Data-driven remote governance of sparsely populated areas: measurement and commensuration of wildcat gold mining in French Guiana

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Data-driven remote governance of sparsely populated areas: measurement and commensuration of wildcat gold mining in French Guiana

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Abstract The increase in the price of gold, due to a shift to safe investments during the global economic crisis, has led to a rapid expansion of gold production. Alongside legal gold mines, wildcat gold mining has developed in French Guiana since the early 2000s. This phenomenon, with its social, environmental and economic consequences, is at the heart of the environmental governance of this territory. However, its difficult quantification is the subject of multiple controversies. Environmental governance is increasingly dependent on metrological regimes aimed at quantifying political action in order to objectify it. This article examines the role of metrology in implementing environmental policies in sparsely populated regions via the example of wildcat gold mining in French Guiana. Based on the study of two observatories, one managed by public authorities, the other by an NGO, we deconstruct their maps and counter-maps of wildcat gold mining. To do so, we make a distinction between measurement, commensuration and its diffusion. This focus on "measurement-commensuration-diffusion" allows us to identify three key phases in the production of nature statistics. We argue that the critical analysis of metrological processes through this three-step framework reveals methodological controversies that reflect different and even divergent political visions. The article also shows that metrological systems for environmental protection are the focus of targeted political disputes. It reports on the current disagreements—not only between the State and NGOs but also within the State itself—on the proposed solutions for fighting the impacts of wildcat gold mining in French Guiana and the broader issues of data production in Amazonia.

Keywords Metrology · Sparsely populated areas · Wildcat gold mining · Critical data studies · Amazonia

Introduction

Environmental governance is increasingly dependent on metrology, which aim to objectify, compare and prescribe political action through the production of statistical and mapping platforms, and various types of observatories. The importance of metrology is not specific to the environmental field, but it manifests itself in a wide variety of ways: the generalization of

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environmental impact assessment practices; the steering of territorial policies through the production of indicators; the evaluation and comparison of environmental management practices; the rise of standards through certification, etc. (Mol, 2009). Thus, increasingly, metrological processes play a central role in responding to the challenges of regulating the environment with data. In sparsely populated areas (SPA), which are characterized by low population density, difficult access, and incomplete and remotely implemented state control (Le Tourneau, 2020a), these regimes and processes serve as powerful policy instruments for justifying and legitimizing public action. In this context, our paper examines the role of metrology in the repression of wildcat gold mining (WGM), a serious environmental problem affecting French Guiana. The question of WGM represents a great deal (environmentally, socially, economically, politically and technically speaking) and yet, no common and shared vision and quantification of this phenomenon are accepted to this day. Indicators attempt to objectify and give visibility to this clandestine activity that takes place in the heart of the tropical forest. They are produced by actors with different political objectives. Deconstructing the conditions of their production and exploitation allows us to reveal these differences.

Often, the construction of a social and political regime requires a shared measurement system. Categories and coding procedures are then established to produce "equivalence classes" (Desrosières, 1998). These processes fall within the realm of "metrology". Producing and circulating tools of spatial metrology then involves negotiations, adjustments and repairs carried out by those seeking to establish a common measurement. We will examine such a process from the perspective of the sociology of quantification applied to administration and the modern state (Diaz-Bone & Didier, 2016). To do so, we will differentiate measurement, commensuration and the imposition of the chosen metric, as three key phases in the production of maps and statistics. Measurement as data capture, commensuration as its categorization, and diffusion as its strategic dissemination offer a three-step framework whose operational and heuristic potential we test.

The first section of the paper provides the theoretical basis, presenting concepts of metrology, commensuration and the characteristics of SPA. The second section presents two observatories focusing on WGM in French Guiana and presented as tools allowing a greater efficiency in the repression of this illegal activity, one run by public authorities and the other by an NGO. The third section examines the commensuration processes used in each of these two instruments. Finally, the last section analyzes the dissemination of information and the resulting tensions it has created in each case. In opposition to defenders of assessments and other environmental audits, who maintain that measurements serve the purpose of objectifying political differences (Colen & Nicholson, 2014; Walpole et al., 2016), this article demonstrates that metrological systems related to environmental protection are subject to targeted political disputes.

Governing remotely with figures and maps: the metrological challenges of sparsely populated areas

Information has become an essential component in the development and monitoring of environmental policies (Esty, 2004). In SPA, various forms of environmental regulation are implemented remotely, in which environmental data (statistics, maps) plays a prominent role.

Regulating the environment with data: metrological challenges

In order to make social and spatial diversity more intelligible, or "legible" as defined by Scott (1998), modern state institutions began categorizing the populations and territories under their responsibility as early as the eighteenth century. Quantification practices then became widespread due to increased computer efficiency and the neo-liberal policies of the 1980s. Barometers, indices, benchmarks, and rankings began to be used to compare and prioritize all forms of activities, and statistics became increasingly essential among "government techniques", while the quantitative assessment of public policies became systematized (Lascoumes & Le Gallès, 2004). The digital revolution accelerated the spread of metrology techniques, which paved the way for the "digitization of politics" (Rose, 1991), "the politics of numbers" (Alonso & Star, 1989) and the full belief in

"documentary intelligence" (Currie, 2020) to manage populations and resources.

This movement gave rise to environmental policies based largely on numerical indicators aimed at converting natural objects into statistics or maps for "management" purposes (Rumpala, 2003). Luke (1999) used the term "eco-managerialism" to define the already prevalent regime of natural resource management combining measurement technologies and managerial approaches, leading to "quantophrenia" and "cartographic bulimia" (Noucher et al., 2019). These phenomena thrive on a "culture of objectivity" (Porter, 1995), in which quantification is used principally in order to portray the decision-making process as disinterested and impartial. Yet many researchers have highlighted the performative dimension of data collection and processing: data is not simply an individual representation of phenomena but rather a construction used to influence the world (Bowker & Star, 2000; Latour, 1987; Porter, 1995; Desrosières, 1998).

The "Informational governance of the environment" is key to understanding two major changes in the management of environmental issues occurred in the last decades of the twentieth century (Gautreau & Noucher, 2013). On the one hand, information has gradually become a central component in public policies, alongside regulatory and economic instruments. On the other hand, information is not merely a base material for developing policies but rather a resource which "restructures processes, institutions and practices" (Mol, 2009), with the potential to transforming the governance itself. If the emergence of informational governance is not limited to the environmental field, it has been particularly strong in it, as proven by the development of collaborative practices in natural inventories, the widespread use of environmental impact assessments, the production of indicators-based territorial policies, etc. According to Mol (2009), how crucial information is now has been evidenced by the fact that social movements now focus on environmental action and simultaneously push for access to information. Technological developments are crucial in this context since they simultaneously change how knowledge is constructed (digitization of data, information systems) and the ways it is circulated and reused, affecting how "environmental problems" are formulated (Gautreau, 2016).

Measurement and commensuration form the basis of "metrological systems" (Cooper, 2015) used in the remote governance of sparsely populated areas. As developed by Scott (1998), these metrological processes are in general of no interest for resident populations, since their primary purpose is to make the regions and resources visible to outside stakeholders. Such processes are supplemented by dissemination strategies aimed at imposing the results in the political and media space. By analyzing the technical, social and political aspects of metrology techniques for monitoring wildcat gold mining sites, this article will seek to understand how these techniques interact with and within territories as forms of knowledge and power (Noucher et al., 2019).

Sparsely populated areas, territorial and informational margins

From a global perspective, sparsely populated regions like the Amazon rainforest or Australian bush exhibit a number of common features, such as a low population density and distinctive economic, political, spatial and social configurations. According to Le Tourneau (2020a), they can be characterized by four key elements: (1) low population density, often with the corollary of a high percentage of public land; (2) remoteness and isolation, both quantitative (physical distance) and qualitative (difficult to access, digital connectivity); (3) cultural practices, human-land relationships and worldviews that differ from urban areas, in particular due to the presence of indigenous communities; (4) partial and remote control by central States based in densely populated regions (*metropolises)*. Therefore, despite climate and ecological disparities, SPA have emerged as an analytical category bearing strong heuristic potential for analyzing the modes of governance implemented in them, especially those related to environmental issues.

The relationship between SPA and their metropolises is mostly based on a "governance from a distance" characterized by remote practices, including both direct (regulatory and legislative measures) and indirect mechanisms (cultural influence, social standards). The relationship between SPAs and their metropolises is part of a legacy from their colonial and post-colonial history. For example, the French overseas territories are the legacy of the "non-self-governing territories" listed by the UN after World

War II. SPA also often serve as "laboratories" (Jacob, 2018) for remote governance techniques as governments try to control them without increasing their investment. One form of these remote techniques is the creation of protected areas, which have grown exponentially in number and surface area since the 1970s (Lewis et al., 2017). In the dual context of climate change and biodiversity loss, sparsely populated regions will likely be even more affected by this governance in the future: as most governments see them as *empty blank spaces on the map*, the political cost of turning them into environmental reserves appears negligible.

However, SPA are not empty—they are inhabited by groups for whom low population density and the consequent unique relationship with land that this implies form key elements of their identity. Environmental conflicts are therefore likely to multiply, since SPA are increasingly subjected to rigid zoning inconsistent with local world views and systems governing the use of space (Rajão, 2013; Brondizo and Le Tourneau, 2016). This can result in a growing sense of territorial dispossession among inhabitants. For example, in French Guiana, the retrocession of 400,000 ha of land to indigenous communities, promised by the Government in 2017 but not yet allocated and located, is the subject of great tension. These types of conflicts can also arise in relations with indigenous peoples when the central power deems their practices *non-ecological*, thereby expelling them from their territories or restricting their activities (Rossi, 2000).

As illustrated by over 3000 cases recorded in the Environmental Justice Atlas,[1] the issues of information rights, measurement systems and data analysis (diagnostic, project, impact data) are often at the heart of environmental conflicts observed in SPA. To regulate SPA, metropolises use systems that rely on metrological methods to measure, compare, rank and ultimately control—symbolically or not—them. In this regard, we develop here a twofold hypothesis: 1. in addition to political, social, cultural and economic marginalization, SPA are also affected by informational marginalization, characterized by the data divide (the social and economic inequalities that can result from a lack of data collection or use) and by specific methods used to produce and circulate environmental information relevant to these territories; 2. these methods have a more pronounced performative component than those used elsewhere due to the key regulatory role of information in controlling these areas remotely.

Deconstructing the metrological systems of SPA: proposed methodology

Given the widespread use of metrology techniques in governing SPA, our goal is to deconstruct false assumptions surrounding arithmetic and cartographic realities that can quickly become the rule in the environmental field. To do so, we must identify the spatial issues involved in their production processes (and thus their genealogy), their circulation and imposition methods, and any local or global opposition they might face.

The first step in our methodology is to analyze measurement production processes, which means highlighting the methods, details and fine socio-technical mechanics involved in producing these measurements. The goal is to gain a clear and concrete understanding of how they emerge and eventually develop into "black boxes" (Latour 2005: 12), that is, dominant standards or frameworks, not easy to understand and easily *naturalized,* that are never or seldom questioned. By focusing on measurement, we can highlight the intellectual operations and practices that lead to the deployment of infrastructure intended to *capture* the targeted phenomenon.

The second step is about commensuration. This refers to the categorization of previously constructed measurements. In the field of environmental humanities and political ecology, it is generally only approached from the perspective of the conflicting "valuation languages" (Martinez Alier, 2002) of the stakeholders involved. The critical approaches endeavor to understand the ways in which certain dominant stakeholders enforce forms of commensuration (such as "market value") for environmental objects that other stakeholders rightly consider to be incommensurable.[2] From a perspective akin to the Science and Technology Studies approach, commensuration can be viewed as contributing to problematization, a process which includes both formulating a problem

[1] https://ejatlas.org/.

[2] For an overview of debates on this subject, see Centemeri (2015).

and *positioning* stakeholders around an "obligatory passage point" (Star, 1995) for its regulation. As Espeland and Stevens point out: "Many of the most consequential uses of numbers entail commensuration—the valuation or measuring of different objects with a common metric" (Espeland & Stevens, 1998: 408). Our purpose here is to make opaque phenomena more legible and visible by shedding light on the social phenomena hidden within the machine of commensuration.

As Espeland and Stevens (ibid.: 332) point out, the act of measuring or rendering something commensurable is hinged on different forms of power: it can support decision-making or justify decisions; it can be manipulated by elites or used to limit their power; it can also establish imposed subjectivities or generate opposition. So the third step is about the diffusion of a measurement that can establish social and spatial order or disorder, or at least spark controversy or social conflict. This is particularly due to the fact that increases in measurements can create new battlegrounds for clashing ideologies, for negotiations, antagonism, and divergent politicization among stakeholders. The political importance of communicating measurements is visible in the increasing—and often frustrated—demands for public and universal access to data. Data-driven and data-producing "algorithmic black boxes", which de facto reinforce the opacity of metrological practices (O'Neil, 2016), can also be pointed out. Therefore, the spectrum ranging from imposition to misuse, retention, dissemination and mobilization must be entirely examined.

This three-step framework highlights the diversity of actors involved in metrics for SPA, which leads to a new set of questions. What are their roles and interests? How do they produce measurements, and by what means and methods? What space management and control practices do they use in connection with these processes? How do they conduct their mapping and quantification of our world? These questions have become all the more crucial given the new promises associated with big data, marked by a resurgence of a form of digital neo-positivism in which measures and indicators are taken as transparent tools. Although criticism of statistics (Desrosières, Didier, Thévenot), cartography (Harley, Crampton, Wood) and technology in general (Simondon, Ellul, Illich) has long existed, it struggles to address these more contemporary issues. By following the process of data and algorithm production in the field, by becoming familiar with the metrological practices of cartographers and statisticians, it is possible to go beyond a radical form of criticism that would reject statistics and maps without any analysis.

Based on this, we have adopted in this paper the critical data studies approach (Iliadis & Russo, 2016; Kitchin & Lauriault, 2014), which seeks to understand the contexts for the production, analysis, dissemination and use of the data circulating on the web in order to reveal the underlying socio-political issues. To study wildcat gold mining in French Guiana, we therefore used mixed methods combining an exploration of cartography techniques used by different stakeholders, the analysis of the gray literature using these maps, and interviews with the persons who produce or use them.

Quantifying and mapping a cryptic activity: disputed measurements of illegal wildcat gold mining in French Guiana (2008–2018)

As an example of contended measurements in SPA, we will focus here on the detection and monitoring of wildcat gold mining in French Guiana up to 2018.[3] Wildcat gold mining is illustrative because attempts to control it from Cayenne (the regional capital) and Paris rely on indicators aimed at objectifying and providing visibility for this covert activity which takes place deep in the rainforest. After providing a general overview of the phenomenon, we analyze two different measurement strategies, one proposed by the French State, and the other by the NGO WWF.

The challenges of measuring wildcat gold mining

French Guiana is located north-east of the Guiana Shield. Unlike the history of most Latin American countries, in which a national idea has long sedimented, the three Guianas (Surinam, Guyana, French Guiana) have in common that they remained colonies late in life. Today, French Guiana is home to a widely diversified population that has been built up over the

[3] A new organizational framework was introduced by the State beginning in 2019. Since this framework is still underway as of 2021, we end our analysis with the situation observed at the end of 2018.

course of its history: indigenous Amerindian peoples from six communities (Kali'na, Lokono, Palikur, Teko, Wayãpi, Wayana), Afro-Creole descendants from the servile population, Maroons (Bushinengue), Indian and Indonesian "indentured" workers, etc. Today, migrants of various origins still cross the Maroni and the Oyapock, border rivers with Surinam and Brazil respectively, which are difficult to control. During the colonial period, Amerindians and Businengue, considered as "primitive", were excluded from the citizenship that Creoles gained in the second half of the nineteenth century. It was not until the 1960s that the French state began to grant them nationality and citizenship on a massive scale, through civil registration campaigns. This "colonial legacy" (Bayart & Bertrand, 2006) is still very present in the socio-economic reality of the territory. From now on, French Guiana is a European overseas, the second largest French province in terms of surface area (84,000 km^2, equivalent to the size of Austria), and the most sparsely populated (3.2 inhabitants per km^2, with a concentration of the population along the coastal strip).

The center and south of French Guiana, home to Indigenous and Maroon communities, from the largest part of the territory and are greatly isolated from the capital of Cayenne (Noucher & Polidori, 2020). This separation from decision-making centers, Cayenne as well as Paris and Brussels, allows illegal activities, which include smuggling, poaching, and the informal exploitation of natural resources, to take place and makes French Guiana an archetypal example of how SPA are remotely (and difficultly) controlled. With the surge in gold prices since the 2000s,[4] gold mining operations have greatly developed, resulting in major environmental and health consequences (Frery et al., 2001).

Gold mining activities are conducted in a variety of ways depending on their legal status, scale and technologies employed. Regarding the first, they can be formal or legal (i.e. acknowledged by the State and given legal permission in form of concessions), informal (i.e. not acknowledged officially and not regulated or taxed as any other economic activity, but tolerated, such as in placer mining in Suriname; some areas may be legally open to this informal activity, like in Brazil where *garimpo* mining is authorized in some places), or illegal (i.e. not recognized officially and banned by law, like in FG or in several types of territories in Brazil). Regarding the scale, gold mining can be industrial and undertaken by big companies, such as Norgold in Suriname. It is then labelled as "large-scale mining", or LSM (Montagne d'Or project in French Guiana, for example). It can also be semi-industrial and undertaken by local firms (Société des Mines de Saint Elie, Espérance in French Guiana) or artisanal but heavily mechanized (like formal placer mining in French Guiana which uses excavators). This category is poorly covered by academic literature, même si quelques études en proposent une overview (Ribeiro-Duthie & Castilhos, 2016; Scammacca et al., 2021). Finally, it can correspond to the "artisanal and small-scale mining" (ASM) defined by Hilson and McQuilken (2014) as "low-tech, labour intensive mineral extraction and processing found across the developing world". ASM gold mining accounts for a substantial share of the world gold production and employs over 16 million people across the world (Seccatore et al., 2014). However, it must be noted that "artisanal small-scale gold mining" does not cover the same reality in Africa or Asia, where it is overwhelmingly manual, and Latin America, where, even if still artisanal, it relies mostly on mechanized means like motorized pumps, electrical generators, etc. Finally, the technologies and type of deposits can vary. The most traditional gold mining activity is "placer", "alluvial" or "secondary" mining, where gold eroded from rocks is extracted from the sediments deposited by rivers. "Primary mining" refers to extracting gold directly from the bedrocks and it generally implies to dig subterranean galleries or to open giant open-pit facilities in case of LSM. Regarding French Guiana, legal mining exists in the form of semi-industrial or artisanal operations, producing about 2 tons of gold per year (Jebrak, 2021). Illegal activities, mostly operated by Brazilian migrants, are however very widespread and their total production is estimated anywhere between 5 and 10 tons a year (Jebrak, 2021; Le Tourneau, 2020b). These operations, which are the object of a strong repression by French authorities, are the focus of this paper. Regarding their techniques, they work both on alluvial deposits or on primary gold veins, their technology allowing for subterranean work up to 50 m deep, or up to the water table level. Illegal gold miners in French Guiana are generally

[4] The price of gold rose from less than 14 USD per gram in August 2000 to over 66 USD in August 2020.

referred to as *garimpeiros*, using the Brazilian word for small-scale artisanal informal (and oftentimes illegal) mining (Le Tourneau, 2020b, 2021), translated, in the Amazonian context, in English as "wildcat gold mining".[5] However, unlike the first gold-mining cycle, which lacked any control by the central government, the activity has now generated a strong response from authorities, who are dedicating considerable resources to deterring the activity (Le Tourneau, 2020b). In 2020, the soldiers of the military operation HARPIE carried out more than 2800 patrols in the forest, on the creeks and at the mouths of the rivers of French Guyana. They captured 4.9 kg of gold, 165 pirogues, 65 quads as well as 231 generators, 196 kg of mercury and 278,385 L of fuel, essential equipment for the activity of wildcat miners.[6]

This new threat to the environment has sparked the condemnation of large segments of society in French Guiana, who have demanded a response from public authorities. Competing surveillance systems led by NGOs or the French government were developed in the second half of the 2000s with the intention of detecting and monitoring WGM. This represented a major technical challenge, given difficulties in accessing the area and the technical limitations of most instruments because of persistent cloud cover and other characteristics of the tropical rainforest environment. Even if other sources such as in situ observation or radio interception were used, the brunt of the data were expected to come from remote observation (from satellite or aircraft).

The observatory of mining activities (observatoire des activités minière—OAM): a government teamwork?

Faced with the limitations of the security forces, inconsistent results in the fight against WGM (Jacob, 2018) and the realization that government agencies were leading this fight in a disorderly manner, data sharing among government agencies was initiated in the late 2000s, removing information barriers that had hitherto existed (Nicolle and Leroy, 2013). To this end, the government created an Observatory of Mining Activities in French Guiana (*OAM*) in 2008. A data infrastructure (Fig. 1) was implemented to facilitate the sharing and hosting on a single server of all the data collected separately by each agency.

The diversity of partners involved (Ministry of Ecology, Guiana Amazonian Park, National Forests Office, French Geological Survey, Armed Forces in French Guiana, Prefecture and the police) reflects in different data collection methods as each one relied on different skills, connections with the field, and means to measure WGM activities using their own *weapons.*

The armed forces

Data collected by the armed forces in French Guiana (FAG) and added to the server where of two types. Most of them were maps and reports derived from field operations: GPS surveys of forest tracks and paths they travelled, locations where equipment was destroyed, reconnaissance information about the wildcat miners' logistical bases, etc. However, although patrols increased, up from 9 in 2002 to nearly 1300 in 2018 (Le Tourneau, 2020b), thus giving a greater wealth of information, remote observation was still used for planning and overall monitoring. Satellite imaging not being considered suitable due to significant cloud cover, low spatial resolution of available images, and a lack of image processing skills, reconnaissance activities were therefore carried out using hundreds of geotagged photographs taken during aerial surveys. The second type of information shared by the FAG therefore included gold mining sites identified through photo-interpretation of these pictures. The consistency of those was however an issue. As the flights were always related to ongoing or foreseen operations, the FAG never performed exhaustive surveys throughout French Guiana.

The Guiana Amazonian park

Contrary to the armed forces, the Guiana Amazonian Park (Parc amazonien de Guyane—PAG) opted for exhaustive surveys of the the 20,300 km^2 forming the park's central area to obtain a comprehensive view of the illegal activities being conducted there. Two to three flight campaigns have been conducted each year, with an helicopter crisscrossing the whole area and reporting each mining sites. Initially carrying out the surveys in collaboration with the National Forests Office (Office national des forêts—ONF), the PAG

[5] See in particular the work of Gordon MacMillan on Roraima, Brazil (MacMillan, 1995).

[6] Source: Forces Armées de Guyane.

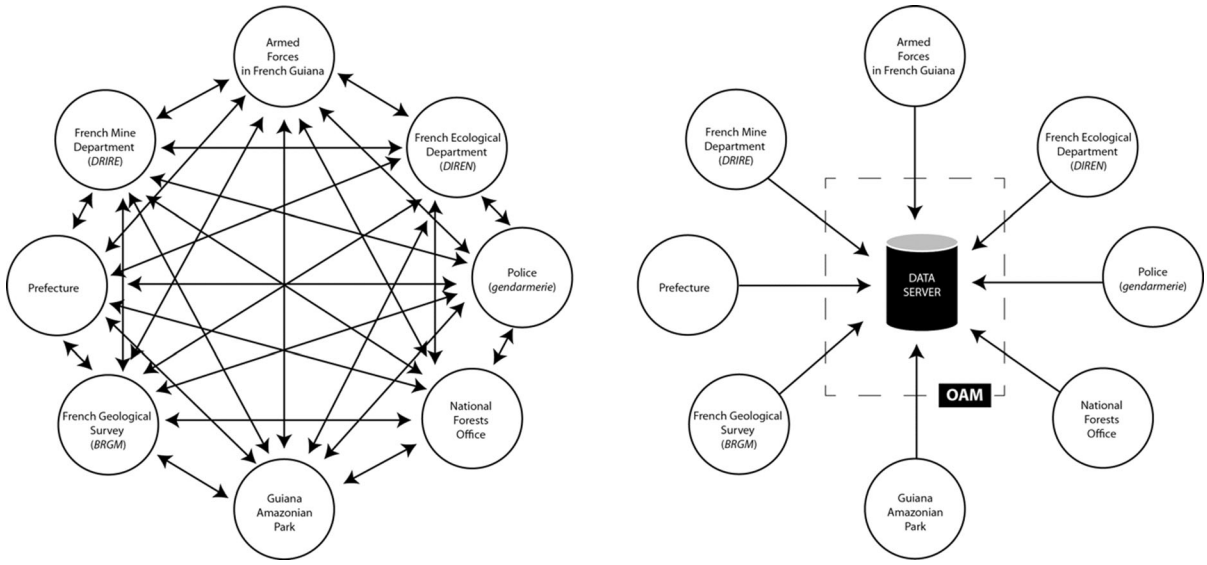

Fig. 1 Overview of plans for the Observatory of Mining Activities in French Guiana at the time of its launch. From bilateral exchanges between government services to centralizing information. © Matthieu Noucher, adapted from (Joubert & Coppel, 2016)

began working autonomously in November 2015. The information derived from the flights (pictures, tables, maps, GIS layers) is also supplemented by fieldwork fluvial or foot expeditions periodically carried out by around twenty environmental police officers. As for the armed forces, such information includes the location of logistical bases, entry points and routes used by the wildcat miners, etc. According to a member of the park's Scientific Council, this "inconspicuous information" was also shared within the OAM platform.[7]

The national forests office

Realizing the limitations of the two previous approaches (the patchy nature of FAG observations and the cost of PAG exhaustive aerial surveys), the ONF had sought alternative solutions even before the creation of the OAM, prospecting the potential of indirect indicators rather than direct observation. Through collaboration with a researcher from CIRAD,[8] they developed a classification algorithm for rivers and streams based on water turbidity, which is a sign of sediment suspension and, by extension, of potentially unusual/anormal activity.[9] Turbid waters having a distinctive spectral signature, they can be detected in satellite images. This detection, however, does not inform the number of active mines upstream. In large mining sites, where sediment tanks are big enough to be detected, a count can be realized. For small mining sites, the only trace is downstream turbidity which can be observed where the stream is at least ten meters wide, giving the indices of mining activities. Improvements of geometric accuracy and temporal frequency provided by SPOT-5 satellite enabled the implementation of an operational early warning and monitoring system (Fig. 2), which relied on semi-automatic detection of turbidity using the PLATOT software, designed and patented by CIRAD for this purpose (Gond et al., 2009). The results of the system (GIS layers and reports) were part of the data added to the OAM server, but between 2008 and 2015 this operational system was gradually abandoned for three reasons, which highlighted the weak points of this type of institutional instrument. First, the program initially developed by CIRAD was based on a proprietary programming language (IDL) that had become obsolete. Second, the availability of SPOT data became erratic. Third and finally, high civil

[7] Telephone interview, April 28, 2020.

[8] French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions.

[9] The wildcat gold mining practiced in French Guiana, based on soil leaching processes, releases a significant amount of suspended matter into streams and rivers.

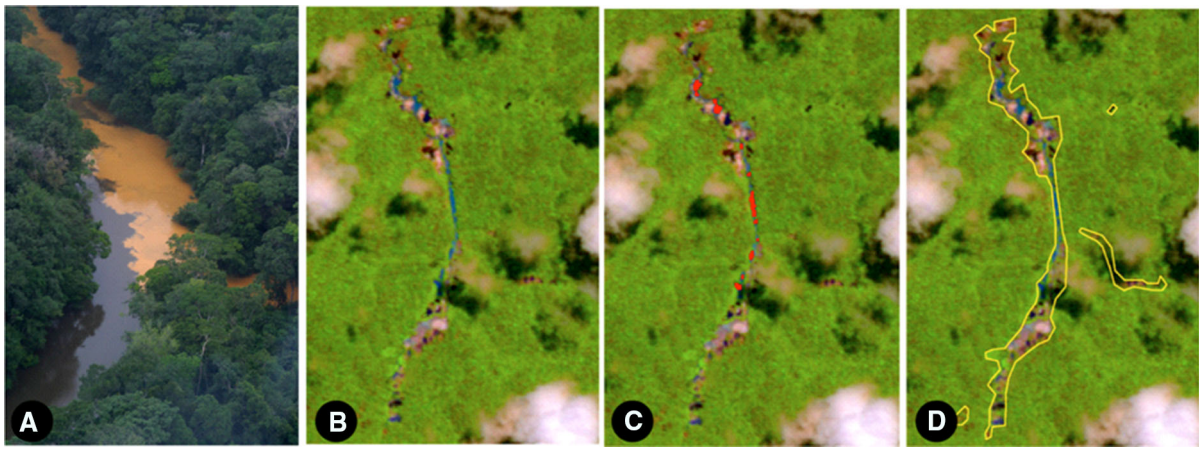

Fig. 2 Detection of a river with high turbidity in October 2017 **a** Aerial photograph, © Sébastien Linarès, DIREN Guyane (**b**) Satellite image SPOT-5 from the same area, © SPOT images—OAM (**c**) Semi-automated detection with the PLATOT program, © CIRAD—OAM (**d**) Manual digitization of nearby deforestation, © OAM

servant turnover in French Guiana resulted in a loss of the skills required to use the tool.

Aside the analysis of water turbidity, the ONF also explored the use of diachronic analysis of Landsat and SPOT imagery to evaluate the cumulated area of forest lost to illegal mining in 1990 (200 ha), 2000 (4,000 ha) and 2006 (12,000 ha).

A catch-all system and its structural weaknesses

Other partners provided additional information. Police forces, for example, occasionally collected information via radio interception and shared them, but most were not georeferenced.[10] Rather than a homogeneous database, the OAM thus became in its 1st years a catch-all system, where each partner added their data sets without taking the others' contributions into account. Excel spreadsheets were included alongside GIS layers and PDF reports, without any organizational scheme or connections being made between them, let alone any efforts to ensure consistency. Starting in 2010, a coordination project was launched with the goal of extracting a summary map from these heterogeneous measurements, in order to obtain a "official vision"[11] of the phenomenon which could enable agencies to work together and be shared with the public. Such a commensuration, process, which we analyze in detail in Sect. 3, ultimately magnified the differences already obvious in the variety of the measurement protocols we have just examined.

The OAM was also confronted with limitations inherent to government's activities in France's overseas territories. The majority of senior civil servants and personnel of the armed forces acting there only hold their positions for quite a limited time: mostly 2 to 3 years, sometimes up to 4 years for the FAG intelligence office, and as little as 4 months in the case of some soldiers involved in the cartographic service. This inevitably leads to repetitive losses of methodological skills and local context comprehension.

The participatory observatory of environmental pressures (observatoire participatif des pressions environnementales—OPPEN): On the ground, with local residents?

OAM data access being granted only to government agencies, the international NGO WWF launched accustom participatory observatory in 2016. According to the local director, the purpose was to "increase our data expertise through training and by developing our own maps." He continues, "Brazil is our model.

[10] These tapped conversations between garimpeiros can help identify common toponyms, some of which have become official, as in the case of Guérilla (Noucher, 2020).

[11] In the words of the civil servant from the ONF responsible for this initiative, during an interview conducted in Cayenne on April 2, 2019.

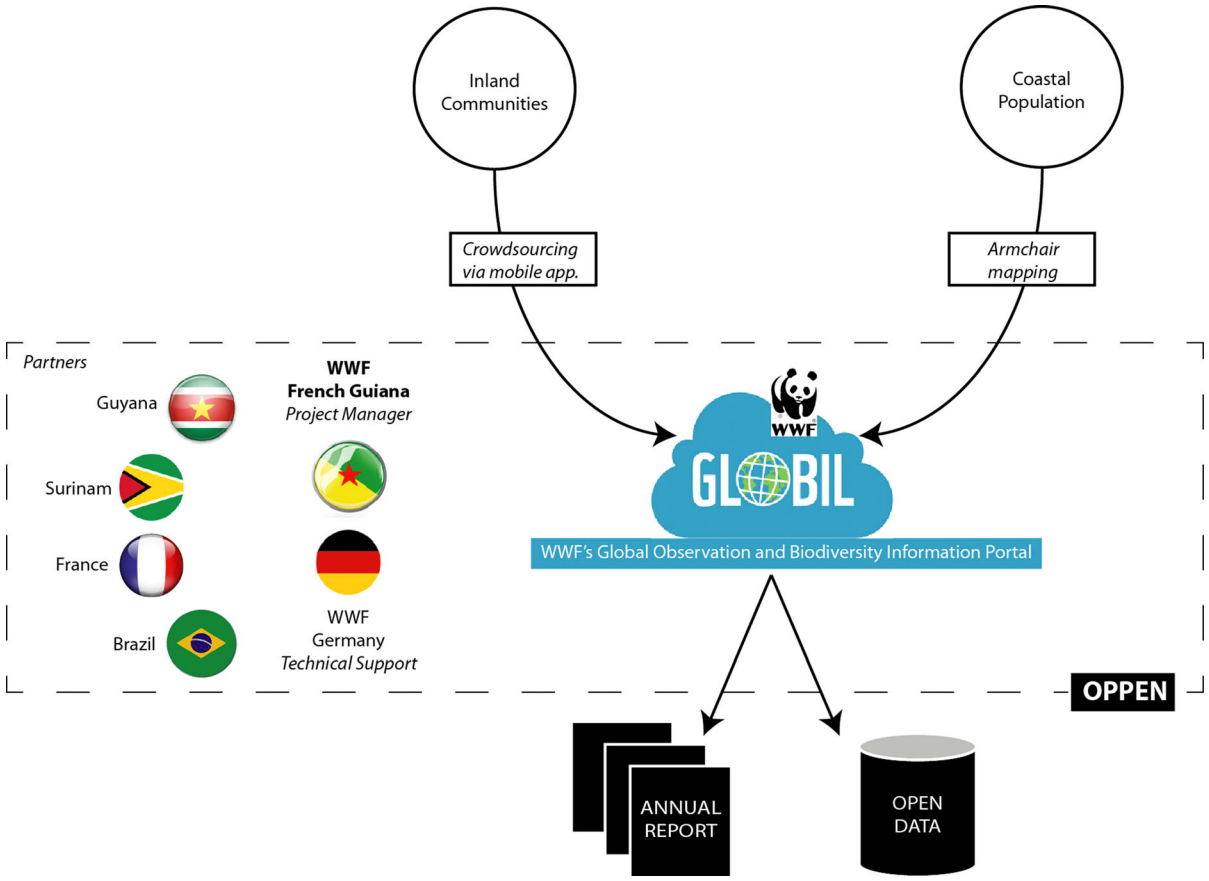

Fig. 3 Summary of the project as presented by WWF © Matthieu Noucher, adapted from (Shapiro & Thibault, 2016)

We should be able to challenge the State the way IMAZON does".[12,13]

Initially, WWF sponsored a mapping of the entire Guiana Shield conducted by a subsidiary firm linked with ONF. The resulting diachronic analysis (over the 2001/2008 and 2008/2014 periods) highlighted a constant increase in the intensity of gold mining activities. In light of the media attention received by these results, WWF French Guiana decided to carry on and launch a new project, in partnership with the WWF offices in Surinam, Guyana and Brazil, which won a grant on the occasion of COP21. Its ambition was to promote "participatory" monitoring activities, implicitly criticizing the OAM seen as a black box reserved for government agencies. The project OPPEn (Participatory Observatory of Environmental Pressures) was twofold (Fig. 3). It aimed at developing a mobile phone application that would allow "local populations to pass on information" both quantitative (flow of dugout canoes) and qualitative (contents of the dugout canoes). It also aimed at producing a collaborative map through participative photo-interpretation of pre-processed images during "mapping party" workshops.

This initiative produced mixed results. Its first part was quickly abandoned for it could be perceived as some sort of denunciation and bring safety concerns to local residents (who had not been consulted beforehand). Furthermore, this approach would have encroached on police surveillance and control powers and led WWF into the potentially dangerous legal territory. The second part of the project was completed. A partnership with the Regional Authority of French Guiana (*Collectivité Territoriale de Guyane*—

[12] A Brazilian environmental NGO that produces monthly data on deforestation based on satellite images and internationally recognized technical expertise.

[13] Interview conducted in Cayenne, March 23, 2016.

CTG) sponsored SPOT and RAPIDEYE image acquisition, completed by free LANDSAT-8 data. WWF Germany, which has expertise in geomatics, carried out a series of pre-processing steps for these images and integrated them into Google Earth Engine to enable remote access and user interface photointerpretation. The *participatory* aspect of the whole operation must be put into perspective. Only two workshops were organized, in September 2016 in Cayenne and in January 2017 in Macapá, limiting the collaborative work to a handful of participants, the majority of whom were environmental activists or academics. Exemplifying "armchair mapping", operations did not involve any fieldwork.

Apparently, government agencies and NGOs have put in place similar strategies when it comes to map wildcat gold mining in French Guiana, relying heavily on remote sensing. Satellite imagery and aerial surveys, in some cases supplemented by field data, have been the main sources of the various monitoring techniques implemented from 2008 to 2018. Important differences however appear in the types of images, objects detected, ability to access the field, means implemented and scales of analysis. These differences reflect diverging strategic and territorial objectives: while the Amazonian Park and the ONF focused on annual (or bi-annual) surveys in their management areas, the FAG prioritized action in the field and correlated information needs, while WWF developed a regional long-term perspective. Even if all these stakeholders shared the same objective of curbing illegal mining, they were approaching it from different perspectives. The comparison of their measurements would soon show how their divergences.

Assessing the development of wildcat gold mining: defining commensuration to impose problem framing and its solutions.

By focusing not only on the results of the observatories but also looking at the fine mechanics involved in collecting information, the previous section looked beyond the magic of the maps and numbers to show the "measurement production". The goal for this section is to show how the categorization of this measurement (i.e., its assignment to a specific class) magnifies the differences. Commensuration, which establishes reference standards used to compare the development of a situation (over time and space), can prove controversial and give rise to power struggles. As an illustration of this phenomenon, we analyze here the geometric and semantic attributions assigned to mapped objects. Our results suggest that each of the commensuration strategies corresponds to a desire to position oneself in the public space in order to legitimize oneself.

Defining and quantifying a changing activity to enable analysis: challenges in the commensuration of wildcat gold mining

While gold mining sites remain difficult to locate, the mere identification of a site in the forest where these activities take place is not in itself a gauge for the activity. Once detected, these weak signals must be described as accurately as possible in order to define them geometrically (determine the exact area involved) and describe them semantically (specify which activity they are representative of). A series of methodological procedures then come into play, guiding and determining results which, depending on the approach adopted, can sometimes be contradictory.

In concrete terms, given the large number of objects potentially identifiable on aerial photographs (*carbet*,[14] *varador*,[15] *barranque*,[16] etc.), how do operators compare this information with other that are different in nature and scale like unusually high turbidity in a riverbed or pixels identified as deforested areas? How do they determine if what they are seeing is actually a gold mining site? How do they determine where an object starts and end? How can they distinguish between two contiguous sites? What's worse, operators also faced the ephemeral nature of the objects they are trying to grasp because of the temporary nature of wildcat gold mining sites. Producing a clear picture of the situation at a given point in time is thus challenging (Scammacca, 2020) and the operators technical choices for each of these issues are also influenced by the (political) intentions of the (political) sponsors for whom they work.

[14] Temporary shelter built in the forest.

[15] Forest tracks used to bypass river dams built by the Gendarmerie.

[16] Pits dug to reach the sediments.

Fig. 4 A wildcat gold mining placer in French Guiana The motor visible in the middle of the image pumps the sediments produced with the pressure jet and throws them into the sluice (in the background). Environmental impacts and deforestation are clearly visible. © François-Michel Le Tourneau, June 2019, Inipi region

Specifying to minimize the results: the "active mining site" concept

As confirmed by an agent from the ONF, in the initial years of operation, the OAM was no more than a vast data repository: "In the beginning, the observatory was just a big stockpile, where everyone deposited their data. This mass of data did not provide a vision of what was happening.[17]" Yet this hodgepodge nature had an advantage since it revealed the heterogeneity of the data produced by the various partners. Work to harmonize and summarize the information began in 2011. One particularly sensitive indicator—the so-called "active mining sites"—sparked controversy. Although the inventories compiled by the agencies tried to include as much information as possible—identifying supply sites, rivers with turbid water, landing coves for dugout canoes, abandoned forest tracks, and even hidden four-wheelers or engines in the forest—producing a common assessment of this patchwork of information proved very difficult. A common methodological framework, the result of hard-fought negotiations, was gradually brought forward to define the concept of "alluvial mining site", which was seen at that time as the reference indicator for approaching the overall dynamics of illegal gold mining in French Guiana.[18] After several months of discussions, a definition was finally agreed upon in 2015 (7 years after the beginning of the observatory), defining such mining sites as "alluvial production units consisting of two motors and a sluice" (Allo, 2015; Fig. 4), therefore including in the unit all the equipment needed to extract gold from alluvial terraces and riverbanks. This definition excluded weaker signals, such as the presence of ancillary tools or equipment non-strictly related to the extraction (ATVs, camps, caches of equipment, etc.).

While this clarification helped harmonize the keys for interpretation, the information still needed to be qualified, especially because wildcat gold mining

[17] Interview, April 2, 2019, ONF, Cayenne.

[18] In addition to the alluvial sites alluded to here, primary mining sites are the other type of mining site favored by gold miners in French Guiana. These sites extract gold present in underground rocks and are operated with underground galleries or shafts. In the mid-2010s a shift seems to have occurred in French Guiana, with "primary" mining sites becoming increasingly popular, due in particular to their high profitability. However, data acquisition for illegal primary mining does not follow the same methodologies as for secondary (alluvial/eluvial) gold mining due to the particular nature of primary mining (e.g., tunnelling and underground techniques).

Table 1 Typology of Alluvial Mining Sites, recommended by the Armed Forces in French Guiana (FAG) adapted from (Loyer, 2018)

Active mining site	Site observed in use (caught in the act) or showing obvious signs of recent activity (equipment observed or discovered in caches)
Destroyed mining site	Site where at least one major and essential piece of equipment required for operation has been destroyed or seized (motor, motor pump)
Partially active mining site	Site where minor equipment has been destroyed or seized but where major equipment could not be found
Abandoned mining site	Site showing significant evidence of inactivity (absence of fresh tracks, regrowth of plants in the area, etc.)

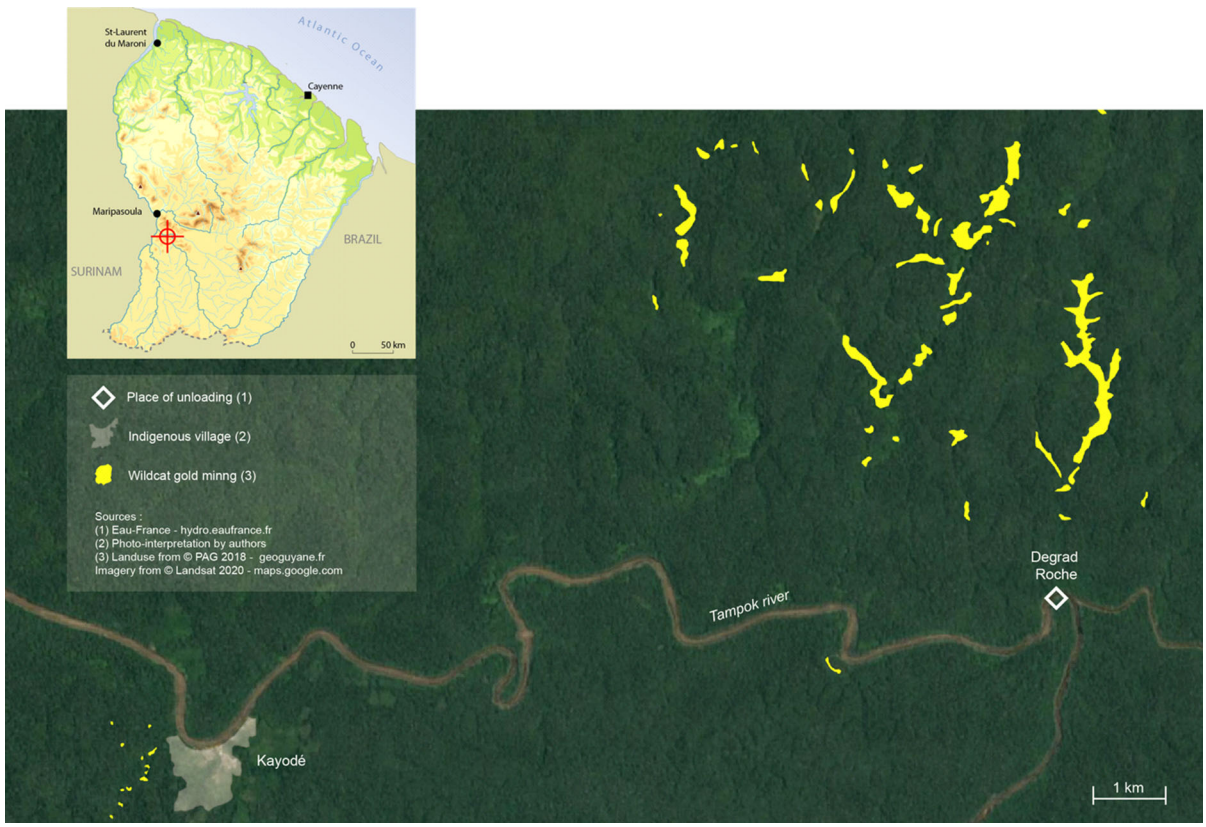

Fig. 5 Deforested areas linked to wildcat mining activities identified by Guiana Amazonian Park in 2018, near the Tampok river: How can the different mining sites be differentiated and counted? © Matthieu Noucher

activities are ephemeral. In order diagnose the situation in a given area, as the ONF and the PAG sought to do, or to prepare a field mission to meet the FAG's objectives, all agencies needed to qualify the state of the mining sites at a given time. Two competing approaches coexisted in the OAM and in the public debate (see part 4). Thus, although the reports used the same definition of mining sites, they were diverging in their results since they reflected different perspectives on the same reality.

In an attempt to highlight their efforts on the ground, FAG used two different categories of mining sites: "active mining sites" and "destroyed mining sites". But this came to be questioned by the PAG, which challenged the effectiveness of site destruction: "Seizing a four-wheeler or burning down a camp is not enough to render a gold mining site inoperable. Many

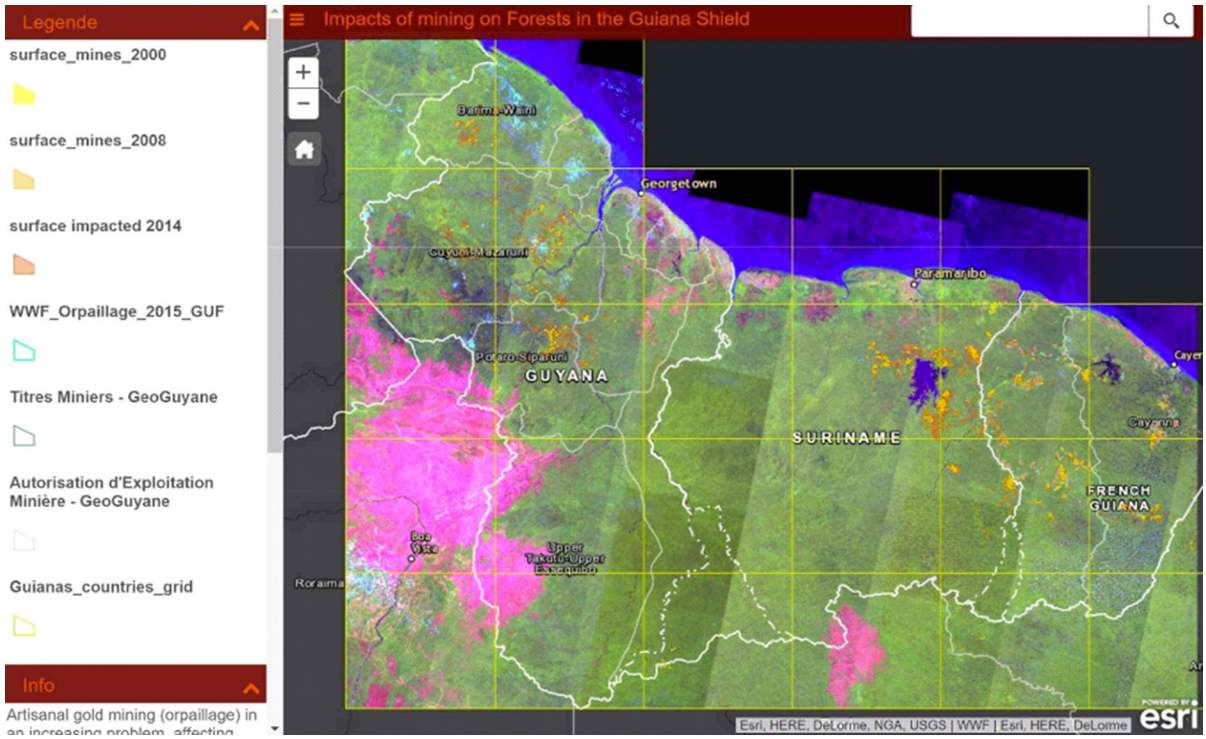

Fig. 6 Mapping portal designed by WWF-Germany The volunteers used this interface, which presents pre-processed Landsat 8 satellite images, to outline deforested areas during the participatory mapping workshop organized as part of the OPPEn project. Source: Shapiro & Thibault, 2016

different caches exist. Sometimes a site considered 'destroyed' can start up again only 24 h after the patrol moves out," a park agent explained.[19] Subtle nuances gradually emerged in the nomenclature: the FAG proposed renaming "destroyed mining site" in "inactive mining site" pointing out a more comprehensive approach. For its part, the PAG introduced the concept of "usable mining sites", less restrictive than "inactive mining sites". Metrological issues are at the heart of these controversies: the quantification of the phenomenon depends on these definitions. In order to put an end to these semantic disputes, which had substantial impact in the public communication of the government action against wildcat gold mining, the Intelligence Office (*Bureau des Renseignements—J2*) of the Command of the FAG, obtained in 2018 the approval for a *Standard Operating Procedure* (Loyer, 2018) to be imposed on all partners. It identified four mining site categories: active, destroyed, partially active, and abandoned (Table 1) and definitively prohibited the use of the expressions "inactive mining site" and "usable mining site".

The mapping of mining sites itself also gave rise to controversy. The protocol of 2018 stipulated that "in the event that a cache is discovered near a mining site, the detachment commander may associate the equipment found with the site. There is no maximum distance for this association […] common sense takes precedence" (Loyer, 2018: 4). Although this seems profoundly operational, the implications are important and refer to conflicts of interpretation which once again tended to influence the results in one direction or another. For the military, the discovery of a cache with a motor located several hundred meters away from a mining site is not necessarily counted as a new site, since the equipment in question had "[…] probably been evacuated from the mining site we were operating on and hidden in the forest," an officer explained. Doing otherwise might be a way of inflating the results in order to make a political point, like attracting attention to the difficult situation of some

[19] Interview May 15, 2018 Guiana Amazonian Park, Remire-Montjoly.

Fig. 7 A camp site in the forest. Some camps leave tree cover in order to escape detection as much as possible. © François-Michel Le Tourneau, 2019

territory. "When the Park counts 10 sites at Degrad Roche that are within 15 m of each other, it communicates very questionable figures…"[20] explained the same officer (Fig. 5). The positions of each stakeholder are quite clear in this case. The agency in charge of repressive actions will favor lower numbers as evidences of its effectiveness, whereas the agency in charge of managing the territory will favor higher numbers because they are political arguments.

As we saw, finding common ground and a—still fragile—common *modus operandi* took 10 years, which demonstrates how, in addition to measurement itself, commensuration is a sensitive step that can reveal or even crystallize tensions.

Generalizing to amplify: when deforestation and wildcat gold mining become one and the same

While WWF used satellite imaging for its OPPEn project, it made a different use of the images than government agencies: it considered deforestation as a proxy for the presence of WGM. The reasoning seems obvious: as wildcat gold miners remove forest cover in the course of gold production, deforestation is synonymous with WGM, and deforestation is easy to detect on satellite images. The only instruction given at the participatory mapping workshops was therefore to outline deforested areas by visual interpretation (Fig. 6). After aggregating the results as a set of polygons, this provided an estimate of the area affected by the activity across of the Guiana Shield. During the first workshop, which we got to observe directly, we have been surprised by the lack of any key for interpreting the images or any consistent input methods (no minimum collection unit or scale of digitalization, for example). The workshop facilitator's response was clear: "We're not here to make a scientific map; we're here to produce a figure that will

[20] Interview, May 18, 2018, Intelligence Office, Operations Division, High Command of the Armed Forces in Cayenne, French Guiana.

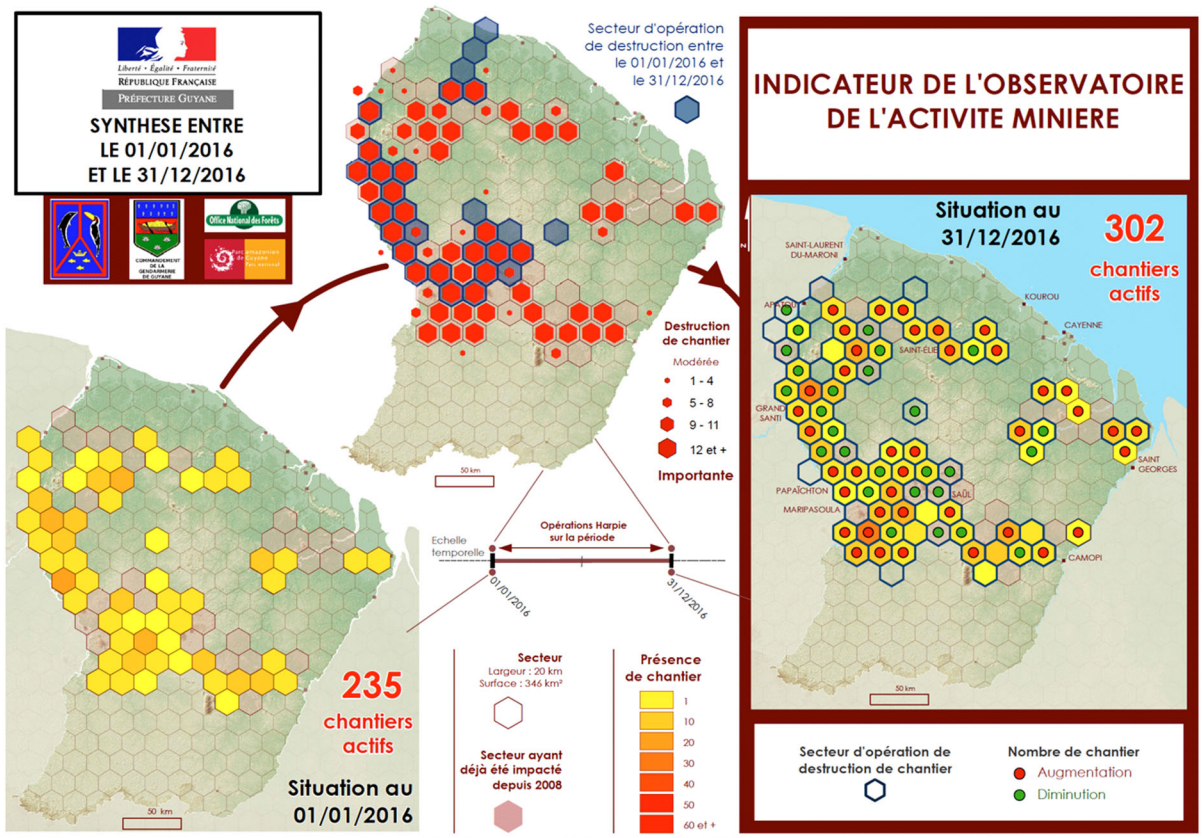

Fig. 8 A honeycomb map presented during one of the prefect's press conferences Source: Observatoire des Activités Minières, January 2017

challenge the government since it refuses to publish data."[21]

In addition to this stance—which lacked rigor but was effective in producing rapid results, as we will demonstrate in the next section –, WWF's approach was not based on a direct tracking of the activity. Instead, it relied on an indirect signal—deforestation—to assess the impacts of gold panning. While this phenomenon was almost negligible in French Guiana in the 1990s, when barge-based[22] practices prevailed, deforestation linked to wildcat gold mining activities began to be observed in the early 2000s (Linarès, 2019). The deforested areas remained small, however, suggesting that most sites we of small size (Le Tourneau, 2020b). In parallel, French Guiana also counts legal mining sites which are allowed to operate and also open significant areas of land which, according to environmental rules, are to be revegetated once operations are completed. Yet the method used by WWF does not make any distinction between these operations and illegal placer mines. It is true that they cannot be easily distinguished since illegal miners sometimes move into their concessions or work in areas abandoned by legal operators. Additionally, WGM can be inconspicuous (Fig. 7). It is not always characterized by deforestation visible on satellite images, especially when spatial resolution is coarser than 5 m per pixel. In particular, the recent development of underground mining makes the impact of WGM much lower in terms of loss of forest cover. Deforestation is therefore only an imperfect indicator and WWF engaged in a form of forced

[21] Statement made at the first participatory mapping workshop for the OPPEn project, organized in Cayenne on September 6, 2016.

[22] Boats that dredge sediments from streams and riverbeds and send them through a series of sluices to extract the gold concentrate.

commensuration by pairing the two indiscriminately (Espeland et al., 2008).

As we saw in this section, a close examination of the allocation process—from measurement to classification—revealed very different approaches between the government and NGO and within government agencies. These differences will be magnified again when we observe the different dissemination methods for these metrology practices.

Controlling equivalences to manage the dissemination of measurements: the challenge of regulating information

Shifting our analysis downstream, we will now look at the dissemination of data and the communication of this information in the political and media spheres. We observe two competing strategies in terms of regulating the dissemination of information: that of French authorities, aimed at controlling and restricting communication about wildcat gold mining, and that of WWF, which, on the contrary, tries to fill the mediatic space gradually abandoned by the government.

Government's failed strategy: limiting and simplifying the results

Wildcat gold mining in French Guiana has been a critical concern for public opinion since the early 2000s. Challenged by environmental conservation NGOs and collectives of indigenous peoples, the French government has been constantly called upon about its efficiency in rooting out *garimpeiro*. To avoid the emission of conflicting messages by various agencies, French authorities decided to coordinate communication by relying on maps provided by the OAM. Beginning in 2013, the prefect began holding regular (about every six months) press briefings, supported by a map depicting the intensity of clandestine gold mining (Fig. 8). In an effort to "blur the data, showing that we know where the sites are but without revealing the precise locations",[23] the data was aggregated on a 20 km × 20 km hexagonal (or "honeycomb") grid.

This map was produced for official communication purposes: its primary goal was to show that the military and police efforts were effective in bringing the situation under control. The transparency implied in the showing of OAM data therefore included subtle methodological adjustments aimed at making things look brighter. For instance, the summary map relied exclusively on "active" mining sites, without any reference to the other types (see Table 1). The computer GIS script used generated the numbers associated with the cells, subsequently represented according to a green–red color ramp, automatically. However, when the picture was unflattering, the result could be adjusted manually, the diluted nature of honeycomb cells, as opposed to individual points, making verification impossible. Therefore, in the opinion of a geomatics specialist from the ONF: "The FAG clearly understood that the best way to lower gold panning activities was to lower the numbers. (…) When an indicator wasn't good, Paint could fix it."[24] Whereas 500 "active mining sites" were listed in 2013, only 485 remained in mid-2014, and the number continued to drop with each briefing. When presenting his last report, Prefect Spitz sported an air of self-congratulation saying that: "The trend is extremely encouraging", providing figures to back this up: "371 mining sites were 'active' on January 1st, 2015, according to the OAM. As of December 7, there were 204."[25] Apparently wildcat gold mining was soon to be wiped out. But things turned out differently.

The triumphalism of the Prefect was also hard to swallow for other agencies which did not see the situation on the ground improve at all. The PAG expressed these sentiments in the media in 2016: "We cannot just be satisfied with simply dismantling mining sites; we must simultaneously take steps to fight and block logistics routes since the gold miners who are dispersed do not leave the forest. […] Some may think in terms of the number of sites to be dismantled in a given area. Our concern, from an environmental and societal perspective—since rivers and streams are important living environments—is that there will be pollution downstream, regardless of whether one or four mining sites are spewing waste

[23] Interview with the geomatics specialist from the ONF, Cayenne, October 7, 2019.

[24] Interview with a geomatics specialist from the ONF, Cayenne, October 7, 2019.

[25] Press conference on Tuesday, December 15, 2015, Prefecture of French Guiana, Cayenne

into the water. If there are ten mining sites, the impacts will be exacerbated, but even one site has an impact. That is our environmental approach."[26] In the same interview, the PAG criticized the OAM counting methods both in terms of detection and classification of the sites. Measurement and commensuration were thus once again at the center of debate. The army's planning of reconnaissance flights was openly called into question: "If you take a picture right after a destruction operation, it is easy to see why the number of active sites is much lower. But if you come back a while after?"[27] Furthermore, the PAG also denounced the constraints related to the classification of "active mining sites" (as defined in Table 1), which tended to minimize the numbers: "We tend to favor counting of what we can observe, such as places where activities are in progress but also traces of recent activity. If people heard a helicopter and took cover, that doesn't mean they won't be back 3 h or 3 days later to continue their business. That's our approach. We try to be as pragmatic as possible."[28]

This crisis led the PAG to decide to communicate its own numbers about its area of intervention (which covers 1/4 of French Guiana), contradicting higher authorities if need be. Thus, during a visit from the Minister of the Interior in French Guyana in 2016, the PAG announced the detection of 128 sites in its survey, the second worst figure in 8 years. When interviewed on this news, the Minister was asked to explain the government's strategy in light of the PAG's announcement. Showing how quantophrenia appeared to have given way to confusion, he responded with a complete misinterpretation of its meaning: "We have achieved very good results (…) Please allow me to provide the correct number. A few months ago, there were 467 sites, now there are 128. That's a 67% decrease!"[29] Mocked by the press, this episode left its mark within local governmental agencies.

The move towards greater transparency through the publication of summary maps, gradually instrumentalized and reduced to mere communication tools, ultimately backfired on the government. In 2016, radical changes were made in the communication doctrine about WGM by the new Prefect: "honeycomb" maps would no longer be released, and briefing were no longer to be given. Furthermore, the ONF's reports on the impacts of mining activities would from now on be reserved for government agencies and no more published online. Moving against the trend towards opening institutional data, which was spreading at the same time through the government, the OAM in French Guiana decided to operate behind closed doors. It was only in 2018 that things started to change. A Chief of Staff position was created to coordinate the repression of WGM and, in 2021, new transparency measures were announced.

Although the French government coordinates all the agencies involved against WGM, from 2013 to 2020, it chose to focus its communication on the repression actions, providing regular reports on means deployed (number of kilometers covered by patrols, air surveys, number of personnel involved) and on the "losses" inflicted on "the adversary" (number of ATV, canoes, motors, etc. destroyed) rather than providing a spatial overview of WGM activities and their territorial impacts. This "information vacuum" was quickly filled by WWF.

Generalize analysis and disseminate raw data: the WWF strategy that paid off

Faced with governmental black-out on data, WWF decided to fill the mediatic void by widely disseminating the results of its OPPEn project. Unlike OAM press conferences, always focused on a snapshot of a given point in time and never looking back more than twelve months, its maps provided diachronic analyses over several years, highlighting the increase and gradual dispersal of the clandestine miners' activities in the western part of French Guiana and, by extension, underlined the limited effectivity of government control over its territory. These conclusions sparked anger among French police and security forces who were directly responsible for it: "WWF? They're the wildcat gold mining paparazzi! All they want is sensationalism!", grumbled Gendarmerie major.[30] Once again, the methodological argument was used to discredit the results. The Prefecture

[26] Interview with Bérengère Bin (Deputy Director of the PAG) by journalist Frédéric Farine (Guyaweb), Oct. 3, 2016.

[27] Ibid.

[28] Ibid.

[29] Special edition, October 4, 2016, Guyane la Première.

[30] Interview, April 4, 2019, Gendarmerie Headquarters in Cayenne, French Guiana.

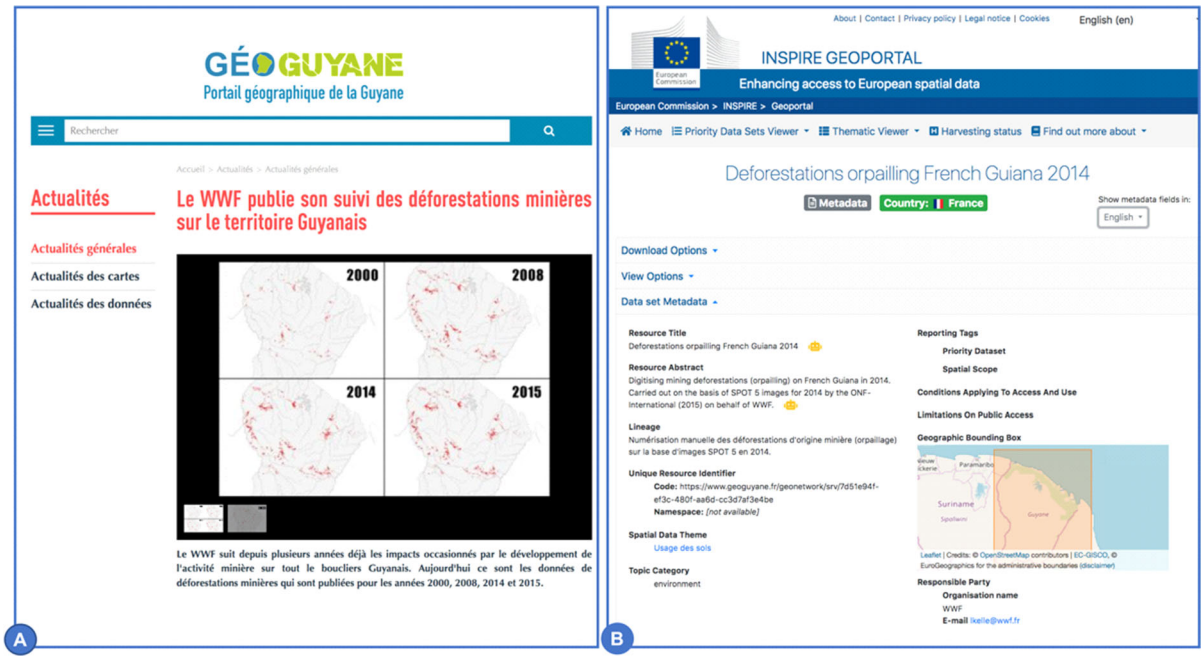

Fig. 9 WWF's mining deforestation data available on the institutional portals (**a**) on French Guiana's spatial data infrastructure: https://www.geoguyane.fr/, (**b**) on the European spatial data infrastructure: https://inspire-geoportal.ec.europa.eu/

challenged the reliability of the diachronic analysis or linked the increase pointed out by WWF with technical enhancements in satellite imagery: "Counting more just means counting better," explains a geomatics specialist from the Prefecture, "detection methods have changed, satellite image resolution has improved, and photo-interpretation techniques have been fine-tuned."[31] However, despite these objections, the OPPEn project's results dominated the media and eventually became a reference. A two-part communication strategy devised by WWF was responsible for this success.

Firstly, the distribution of its maps and reports included making data available on a web service (WMS) that could be integrated into a GIS. The decision not to simply share a summary map in a non-reusable format (PDF), as did government agencies, but instead supplement the reports with data that anyone could download, analyze or combine with other data and other sources, was aimed at promoting open data in general while pushing more transparency from the government. This happened at the same time when the public dissemination of geographical data sharply increased in Europe, becoming a norm as part of the EU INSPIRE directive.[32] As far as French Guiana is concerned, the spatial data infrastructure GéoGuyane, which hosts all types of GIS layers and their metadata (Fig. 9a), played a key role. It is standardized and interoperable, and connected to other platforms, such as the national Géocatalogue, itself linked to the European spatial data infrastructure (Fig. 9b), through data-scraping systems. As WWF's data was uploaded to the Geoguyane platform, it ended indexed in a set of multiple interconnections, while the integration via the WMS exchange protocol created a potential for multiplying the uses.

The second part of WWF's strategy has been to work with partners from Guyana, Surinam and Brazil

[31] Interview, April 3, 2019, Prefecture of French Guiana, Cayenne.

[32] INSPIRE is an EU initiative to establish an infrastructure for spatial information in Europe that is geared to help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development. The INSPIRE directive lays down a general framework for a spatial data infrastructure (SDI) for the purposes of European Community environmental policies and policies or activities which may affect the environment. The INSPIRE Directive entered into force on 15 May 2007. Source: Official Journal of the European Union, L 108, 25 April 2007.

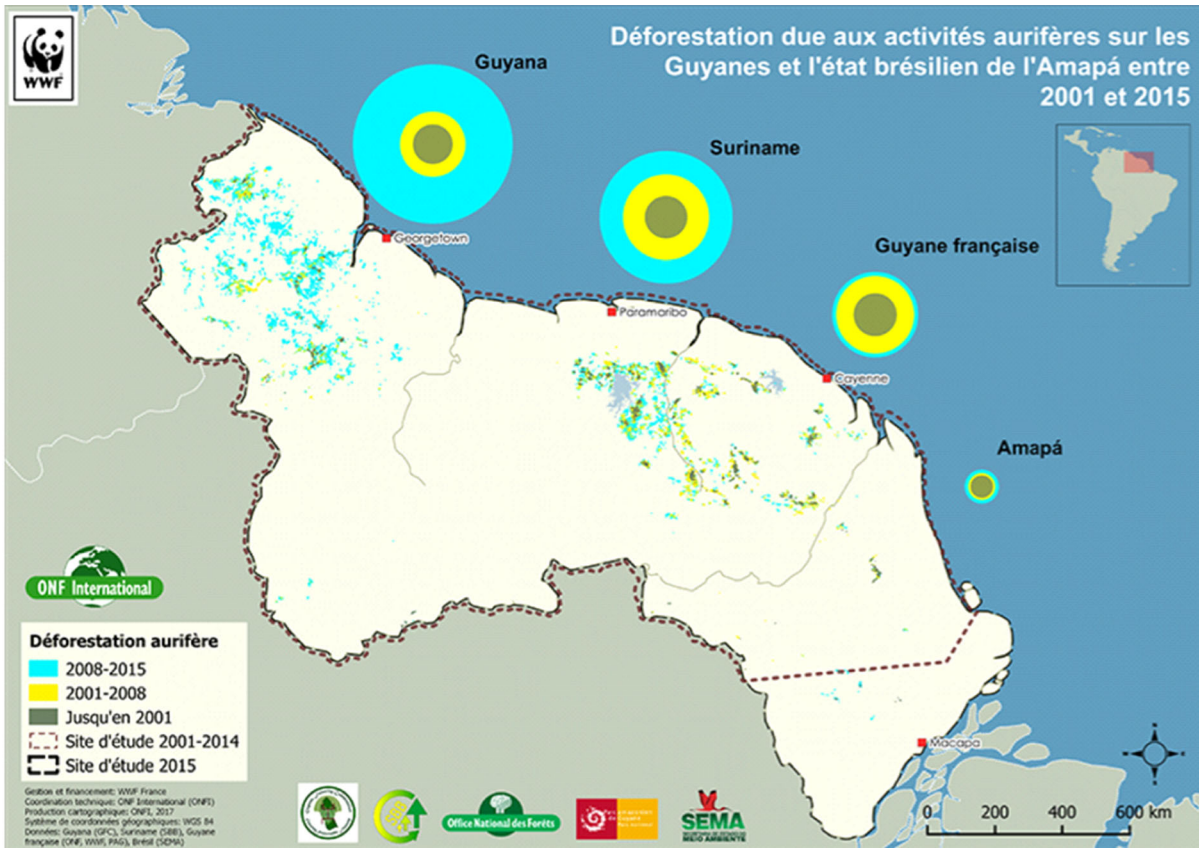

Fig. 10 Deforestation caused by gold mining between 2001–2008 and 2008–2015 periods using a MMU of 1 ha. Extract from WWF report "Monitoring the impact of gold mining on the forest cover and freshwater in the Guiana Shield" (Rahm et al., 2017)

(Fig. 3). Capitalizing on this network, WWF French Guiana became the only entity capable of presenting a regional vision at the scale of the Guiana Shield (Fig. 10).

Unlike PAG, which focused its counter-expertise on its area of responsibility, despite still timid attempts at cross-border collaboration, WWF expanded its scope of intervention to include four countries, showing that the dynamics of WGM activities defy borders. This represented a sharp contrast with state action where, as intergovernmental cooperation being still very much in its infancy, each country struggles to produce a reliable map of gold mining activities in its territory (assuming they want to, since the activity is legal or tolerated in some areas). Regardless of methodological bias, the cross-border vision brought forward by WWF was the first of its kind and quickly became a reference source.

As frequently happens nowadays with data produced by NOGs, this dataset was increasingly used in scientific publications and institutional reports, which brought it to grow far beyond its original sphere of influence within the non-profit and activist sector to become a reference standard, despite these methodological biases.

Conclusion

The decoding of metrological processes around wildcat gold mining provides keys to understanding the informational stakes of sparsely populated regions. The latter, historically linked to the "blank of maps", seem today to be characterized less by a question of data deficiency or asymmetry of capacities to capture and process information than by the modality of circulation and modes of categorization by social actors. Our metrological approach shows that the central problem is that of the qualification of the data, which is never raw, during its commensuration and

then its control during its diffusion. The importance of synoptic methods, which are easy to generalize and to image (the approach by deforestation rather than by water turbidity), confirms once again the power of maps, accentuated in the SPAs by the difficulties of access to the field. In this sense, metrological processes also participate in the formalization of these spaces.

From raw data to the metrology layer

Although the government has long had the monopoly on environmental data production in French Guiana (Nicolle and Leroy, 2013), the situation changed. A lack of transparency about a sensitive social and environmental issue ultimately prompted an NGO to upgrade its expertise and produce datasets challenging official communication. Paradoxically, state agencies should have had an edge since France adopted in 2016—the year WWF launched its project—its Digital Republic Law.[33] This raises the question of the exceptionality of French Guiana and SPA at large. If these remote territories, governmental action often maintains older patterns and, when adverse, its results are more easily shrouded in secrecy.

When it comes to wildcat gold mining, up to now, the government has not followed through with this "digital transparency" promise, practicing instead what the Ministry of Ecological Transition calls, not without malice, "controlled release of data".[34] While some web portals are now available, such as CAMINO,[35] which provides access to mining titles, this dissemination movement remains selective and data on wildcat gold mining sites remain inaccessible or bound with non-disclosure clauses. This has been all the more damaging that the communication based on aggregated data and summary maps had created expectations, unfulfilled after the information blackout started in 2015. Such a void of data-based information provided room for WWF's counter-maps to be circulated and become, by default, reference standards. To the eyes of the WWF's local director, the success of this counter-expertise can be traced to its transparency since "raw data" were disseminated, as opposed to the aggregated data in official honeycomb maps. However, as Lisa Gitelman (2013) points out, "raw data is an oxymoron" since this means erasing the traces of its production and the context of its initial uses. Making a data raw implies rendering invisible all the metrological process, thus providing the data with an appearance of objectivity it inherently lacks.

Far from minimizing wildcat gold mining impacts and the associated challenges, this contribution examined how this activity is measured and the technical and political *tests* that guide the production and dissemination of data relative to it, underlining the socio-technical layer of spatial data intended for "open" use. This layer remains a blind spot in the research that focuses on the analysis of map and data as a product without paying attention to the processes in which they were produced and to the social effects of their communication.

Map evidence: the imposition of metrology

Spatial data and maps are used to make wildcat gold mining activities visible and measurable, thus creating a statistical benchmark about public authorities' efficiency as far as territorial control and population protection are concerned. However, controversies surrounding maps and counter-maps tend to make the attention of the public drift. Confronted with an inherently evasive activity, stakeholders now seem to see their legitimacy and efficiency gauged by their capacity to measure the phenomenon more than by their efforts against it.

While maps are powerful instruments—guiding action and, in the case of disseminated maps, public debate—they also emerge as performances (Currie, 2020). They indeed craft the image of competent and innovative organizations for the agencies or NGO able to produce them. The emphasis on their methodological robustness—while avoiding reference to adjustments, improvements and inevitable compromises—provides technical legitimacy and a form of authority that is difficult to challenge. In the end, only organizations capable of producing such "evidence" are heard. Both the observatories we analyzed here—the State-led OAM and WWF OPPEn project—thus act as instruments of knowledge production, deemed

[33] Loi pour une République numérique, aimed at "giving France a head start in the digital field by promoting an open data and knowledge policy". Explanatory notes to Law no. 2016-1321 of October 7, 2016 for a Digital Republic. Source: www.legifrance.gouv.fr (accessed February 7, 2021).

[34] Interview, April 12, 2019, Cayenne.

[35] https://camino.beta.gouv.fr/.

relevant since they have been justified by their scientific nature (Alphandéry et al., 2012). As socio-technical systems, they rank and order data and knowledge, delegitimizing alternative knowledge that is not based on metrics. But in doing so, certain processes, stakeholders and territories are left invisible, as observed by (Rajão, 2013). In French Guiana and in the Amazon more broadly, this includes Indigenous peoples' knowledge, which is entirely absent from these debates, despite their position as first witnesses in some areas. Their absence in these maps and counter-maps battles is indicative of the marginalization of these populations in a wide range of decision-making processes.

Measurement and commensuration as products and producers of sparsely populated regions

The governance at a distance of SPA regions is based on data that is mainly produced remotely as well, or often in a fragmented manner and SPA have been the target of data experimentation (Jacob, 2018), where methods and techniques are designed, tested and adjusted. As a result, they are depicted by maps which result principally from data "extrapolatory tricks and poaching" (de Certeau, 1980) that we must be able to decipher.

The shortcomings of official or sovereign cartography incite stakeholders from different backgrounds to supplement, circumvent and even directly compete with governments in the production of data. Since in situ observation is no longer an essential prerequisite, what matters now is to master remote mapping techniques. Unlike field expeditions, these are increasingly accessible or, at least, increasingly shared with "civil society" both inside and outside the concerned territory. In marginalized regions such as SPA, ultra-local, macro-regional or even planetary connected NGOs have stepped up efforts to challenge governmental monopole on data and information and produce their own maps or counter-maps (Peluso, 1995).

Like maritime areas, which are not as well-mapped as most inland areas (Saïd & Trouillet, 2020), less data exist about SPA than about the metropolises that control them. Geographical information nevertheless remains a key tool for remote governance and the deconstruction of its production and dissemination is therefore more important than ever. The performativity of mapping and quantifying territorial margins partially explains the actions aimed at understanding and controlling them. It proposes an interpretive framework for these marginalized areas, and thus deserve close attention. Further empirical studies are then needed to take a full account of how metrology are both products and producers of sparsely populated regions.

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