The politics of toxicity governance in Colombian gold mining

Christoph J. Kaufmann[1]

Universidad del Rosario, Colombia

Abstract

The most recent Global Mercury Assessment estimates that human-made mercury releases are approximately 2,220 tons per year and that a significant source is artisanal and small-scale gold mining (UNEP 2019). The ubiquity of mercury and its negative effects on human health and the environment have given rise to mercury governance schemes at different administrative scales, and Colombia banned the substance from mining in 2018. This ban is depicted as protecting the environment and human health from toxic mercury, but it has been highly contested within artisanal and small-scale gold mining communities. This contribution will show that the contestations of the mercury ban are intimately related to the deeply political and representational qualities of mercury held by artisanal and small-scale gold producers. Hence, mercury governance has become an important dimension of a broader negotiation over the place of historically marginalized and increasingly criminalized artisanal and small-scale gold producers in contemporary extractivism. The combination of legal framework analysis with semi-structured interviews and ethnographic work in two gold mining towns in Colombia provides a more nuanced and politicized understanding of local opposition to mercury governance that moves beyond simplistic assumptions about mercury users and their contaminated bodies.

Keywords: Toxicity governance, extractivism, conflict, Northeastern Antioquia, Colombia

Resumen

La Evaluación Global del Mercurio más reciente estima que las liberaciones de mercurio de origen humano son de aproximadamente 2.220 toneladas por año y que una fuente importante de estas liberaciones es la minería de oro artesanal y de pequeña escala (PNUMA 2019). La ubicuidad del mercurio y sus efectos negativos en la salud humana y el medio ambiente han dado lugar a esquemas de gobernanza del mercurio en diferentes escalas administrativas, y Colombia prohibió el uso de la sustancia en la minería de oro en 2018. Esta prohibición se ha presentado como una medida para proteger el medio ambiente y la salud humana del mercurio tóxico, pero ha sido muy cuestionada por las comunidades mineras artesanales y de pequeña escala. Esta contribución mostrará que las disputas alrededor de la prohibición del mercurio están íntimamente relacionadas con las cualidades profundamente políticas y representacionales del mercurio para los productores de oro artesanal y de pequeña escala. Por lo tanto, la gobernanza del mercurio se ha convertido en una dimensión importante de una negociación más amplia sobre el lugar que ocupan los productores de oro artesanal y en pequeña escala, históricamente marginados y cada vez más criminalizados, en el extractivismo contemporáneo. La combinación del análisis del marco legal con entrevistas semiestructuradas y trabajo etnográfico en dos pueblos mineros en Colombia proporciona una comprensión más matizada y politizada de la oposición local a la gobernanza del mercurio que va más allá de suposiciones simplistas sobre los usuarios de mercurio y sus cuerpos contaminados.

Palabras clave: gobernanza de la toxicidad, extractivismo, conflicto. Nordeste antioqueño, Colombia

---

[1] Dr. Christoph J. Kaufmann is senior researcher at the Center for Innovation for Mining and the Environment (CIMA) at Rosario University in Bogotá, Colombia. Email: christoph.kaufmann@urosario.edu.co. This contribution draws on PhD research at the University of Zurich on the effects of mining regulation on artisanal and small-scale gold production in Colombia. Acknowledgements: I want to thank the research participants in Colombia for their invaluable insights, time and trust that enabled this research. My gratitude also goes to Dr. Muriel Côte and Dr. Timothy Raeymaekers for their comments on previous drafts of this contribution, as well as the editors and anonymous reviewers whose feedback helped improve the article. In Swistun, D, Lugo-Vivas, D. A. & Vélez-Torres, I. (eds.) 2024. Toxic dispossession and environmental violence in Latin America. Special section, *Journal of Political Ecology*, 31.

Resumo

A mais recente Avaliação Global de Mercúrio estima que as emissões de mercúrio de origem humana são de aproximadamente 2.220 toneladas por ano e que uma fonte significativa destas emissões é a mineração de ouro artesanal e em pequena escala (PNUMA 2019). A omnipresença do mercúrio e os seus efeitos negativos na saúde humana e no ambiente deram origem a esquemas de governação do mercúrio em diferentes escalas administrativas, e a Colômbia proibiu o uso da substância para mineração de ouro em 2018. Esta proibição é descrita como uma protecção do ambiente e da saúde humana contra substâncias tóxicas, mas tem sido altamente contestado nas comunidades de mineração de ouro artesanal e em pequena escala. Esta contribuição mostrará que as contestações à proibição do mercúrio estão intimamente relacionadas com as qualidades profundamente políticas e representativas do mercúrio para os produtores de ouro artesanais e de pequena escala. Assim, a governação do mercúrio tornou-se uma dimensão importante de uma negociação mais ampla sobre o lugar dos produtores de ouro artesanais e de pequena escala, historicamente marginalizados e cada vez mais criminalizados, no extrativismo contemporâneo. A combinação da análise do quadro jurídico com entrevistas semiestruturadas e trabalho etnográfico em duas cidades mineiras de ouro na Colômbia proporciona uma compreensão mais matizada e politizada da oposição local à governação do mercúrio que vai além de suposições simplistas sobre os utilizadores de mercúrio e os seus corpos contaminados.

Palabras chave: Governança da toxicidade, extrativismo, conflito, Nordeste antioqueño, Colômbia

1. Introduction

In 2011, Segovia and the wider gold-producing regions of Northeastern Antioquia and adjacent Bajo Cauca, Colombia, were declared among the places in the world most polluted with mercury (Cordy *et al*., 2011). The substance is widely used in artisanal and small-scale gold mining (ASGM) because it allows for comparatively quick and inexpensive gold extraction. In addition, mercury amalgamation is suitable for processing small quantities of ore and requires less specialized technical knowledge than most other gold processing techniques (G. R. Davies, 2014; Cordy *et al*., 2011). However, mercury from artisanal and small-scale gold mining has been qualified as "the single most pressing issue impacting health and safety in the [ASGM] sector" (Smith *et al*., 2016, p. 44). Acute or chronic mercury exposure leads to several afflictions in human bodies, including damage to the nervous system and developmental impairments in fetuses and young children (WHO, 2016, pp. 7–9; see also Ekino *et al*., 2007; Basu *et al*., 2018). Releases of mercury also have negative effects beyond mining spaces because of long-range atmospheric circulation, and bioaccumulation in aquatic food chains (UNEP, 2019), making the substance a "pollutant of global concern" (UNEP, 2019, p. 53). Given the high rates of mercury emission from ASGM and the risks this poses to human health and the natural environment, it is not surprising that mercury abatement has become central to ASGM governance in and beyond Colombia.

In this article I discuss the ways in which mercury governance interacts with negotiations over the role of artisanal and small-scale gold production in contemporary extractivism. In 2013, efforts to govern mercury culminated in the Minamata Convention on Mercury. This was the first international, legally binding regulatory framework to cover the whole lifecycle of a heavy metal (Eriksen & Perrez, 2014). The objective of the convention is "to protect human health and the environment from anthropogenic emissions and release of mercury and mercury compounds" (UNEP, 2013b, Art. 1). In parallel to these international efforts, Colombia ratified national legislation on mercury and prohibited the substance in mining as of 2018 (Congreso de Colombia, 2013). Despite this ban, however, mercury continues to be widely used in non-industrial gold production. In January 2023, the Attorney General's Office alerted that Colombia had the world's highest per-capita mercury releases and convened a 'National Roundtable to Control Mercury.' At the event, the attorney general reaffirmed that it was "necessary to adopt zero-tolerance towards the use" of mercury, to restore damaged ecosystems, and to improve the efficiency of state responses to mercury and its users. Significantly, it was further underlined that the substance is predominantly used in "illicit activities" and that the "permissive stance" of state institutions towards the substance was based on the "wrong premise" that mercury users "defend artisanal and ancestral mining" (Procuraduría General de la Nación, 2023). This is symptomatic of a broader mechanism whereby the 'place' of artisanal and small-scale gold mining in relation to state-sanctioned extraction

is renegotiated through mercury governance. The question I address in this article is therefore not so much about how to make mercury governance 'work', but rather about the political work that mercury governance does in re-shaping mining legitimacy – even, or maybe exactly because, it does not 'work.' It is thus fundamental to consider the material qualities of mercury that make the substance suitable for ASGM gold production, but also that make it harmful to human health and the environment. Mercury toxicity has political ramifications that are embedded in broader dynamics of ASGM marginalization and criminalization.

The negotiation of mining legitimacy happens at a conjuncture where the non-industrial extraction of gold and other minerals provides livelihoods for an increasing number of poor and marginalized people in Colombia and across the so-called Global South (World Bank, 2020). However, this diverse set of practices is also portrayed as a particularly problematic feature of contemporary extractivism. The latter is due to the widely rehearsed negative impacts of non-industrial gold production that include exposure to mercury and other toxic chemicals, appalling labor conditions, and vulnerability to armed group interference (UNITAR and UN Environment, 2018; Schwartz *et al*., 2021; OECD, 2016). A core assumption that transcends most analyses is that persistent informality in artisanal and small-scale gold production is one of the root causes of the aforementioned negative impacts and that it is thus necessary to bring these activities into the legal economy (UNITAR & UN Environment, 2018; OECD, 2016; 2017; Buxton, 2013; Schwartz *et al*., 2021). The proposed formalization schemes have had little success, however, since an estimated 80-90 percent of non-industrial gold producers worldwide do not hold the necessary state licenses to operate 'legally' (World Bank, 2020, p. 1). The failure of state-sanctioned ASGM governance is generally explained as due to greed and a lack of formal education among non-formalized miners, as well as bureaucratic and financial impediments to implementing formalization schemes and less 'harmful' gold processing technologies (Veiga & Marshall, 2019; Hilson & Maconachie, 2017; Clifford, 2014). What these analyses often share is a more or less explicit depoliticization of state regulation, because of their strong focus on policy recommendations. The proposed improvements are important to make mining governance more viable, but it is also important to consider the political work that the depoliticizing dynamic does. In this article I aim to re-politicize mercury toxicity (see Meagher, 2021), and I do this by analyzing how mercury governance interacts with localized conflicts over legitimate gold production in Colombia.

Methodologically, I employ an extended case study because this allows me to trace how "[c]ontemporary policy-making processes have promiscuously spilled over jurisdictional boundaries, both 'horizontally' (between national and local political entities) and 'vertically' (between hierarchically scaled institutions and domains)" (Peck, 2011, p. 773). This research design thus pays attention to the ways in which mining governance frameworks and their underlying representations are "locally engaged, that is, negotiated, adopted, and contested in place and reworked through social networks" (Valdivia, 2005, p. 286). The extended case study design is a useful method to study the effects of paradigmatic representations of artisanal and small-scale goldmining for two reasons. Firstly, it is suitable to analyze "how policies-from-elsewhere are put to work by local actors, and how they are translated, contextualized, and embedded" (Peck & Theodore, 2012, p. 25). Secondly, an extended case-study design is "sensitive both to movement (for instance, transnationalizing policy models, peripatetic modes of expertise) and to those variable experiences of embedding and transformation underway in 'downstream' sites of adoption/emulation" (*ibid.*, p. 24). In sum, the crossing and combining of scales of analysis that characterizes an extended case study design enables the generation of knowledge about the localized repercussions of macro-level mechanisms (see Agard-Jones, 2013).

The necessary first step to study the politics of mining governance was to analyze the legal frameworks that regulate gold production in Colombia. I therefore chose 28 legal provisions that have emerged over the past few decades. The aims of these frameworks are to integrate 'extralegal' mining into the formal economy, to abate mercury, to sever the ties of gold with armed conflict, and to advance the political transition project. Understanding the evolution of these frameworks required contextualizing mining governance in broader politico-economic mechanisms on the national and international scales. My second data collection step, therefore, consisted in consulting a series of state reports on goldmining, mercury, armed conflict, and extractive development strategies. I then complemented this with the analysis of the ways in which Colombian legislation has incorporated international efforts to regulate artisanal and small-scale gold production; the 2013 Minamata Convention on Mercury is one important example of this. In order to bring politics back into debates around

mercury governance, I chose to supplement the policy and document analysis with semi-structured interviews with state actors at different administrative scales who are involved in implementing mining regulation, with people working in artisanal and small-scale gold production in Segovia and Remedios, and with mining activists.

Re-politicizing mercury toxicity requires considering the ways in which mercury alters and damages human and non-human matter,[2] but also the political work that mercury and its governance do in the negotiation over legitimate gold production. So, rather than taking toxicity as an intrinsic, essential quality of mercury, I conceptualize toxicity with Michelle Murphy (2017, p. 496) as resulting from "complex bundles of extensive relations." These relations include mercury, human and non-human matter that interacts with the substance, infrastructure that releases or captures or replaces mercury with other (toxic) substances, and the political-economic system in which these practices are embedded. Mercury governance is a way to re-shuffle these bundles of relations. Rather than an exclusively technical issue, persistent mercury use is therefore more adequately understood as "nested in, and influenced by, broader social processes and value systems" (Spiegel *et al*., 2018, p. 2). Mercury governance is therefore a profoundly political process because it is deeply embedded in a broader negotiation over the legitimate place of artisanal and small-scale gold production in contemporary extractivism. I argue that bringing politics back into debates around mercury governance is fundamental to more effectively decrease the risks emanating from the toxic substance, but also those risks to artisanal and small-scale gold producers that come from increased criminalization that is partially legitimated by the very toxicity of mercury.

This article draws on an emerging body of critical analyses of how exposure to toxicity is embedded in the political ecology of extractivism. In these approaches, toxicity is employed as a heuristic that:

> …can allow us to focus on how forms of life and their constituent relations, from the scale of cells to that of ways of life, are enabled, constrained and extinguished within broader power systems. Toxicity both disrupts existing orders and ways of life at some scales, while simultaneously enabling and maintaining ways of life at other scales. (Liboiron *et al*., 2018, p. 331)

Toxicity is thus deeply embedded in, and resulting from, uneven power relations. Perreault (2012), for example, writes that the accumulation of toxic substances from large-scale mining in agricultural fields facilitates the dispossession of indigenous *campesino* communities in the Bolivian altiplano. The uneven exposure to toxicity is therefore "entangled within community, ecological, colonial, racial, gendered, military, and infrastructural histories that have profoundly shaped the susceptibilities and potential of future life" (Murphy, 2017, p. 497).

This article adds another dimension to the debates around toxicity within political ecology by arguing that these uneven power relations are not only manifested in uneven exposure to toxic substances, but also in the ways in which specific forms of toxicity are regulated. This is visible in the fact that mercury harmfulness has been used to legitimate the increasing criminalization of historically marginalized artisanal and small-scale gold production networks. Incorporating political dimensions in the analysis of the "bundle of extensive relations" (Murphy, 2017, p. 496) that make up mercury toxicity is thus fundamental to understanding the ways in which mercury regulation interacts with a broader negotiation over the 'place' of artisanal and small-scale gold production in contemporary extractivism.

In order to develop this argument, I proceed in three steps. First, I analyze how politics was excluded from the discussion in the first place. I trace the ways in which knowledge about mercury toxicity has been

[2] This conceptualization draws on a broad body of literature that questions the dichotomy that separates 'the chemical' from 'the natural.' Within assemblage theory, for example, the different components that make up an assemblage are conceptualized as mutually constitutive and transformative. In this view, assemblages emerge through "a set of conditioning relations" that make "elements appear to be meaningfully related" (Nail, 2017, p. 25). Another school of thought, the so-called Actor Network Theory (ANT), has similarly conceptualized matter as "a source of action" that "can do things, has sufficient coherence to make a difference, produce effects, alter the course of events" (Bennett, 2010, p. vii, in reference to Latour, 1999).

produced, focusing on technoscientific knowledge of the interactions of mercury with (non-)human matter. This type of knowledge makes mercury toxicity visible to policymakers and scientists, but it also renders mercury abatement a predominantly 'technical' and therefore 'apolitical' issue. I destabilize this assumption in two ways. First, I use the specific temporality of mercury in order to include the toxic traces left from historical forms of capitalist production in the analysis of contemporary risks that mercury poses to (non-)human matter. Second, I show that quantitative studies of mercury traces in the environment and human bodies have become part of localized conflicts over 'legitimate mining' in Segovia and Remedios. After that I then proceed, in a second step of the argument, to describing the emergence of mercury governance frameworks that find their legitimation in technical studies of mercury toxicity. In that section, I bring politics back in, conceptualizing these governance frameworks as an ongoing negotiation where politico-economic interests intersect with environmental and health protection imperatives. In the last section of the article, I zoom in on Colombian mercury governance and its contestation in the study area to underline the importance of considering mercury as both a biophysical and a political substance.

2. The politics of technoscientific mercury

A key criterion used to legitimate mercury governance is technoscientific knowledge about the ways in which mercury alters and damages human bodies and the natural environment. The methods for generating such technoscientific knowledge of mercury toxicity include lab tests with (non-)human contaminated matter, medical analyses of the effects of mercury entering human bodies, thresholds that establish different degrees of contamination or poisoning, and studies on the metabolization of elemental mercury and the subsequent biomagnification of organic mercury compounds in aquatic and other organisms (UNEP, 2002; 2013a; 2019; Ekino *et al*., 2007; Basu *et al*., 2018; Gibb & O'Leary, 2014). This technoscientific knowledge has been fundamental for converting mercury toxicity into a coherent concept for policymakers. This happens mainly because technoscientific knowledge reduces the manifold "forces and relations" (Murray Li, 2007, p. 270) of mercury to its material characteristics. However, while the materiality of mercury makes the substance harmful to the natural environment and human health, it also makes it particularly suitable for the artisanal and small-scale production of gold. In this section, I will show how this technoscientific knowledge has played a role in localized conflicts over legitimate gold production in Segovia and Remedios. Before elaborating on this, however, I will briefly outline the ways in which mercury is released to the atmosphere and the multiple temporalities that influence contemporary risks that mercury poses to human health and the environment.

Mercury enters the atmosphere, aquatic systems, and human and non-human matter either through geogenic or anthropogenic pathways (Figure 1). Geogenic mercury is released through natural processes that include volcanic eruptions, the weathering of mercury-bearing rocks, and geothermal activity. It is estimated that geogenic sources account for approximately 10 percent of the mercury that currently circulates in the atmosphere (UNEP, 2013a, pp. 4–5). Conversely, anthropogenic mercury releases result from human practices. Today, artisanal and small-scale gold mining (ASGM) contributes approximately 38 percent to annual human-made mercury releases, followed by coal burning with 21 percent. In South America, 83 percent of mercury releases are from ASGM (UNEP, 2019). The exact amount of mercury that ASGM releases is unclear, but "may exceed the combined emission of coal combustion, cement production, chlor-alkali plant operation, and large-scale industrial mining and metallurgy" (Esdaile & Chalker, 2018, p. 6908, referring to UNEP, 2013a). This data legitimizes the need for mercury governance in artisanal and small-scale gold production, but a closer look reveals that the mercury that currently circulates in the atmosphere is also a vestige of past practices.

Human-made mercury releases surpassed the geogenic releases at the outset of the industrial revolution, when the use of mercury in industrial processes diversified and expanded (Hagan *et al*., 2011). This is relevant because mercury is often re-released several times through geological processes before it is permanently stored in lower sediments. The 2019 Global Mercury Assessment (UNEP, 2019, p. 8) estimates that the atmospheric mercury budget consists of approximately one third of new releases and two thirds of re-releases. The same report states that "[h]istorical emissions up to the end of the 19th century, mainly from gold and silver mining in the Americas, and mercury (cinnabar) mining and refining contributed more to the present-day anthropogenic mercury in soils and the oceans than all 20th century industrial sources combined" (*ibid*., p. 3). A study on toxic

residues from a closed industrial complex in China that used mercury similarly indicates that "the plant and its remaining Hg [mercury] wastes […] still represent strong sources releasing Hg to the surrounding natural area" (Zhu *et al*., 2018, p. 725).

There are no studies that specifically measure historical mercury emissions in Segovia and Remedios. However, the biophysical characteristics of the substance indicates that the amount of mercury in the natural environment and human bodies in places with a long history of mining also needs to be conceptualized considering multiple temporalities, even if industrial mines in Colombia have changed their processing technologies and mercury is today exclusively used in non-industrial gold production.

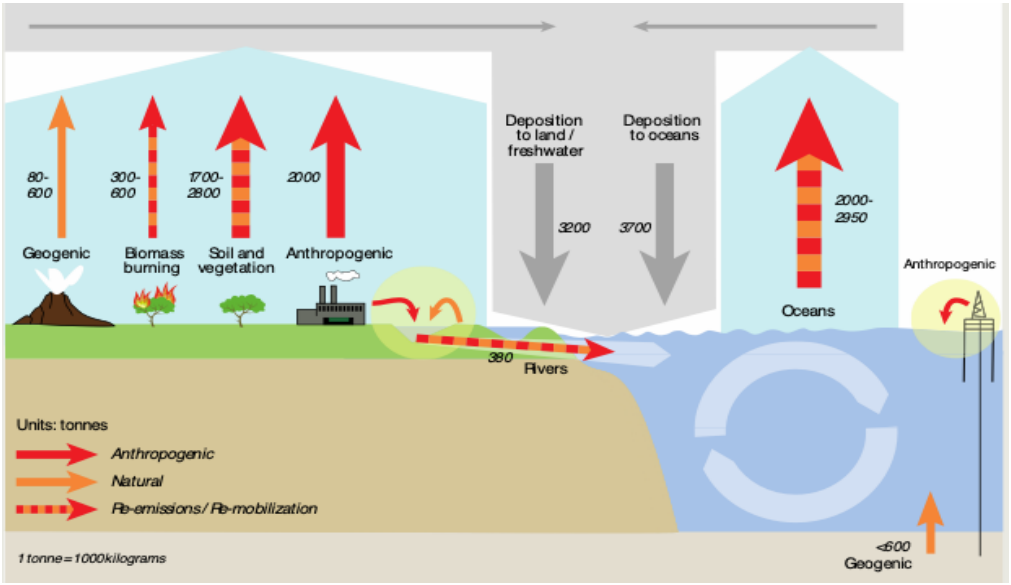

Figure 1: Global mercury cycle, retrieved from the 2013 Global Mercury Assessment (UNEP 2013a, 5).

Mercury also has negative repercussions on human and non-human matter beyond the spaces where the substance is released. This is related to the ways in which it circulates in the atmosphere, as well as to how it interacts with organisms. Once mercury enters waterways, bacteria transform inorganic mercury into particularly neurotoxic methylmercury (MeHg). This organic mercury subsequently bioaccumulates and biomagnifies in the aquatic food webs (Basu *et al*., 2018) and the ingestion of contaminated fish and shellfish has been referred to as "the form of greatest concern" (UNEP, 2002, p. iii) of human mercury exposure beyond mining spaces. The most infamous case of MeHg poisoning happened in the Minamata Bay area in Japan, where a factory produced acetaldehyde and dumped mercury-contaminated waters in a river. The consumption of contaminated fish and shellfish – the main protein source of the local communities – led to serious nerve damage and congenital affliction of babies that were born to mothers with high levels of methylmercury in their bodies. The congenital diseases included "severe cerebral palsy, blindness, and profound mental retardation" (Gochfeld, 2003, p. 177). These and other symptoms of mercury poisoning comprise what has been coined "Minamata Disease". The politicization of mercury toxicity thus requires considering the ways in which mercury releases have been embedded in specific economic activities, the place that these activities occupy in the global capitalist system, and the multiple temporalities and geographies of mercury exposure.

Notwithstanding these complexities, there is a strong tendency in policymaking and political discourse to isolate specific aspects of the "complex bundles of extensive relations" that characterize its toxicity (Murphy, 2017, p. 496). The "cult-like following from scientists" who use technoscientific data to "draw attention to, and reemphasize" the risks that mercury from ASGM poses to human health and the natural environment is one

example of this (Hilson *et al*., 2020, p. 123). In a context in which the place of artisanal and small-scale gold production in state-sanctioned extractivism is being struggled over, these studies have profoundly political effects. After describing mercury use in contemporary ASGM in Segovia and Remedios, as well as its health effects, the remainder of this section will show how technoscientific data has become part of localized conflicts over legitimate mining in Segovia and Remedios.

In Segovia and Remedios, gold extraction with mercury happens in artisanal gold processing facilities, locally known as *entables.* These processing plants are concentrated in the urban perimeters of the two municipalities. The artisanal and small-scale miners bring their ore to one of these *entables* where it is introduced into small ball mills (so-called *cocos,* Figure 2). *Entable* workers then add water and mercury to the *cocos* and let the mills turn for several hours. This allows for mercury to amalgamate with the free-floating gold particles. Once this is done, the workers take the material out of the *cocos*. Mercury is heavier than the sludge and this allows the workers to recover the amalgam. The workers therefore first remove a large portion of the sludge by adding more water, and subsequently remove the heavier parts of the mixture to recover the amalgam. This last step generally involves the use of a traditional gold pan or *batea* (Figure 3). The recovered amalgam is then squeezed through a cloth to remove mercury that has not amalgamated with gold particles (see Figure 4). The 'dry' amalgam is subsequently brought to a gold smelting shop, where it is burned (see Figure 4, 5).[3] The tailings still contain a certain amount of gold and in some *entables*, the sludge is put in tanks where more water and cyanide are added.[4] Cyanide allows the recovery of smaller gold particles, but tailings that contain both mercury and cyanide are particularly toxic (Verbrugge *et al*., 2021). Mercury escapes throughout this process: when the ball mills are emptied; when the amalgam is squeezed through the cloth; when the contaminated tailings leach into waterways; and when the amalgam is burnt.

Figure 2: Workers operating ball mills (*cocos*) in artisanal gold processing facility. Visits to *entables*, Segovia, 11 May 2019. Photograph by author.

[3] Field notes, Segovia, 11 & 28 May 2019; see also Cordy *et al*., (2011); García *et al*., (2015).

[4] Cyanide can be legally purchased in specialized shops in Colombia (El Nuevo Siglo, 2019). Although cyanide is more efficient to extract gold and degrades more easily through natural processes than mercury (Alvillo-Rivera *et al*., 2021), cyanide is more immediately toxic than mercury. The ingestion of as little as 200 milligrams of cyanide is generally lethal to humans (El Nuevo Siglo, 2019). Additionally, the improper management of cyanide-contaminated waste from mining poses serious risks to the natural environment (Chaparro Ávila & Güiza-González, 2020).

Figure 3 (left): Traditional gold pan (batea) used to recover the mercury amalgam in artisanal gold processing. Figure 4 (right): Worker recovering mercury amalgam by squeezing it through a cloth. Visits to entables, Segovia, 11 May 2019. Photographs by author.

Figure 5 (left): Gold smelter for artisanally mined gold. Figure 6 (right): Amalgam burning in gold smelter for artisanally mined gold. Visits to gold smelting shops, Segovia, 11 May 2019. Photographs by Author.

In 2011, Cordy *et al.* (2011, p. 154) alerted that the estimated 150 tons of mercury released each year into the environment by ASGM in Colombia gave "this country the shameful first position as the world's largest mercury polluter per capita from artisanal gold mining," and the third biggest source of mercury releases globally (*ibid.*, p. 155). The authors estimated that gold mining in Northeastern Antioquia and adjacent Bajo Cauca regions contributed 62 percent of the total mercury releases from Colombian gold mining that year (*ibid.*, p. 154). Re-emphasizing the risk this poses to human health and the environment, Siegel (2013, p. 451) warned that "[g]round level concentrations of atmospheric mercury from small-scale mining in Antioquia, Colombia, are so high that experts fear an environmental health crisis worse than any caused by mercury since Minamata, Japan, in the mid-twentieth century." Indeed, a study with 50 miners from Segovia, conducted in 2012, showed that:

> …all selected individuals who had urine analyzed revealed levels of total mercury above 100 µg Hg/g of creatinine, which is the level where an individual has high probability of developing clinical symptoms of mercurialism [intoxication with mercury] (WHO, 2007). About 24 % of these individuals showed tremors, 6 % showed muscular aches, 2 % had lost teeth, 78 % had short-term memory problems […], 24 % had visual-motor problems, 8 % had problems with space-time orientation and 6 % demonstrated audio-attention problems (García *et al*., 2015, p. 247).

Mercury also affects the kidneys and liver, and may lead – in extreme cases – to death (Ekino *et al*., 2007; Yorifuji *et al*., 2011). Additionally, mercury has harmful effects on the developing brain of embryos because mercury "readily passes the placental barrier and the blood-brain barrier" from the mother to the unborn child (UNEP, 2002, p. 35), which adds yet another layer to the complex temporalities of mercury toxicity.

These brutal effects of mercury on the bodies of those who work with mercury and/or live in proximity to *entables* and smelting shops in Segovia and Remedios have prompted technical interventions to decrease the risks emanating from mercury. These adaptations consist of two approaches: 1) technologies that make mercury more efficient in recovering gold, thus requiring less initial mercury input, and 2) technologies that allow the recuperation of a higher percentage of mercury used in the gold recovery process (Cordy *et al*., 2013). Although qualified as "successful" in reducing mercury inputs and releases in Segovia and Remedios (García *et al*., 2015), these technical adaptations have become illegible to the state because Colombia officially banned mercury from mining in 2018. The mercury ban also contributes to the criminalization of artisanal and small-scale gold producers who continue to use mercury, as the example from the National Roundtable on Mercury in the Introduction to this article illustrates. However, there is a concomitant dynamic wherein non-industrial gold producers in the study area use technoscientific studies of mercury to reclaim their 'responsible' use of the substance. These studies are significant because they illustrate how apparently apolitical, technoscientific studies on mercury interact with localized conflicts over legitimate mining.

In 2019, the ASGM organization *Mesa Minera* commissioned a report with the University of Antioquia to measure mercury in air, water and humans in Segovia (Restrepo, 2020). The report found that the amount of mercury used in ASGM where technologies had been adapted was reduced by "more than 75 percent" and that the rates of mercury in air also decreased significantly. The report states that this improvement was possible because of technical support from Antioquia University, a shift in technologies, and a "change of mentality" in miners and municipal authorities. Interestingly, the head of this project told the University newspaper that "the community told us that they needed our presence, our technical advice, our services and everything that has to do with the implementation of clean technologies (*tecnologías limpias*) to diminish or completely eradicate mercury use" (Restrepo, 2020). He then specified that *Mesa Minera* facilitated field access to the research team. In a context where the definition of legitimate mining is being negotiated, this representation of the local mining community and *Mesa Minera* is meaningful because it underlines the importance of technoscientific knowledge not only for state authorities, but also the ASGM gold producers and their political organization. It seems as if *Mesa Minera* and the wider small-scale mining community wanted to show with this new dataset that ASGM gold producers in Segovia and Remedios are not as resistant to changing their processing techniques as is

generally assumed. The technoscientific studies of mercury releases and toxicity thereby serve as a political device that is strategically mobilized to legitimate specific forms of extraction. Rather than exclusively 'technical,' mercury has been rendered a political substance through which access to gold production is mediated and legitimated.

Understanding the ways in which mercury interacts with the negotiation over the place of artisanal and small-scale gold production in contemporary extractivism requires a closer look at the ways in which the substance has been regulated. In what follows, I will therefore trace the emergence of international and Colombian mercury regulations that locate their legitimation in technoscientific studies. In focusing on the ways in which these regulatory frameworks have been negotiated, I will show how the apparently apolitical goal of protecting the environment and human health from mercury has been embraced by specific political and economic interests that shape the ways in which toxic substances are regulated.

3. The genealogy of mercury governance

The UN Convention on Mercury or Minamata Convention is the first international, legally-binding framework to regulate the life-cycle of a heavy metal (H. Selin *et al*., 2018). The goal of the Convention is "to protect the human health and the environment" (UNEP, 2013b, Art. 1) from the harmful effects of mercury in all its biophysical manifestations. Celebrated as "an impressive and stimulating proof of how successful multilateralism can be to solve global problems and challenges" (UNEP, 2017, p. 7), the integral character of the Minamata Convention is generally depicted as a significant change in the landscape of international environmental frameworks, as previous agreements only regulated certain aspects of toxic substances (Eriksen & Perrez, 2014). The Minamata Convention can be seen as the culminating point of a process that converted mercury toxicity and the need to regulate the substance into a "coherent concept" for policymakers (see Foucault, 1969/2002)[5]. Yet, as I will show in this section, this coherence of technoscientific mercury toxicity invisibilizes the politics of negotiation and the uneven effects of mercury regulation on different types of economic practices. Before elaborating on this further, I will briefly outline the history of mercury governance prior to the enactment of the Minamata Convention.

The large-scale mercury poisoning in the Minamata Bay area accelerated technoscientific knowledge production about mercury and its toxicity. This knowledge was subsequently used as the empirical basis of elaborate mercury governance frameworks that have been emerging since the 1950s.[6] On a global scale, these treaties include the so-called Basel Convention that regulates the international trade and disposal of mercury-containing waste (UNEP, 2014 [1989]) and the Rotterdam Convention that regulates the international trade of the substance itself (UNEP & FAO, 2020 [1998]).[7] The regulation of mercury contamination gained new momentum with the publication of the first Global Mercury Assessment in 2002 that found "sufficient evidence of significant global adverse impacts [of mercury] to warrant international action to reduce the risks to human health and/or the environment" (UNEP, 2002, paragraph 139).

The question of *what* such a regulation should look like continued to be debated. There were three options: first, a freestanding legally binding international treaty; second, voluntary international cooperation;

[5] Foucault defines a "coherent concept" as a concept "whose content and usage had been established once and for all" (Foucault 1969/2002, p. 38). Yet, as the author also observes, this coherency contrasts with the complexity of realities and political-economic rationales. Rather than seeking an "architecture of concepts sufficiently general and abstract to embrace all others", therefore, he suggests analyzing the "simultaneous or successive emergence" of different, sometimes incompatible, concepts and "the interplay of their appearances and dispersion" (*ibid.*, 38-39). In this article, I analyze two concomitant dynamics that contribute to a more nuanced and grounded understanding of the effects of the seemingly coherent mercury toxicity: firstly, the interactions of technoscientific knowledge and political-economic rationales in the negotiation of mercury governance frameworks; and, secondly, the impacts of this seeming coherence with the complexities of mercury-use in an extractive space where different rationales to gold production compete for legitimacy.

[6] For an overview of international and regional agreements that address mercury, see UNEP, 2002, p. 196.

[7] The Basel Convention was signed in 1989 and ratified in 2001. The Rotterdam Convention was signed in 1998 and ratified in 2004. Interestingly, the Stockholm Convention on Persistent Organic Pollutants (signed in 2001 and ratified in 2004) does not list organic mercury compounds, even though they are widely considered to be particularly harmful to human health.

and, third, the inclusion of mercury in already existing governance schemes. The third option was soon discarded because the aforementioned treaties were seen to not be encompassing enough to address the complexity of mercury contamination (Andresen *et al*., 2013, pp. 429–430). The decision to adopt a legally binding as opposed to a voluntary instrument mandated by the UNEP Governing Council in 2009 (GC-25/GMEF, 2009, p. 8) illustrates the entanglements of toxicity governance frameworks with political-economic rationales. Those favoring a voluntary approach argued that this would be more cost- and time- efficient, and "China and India argued that a legally binding approach could limit the right to economic development for which mercury emissions were unavoidable" (Eriksen & Perrez, 2014, pp. 196–197). Conversely, in Latin America and Africa, most mercury is released through ASGM (UNEP, 2019, p. 12), a set of practices that governments generally view as impeding the implementation of neoliberal developmentalist agendas. The negotiation of 'acceptable' externalities of toxicity governance is therefore likely to be related to the ways in which contaminating practices are embedded in the political economy of a country.

The Minamata Convention was signed in October 2013 and came into force on 16 August 2017, and mercury releases from ASGM were addressed early on in the negotiations that led to its signing. While some countries lobbied for a mercury ban in these extractive practices, others favored a more flexible approach (Eriksen & Perrez, 2014). Recognizing that ASGM is a significant livelihood strategy in many gold-rich regions "that will only shift to the black market if suppressed" (Sippl, 2015, p. 199), the parties agreed that the releases from ASGM should be governed through a combination of compulsory and voluntary measures. Rather than banning mercury from ASGM, the Convention thus requires that "[e]ach Party that has artisanal and small-scale gold mining and processing […] within its territory shall take steps to *reduce, and where feasible eliminate*, the use of mercury and mercury compounds in, and the emissions and releases to the environment from, such mining processing" (UNEP, 2013b, Art. 7, emphasis added). The focus on reduction and technological adaption, rather than prohibition, was also the position the Colombian delegation held during the negotiations[8] – even if Colombia banned mercury in its national legislation.

In 2013 Colombia passed Law 1658, its first national mercury legislation. The Colombian Foreign Ministry celebrated this law, saying that it "allowed the country to be at the forefront in the implementation of international obligations" (Cancillería de Colombia, 2020). Colombia had already participated proactively in the elaboration of the Minamata Convention, but only ratified the treaty on 26 August 2019 (*El Tiempo*, 2019b). Interviewees that have been involved in national mercury regulation and/or its implementation interpret this disconnect between 'official' narratives and the slow ratification as resulting from complex bureaucracy and political priorities.[9] Environmental organizations therefore lobbied in the legislative bodies to push forward the ratification and to raise awareness about mercury toxicity. Mauricio Cabrera Leal from World Wildlife Fund (WWF)[10] explained that his organization had published a report that found "terrible results" of mercury contamination and subsequently launched a social media campaign to "put pressure" on the government to sign and approve the Law necessary to ratify the Convention.[11] Technoscientific knowledge of mercury toxicity was thus strategically used to reassert the importance of ratification, but this knowledge had to be translated into a political priority through lobbying and campaigning. This illustrates the interactions of technoscientific knowledge with mechanisms that render mercury 'technical' or 'political.'

Contrary to the slowness of ratification, the national legislation stipulated an ambitious timeframe to eliminate mercury emissions from the Colombian economy. Law 1658 establishes that mercury is to be eliminated from mining within five years and from industrial processes within ten years after the enactment of the law (i.e., 2018 and 2023, respectively) (Congreso de Colombia, 2013, Article 3). These different time frames point to uneven power relations in the negotiations of Law 1658. Mauricio Cabrera Leal told me that the industry association ANDI lobbied for more time to eliminate mercury from non-mining industrial processes. However, the main users of mercury are artisanal and small-scale gold miners, and "there was nobody who would fight

[8] Interview with Mauricio Cabrera Leal, WWF, Bogotá, 2 February 2019.

[9] Interview with functionary at Ministry of Environment and Sustainable Development, Bogotá, 26 February 2019; interview with UNDP advisor, Bogotá, 28 February 2019.

[10] He specifically requested me to use his full name in publications.

[11] Interview with Mauricio Cabrera Leal, WWF, Bogotá, 2 February 2019.

on their behalf to extend the time (*no hubo nadie que peleara por ellos para extender el tiempo*)" allowed to implement mercury-free technologies.[12] Political-economic capital clearly shapes possibilities of influencing the codification of 'legitimate contamination' in environmental governance.

Even though there is now a national law that prohibits mercury in mining, the details and operational implementation of this regulation are faced with barriers. The question of environmentally sound storage of mercury and mercury-wastes is a good example of what can happen when new legislation 'lands on the ground.' The current Police Code, updated in 2016, allows the police to confiscate mercury and other chemical substances "used in the process of exploration, exploitation, and extraction in illegal mining [sic]."[13] (Congreso de Colombia, 2016, Art. 108). Yet, when the Police Code came into force, there was no facility in Colombia to store the confiscated mercury. The United Nations Industrial Development Organization (UNIDO) representative in the Andean Region observed that mercury is confiscated "in larger quantities, but it is not very clear what to do with this mercury. In other words, there is no system yet to store it safely" (Deutsche Welle, 2019). This is symptomatic of a recurrent dynamic where national legislation can be quite disconnected from the realities on the ground (see Robles Mengoa & Urán, 2020).

In this section, I have shown that mercury governance schemes emerge through a combination of technoscientific knowledge around its toxicity, a negotiation and codification of 'acceptable' externalities of economic practices, and the uneven political-economic capital of mercury-users. Technoscientific studies are therefore just one ingredient in the conversion of mercury toxicity into a governance issue. These political dimensions become even more apparent when considering the ways in which the 2018 mercury-ban interacts with a broader negotiation of the 'place' of artisanal and small-scale gold production in contemporary extraction. In the remainder of this article, I will therefore describe the political work that mercury does in re-shaping mining legitimacy in Segovia and Remedios. I will first introduce the state strategy to eliminate mercury from Colombian gold production, then show how artisanal and small-scale gold producers relate the mercury ban to dynamics of criminalization, and, finally, examine the political effects of legalistic approaches to mercury governance on the negotiation of what form of mining can be legitimate in Segovia and Remedios.

4. The effects of the mercury ban in Segovia and Remedios

The strategy to eliminate mercury from artisanal and small-scale gold production in Colombia consists of three pillars: one, the control and elimination of mercury use; two, the implementation of mercury-free technologies; and three, the establishment of a label that certifies that the gold was extracted without using mercury (Congreso de Colombia, 2013). However, the reduction of mercury abatement to a technical and educational issue (that is visible in this strategy), and the broader literature and policy discourses, obscures the deeply political effects that banning the substance has had in places like Segovia and Remedios. These political effects take form around interactions of the mercury ban with an increasing marginalization and criminalization of historically legitimate, but predominantly informal artisanal and small-scale gold production. The political dimensions of mercury and its regulation need to be taken seriously if mercury-free technologies are to be implemented sustainably.[14] Re-politicizing mercury is a key to effectively reducing the risks emanating from the substance because it allows us to conceive these risks in broader terms that bring health and environmental aspects together with the political, socioeconomic, and cultural dimensions of mercury use. These dimensions

[12] Interview with Mauricio Cabrera Leal, WWF, Bogotá, 2 February 2019.

[13] The Police Code mentions zinc, borax, cyanide, and mercury.

[14] Mercury-free technologies can be categorized into two types. Firstly, there are gravimetric methods to concentrate gold (Vieira, 2006). Secondly, there are techniques that employ chemicals deemed more environmentally friendly than mercury, such as borax or cyanide (Veiga *et al*., 2014). However, the suitability of a given processing technology depends on the mineralogical makeup of the ore and there is thus no 'blueprint' approach to technological adaptation (Chaparro Ávila & Güiza-González, 2020). This can be a hinderance for small-scale gold producers, given that the most favorable technologies for small-scale processing should be "fast, easy and cheap, i.e. any change should be accompanied by a rapid rate of return, increased simplicity and a low investment (or reasonable investment countered with appreciable returns)" (Hinton *et al*., 2003, p. 102; see also G. R. Davies, 2014).

are fundamental to understanding why mercury use persists in mining settings (see Spiegel *et al*., 2018; Bugmann *et al*., 2022) and should therefore receive a central role in its governance.

Ethnography is uniquely suited to grasp these dimensions of mercury use. It allows grounding the multiple dimensions of mercury use in its specific setting, thus contributing to a better understanding of the contradictions that have emerged through the failing implementation of its state-sanctioned governance. The following episode that took place during fieldwork gives insights into the ways in which mercury toxicity interacts with a broader negotiation over legitimate mining in the study area.

"Mercury doesn't bite, you know. You will see. You won't lose your hand when you touch it", said Fredy.[15] Fredy agreed to show me the most traditional gold processing technique where the ore is milled manually before amalgamating it with mercury, and his brother Jeferson wanted to take pictures. They wanted me to experience the strenuousness of artisanal gold processing. More notably, however, it seemed to be important to them to show me that mercury is not as bad as it is generally depicted. Especially Fredy was skeptical about the harmfulness of mercury on human health and repeated on several occasions that he had been exposed to the substance for a long time and did not feel any negative effects. The small amount of mercury that Fredy acquired for this occasion was in a plastic bottle. Fredy quickly showed me the mercury before putting the bottle back into a black plastic bag. He seemed to be uncomfortable and aware that the possession and purchase of mercury had been made illegal in Colombia in mid-2018. I carried a small bag with me and proposed to put the bottle into the bag. Fredy agreed, and jokingly said that we now needed two bodyguards to keep us safe and protect us from the police.[16]

This episode speaks to both the material characteristics of mercury and its political effects in the negotiation over the 'place' of artisanal and small-scale gold production in state-sanctioned extraction. The materiality of mercury contributes to "spatiotemporal complexities" (T. Davies, 2018, p. 1538) because mercury intoxication rarely manifests in immediate health symptoms. Similar to Fredy, another small-scale miner who has been exposed to mercury for a long time insisted that he did not show the symptoms, such as tremors, typically associated to mercury intoxication.[17] A municipal functionary also indicated that "a myth has been created around mercury" and he related this 'myth' to international regulatory frameworks, particularly the Minamata Convention, which requires Colombian authorities to adapt national regulations.[18] Notwithstanding this, however, a municipal health officer told me that "all the studies that were done" to measure mercury in human bodies showed high levels of mercury and that it is thus "unlikely that anyone living in Segovia doesn't show symptoms of mercury exposure" (see also García *et al*., 2015).[19] At first sight, the contestations of mercury toxicity despite high rates of contamination seem to confirm the "most widely accepted explanation" for the continued use of the substance in ASGM: namely, that miners simply "refus[e] to accept the link between cause and symptom" of mercury toxicity and bodily damage (G. R. Davies, 2014, p. 114). As I will develop in this section, this assumption is symptomatic of the political work that mercury does. The biophysical characteristics of mercury are used to legitimize its governance, but this disregards the spatiotemporal ambiguities of mercury intoxication and the political relations that are mediated through mercury. The question I address in this section is therefore not so much about mercury toxicity as such, but rather about the ways in which mercury governance interacts with the renegotiation of mining legitimacy in Segovia and Remedios.

The political relations mediated through mercury become visible when considering the contested place that artisanal and small-scale gold production occupies in the contemporary extractive landscape in and beyond Colombia. There have been sustained efforts to expand state control mechanisms to improve the socioenvironmental sustainability of gold, and this effort has also been part of mercury abatement strategies across artisanal and small-scale mining settings (see UNITAR & UN Environment, 2018). The head of the departmental mining office told me in an interview that they are "in a campaign to fight mercury with

[15] Names anonymized.

[16] Field diary, Segovia, 28 May 2019.

[17] Visit to artisanal and small-scale mines, Remedios, 16 March 2019.

[18] Given that this statement is quite controversial, I refrain from disclosing more details about who said it.

[19] Interview with municipal health officer, Segovia, 30 May 2019.

formalization" and that their "permanent fight is with informal miners that continue to use" mercury.[20] Artisanal and small-scale gold producers in Segovia and Remedios perceived the fight against mercury use as an increasing criminalization of their livelihood. Considering these political dimensions, an interviewee who has been involved for several decades in mercury abatement initiatives told me that the issue with mercury is "not that they [artisanal and small-scale gold producers] don't know that mercury is harmful […], everybody knows that it is harmful, that it is not good. But if they are unable to sell [gold because they can't process it], there is […] no food. This is why they defend [mercury]."[21] The technical adaptations to capture mercury used in gold processing and the ways in which artisanal gold producers have mobilized studies to prove their 'responsible' use of the substance described above further corroborate local awareness of mercury toxicity.

The contestation of existing mercury governance schemes in Segovia and Remedios is also related to often-violent conflicts between artisanal and industrial mining actors over access to gold production networks (Ordóñez, 2012; Semana, 2017). The interviewee added that the mining company "wants to remove them […] through legal procedures, they want to displace them, so [the artisanal gold producers] oppose [mercury governance], saying that all of this is a lie. They tell this to others, but they are well aware that it is not like this."[22] A member of an ASGM association in the study similarly told me that mercury has been "demonized" to legitimize the encroachment of ASGM and the expansion of industrial mining in the municipalities.[23] A municipal health officer succinctly summarized the interactions between persistent mercury use and informality with the criminalization of historically legitimate, but informal gold production when he told me that "if you talk about mercury, the community identifies this as an issue of persecution (*un tema de persecución*) against artisanal and small-scale gold production."[24] In this view, denying the health effects of mercury is seen as a strategy to contest the negative impact of state-sanctioned toxicity governance on already marginalized artisanal and small-scale mining livelihoods.

The most immediate effect of the mercury ban in Segovia and Remedios has been a significant increase in mercury prices.[25] Some policymakers claim that more expensive mercury would incentivize small-scale miners to adopt mercury-free processing techniques (Veiga *et al*., 2006, pp. 444–445). Others have argued however that increasing mercury prices will deepen miners' socioeconomic precarity. Costlier mercury translates into higher costs for gold processing, and this means that the extraction of lower-degree ores has become unprofitable. Hence, in Segovia and Remedios, higher mercury prices have "slowed down the economy of the people because there is not so much ore with high grades of gold anymore."[26] Mercury has therefore become an "agent of poverty" (Hilson & Pardie, 2006) that 'traps' ASGM communities in precarious living, working, and health conditions. So, rather than solving the problem, increasingly restrictive mercury policy in combination with higher mercury prices and failing formalization schemes contribute to "the exclusion of the most marginalized miners and a move towards more clandestine gold production" (Nkuba *et al*., 2019, p. 803).

Artisanal and small-scale gold production in Segovia and Remedios has historically taken shape at the margins of state control, but this mining informality is increasingly considered a particularly problematic feature of non-industrial gold production. The importance of legalistic approaches to mercury governance is visible in that Law 1658 also requires processing facilities to formalize their activities. Law 1658 establishes that processing plants require environmental licenses in case they introduce new technologies (Congreso de Colombia, 2013, Art. 9). In order to receive such a license, the applicants must be able to prove that the ore they process stems from formalized mines (Ministerio de Minas y Energía, 2015, Art. 2.2.5.6.1, 1.4). This provision has contradictory effects: on the one hand, it expands the reach of environmental governance and could therefore contribute to more sustainable gold production, but on the other hand it also augments the

[20] Interview with departmental mining secretary, Segovia, 22 March 2019.

[21] Interview with industry insider, Segovia, 28 April 2019.

[22] Interview with industry insider, Segovia, 28 April 2019.

[23] Given that this statement is quite controversial, I refrain from disclosing more details about who said it.

[24] Interview with municipal health officer, Segovia, 30 May 2019.

[25] Field diary, Segovia, March-May 2019.

[26] Interview with industry insider, Segovia, 28 April 2019.

vulnerability of artisanal and small-scale gold producers that are unable to comply with formalization requirements. The mercury ban is therefore not simply about the protection of the environment and human health, as the law stipulates, but it is also a powerful ingredient in the renegotiation of what is considered legitimate mining in light of persistent informality and mercury use in artisanal and small-scale gold production.

Law 1658 created new patterns of exclusion as it pushed artisanal gold processors into illegality. People involved in non-industrial gold production are required to take more risks to maintain their current activities or to find other livelihood strategies.[27] Mercury sales and supply have indeed become more opaque since the substance was banned in Colombia. A gold seller in Segovia told me that Medellín is an important node in mercury provision for Northeastern Antioquia, but it is less clear how the mercury reaches Medellín (UPME & Universidad de Córdoba, 2014, p. 193). The mercury is subsequently smuggled in various ways to Segovia and Remedios, including on public transport, informal taxi services, or in private cars.[28] An additional factor that needs to be mentioned here is that the mercury trade has become a lucrative business. Illegally armed groups are likely to be involved (Indepaz, 2020, p. 14), thus further complexifying the interactions of gold production with the armed conflict that has simmered in Colombia for decades. Banning mercury might thus have had the unintended effect of solidifying the position of 'organized criminality' in non-formalized gold production networks. This increases the vulnerability of artisanal and small-scale gold producers because they depend on illegalized mercury suppliers with possible links to illegally armed groups (see Fritz *et al*., 2016; Nkuba *et al*., 2019).

The increasing vulnerability of non-formalized gold producers is also related to a second provision in Law 1658 that prohibits gold processing in residential areas. Law 1658 requires municipal authorities to realize a census of processing facilities in "prohibited areas," to define "suitable areas" for gold processing in its land management plan, and to "design and implement a re-ubication program."[29] It establishes timeframes for these different actions and specifies that after the allotted period for adoption, "mayors, environmental authorities and other relevant [state] authorities will proceed in closing gold processing plants that are located in prohibited zones or that do not comply with current environmental norms" (Congreso de Colombia, 2013, Art. 9). In the case of Segovia, however, the land management plan that was valid when I conducted fieldwork dated from 2002, and therefore did not include a specific area for gold processing. Notwithstanding this, state authorities had already initiated raids in *entables* (Semana, 2017). The disconnect between legal provisions and local mining spatialities has further reified the vulnerability of ASGM gold producers: if they invest in new technologies, but do not relocate, they may still run into problems with the authorities because their *entables* remain in 'prohibited zones' and do not hold an environmental license. The *entable* owners therefore remain in a limbo: their processing practices have been made illegal, but their introduction into the formal economic system is fraught with many spatial-regulatory impasses.

Hence, most artisanal and small-scale gold production is today de-legitimized in two mutually reinforcing ways. First, it is de-legitimized because most ASGM continues to rely on mercury amalgamation even though this practice was made illegal in 2018. Second, ASGM is de-legitimized because it happens predominantly without the necessary state licenses to operate legally. Mercury abatement efforts can't be regarded as separate from the expansion of the formal economy, but as a factor that legitimizes and supports it. Mercury abatement reproduces and reinforces the reduction of legitimacy to legality, in that it adds a biopolitical dimension to legitimize formality: legality in mining is henceforth not only legitimated because it increases state and corporate control mechanisms, but also because it is depicted as a means to abate toxic mercury and thus to increase mining sustainability. This mechanism contributes to reifying the stigmatization and criminalization of those people and livelihoods that do not 'fit' into legalistic categories of state recognition, and

[27] Interview with gold processing association, Medellín, 21 April 2018. See also El Tiempo, 2019a.

[28] Interview with gold seller, Segovia, 11 April 2019.

[29] Ubication refers to location or place, in Spanish and English. The same law defines these 'prohibited areas' as spaces used for "residential, commercial, institutional or recreational" purposes (Congreso de Colombia, 2013, Art. 9). In contrast, 'suitable areas' are defined as either being located within a mining title (*ibid.*) or in areas that do not correspond to the prohibited features described above.

this shapes the ways in which mercury interacts with the political renegotiation over what 'legitimate mining' is in Segovia and Remedios.

5. Conclusions

Mercury governance appears to be apolitical at first sight because it is portrayed as being exclusively about protecting the environment and human health from the harmful effects of mercury. An important underlying rationale of this assumption is that mercury is rendered "technical." This happens through the production of technoscientific knowledge that isolates "a set of relations that can be formulated as a diagram in which problem (a) plus intervention (b) will produce (c), a beneficial result" (Murray Li, 2007, p. 264). This mechanism alone does not, however, explain why artisanal and small-scale gold producers continue to use mercury, despite its harmful effects.

The biophysical characteristics of mercury are used to legitimize its ban in Colombia, but this neglects the relationality of mercury that goes well beyond its materiality. Instead, the apparently apolitical goal of protecting the environment and human health has become part of a more profound conflict over what form of mining is considered legitimate. The tension between ASGM as a legitimate livelihood and its 'problematic' aspects – in this case, mercury – leads to a dilemma. On the one hand, the Colombian government pushes the implementation of control mechanisms that target 'illegal' and 'harmful' mining, but on the other hand the government also wants to include artisanal and small-scale mining in its formal, extractivist economic system.

The allegedly apolitical mercury toxicity adds an important biopolitical dimension to this dilemma. Non-formalized artisanal and small-scale gold mining activities are not only considered 'illegal' because they are operating without a mining title and 'criminal' because of their assumed collaboration with illegally armed groups, but they are also seen as dangerous to the natural environment and human health because of their mercury use. The harmfulness of mercury thereby contributes to the construction of 'dangerous' mining subjects that need to be controlled and disciplined. This mechanism significantly shapes the ways in which toxicity governance interacts with broader negotiations over the 'place' of artisanal and small-scale gold production in contemporary extraction.

References

Agard-Jones, V. (2013). Bodies in the system. *Small Axe: A Caribbean Journal of Criticism*, *17*(3), 182–92. https://doi.org/10.1215/07990537-2378991

Alvillo-Rivera, A., Garrido-Hoyos, S., Buitrón, G., Thangarasu-Sarasvathi, P., & Rosano-Ortega, G. (2021). Biological treatment for the degradation of cyanide: A review. *Journal of Materials Research and Technology*, *12*, 1418–1433. https://doi.org/10.1016/j.jmrt.2021.03.030

Andresen, S., Rosendal, K., & Birger Skjærseth, J. (2013). Why negotiate a legally binding mercury convention? *International Environmental Agreements: Politics, Law and Economics*, *13*(4), 425–440. https://doi.org/10.1007/s10784-012-9198-6

Basu, N., Horvat, M., Evers, D., Zastenskaya, I., Weihe, P., & Tempowski, J. (2018). A state-of-the-science review of mercury biomarkers in human populations worldwide between 2000 and 2018. *Environmental Health Perspectives*, *126*(10), 1–14. https://doi.org/10.1289/EHP3904

Bennett, J. (2010). *Vibrant matter: A political ecology of things*. Duke University Press.

Brunnée, J. (2009). The Stockholm declaration and the structure and processes of international environmental law. In A. Chircop, T. L. McDorman, & S. J. Rolston (Eds.), *The future of ocean regime-building: Essays in tribute to Douglas M. Johnston* (pp. 41–62). Martinus Nijhoff.

Bugmann, A., Brugger, F., Zongo, T., & van der Merwe, A. (2022). 'Doing ASGM without mercury is like trying to make omelets without eggs'. Understanding the persistence of mercury use among artisanal gold miners in Burkina Faso. *Environmental Science & Policy*, *133*, 87–97. https://doi.org/10.1016/j.envsci.2022.03.009

Buxton, A. (2013). *Responding to the challenge of artisanal and small-scale mining. How can knowledge networks help?* IIED. https://www.iied.org/sites/default/files/pdfs/migrate/16532IIED.pdf

Cancillería de Colombia. (2020, December 19). *Sustancias Químicas*. https://www.cancilleria.gov.co/internacional/politica/ambiental/sustancias-quimicas

Caracol Radio. (2013, January 24). *Colombia recibió la mención 'Mercury Club Bronze Award' en Convención Internacional*. http://caracol.com.co/radio/2013/01/24/ecologia/1359048480_830511.html

Chaparro Ávila, E., & Güiza-González, S. (2020). Vertimientos tóxicos relacionados con la minería aurífera. In E. Chaparro-Ávila & L. Güiza-Suárez (Eds.) *Mitos y realidades de la minería aurífera en Colombia* (pp. 86-140). Editorial Universidad del Rosario. https://doi.org/10.12804/tj9789587844887

Clifford, M. J. (2014). Future strategies for tackling mercury pollution in the artisanal gold mining sector: Making the Minamata convention work. *Futures, 62*, 106–112. https://doi.org/10.1016/j.futures.2014.05.001

Congreso de Colombia. (2013, July 15). Ley 1658 de 2013. *Diario Oficial*, *48852*.

Congreso de Colombia. (2016, July 26). Ley 1801 de 2016. *Diario Oficial*, *49949*.

Cordy, P., Veiga, M., Crawford, B., García, O., González, V., Moraga, D., Roeser, M., & Wip, D. (2013). Characterization, mapping, and mitigation of mercury vapour emissions from artisanal mining gold shops. *Environmental Research*, *125*, 82–91. https://doi.org/10.1016/j.envres.2012.10.015

Cordy, P., Veiga, M., Salih, I., Al-Saadi, S., Console, S., García, O., Mesa, L A., Velásquez-López, P. C., & Roeser, M. (2011). Mercury contamination from artisanal gold mining in Antioquia, Colombia: The world's highest per capita mercury pollution. *Science of the Total Environment*, *410–411*, 154–160. https://doi.org/10.1016/j.scitotenv.2011.09.006

Davies, G. R. (2014). A toxic free future: Is there a role for alternatives to mercury in small-scale gold mining? *Futures*, *62*, 113–19. https://doi.org/10.1016/j.futures.2013.11.004

Davies, T. (2018). Toxic space and time: Slow violence, necropolitics, and petrochemical pollution. *Annals of the American Association of Geographers*, *108*(6), 1537–1553. https://doi.org/10.1080/24694452.2018.1470924

Deutsche Welle. (2019, June 13). *Mercurio, el veneno de la minería artesanal en Sudamérica*. https://www.dw.com/es/mercurio-el-veneno-de-la-miner%C3%ADa-artesanal-en-sudamérica/a-49188553

Ekino, S., Susa, M., Ninomiya, T., Imamura, K., & Kitamura, T. (2007). Minamata disease revisited: An update on the acute and chronic manifestations of methyl mercury poisoning. *Journal of the Neurological Sciences*, *262*, 131–144. https://doi.org/10.1016/j.jns.2007.06.036

El Nuevo Siglo, Redacción Nacional. (2019, January 13). *Continúa debate sobre venta libre de cianuro*. https://www.elnuevosiglo.com.co/articulos/01-2019-continua-debate-sobre-venta-libre-de-cianuro

El Tiempo. (2019a, February 2). *la lucha de los mineros ancestrales contra la Gran Colombia Gold*. https://www.eltiempo.com/colombia/medellin/la-lucha-de-los-mineros-ancestrales-contra-la-gran-colombia-gold-322272

El Tiempo. (2019b, August 26). *Colombia ratifica su lucha contra el mercurio con convenio de Minamata*. https://www.eltiempo.com/vida/medio-ambiente/colombia-ratifica-su-lucha-contra-el-mercurio-con-convenio-de-minamata-405304

Eriksen, H. H., & Perrez, F. X. (2014). The Minamata convention: A comprehensive response to a global problem. *Review of European, Comparative & International Environmental Law*, *23*(2), 195–210. https://doi.org/10.1111/reel.12079

Esdaile, L. J., & Chalker, J. M. (2018). The mercury problem in artisanal and small-scale gold mining. *Chemistry - A European Journal*, *24*(27), 6905–6916. https://doi.org/10.1002/chem.201704840

Foucault, M. (2002). *Archaeology of knowledge.* Routledge Classics. Original work published 1969.

Fritz, M. M. C., Maxson, P. A., & Baumgartner, R. J. (2016). The mercury supply chain, stakeholders and their responsibilities in the quest for mercury-free gold. *Resources Policy*, *50*, 177–192. https://doi.org/10.1016/j.resourpol.2016.07.007

García Arbeláez, C., Rodríguez Vargas, P., Pinto Martínez, E., Peña Niño, J., Cabrera Leal, M., Arciniegas Rojas, L. J., Varón Rey, D., & Escolar González, A. (2017). *El convenio de Minamata. Así actúa Colombia frente al mercurio*. (2nd ed.). WWF-Colombia.

García, O., Veiga, M. M., Cordy, P., Suescún, O. E., Molina, J. M., & Roeser, M. (2015). Artisanal gold mining in Antioquia, Colombia: A successful case of mercury reduction. *Journal of Cleaner Production*, *90*, 244–252. https://doi.org/10.1016/j.jclepro.2014.11.032

GC-25/GMEF. (2009). Summary of the 25th session of the UNEP Governing Council/Global Ministerial Environment Forum: 16-20 February 2009. *Earth Negotiations Bulletin*, 16(78), 1–16. https://enb.iisd.org/events/25th-session-unep-governing-councilglobal-ministerial-environment-forum-gc25gmef

Gibb, H., & O'Leary, K. G. (2014). Mercury exposure and health impacts among individuals in the artisanal and small-scale gold mining community: A comprehensive review. *Environmental Health Perspectives*, *122*(7), 667-672. https://doi.org/10.1289/ehp.1307864

Gochfeld, M. (2003). Cases of mercury exposure, bioavailability, and absorption. *Ecotoxicology and Environmental Safety*, *56*, 174–79. https://doi.org/10.1016/S0147-6513(03)00060-5

Hagan, N., Robins, N., Hsu-Kim, H., Halabi, S., Morris, M., Woodall, G., Zhang, T., Bacon, A., Richter, D. B., & Vandenberg, J. (2011). Estimating historical atmospheric mercury concentrations from silver mining and their legacies in present-day surface soil in Potosí, Bolivia. *Atmospheric Environment*, *45*(40), 7619–26. https://doi.org/10.1016/j.atmosenv.2010.10.009

Hilson, G., Hu, Y., & Kumah, C. (2020). Locating female 'voices' in the Minamata convention on mercury in Sub-Saharan Africa: The case of Ghana. *Environmental Science & Policy*, *107*, 123–136. https://doi.org/10.1016/j.envsci.2020.02.003

Hilson, G., & Maconachie, R. (2017). Formalising artisanal and small-scale mining: Insights, contestations and clarifications. *Area*, *49*(4), 443–451. https://doi.org/10.1111/area.12328

Hilson, G., & Pardie, S. (2006). Mercury: An agent of poverty in Ghana's small-scale gold-mining sector? *Resources Policy*, *31*(2), 106–116. https://doi.org/10.1016/j.resourpol.2006.09.001

Hinton, J. J., Veiga, M. M., & Veiga, T. (2003). Clean artisanal gold mining: A utopian approach? *Journal of Cleaner Production*, *11*, 99–115. https://doi.org/10.1016/S0959-6526(02)00031-8

Indepaz (2020). *Informe sobre presencia de grupos armados en Colombia. Actualización 2018-2 y 2019*. Indepaz.

Liboiron, M., Tironi, M., & Calvillo, N. (2018). Toxic politics: Acting in a permanently polluted world. *Social Studies of Science*, *48*(3), 331–349. https://doi.org/10.1177/0306312718783087

Meagher, K. (2021). Informality and the infrastructures of inclusion: An introduction. *Development and Change*, *52*(4), 729–755. https://doi.org/10.1111/dech.12672

Ministerio de Minas y Energía. (2015, May 26). Decreto 1073 de 2015. *Diario Oficial*, *49523*.

Murphy, M. (2017). Alterlife and decolonial chemical relations. *Cultural Anthropology*, *32*(4), 494–503. https://doi.org/10.14506/ca32.4.02

Murray Li, T. (2007). Practices of assemblage and community forest management. *Economy and Society*, *36*(2), 263–293. https://doi.org/10.1080/03085140701254308

Nail, T. (2017). What is an assemblage? *SubStance*, *46*(1), 21–37. https://doi.org/10.3368/ss.46.1.21

Nkuba, B., Bervoets, L., & Geenen, S. (2019). Invisible and ignored? Local perspectives on mercury in Congolese gold mining. *Journal of Cleaner Production*, *221*, 795–804. https://doi.org/10.1016/j.jclepro.2019.01.174

OECD. (2016). *OECD due diligence guidance for responsible supply chains of minerals from conflict-affected and high-risk areas*. (3rd ed.). OECD Publishing. https://doi.org/10.1787/9789264252479-en

OECD. (2017). *OECD due diligence guidance for meaningful stakeholder engagement in the extractive sector*. OECD Publishing. https://doi.org/10.1787/9789264252462-en

Ordóñez, F. (2012). Producción capitalista del territorio y alternativas campesinas en el bajo nordeste antioqueño. *Ciencia Política, 12*, 80–112.

Peck, J. (2011). Geographies of policy: From transfer-diffusion to mobility-mutation. *Progress in Human Geography*, *35*(6), 773–97. https://doi.org/10.1177/0309132510394010

Peck, J., & Theodore, N. (2012). Follow the policy: A distended case approach. *Environment and Planning A: Economy and Space*, *44*(1), 21–30. https://doi.org/10.1068/a44179

Perreault, T. (2012). Dispossession by accumulation? Mining, water and the nature of enclosure on the Bolivian altiplano. *Antipode*, *45*(5), 1050–1069. https://doi.org/10.1111/anti.12005

Procuraduría General de la Nación. (2023, 5 January). Colombia el mayor emisor de mercurio per cápita en el mundo. *Boletín 95*. https://www.procuraduria.gov.co/Pages/colombia-mayor-emisor-de-mercurio-por-persona-en-el-mundo.aspx

Restrepo, C. O. (2020, February 6). Segovia ya no es el más contaminado por mercurio. *Periódico Alma Mater Universidad de Antioquia*. http://www.udea.edu.co/wps/portal/udea/web/inicio/udea-noticias/udea-noticia/?page=udea.inicio.udea.noticias.noticia&urile=wcm%3Apath%3A%2FPortalUdeA%2FasPortalUdeA%2FasHomeUdeA%2FUdeA%2BNoticias%2FContenido%2FasNoticias%2FPeriodicoAlmaMater%2Fsegovia-mercurio

Robles Mengoa, M. E., & Urán, A. (2020). Colombia: legal loopholes behind illegal gold trade. In B. Verbrugge, & S. Geenen (Eds.), *Global gold production touching ground: Expansion, informalization, and technological innovation* (pp. 69–96), Palgrave Macmillan.

Schwartz, F. W., Lee, S., & Darrah, T. H. (2021). A review of the scope of artisanal and small-scale mining worldwide, poverty, and the associated health impacts. *GeoHealth*, *5*(1), e2020GH000325, https://doi.org/10.1029/2020GH000325

Selin, H. (2014). Global environmental law and treaty-making on hazardous substances: The Minamata convention and mercury abatement. *Global Environmental Politics*, *14*(1), 1–19. https://doi.org/10.1162/GLEP_a_00208

Selin, H., Egan Keane, S., Wang, S., Selin, N. E., Davis, K., & Bally, D. (2018). Linking science and policy to support the implementation of the Minamata convention on mercury. *Ambio*, *47*(2), 198–215. https://doi.org/10.1007/s13280-017-1003-x

Selin, N. E., & Selin, H. (2006). Global politics of mercury pollution: The need for multi-scale governance. *RECIEL*, 15(3), 258–269. https://doi.org/10.1111/j.1467-9388.2006.00529.x

Semana. (2017, August 26). *Segovia, polvorín minero*. http://www.semana.com/nacion/articulo/segovia-paro-minero-deja-heridos-disturbios-y-desabastecimiento/537747

Siegel, S. (2013). Community without solidarity: Mercury pollution from small-scale mining and Colombia's crisis of authority. *Community Development Journal*, *48*(3), 451–65. https://doi.org/10.1093/cdj/bst027

Sippl, K. (2015). Private and civil society governors of mercury pollution from artisanal and small-scale gold mining: A network analytic approach. *The Extractive Industries and Society*, *2*(2), 198–208. https://doi.org/10.1016/j.exis.2015.01.008

Smith, N. M., Ali, S., Bofinger, C., & Collins, N. (2016). Human health and safety in artisanal and small-scale mining: an integrated approach to risk mitigation. *Journal of Cleaner Production*, *129*, 43–52. https://doi.org/10.1016/j.jclepro.2016.04.124

Spiegel, S. J., Agrawal, S., Mikha, D., Vitamerry, K., Le Billon, P., Veiga, M., Konolius, K., & Paul, B. (2018). Phasing out mercury? Ecological economics and Indonesia's small-scale gold mining sector. *Ecological Economics*, *144*, 1–11. https://doi.org/10.1016/j.ecolecon.2017.07.025

UNEP. (2002). *Global mercury assessment 2002*. UNEP Chemicals.

UNEP. (2013a). *Global mercury assessment 2013: Sources, emissions, releases and environmental transport.* UNEP Chemicals Branch.

UNEP. (2013b). *Minamata Convention on mercury*. United Nations.

UNEP. (2014). *Basel convention on the control of transboundary movements of hazardous wastes and their disposal: Protocol on liability and compensation for damage resulting from transboundary movements of hazardous wastes and their disposal. Texts and annexes. Amended in 2014*. United Nations.

UNEP. (2017). *Minamata Convention on mercury. Texts and Annexes*. UNEP.

UNEP. (2019). *Global mercury assessment 2018*. UNEP Chemicals and Health Branch.

UNEP, & FAO. (2020). *The Rotterdam convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade. Texts and annexes. Revised in 2019*. Secretariat of the Rotterdam Convention.

UNITAR, & UN Environment. (2018). *Handbook for developing national ASGM formalization strategies within national action plans*. UNITAR & UN Environment.

UPME & Universidad de Córdoba. (2014). *Estudio de la cadena del mercurio en Colombia con énfasis en la actividad minera de oro.* (Vol. 1). UPME.

Valdivia, G. (2005). On indigeneity, change, and representation in the northeastern Ecuadorian Amazon. *Environment and Planning A, 37*(2), 285–303. https://doi.org/10.1068/a36182

Veiga, M. M., Angeloci-Santos, & Meech, J. A. (2014). Review of barriers to reduce mercury use in artisanal gold mining. *The Extractive Industries and Society*, *1*(2), 351–361. https://doi.org/10.1016/j.exis.2014.03.004

Veiga, M. M., & Marshall, B. G. (2019). The Colombian artisanal mining sector: Formalization is a heavy burden. *The Extractive Industries and Society*, *6*(1), 223–228. https://doi.org/10.1016/j.exis.2018.11.001

Veiga, M. M., Maxson, P. A., & Hylander, L. D. (2006). Origin and consumption of mercury in small-scale gold mining. *Journal of Cleaner Production*, *14*(3–4). 436–447. https://doi.org/10.1016/j.jclepro.2004.08.010

Verbrugge, B, Lanzano, C., & Libassi, M. (2021). The cyanide revolution: efficiency gains and exclusion in artisanal- and small-scale gold mining. *Geoforum*, *126*, 267–276. https://doi.org/10.1016/j.geoforum.2021.07.030

Vieira, R. (2006). Mercury-free gold mining technologies: Possibilities for adoption in the Guianas. *Journal of Cleaner Production*, *14*(3–4), 448–454. https://doi.org/10.1016/j.jclepro.2004.09.007

Wesselink, A, Buchanan, K. S., Georgiadou, Y., & Turnhout, E. (2013). Technical knowledge, discursive spaces and politics at the science–policy interface. *Environmental Science & Policy*, *30*, 1–9. https://doi.org/10.1016/j.envsci.2012.12.008

WHO (2016). *Environmental and occupational health hazards associated with artisanal and small-scale gold mining*. World Health Organization.

World Bank (2020). *2020 State of the artisanal and small-scale mining sector*. World Bank.

Yorifuji, T., Tsuda, T., Inoue, S., Takao, S., & Harada, M. (2011). Long-term exposure to methylmercury and psychiatric symptoms in residents of Minamata, Japan. *Environment International, 37*(5), 907–13. https://doi.org/10.1016/j.envint.2011.03.008

Zhu, W., Li, Z., Li, P., Yu, B., Lin, C-J., Sommar, J., & Feng, X. (2018). Re-emission of legacy mercury from soil adjacent to closed point sources of Hg emission. *Environmental Pollution, 242*, 718–727. https://doi.org/10.1016/j.envpol.2018.07.002