrators and users alike (Hetherington, 2012; Mitchell, 2002; Scott, 1998). These ideas have been reinvigorated in Amazonian regions like Loreto, where the use of GPS technologies and GIS software in surveying promises to stabilize polygons in the plane of mathematical reference of global geographic coordinates. As Loreto and other Amazonian regions receive significant foreign aid funds, adopt new technologies, and institute administrative reforms in the larger context of the global environmental crisis, the state hopes to turn tropical rain forests into spaces of fine-grained technical legibility. In doing so, it aims to stabilize Indigenous property polygons so that they can transcend the mere "referentiality" of old paper-based maps, leading to a new era of environmental transparency, efficiency, and accountability. In this new era, Indigenous ownership will be firmly brought into the orbit of emerging regimes of global environmental governance.

Crucially, such promises take hold in an imagined space: a smooth plane of mathematical reference where self-consistent mathematical objects can be stitched and visualized with incontestable geometric certainty. And yet, as revealed in Dairon's dialogue with the Indigenous chiefs, there is a different way to envision Indigenous property polygons, one that better aligns with the turbulent processes that we have followed across old topographic drawing desks, state georeferentiation activities, and the yellowed files held by Indigenous chiefs in Loreto. For just as the materialities of mud and fluvial sediment accumulate to produce the Amazon's unstable and shifting landscapes, Dairon and his interlocutors understand that the lines, angles, and distances that they measure today will join previous polygonal interpretations that have accumulated across irreconcilable maps, written documents, and human-

made marks on the landscape. Further, they anticipate that future generations might forget or refuse the lines and angles that they stabilize today. And so they do not see polygons as stitched on a definitive surface that is smooth and fixed, but rather as woven into an unstable epistemic and political terrain created by the convergence of unruly accumulations. The ingeniero, as I have proposed, appears as the trace-making figure who mediates such processes of unruly accumulation. As a foreign and transient character, ingenieros like Dairon inhabit a space that oscillates between reverential authority and moral skepticism, between the forgetfulness of the past and the urgency of the present. Ingenieros, therefore, are privileged prisms through which to appreciate how mathematical abstractions become political terrain where Indigenous territorialities are stabilized and destabilized in contemporary Peruvian Amazonia.

To appreciate polygons as political terrain carries important lessons for contemporary anthropological theory. Particularly, it shows that to examine the politics of bureaucratic rule and technical expertise, anthropology must contend with how mathematical abstractions can become unsettled terrains of political struggle. Such struggles are irreducible to the instantiations of mathematical objects in paper documents, digital media, and more-than-human landscapes. For as mathematical objects like angles, lines, and areas travel from more-than-human landscapes to maps, and from traces on paper to the plane of global geographic coordinates, what comes to the fore is a more subtle struggle over the very stabilization of mathematical abstractions that participate in but are ultimately irreducible to any specific point of material reference. As shown by the controversy over the Shiringayoc Creek, these struggles have become important terrains of imagination and praxis where Indigenous claims for territorial control are articulated today. But this does not mean that Indigenous territorialities have been colonized by the rigidity and boundedness that is conventionally associated to property polygons. It means, in fact, exactly the opposite. Just as the accumulations of mud, fluvial sediment, and vegetal life constantly redraw Amazonian landscapes, so have polygons been colonized by a similar logic of unruly accumulation, as their traces create unstable and shifting terrains of epistemic and political interpretation.

Following the contentious lives of Indigenous property polygons in Loreto allows us to pose new questions about the emerging politics of mathematical abstractions as we move into the age of climate change and biodiversity loss. As tropical rain forests both in Amazonia and beyond are increasingly transformed into technologies of climate change mitigation (Gabrys, 2020), mathematical abstractions like Indigenous property polygons will become subject to even more demands for granular precision, environmental accountability, and technical transparency. In the context of this planetary push for certainty, what to make of the unruly accumulations through which people across state offices, Indigenous villages, and rain forests have engaged polygons over the years? How can one take hold of the historical turbulence of paper, mud, and sediment, and turn it into a controlled and unified flow of mathematical certainty?

ACKNOWLEDGMENTS

I want to thank the state surveyors and Indigenous peoples who allowed me to work alongside them in different parts of Loreto, and to the three anonymous reviewers who provided valuable feedback during revisions.

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ENDNOTE

¹Throughout this article, I use pseudonyms for all interlocutors, Indigenous communities, and rivers and streams. The fieldwork for this research was conducted exclusively in Spanish. All translations are mine.

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How to cite this article: Romero Dianderas, Eduardo. 2023. "Polygons." *American Ethnologist* 1–13. <https://doi.org/10.1111/amet.13196>