

## VOLUMES: The Politics of Calculation in Contemporary Peruvian Amazonia

EDUARDO ROMERO DIANDERAS

University of Southern California

 <https://orcid.org/0000-0003-1149-4811>

On the morning of November 24, 2015, one of the most decisive events in the history of Peru's fight against illegal logging took place in the port of Iquitos, the capital of Peru's Amazonian region of Loreto. That morning, state authorities confiscated an immense contingent of illegal timber lodged in the *Yacu Kallpa*, a cargo ship that year by year transported timber processed in Iquitos to commercial ports in Mexico and the United States. An array of national and international media agencies echoed news about the intervention, celebrating it as a signal of Peru's newfound commitment to securing the legality of tropical timber supply chains. Mostly left unmentioned in such celebratory remarks was the extensive labor of measurement and calculation that had preceded this large-scale state intervention.

Months before state authorities even set foot on the *Yacu Kallpa*, they focused their attention on exporting companies previously identified as highly susceptible to trading with illegal timber. In Peru, all commercial timber must be backed by a forestry transport permit (FTP) that grants companies the legal right to transport and trade a given volume of timber. The FTP serves as a legal declaration by which loggers state that their timber shipments come from authorized logging sites where they previously listed and georeferenced a given number of harvestable

trees. By examining the FTPs attached to the timber shipments of suspicious exporting companies, the authorities selected a group of logging operations from which some of the *Yacu Kallpa*'s timber cargo had allegedly originated. In the following months, state forest supervisors then embarked on several inspection visits in remote logging concessions throughout Loreto. Their reports confirmed what they had suspected: the FTPs attached to some of the *Yacu Kallpa* timber had been used deceitfully. Inspectors found no evidence for the existence of hundreds of trees that supposedly were the source of many timber goods on the ship. This meant that, as people commonly say in Loreto, such timber had been "laundered" (*lavada*). Officially, the FTP claimed that the timber hailed from an authorized logging site when, in fact, it had been illegally extracted from elsewhere.

The meticulous labor conducted by the authorities before the intervention had been aimed at the calculation of a crucial volumetric number: 1,312 cubic meters ( $m^3$ ). After state supervision reports invalidated dozens of deceitful FTPs,  $1,312m^3$  became the aggregated volume of timber that, up to that moment, had been determined as illegal within the *Yacu Kallpa*. At the time of the intervention, however, not all timber in the huge cargo ship had acquired this status. The number represented only 12.5 percent of the total timber volume inside the vessel. Pressured by the crew of the *Yacu Kallpa*, who desperately needed to depart for the Dominican Republic, state authorities decided not to confiscate the  $1,312m^3$  of timber physically, but *legally*, via a signed agreement by which the crew committed to turn in the illegal timber after their return to Iquitos a few months later. And yet, once the *Yacu Kallpa* set sail and left Peru, the volume of illegal timber within the ship kept growing at a distance. As state forest supervisors visited more logging operations and corroborated the falsity of even more FTP declarations, new state calculations continued to change the overall balance of legal and illegal timber now on its way to enter international tropical timber markets. As the *Yacu Kallpa* crossed Brazil via the Amazon River and turned toward the Caribbean Basin, three new state supervisions added to the original amount of illegal timber volume. In early January, when the *Yacu Kallpa* had reached the Dominican Republic, Peruvian authorities confirmed the amount of illegal timber at  $6,891.28m^3$  (71.4 percent of the sum total,) and by January 26, when the ship arrived at the port of Tampico in Mexico, this number had grown to  $9,268.49m^3$  (96.03 percent of the total) (see [Global Witness 2017](#)). If in November the *Yacu Kallpa* had lodged about  $10,000m^3$  of legalized tropical timber, two months later, Peruvian authorities had illegalized well-nigh all the timber inside the ship. After a laborious process of verification and calculation spanning many months, state authorities had

thus successfully uncovered the deceitful technical and legal relationship binding dozens of FTPs, the inexistent trees they supposedly stood for, and almost all the timber lodged within the *Yacu Kallpa*.

The *Yacu Kallpa* scandal unveiled the astonishing levels of illegality that peruse every stage of the tropical logging industry in Peruvian Amazonia, but it also made visible the complex constellation of actors, both human and otherwise, that have emerged over the past two decades to secure the legal origin of tropical timber all the way down to the scale of individual trees. As Amazonian rain forests have emerged as critical sites for biodiversity conservation and carbon sequestration in the larger context of the global environmental crisis, securing the legality of tropical timber has become a political imperative to which the Peruvian state is increasingly bound through international environmental agreements, commercial incentives, and legal pressures. But just as the *Yacu Kallpa* intervention shows, large-scale planetary ambitions to guarantee the legality of the international tropical timber trade ultimately depend less on the grand schemes of diplomacy than on securing the precise calculability of a humble mathematical abstraction: volumes.

In contemporary Peruvian Amazonia, volumes serve as calculational abstractions that bind together a vast array of technocratic practices related to the tropical logging industry. They are crucial for timber products to circulate as disentangled commodities representing fixed quantities of commensurable value (see [Marx 1999](#); [Çalışkan and Callon 2010](#)). But just as important, volumes are fundamental for state regulatory institutions aiming to organize regimes of technocratic governance on an industry traditionally associated with illegality and deceit. From the measurement of regional forest productivities to the calculation of industrial sustainability, and from the implementation of state inspections to the enforcement of public accountability and transparency, defining volumes in precise and accountable ways proves key to the technocratic governance of tropical logging. And yet, as volumes move and circulate across different scales and media registers, slipping from the humble paper notations performed by logging workers to the yearly annuals of Peru's national timber exports, they come to have contentious epistemic and political lives. For how to calculate mathematical abstractions like volumes is a question entangled in disparate political histories and affective dispositions, from long intractable legacies of racialized exploitation to emerging liberal dreams of transparency in the age of climate change and biodiversity loss.

In this article, I examine the contentious practices by which tropical timber is regularly transformed into calculational abstractions known as volumes in contemporary Loreto. I do this at a time when timber volumetric calculation

procedures are becoming increasingly standardized and supervised as part of a series of intense regulatory reforms that aim to secure their precision, auditability, and consistency across scales. Drawing on twenty-four months of fieldwork in state offices, sawmills, and logging campsites, I examine how volumes contentiously emerge in the everyday activities of Indigenous peoples, loggers, timber industrialists, and state technocrats in Loreto. My attention to volumes developed as I conducted research on Peru's tropical rain-forest governance and its recent transformations in the context of climate change and biodiversity loss. At first, I understood volumes as artifacts of new technocratic dreams of legibility that could be analytically opposed to the arbitrariness and confusions historically associated with tropical logging in Peruvian Amazonia. And yet, as I began to consider specific situations where measurements were taken, formulas applied and numbers calculated, it soon became clear to me that volumes could not be understood as entities detached from the memories, aspirations, and desires of those calculating them. Far from constituting matters of strict technical concern, volumes repeatedly emerged into discussion as people recalled long histories of racialized exploitation, articulated claims of cultural difference, or expressed aspirations for technocratic transparency and accountability. Following volumes, therefore, revealed them as complex and multifarious creatures with long and complicated histories in the tropical rain forests of Loreto.

By thinking through volumes, I aim to interrogate the politics of calculational abstractions and their importance to understand emerging modes of global environmental governance today. In recent years, anthropologists have pushed against the self-declared disembodied rationality of bureaucratic rule by showing how the material composition, circulation, and manipulation of documents can reveal unexpected processes of political contestation, disruption, and resistance (Campbell 2015; Göpfert 2013; Hull 2012; Hetherington 2011; Pinker 2015). But as ethnographic objects, volumes do not easily yield to such an analytical focus on materiality. As numerical magnitudes established through the combination of formal mathematical formulas and situated empirical measurements, volumes make for ideal transcendental entities that simultaneously remain intimately imbricated in the bodily entanglements of specific peoples, logs, notebooks, measuring tapes, mud, and water. Importantly, such ontological ambivalence demands that we not only address their political lives by locating volumes in specific events of measurement, calculation, and registration, thus leaving the mathematical sets of relations that formally constitute them as if untouched by the vicissitudes of the world. Rather, committing to volumes as ethnographic objects requires that we also

go beyond materiality and consider how mathematical realms of experience like arithmetic or geometry can become political in their own sake. For as I will show, the very mathematical structures of volumetric formulas become political mediators that mobilize interests, constrain or foster particular practices of exploitation, and, more broadly, resonate with larger political visions about the past and future trajectories of the tropical logging industry in Loreto. In this sense, I contend that tracing the politics of calculational abstractions like volumes proves crucial to understanding how emerging modes of global environmental governance ultimately fuel struggles over the conditions by which we are to measure, calculate, and trace different objects of environmental concern at local and planetary scales.

By interrogating the politics of calculational abstractions, anthropology can thus consider how even apparently mundane mathematical entities like volumes can be persistently haunted by power, history, and bodily experience. In recent years, a robust body of work has interrogated practices of quantification and calculation by showing that contemporary modes of numerical reasoning do not produce neutral representations of reality, but rather constitute laborious and performative processes within which different political projects, ambitions, and desires find articulation (Espeland and Stevens 2008; Diaz-Bone and Didier 2016; Ballestero 2015; Guyer 2014). With this literature in mind, I examine volumes by subscribing to William Deringer's (2018, 38) call to not approach "numerical calculations . . . as 'black boxes,' whose operation in the broader world can be understood separately from their inner workings." Instead, I focus on the "calculation grammars" that inform tropical timber volumes in Loreto as a way to unveil the affective and political dimensions of seemingly mechanistic technical practices in a larger context of intense technocratic transformation (see Ballestero 2015, 266.) Importantly, I show how such calculation grammars are neither universal nor statically constructed. Following Helen Verran's study of numbering in Yorubaland, I suggest that such disparate ways of envisioning volumes emerge from historically contingent sets of ritualized practices that, crucially, are grounded on different mathematical figurations of the physicality of logs (Verran 2001). In this sense, I consider the very mathematical structure of volumetric formulas and the technical procedures by which tropical timber is measured as sites of intense political and affective elaboration that merit specific ethnographic scrutiny. From this perspective, calculational abstractions like volumes become fertile ethnographic terrains from which to appreciate how competing forms of political imagination intersect and collide with each other as Amazonia enters the age of climate change and biodiversity loss.

In what follows, I first discuss the rise of timber volumetrics, the practice of measuring timber volumes, in modern scientific forestry, and examine a particular volumetric formula, the Doyle Formula, which eventually would come to embroil itself in the economic and political life of Loreto's tropical logging industry during the twentieth century. The Doyle Formula has traditionally been the privileged means to calculate volumes across Loreto's tropical timber supply chains. And yet, its peculiar mathematical structure has played a fundamental role in fostering the modes of racialized exploitation and technolegal deceit that have thrived in Peru's tropical logging industry for generations. I then show how the Peruvian state sought to tackle such legacies of exploitation and deceit by creating new technocratic regimes with the goal of stabilizing timber volumes as creatures susceptible to be calculated, followed, and audited across scales through standardized and accountable procedures. I show how this, in part, was envisioned through the enforcement of an alternative volumetric formula, the Smalian Formula, a formula considered *trueer* than Doyle. I conclude the article by discussing an ethnographic scene in which both the Smalian and the Doyle Formula interact in the context of a timber purchase involving a timber trading company and an Indigenous logging squad. By considering the tales told through the contrasting lives of these two formulas, I seek to unsettle the relations between abstract volumes and physical things and reveal the contentious practices that go into producing calculational abstractions in emerging forms of global environmental governance today.

### **DOYLE: A Mathematics of Exploitation**

"Thank you for coming, ladies and gentlemen. It is an honor to be with you today," said Teran, Loreto's regional state director of forestry resources, as he glanced on the dozens of loggers that had gathered to meet him. Outside the meeting room, the orange light of the afternoon fell onto the port of Masusa, the largest timber-processing center in Iquitos, a long and crowded stretch of warehouses and sawmills filled with muddy docks, mountains of piled logs, and the never-ending sound of mechanized saw blades (see [Figure 1](#)). Teran had come to Masusa to meet a group of loggers concerned about the long-term decay of their businesses in the aftermath of the *Yacu Kallpa* intervention a few years earlier. As soon as he had politely introduced himself in the name of Loreto's regional government, Dudu, a bulky logger in his sixties, rapidly took the stage. "Teran, thank you for coming. We have invited you here today so you can explain to us what you plan to do about the new volumetric guidelines that the government wants to force on us."



**Figure 1.** Piles of logs near the port of Masusa. Photo by Eduardo Romero Dianderas.

What Dudu referred to were a series of new calculational guidelines recently issued by the Peruvian state that standardized the procedures by which loggers and sawmill industrialists were to calculate and report to state authorities the timber they harvested and processed. Crucially, such guidelines sanctioned the use of a metric-based volumetric method known as the Smalian Formula, which was mostly foreign to Peru's tropical logging industry. The state technocrats advancing these new regulations posed Smalian as a way to calculate what they insisted was the *true* volume of timber. Thus it was envisioned as a privileged means to guarantee the self-consistency of tropical timber shipments as they moved across Peru's tropical timber supply chains. Such claim stood in direct criticism of the Doyle Formula, the imperial-based method of timber calculation extensively used across Loreto for generations. Since announced, the policy had come to be seen with a mixture of suspicion, irritation, and fatalism in the sawmills and river ports of Masusa.

Somewhat uncomfortable, Teran replied to Dudu: "There is unfortunately nothing I can do about that," he said, when loggers suddenly stood up from their improvised seats and the overall mood of the room started to change. "But please realize that these guidelines are important. We need real calculations, not only as

industrialists but as a country. Sawmills must produce precise calculations for the government to know how much timber we are producing, how much value we are creating,” continued Teran. “For this, we need to start using cubic meters, not board feet. And to report our yields in Smalian, not Doyle.” Quite irritated with Teran’s answer, Dudu took the stage once again and, in a revealing turn of events, articulated his frustration not in terms of technical discrepancy, but of cultural difference. “Teran, how we measure timber is part of our *culture*. The state should acknowledge the *tradition* we have here. These guidelines come from Lima [Peru’s capital]. That is a whole different reality. If you ask people in Loreto to calculate in cubic meters and not in board feet, a lot of them are not going to be able to do it.”

The culture of calculation referenced by Dudu, of course, does not only bring together the loggers gathered that day in Masusa. As an industry that intractably ramifies throughout Loreto, binding international tropical timber supply chains with remote (and quite often illegal) logging operations in the rain forest, such “culture” brings together hundreds of small-scale loggers, Indigenous and otherwise, that harvest timber for large timber tradespeople or their intermediaries. But where does Loreto’s culture of timber calculation come from? And how can we come to terms with understanding utterly technical practices like timber volumetrics as traditional and cultural things? Exploring these questions forces us to dwell on the historical trajectories of volumetric formulas and how their formalized mathematical abstractions have come to resonate with broader political and economic processes in Loreto and elsewhere.

The practice of measuring timber volumes has been a key component of forestry since forests turned into modern sites of state productivity. In the late eighteenth century, forests became spaces for some of the most ambitious practices of surveying, measurement and calculation in the wake of the Enlightenment’s quantifying spirit (Warde 2018, 200; Viitala 2016, 1040; Lowood 1990, 317). Rendering trees into volumes via standardized volumetric methods played a key role in such technical processes of forest rationalization (Scott 1998, 12; see also Warde 2018, 207). Early scientific foresters did not, however, primarily aim to measure and calculate *current* volumes of wood in a given forest; rather, they sought to optimize wood stocks by securing as much wood as possible *in the future* (Warde 2018, 180; Viitala 2016, 1044.) Foresters thus became increasingly concerned with understanding the intricacies of tree growth rates and with organizing forest management through principles of sustainable optimization and efficiency amenable to their future-oriented goals (Lowood 1990, 338.)



Emerging in the context of the westward expansion of North America's timber industry in the nineteenth century, the Doyle Formula offers a perfect example of the abstractive and future-oriented legacies of early scientific forestry (Collingwood 1952, 943). As a form of calculation, it is not concerned with measuring the precise volume of a log. Rather, it aims to determine what amount of useful timber it will yield once processed as commercial timber. This particular goal informs the structure of the Doyle Formula itself. As the formula projects the shape of a regular timber block within the tridimensional space of a given log, it only takes into consideration the smallest of its diameters. It also applies a de facto diametrical discount of four inches that factors in the useless width of the bark and the unintended subtractions performed by saw blades. Further, the Doyle Formula is calculated in inches and feet. And since the formula does not authorize inch fractions, calculations round down to the closest whole inch. Thus the Doyle Formula remains far from yielding neutral mathematical descriptions of log tridimensional shapes. In fact, its mathematical structure represents only one among many dozens of different volumetric methods regionally used in North America alone by the early twentieth century (Belyea 1953, 200). While each of these methods exhibited its own balance of time efficiency and mathematical accuracy, with some privileging respect for the morphology of logs and others emphasizing practical simplicity and transactional efficiency, the Doyle Formula had a peculiar feature: it was an abstract construct designed to structurally skew volumetric calculation away from the interests of the feller and toward the future-oriented modes of accounting required by timber-processing centers and their operators.

*The Doyle Formula*

$$V \text{ (in board feet)} = [Dm - 4]^2 / 16 \times L$$

Where...

Dm = smaller diameter

L = length

Although the dissemination of the Doyle Formula in Peru's tropical logging economy is unclear, it was certainly tied to the late twentieth-century expansion of tropical timber supply chains and how they came to articulate timber industrialists with Indigenous and rural labor in Amazonia. Since its earliest iterations, Peru's tropical logging industry has heavily depended on externalizing timber supply onto racialized labor relations that had thrived in the region since the rubber boom of

the early twentieth century. For timber industrialists and tradespeople, venturing for months into the rain forests, exposing themselves to the unpredictable risks of daily work, and becoming economically responsible for the sustenance of workers in remote logging sites did not make for an attractive choice. Instead, they came to depend on networks of extractive posts, patron-client bondage relations, and violent forms of exploitation that constituted the economic infrastructures by which forest goods had traditionally flown from all over Loreto into the ports of Iquitos.

Paramount among these relations was *habilitación*, a figure by which patrons disbursed advancements in money and industrial goods to riverine dwellers (both Indigenous and otherwise) who would then become responsible to venture into the rain forest and gather an agreed-upon amount of forest goods for the sake of their patron. After a few months, the *habilitado* would bring the goods to the patron, and together they would calculate the value of what had been delivered minus the value of the original advancement made by the patron. Finally, the patron would pay the surplus to the *habilitado* in either money or industrial goods, thus extinguishing the immediate obligation. *Habilitación* relations flourished as the quintessential way of articulating timber supply chains in Loreto throughout the twentieth century. In addition to constituting a model of relationality that distributed responsibility and investment in ways advantageous to timber patrons and their intermediaries, *habilitación* also made for a profoundly moral relationship: not only to the extent it bound patrons and their riverine clients in relations of obligation, submission, and care that transcended the transactions themselves but also because in all cases, *habilitación* performed racialized hierarchies between Indigenous and rural workers and the urban patrons that provided them with industrial goods and money. *Habilitación*, therefore, became a vehicle of legitimation for social hierarchies, modes of exploitation, and knowledge asymmetries that would mark the social and political landscape of Loreto in the twentieth century (see Santos-Granero and Barclay 2000).

In time, the particular mathematical properties of the Doyle Formula came to play a critical role in fostering *habilitación* relations. To the extent that *habilitación* requires the calculation of timber volumes to estimate exchange value, volumetric calculation becomes a space fraught with ritualistic and moral undertones that reinforces enduring racialized relations between riverine dwellers (Indigenous and otherwise) and their occasional patrons. *Cubicación* is the name still given today to the act of performing formulaic measurements on a log to determine its volume. As timber industrialists and tradespeople cultivated networks of intermediaries to hold *habilitados* in various towns and basins all over Loreto, the figure

of the *cubicador*, the performer of *cubicación*, became a folkloric trope that indexed racialized relations of trickery and cunningness. Various riverine interlocutors I talked to told me about how, in the past, their grandparents would regularly find themselves tricked and paid unfairly by the intermediaries holding them as *habilitados*. Sometimes, trees would not even be volumetric, but remain merely voluminous entities in these transactions, as their grandparents would offer entire trees for a few pennies. As the century progressed and younger generations gained better mathematical foundations through schooling and a more robust involvement with the craft of regional commerce, riverine dwellers acquired a better understanding of the Doyle Formula and, accordingly, a better stance for negotiating timber volumes in *habilitación* relations.

Even today, however, a whole regional vocabulary describes the ways in which *habilitación* relations enact social injustice by effectively turning the volumetric calculations performed by *cubicadores* into weapons of racialized exploitation. As many forest engineers told me, for timber buyers in Loreto, “the profit resides in the purchase.” Terms such as *pase* (toll) and *castigo* (punishment) are conventionally deployed to name the discounts enforced by *cubicadores* by any kind of defect exhibited by a log. To “kill the volume” (*matar el volumen*) makes reference to the goal of this subtle craft: to detect rotten wood or small holes in the surface of a log and argue about them to shrink the calculated abstract volume of a log and pay less money. “If the *true* volume of a set of logs is 140,000 board feet,” Rolando, a senior forester in Loreto, told me, “then a skilled *cubicador* can easily lower that down to 90,000. It is an armed robbery!”

What emerges from this account is a constellation of tropes that place the *cubicador* as a mediating figure who skews timber volumes by tactically mobilizing costs of opportunity, patronizing forms of manipulation, and inequalities in calculational craftsmanship. Such craftsmanship, of course, does not happen in a vacuum. The skill set of the *cubicador* builds on the Doyle Formula’s own structural biases, which privilege future-oriented speculation and the execution of various kinds of discounts in the expectation of future yields. The relation of volumetric abstraction with material things that emerges here becomes a function of hierarchical relations of power that accommodate mathematical abstractions to the whims of industrial urban needs. Once logs depart from riverine towns toward the processing sawmills, timber industrialists take advantage of the tactical (mis) calculations secured by their *cubicadores* to increase their yields and profits. A shifting gap thus opens in the slow travel of logs from the riverine towns of *habilitados* to the industrial sawmills. In this displacement, the sociological and geographical

distance that someone might hold from Iquitos seems to be in direct correlation with the gradual shrinking of their volumes. As logs move closer and closer to timber-processing centers, volumes grow as if affected by magic, and the relation between the abstract and the concrete becomes more tractable and less polluted by trickery and manipulation.

At the turn of the twenty-first century, therefore, volumes were malleable creatures. To the extent that they did not remain identical to themselves as they moved around and changed hands, they did not exhibit self-consistency across time and space. Quite to the contrary, their contractions and inflations became artifacts of the hierarchical relations of trickery and exploitation that constituted Loreto's tropical timber supply chains. Such malleability made volumes unreliable objects of technolegal inspection. Since volumes could easily mutate from one situation to the next, state authorities could not use volumetric calculations to establish with any certainty whether the timber they would encounter in ports, deposits, and campsites was indeed illegal. How, for instance, would a state inspector manage to prove that the volume of *this* timber shipment was larger than the volume authorized by the FTP of the logging concession where it supposedly came from? How could they, on the basis of such difference, legally infer that, accordingly, a portion of such timber had an illegal origin? Answering such questions successfully became key for state technocrats concerned with how to bring transparency and accountability to a badly reputed tropical logging industry in the second decade of the twenty-first century. And yet, despite their self-proclaimed technicality, such questions also confront us with the ways even calculational abstractions like volumes remain entangled in complicated relations between abstraction and materiality that spring from larger configurations of power, history, and bodily experience.

### **SMALIAN: Taming Volumes**

By the late 2010s, a wave of international trade agreements, foreign aid commitments, and environmental campaigns had progressively changed the Peruvian state's traditional tolerance for the ubiquitous illegality of the tropical logging industry. The growing pressure brought by this emerging international climate eventually led state institutions to initiate a series of regulatory reforms aimed at securing the legal origin of tropical timber in Amazonia. Paramount among these reforms was the implementation of standardized guidelines and onsite inspections that aimed to enforce the self-consistency and precision of timber volumes across tropical timber supply chains. At this juncture, state authorities introduced a new volumetric formula, the Smalian Formula, as an alternative to the Doyle

Formula. Although the history of the Smalian Formula is not as well documented as Doyle's, some indications suggest it originated in the work of Heinrich Ludwig Smalian, a nineteenth-century German forester. By the late twentieth century, international institutions like the Food and Agriculture Organization promoted the Smalian Formula, and the Peruvian state timidly adopted it in non-binding guidelines. Yet throughout the second decade of the twenty-first century, the Peruvian state started to adopt a series of new calculational guidelines by means of which all administrative documentation concerning logging activities was progressively bound to be calculated in Smalian and not Doyle, a demand imposed not only on state officials but also onto loggers and traders themselves. In 2014, the Agency for the Supervision of Forest Resources and Wildlife (OSINFOR), the state institution in charge of conducting the onsite inspections of logging operations, also created a training program to foster the use of Smalian in Indigenous communities, with the understanding that the traditional Doyle Formula used by *cubicadores* worked to the detriment of their economic rights as small-scale loggers. The state enforcement and promotion of Smalian, therefore, has become ubiquitous in Peru during the past fifteen years.

According to proponents of these new technocratic regulations, the standardized application of the Smalian Formula across all aspects of timber harvesting, transportation, and trade would bring volumetric calculations into a new regime of transparency and accountability, where precise volumes would finally become trustworthy objects of technolegal inspection. For state technocrats advancing these regulatory reforms, Smalian constituted a way to homologize practices of measurement for all actors in the logging industry. But perhaps even more importantly, it offered a way to do this by capturing what they understood as the *true* volume of logs. In such a narrative, Doyle emerged as the legacy of a century of exploitation and illegality in the logging industry, where volumes were the protagonists of histories of trickery, inconsistency, and deceit. Smalian was showcased as an alternative to such a legacy because of its particular mathematical characteristics. Instead of just taking the smaller diameter of a log, Smalian took an average of its two extremes to work with a cylindrical representation halfway between the two. Further, Smalian, unlike Doyle, did not include bark discounts in its formulaic structure. And finally, measurements in Smalian were conducted in the metric system, making fractions easier to take and making rounding down unnecessary.

The combination of all these factors made the logs measured in Smalian speculative objects of a much less untamable nature, and provided log sellers—many of them still embroiled in *habilitación* relations—with a better standing

in bargaining for the value of their work. In contrast to Doyle, Smalian did not approach logs from the future-oriented standpoint of the timber industrialist. Rather, it aspired to achieve a fine-grained representation of logs as they were today, without negotiated discounts because of malformations or putrefactions. As a consequence, calculating with Smalian typically made volumes larger, subsequently translating into larger payments for timber sellers and lower profits for timber industrialists.

*The Smalian Formula*

$$V \text{ (in m}^3\text{)} = 0.7854 \times (DX)^2 \times L$$

Where...

DX = Average diameter

L = Length

Similarly, in contrast to the cunning trickeries performed by *cubicadores* with the Doyle Formula, the Smalian Formula was to be enforced following strict standardized protocols of measurement. Such idea became concretized in 2012, when state authorities issued a comprehensive protocol that standardized all measuring practices across Peru's tropical timber supply chains. The resulting document, known as the Convergence Protocol (*Protocolo de Convergencia*), compiles all possible field contingencies to provide standardized guidelines of measurement for any situation. Over the years, several iterations of the Convergence Protocol have followed, each incorporating more and more casuistry—different kinds of trees, different possible disputes—to eliminate the possibility of two acts of measurement ever significantly differing. By subsuming acts of measurement under strict formalized procedures, the goal of this process of convergence was to trivialize two factors seen as conspiring against the ultimate self-consistency of volumes. First, the role of field contingencies and heterogeneous situations—the differences that arose between measuring a log lying on the forest floor versus one floating in water, for instance. And second, the role played by the *cubicadores*' tactics of trickery and deceit in skewing volumetric calculations in favor of timber industrialists.

Yet in recent years, loggers and tradespeople have criticized such attempts to tame volumes through volumetric precision and standardization. Interestingly, such critiques do not revolve around technical discrepancies on the best way to standardize and coordinate acts of measurement. Rather, they usually point to the limits of standardization itself, that is, to the impossibility of calculational

abstractions like volumes to remain fully self-consistent across time and space. Testimonies of critical forest engineers and logging workers prove curious in this respect, as they defend the incommensurability of their practices of measurement by insistently dwelling on the microscopic frictions that inevitably shape volumetric calculations. Their descriptions abound in the small deviations of measuring tapes when pressured against a tree bark, the arbitrariness of what diameter to take when measuring the irregular flat side of a log, or the unstable movement of a log raft when one stands on it as it flows into the water. Importantly, when these microscopic frictions add up to yield disparate volumetric results, they can make a real difference in the world. “Sometimes, a state inspector might come, measures logs in your piling yard, and tells you it is all okay,” Diego, a forest engineer working for a logging concession, told me; “but then another one comes, measures the same log, and tells you that you have done it all wrong” (see [Figure 2](#)).



**Figure 2.** A measuring tape pressed against the bark of a tree.  
Photo by Eduardo Romero Dianderas.

Despite rising state demands for volumetric self-consistency, therefore, volumes remain today difficult to follow and stabilize on account of disparate styles of measurement and arbitrary judgments that conspire against their full coordination across time and space. Given this lack of self-consistency, a gray space of technical

interpretation emerges, where it is not entirely clear in the face of controversy whether the real responsible for a mismatch between two proposed calculations lies with an incompetent state inspector or a ruthless logger. For, as Diego concludes, “no two measurements can ever be totally alike.” This phrase points to the incommensurability that lies at the core of every act of measurement. And yet, what is needed for securing the success of today’s state-technocratic reforms is precisely a way to tame such incommensurability through converging modes of coordination that render the frictions of the rain forest and bodily experience into trivial matters.

An ambivalent situation emerges from this account. On the one hand, in the previous decade, volumes have indeed become quite self-consistent, at least across the more legal threads of the tropical logging industry. As the case of the *Yacu Kallpa* showed us, this has been achieved by mounting a complex infrastructure of standardization and coordination that has effectively disciplined, although never completely, the calculational practices that until the early twenty-first century boundlessly mediated tropical timber supply chains in Loreto. On the other hand, however, no measurement protocol or volumetric formula can ever fully extinguish the possibility that timber volumes are affected by violent legacies of racialized exploitation, or the irreducible eventfulness of an act of measurement, or the cunning tactics of deceitful *cubicadores*. Regulating volumetrics cannot magically produce a technocratic space perfectly legible from all sides and fully evacuated from history, power, and bodily experience. What we find, rather, is an ambivalent space in which the mathematical affordances of both formulas and the ritualized practices cultivated around them coexist and overlap with each other. And nowhere does this ambivalence emerge more clearly today than in the mundane act of buying and selling timber.

### A TALE OF TWO FORMULAS

The dawn was still dark when in the muddy shores of the sawmill we started to pile up our provisions for the upcoming two weeks. On the horizon, intense mixtures of orange and yellow started to light up the morning. “We need to hurry,” said Timao, a forest engineer working for the sawmill; “we do not have a navigation permit, so we need to leave Iquitos when it is still dark.” A few days before, Timao had introduced me to Zhao, a Chinese timber industrialist who about a decade ago had arrived in Iquitos to take advantage of the rising timber commerce between Peru and China. With Timao’s intermediation, Zhao had granted me authorization to join the crew that would depart today for the Pucayacu River. There we were to



visit the Indigenous community of Puca Urco, where an Indigenous logging brigade funded by Zhao had recently announced their log rafts ready for pickup. “Water is already going down,” Zhao told me, as he smoked a cigar and supervised the trip preparations from a corner; “you all need to hurry up” (see [Figure 3](#)).



**Figure 3.** Zhao’s crew prepare for work. Photo by Eduardo Romero Dianderas.

A day and a half after we had left Iquitos, our boat arrived to the mouth of the Pucayacu River, where the small port of Esperanza is located. Here, we were to wait for Pancho, a *cubicador* that Zhao had asked to join the crew. “He is the *cubicador* that Zhao trusts the most,” Timao told me, because “he really knows how to *see* the wood.” The next day, very early, Pancho arrived in Esperanza in a boat coming from the border with Brazil. He was a short, bulky man with curly hair and a cunning gaze. Pancho did not work exclusively for Zhao, for after earning a name as a good *cubicador*, he now had several clients across Loreto.

Pancho’s valuable calculative skills were not, of course, limited to taking mechanical measurements of cylindrical shapes. Sure, Pancho knew the subtleties of volumetric formulas and how to use them to his advantage. But as Timao said, Pancho knew how to *see* timber. And indeed, he did. For he proved a savvy examiner of the nuances in the logs he would be commanded to buy. He knew how to spot, just by carefully looking at and touching their surfaces, whether logs

concealed interior corruptions or diseases. He knew how to infer whether a small fissure could in fact announce the existence of a hidden large fracture. And he could cite with encyclopedic memory the various proclivities and properties of dozens of different species of wood: how to cure a heavyweight *Ishpingo* to make it float in the water; what portions of a *Tornillo* are more prone to rot; why felling trees in full moon negatively affects wood quality.

Pancho's was an analytical knowledge not only discursive and explicit but also embodied and sensuous. Every time he approached a log, he did so not only with his eyes and words. Rather, he smelled it, touched it, and even tasted it. Pancho's skill set as a volume calculator was thus deeply rooted in intimacy with the materiality of timber. But these skills were not restricted to knowing woods. He also knew how to *see* people. Once he would examine a given log raft, he deployed an elaborate set of persuasive techniques addressed at setting prices at his favor when bargaining with timber sellers. "I am not so bad as the other *cubicadores*, you know," Pancho told me, as we drank and the boat finally started to move upstream into the Pucayacu; "these are humble people who live of their work, so I also try to be fair with them." In this way, even if Pancho's craft depended on an intimate familiarity with the mathematical structure of the Doyle Formula, it simultaneously depended on a complex balancing of sensuous, speculative, and moral factors always held in tension. And so, calculational abstractions no longer seemed to escape from the vicissitudes of the world, but rather appeared intimately entangled in irreducible sensuous materialities and subtle techniques of negotiation.

"When you calculate the volume [*cubicas*], you have to always keep in mind the yard of the sawmill," Pancho said, while he smoked some black tobacco and set up his tent on the boat's deck. The calculative act of *cubicar*, in his view, was about maximizing profits by embracing the future-oriented view of the timber industrialist. And this could not be done just by considering the log as it seemed to be. Rather, Pancho's success as a *cubicador* depended on refiguring the log as a speculative object that concealed a potentiality in need of uncovering or, rather, of being successfully disputed. For this, he could not take refuge in the merely irreflective act of mechanical calculation. Quite to the contrary, he needed to bring together the mathematical affordances of the Doyle Formula and a deep, sensuous engagement with the peoples and things in front of him to become an emotionally savvy negotiator with his counterparts. Only then could the *true* volume, that is, the *useful* volume, of a log be determined, and less of Zhao's money would go to waste.

Of course, this was not the only *true* volume that emerged in the process of buying and selling timber. For at the same time that Pancho would calculate

the volume of each log with the Doyle Formula, Timao would be next to him conducting the same process with the Smalian Formula. “The Smalian is only for talking to the state,” continued Pancho, “just to submit our reports and pay taxes and those kinds of things.” Pancho’s take on Smalian as *just for talking* to the state framed it as a mere performative gesture that only stood as the true volume of timber for the eyes of state authorities. And yet, Timao could not fail to perform such calculations. The existence of such parallel acts of calculation, both happening simultaneously, side by side, and each claiming to be the *true* volume in different ways and for different publics, evoked the complex legacies and desires that converged in the humble practical act of buying and selling timber in contemporary Loreto. On the one hand, long intractable histories of racialized exploitation, trickery, and deceit. On the other hand, liberal technocratic hopes to make volumes precise and self-consistent.

After endless, meandering turns along the Pucayacu River, we finally arrived at Puca Urco. Once we landed, Ezequiel, the leader of Puca Urco’s logging brigade, warmly welcomed us and invited us to his house. After a round of catching up and some toasts, Timao, Pancho, and Ezequiel started to plan our activities for the next day. While they talked, I smoked black tobacco with Ezequiel’s father-in-law, Don Julio, an old Indigenous Bora man in his seventies. “When I was young, the patrons would come and buy our timber for pennies. And we just did not know. We just sold our wood to get whatever we could,” Don Julio said; “now is different. The engineer Timao is a good man, and the state comes and gives us training to learn how to measure our trees.” In Don Julio’s words, volumes insinuated themselves as creatures that could not be fully detached from the fraught legacies of the past. From the old exploitative offerings of patrons to contemporary hopes that better knowledge and state tutelage could bring redemption for prior harms, Don Julio’s comment captured the ways in which calculational abstractions like volumes could become an important terrain for redeeming enduring injustices against Indigenous peoples today.

The next morning, our work began in earnest. Ezequiel and his brigade departed in their boats before dawn to collect the log rafts they had left floating in nearby streams and channels. By early morning, they had spurred the log rafts in the river next to the port of Puca Urco, where they could be lifted by the boat’s huge crane and deposited in its frontal cargo space. Some of the crew members joined Ezequiel’s brigade in the water, where they spent the day swimming and walking on the log rafts, untying the logs and securing the crane’s hook onto each of them (see [Figure 4](#).) Once a log was firmly hooked, a crew member would

scream “Secured!” and the crane would immediately lift the log into the air and carefully pile it alongside the others. As crew members alerted me, this was dangerous work where the rushing rhythms of industrial efficiency would sometimes crash with the imperative of human safety and well-being. (I once witnessed a terrible accident in which a huge log hit a crew worker in the chest. Luckily, he survived.) Each time the crane released a log in the frontal cargo space of the boat, the whole deck would tremble and everybody would stare until the piles of logs looked stable again. Then, Timao, Pancho, Ezequiel, Don Julio, and I would all rush toward the new sitting log and measure it quickly before the next flying one would come and surprise us from the back. This ritual would take just a minute or two for each log. Pancho would first stare at the log and yell its species to us. Then, he would quickly measure its length and the diameters at both extremes in both imperial and metric units. Timao would then write down the metric measurements reported by Pancho in his small notebook to later determine the Smailian volume for each log.



**Figure 4.** Workers walk on log rafts to secure the crane. Photo by Eduardo Romero Dianderas.



Pancho's calculation with Doyle required some extra steps. As a newly arrived *Moena* log was left by the crane and Pancho ran to measure it, he turned to Ezequiel and said "OK, speak" (*Ya, habla*). The following, quick negotiation between the two men addressed whether any discounts would apply to the overall volume of the log, and why. "Three, four months ago, this wood was beautiful," said Ezequiel, trying to justify the rotten state of the wood on account of the crew's delayed arrival to pick up the logs. "Fissure? All this side is already rotten, my friend!" insisted Pancho, as he asked Timao to cut a small chunk of wood from a side of the *Moena* log. Then he smelled it. "You see? This does not smell like a healthy *Moena*. You believe me now? So how much will we discount then? Four inches?" "That is too much, let's go with two" replied Ezequiel. "My friend, there is clearly a huge hole within this log," Pancho replied. "Let's do it halfway—shall we say three?" Once Ezequiel conceded to Pancho's suggestion, the latter wrote down the agreed-on numbers in his little notebook with a subtle smirk. "That is how I like to do business. I do not want to trick you, my friend. They don't pay me to trick nobody," he said as he withdrew from the cargo space just before a new log came along (see Figure 5).



**Figure 5.** Ezequiel and Pancho measure a log. Photo by Eduardo Romero Dianderas.

Our workday came to an end after more than a hundred of these negotiations between Ezequiel and Pancho. As we all gathered for a card game in the

main deck of the boat, I could not help noticing that the two notebooks Pancho and Timao had been filling up all day sat on the table next to us (see [Figure 6](#)). Both notebooks looked alike, but the lives they were made to have differed markedly. One was destined to serve as an accounting tool for Zhao's sawmill so that he would know how many logs passed through its sawblades. If Pancho had been savvy enough, such numbers would be an underestimation of their final timber yield. And if not, Pancho would have failed as a cunning *cubicador*. In any case, they were made to join a long tradition of volumetric calculation born from speculating on the difference between what was paid to riverine workers and what was finally processed in sawmills. Conversely, the numbers in the other notebook, Timao's, would enter a different orbit. They would not feed industrial speculations, but would nurture technocratic aspirations of achieving precision and self-consistency at various scales. And as they were reported back to the state, they would become part of a variety of instruments—from national industrial statistics to technical operational inspections to fiscal payment datasets—that would participate of the hopeful rise a new logging industry committed to environmental transparency and accountability. In the gap that widened between the trajectories of both sets of numbers, the lives of Ezequiel, Don Julio, Timao, and Pancho emerged as disparate but related depictions of the ways in which, despite the increasing sophistication of contemporary technocratic endeavors, volumes remained deeply entangled in enduring affective landscapes of power, history, and bodily experience.



Figure 6. Pancho's notebook. Photo by Eduardo Romero Dianderas.

## THE POLITICS OF CALCULATIONAL ABSTRACTIONS

Learning how to inspect logs with Pancho casts a new light on the *Yacu Kallpa* intervention with which this article began. In newspaper articles and specialized reports at the time, the calculational abstractions recruited by state authorities to establish the illegality of the timber cargo appear as nothing more than docile technocratic currencies. The transcendental logic of volumes thus successfully dominates the imagination of commentators and analysts that constitute the privileged publics of rising technocratic interventions in Peru's tropical logging industry. In a way, this could and *should* not be otherwise. As we have seen, volumes need to emerge as docile and commensurable quantities that allow for sheer procedural efficiency, compelling technolegal inspection, and public accountability. As one imagines the smooth wooden textures of the timber cargo within the *Yacu Kallpa*, it does not matter that *this* timber board over there came from an internationally certified logging concession near Iquitos, whereas *that* other one was bought for pennies from impoverished Indigenous workers in the headwaters of a remote basin. At this point, we might never even know. What matters is how such wholes relate to calculated numbers, the way such numbers assign technolegal responsibilities, and the myriad technocratic operations that can now be performed on them to pursue particular kinds of decision making. Thus, history is concealed, power suspended, bodily labor evacuated. The immanent frictions of the world are contained to make space for the transcending authority of the technocratic state.

But as the present article has shown, this narrative remains incomplete, for calculational abstractions like volumes are also entangled in competing and irreducible forms of political imagination. The future-oriented structure of the Doyle Formula is embroiled in the legacies of the century-long racialized networks of exploitation that perfused the rain forests of Loreto during the twentieth century, whereas the state-enforced Smalian Formula carries today liberal technocratic hopes to make Peru's tropical logging industry subject to global standards of environmental transparency and accountability. Importantly, such entanglements are not reducible to specific forms of materiality, since the highly abstract mathematical structure of volumetric formulas constitutes them as fertile terrains for cultivating different projects, relations, and desires. Further, measurements taken on logs are also revealed as irreducibly eventful, for no two measurements can ever be identical. And sometimes, such irreducibilities add up to produce incommensurability and disjunction between two calculations of the same thing, thus opening ambiguous spaces of technolegal interpretation. These conditions produce calculational abstractions that depart in significant ways from the docile technolegal

currencies seemingly at stake in the *Yacu Kallpa* intervention. For once one follows volumes across logging campsites, sawmills, and Indigenous villages, they reveal themselves as ontologically ambivalent technolegal entities that are simultaneously transcendental mathematical units and creatures imbricated in long histories of racialized exploitation, deceitful practices of calculation, and the irreducible eventfulness of acts of measurement.

The desire for modes of knowledge uncontaminated by politics and subjective judgment is in many ways coterminous with late modernity (see [Daston 2007](#)). Today, climate change and biodiversity loss reinvigorate such desire via sophisticated modes of calculation aiming to make mathematical abstractions increasingly precise, auditable, and self-consistent at planetary scales. As the global environmental crisis demands ever more scalable technical infrastructures for rendering the Earth's materialities and environments into objects of intensive technocratic regulation, how are we to govern the relations that bind calculational abstractions with the materialities that they stand for, not only within particular countries or regions but also at planetary scales? And what sort of awkward place should we acknowledge to history, power, and bodily experience in the organization and circulation of such elusive calculational abstractions?

In pursuing such questions, the governance of tropical timber supply chains can be recast as a privileged laboratory in which to consider the effects of rising calculational controversies that lie at the heart of contemporary modes of global environmental governance. For while today vast technocratic interventions are deployed to render volumes as reliable planetary units of environmental transparency and accountability, the exploitative and deceitful legacies of Peru's tropical logging industry enduringly haunt attempts to bring tropical timber firmly into the orbit of global environmental governance. In this context, volumes do not work as technolegal entities that allow us to move seamlessly across calculational scales by transcending the frictions of power, history, and bodily experience. Rather, they become engrained in multiple temporalities, political goals, and historical legacies that destabilize the contentious relations between abstraction and materiality. Contemporary reforms to timber volumetric calculation procedures thus produce a rather paradoxical effect. For right at the moment when volumes become objects of intensive technocratic regulation, they also reveal themselves as fertile terrains for political and affective dispute. And as such, they become ethnographic prisms where to appreciate long and recalcitrant forms of political imagination and practice in contemporary Peruvian Amazonia and beyond.



**ABSTRACT**

*Recent years have witnessed the advancement of several technocratic interventions in the context of the global environmental crisis that aim to calculate and track different objects of environmental concern at various scales. In this article, I focus on how such technocratic interventions are transforming the processes by which tropical timber is technically rendered into calculational abstractions known as “volumes” in Peru’s tropical timber supply chains. Drawing on twenty-four months of fieldwork following the activities of loggers, timber industrialists, and state technocrats across Peru’s Amazonian region of Loreto, I show how calculational abstractions can never fully circumvent the frictions of power, history, and bodily experience. Rather, technocratic interventions aiming to standardize tropical timber-calculation procedures ultimately transform volumes into fertile ethnographic terrains from which to appreciate how competing forms of political imagination intersect and collide with each other as Amazonia enters the age of climate change and biodiversity loss. [Peruvian Amazonia; global environmental governance; volumes; calculational abstractions; calculation; tropical timber; climate change]*

**RESUMEN**

*Durante los últimos años, distintas intervenciones tecnocráticas han sido desplegadas en el contexto de la crisis ambiental global con el fin de calcular y trazar distintos objetos de preocupación ambiental a distintas escalas. En este artículo, me centro en cómo estas intervenciones tecnocráticas están transformando los procesos por los cuales la madera tropical es convertida en abstracciones calculacionales llamadas “volúmenes” dentro de las cadenas de suministro de madera tropical del Perú. Sobre la base de veinticuatro meses de trabajo de campo siguiendo las actividades de madereros, industriales y tecnócratas del Estado en la región amazónica de Loreto, muestro cómo las abstracciones calculacionales nunca pueden escapar del todo de las fricciones del poder, la historia y la experiencia corporal. Más bien, las intervenciones tecnocráticas que buscan estandarizar los procedimientos de cálculo sobre la madera tropical transforman los volúmenes en terrenos etnográficos fértiles desde los cuales es posible apreciar cómo distintas formas de imaginación política se intersectan y colisionan al tiempo que la Amazonía ingresa a la era del cambio climático y la pérdida de biodiversidad. [Amazonia Peruana; gobernanza ambiental global; volúmenes; abstracciones calculacionales; cálculo; madera tropical; cambio climático]*

*Acknowledgments* Funding for this research was generously provided by the Wenner-Gren Foundation, the Social Science Research Council, the National Science Foundation, and the Explorer’s Club. I thank the loggers, timber industrialists, state supervisors, and Indigenous leaders who offered me their valuable time and allowed me to walk with them in different parts of Loreto. Finally, I thank the two anonymous reviewers who provided careful feedback during revisions.

## REFERENCES

- Ballestero, Andrea  
 2015 “The Ethics of a Formula: Calculating a Financial Humanitarian Price for Water.” *American Ethnologist* 42, no. 2: 262–78. <https://doi.org/10.1111/amet.12129>
- Belyea, Harold  
 1953 “Log Rules, with Special Reference to the Scribner and Doyle Diameter.” *Southern Lumberman* 187: 276–86.
- Çalışkan, Koray, and Michel Callon  
 2010 “Economization, Part 2: A Research Programme for the Study of Markets.” *Economy and Society* 39, no. 1: 1–32. <http://doi.org/10.1080/03085140903424519>
- Campbell, Jeremy M.  
 2015 “The Land Question in Amazonia: Cadastral Knowledge and Ignorance in Brazil’s Tenure Regularization Program.” *PoLAR: Political and Legal Anthropology Review* 38, no. 1: 147–67. <http://doi.org/10.1111/plar.12091>
- Collingwood, George Harris  
 1952 “The Lost Identity of Doyle and Scribner.” *Journal of Forestry* 50: 943–44.
- Daston, Lorraine  
 2007 *Objectivity*. Cambridge, Mass.: MIT Press.
- Deringer, William  
 2018 *Calculated Values: Finance, Politics, and the Quantitative Age*. Cambridge, Mass.: Harvard University Press.
- Diaz-Bone, Rainer, and Emmanuel Didier  
 2016 “The Sociology of Quantification: Perspectives on an Emerging Field in the Social Sciences.” *Historical Social Research* 41, no. 2: 7–26. <http://doi.org/10.12759/HSR.41.2016.2.7-26>
- Espeland, Wendy Nelson, and Mitchell L. Stevens  
 2008 “A Sociology of Quantification.” *European Journal of Sociology* 49, no. 3: 401–36. <http://doi.org/10.1017/S0003975609000150>
- Global Witness  
 2017 “Compradores de buena fe: Cómo los exportadores de madera son cómplices en el saqueo de la Amazonía Peruana” [Buyers in Good Faith: How Timber Exporters are Complicit in Plundering Peru’s Amazon]. *Global Witness*.
- Göpfert, Mirco  
 2013 “Bureaucratic Aesthetics: Report Writing in the Nigérien Gendarmerie.” *American Ethnologist* 40, no. 2: 324–34. <http://doi.org/10.1111/amet.12024>
- Guyer, Jane I.  
 2014 “Percentages and Perchance: Archaic Forms in the Twenty-First Century.” *Distinktion: Journal of Social Theory* 15, no. 2: 155–73. <http://doi.org/10.1080/1600910X.2014.920268>
- Hetherington, Kregg  
 2011 *Guerrilla Auditors: The Politics of Transparency in Neoliberal Paraguay*. Durham, N.C.: Duke University Press.
- Hull, Matthew S.  
 2012 *Government of Paper: The Materiality of Bureaucracy in Urban Pakistan*. Berkeley: University of California Press.
- Lowood, Henry E.  
 1990 “The Calculating Forester: Quantification, Cameral Science, and the Emergence of Scientific Forestry Management in Germany.” In *The Quantifying Spirit of the Eighteenth Century*, edited by Tore Frängsmyr, J. L. Heilbron, and Robin E. Rider, 315–42. Berkeley: University of California Press.
- Marx, Karl  
 [1867] 1999 *El Capital (Volumen I)*. Trans. Wenceslao Roces. Buenos Aires: Fondo de Cultura Económica.

- Pinker, Annabel  
 2015 “Papering over the Gaps: Documents, Infrastructure and Political Experimentation in Highland Peru.” *Cambridge Journal of Anthropology* 33, no. 1: 97–112. <http://doi.org/10.3167/ca.2015.330108>
- Santos-Granero, Fernando, and Frederica Barclay  
 2000 *Tamed Frontiers: Economy, Society, and Civil Rights in Upper Amazonia*. Boulder, Colo.: Westview Press.
- Scott, James C.  
 1998 *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. New Haven, Conn.: Yale University Press.
- Verran, Helen  
 2001 *Science and an African Logic*. Chicago: University of Chicago Press.
- Viitala, Esa-Jussi  
 2016 “Timber, Science and Statecraft: The Emergence of Modern Forest Resource Economic Thought in Germany.” *European Journal of Forest Research* 135: 1037–54. <http://doi.org/10.1007/s10342-016-0992-5>
- Warde, Paul  
 2018 *The Invention of Sustainability: Nature and Destiny, c. 1500-1870*. New York: Cambridge University Press.