



The materiality of data transparency and the (re)configuration of environmental activism in the Brazilian Amazon

Raoni Rajão^a  and Juliane Jarke^b 

^aDepartment of Production Engineering, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil; ^bInstitute for Information Management Bremen (ifib) & Centre for Media, Communication and Information Research (ZeMKI), University of Bremen, Bremen, Germany

ABSTRACT

This article examines the relation between data transparency and environmental activism in the Amazon rainforest. For this purpose, we analyze the history of PRODES and DETER, two satellite-based monitoring systems developed by the Brazilian Institute for Space Research (INPE). We discuss its role in environmental activism and the formulation of policy toward the Amazon over the last three decades. Based on this analysis, we argue that the level of aggregation (e.g. regional figures vs. individual events) and temporality (e.g. yearly consolidations vs. near real-time releases) of open data configure different ways of performing environmental activism. Aggregated figures tend to have wider policy significance due to their simplicity and scale, yet allow very little room for reinterpretation, contribution from environmental activists, and direct use in policy implementation. Disaggregated data, while allowing more forms of (unexpected) reinterpretations and additions via the overlay of different data-sets, also require the intervention of environmental activists and other info-mediators in order to acquire meaning for the broader public. Similarly, while consolidated data-sets have the advantage of allowing more time for the creation of higher quality data, they are often published at a point in the policy-making cycle in which the negative effects of current choices are irreversible. At the same time, while more frequent data releases may lead to more responsive policies, they also place governmental agencies in a more vulnerable position since near real-time data are more prone to contain errors. Based on these considerations we conclude that monitoring data do not simply represent deforestation in the Amazon. Instead, different publics and data configurations (i.e. spatial and temporal aggregation levels) produce different objects (e.g. a threatened Amazon, a successful policy) and subjects (e.g. knowledgeable environmental activists, an unresponsive government).

ARTICLE HISTORY

Received 6 December 2016
Accepted 23 March 2018

KEYWORDS

Open data; Brazilian Amazon; environmental activism; data practices; materiality; actor–network theory; satellite-based monitoring

When the Brazilian military rulers initiated the large-scale colonization of the Amazon in the 1970s, the rapid process of deforestation that followed was received positively both in Brazil and abroad, with the exception of very few dissenting voices. For instance, in 1971 the U.S.A. news magazine *Time* described the building of the Transamazonica highway as ‘the work of the century’ (*Time*, 1971),

while in 1973, the front-page article of the British newspaper *The Times* showed pictures of modernist Brasília and the construction of the Transamazonica highway side by side to highlight how the country's 'industrial expansion and development [was] almost unparalleled among countries of the Third World' (Frenchman, 1973, p. 1). By the end of the 1980s, however, the situation had changed. The leaders of developed countries accused the Brazilian Government of committing an environmental crime, while the World Bank suspended loan payments for large projects in the Amazon region due to humanitarian and environmental concerns (Keck & Sikkink, 1998; Price, 1994). Despite its contradictions and false starts, since the 1990s the government has more than doubled the size of protected areas in the Amazon and changed the law, increasing the forest reserve requirements in private areas from 50 to 80% in the region (Hochstetler & Keck, 2007). Since the mid-2000s, the government has implemented a series of command and control policies that led to an 81% decrease in Amazon deforestation rates between 2004 and 2012 (INPE, 2017).

A large body of literature has pointed out the central importance of social movements in transforming Brazilian policy-making toward the Amazon. Different fields of study in the social sciences have highlighted the role of non-governmental organizations (NGOs) (Keck & Sikkink, 1998; Price, 1994), grass-roots movements (Gonçalves, 2005; Hecht & Cockburn, 1989), the mass media (Bendix & Liebler, 1991; Slater, 1996) and some progressive senior officials within the government (Guimarães, 1991; Kolk, 1998; Viola, 1998) in the U-turn taken by Amazon-related policies (see also Hochstetler & Keck, 2007; Keck, 2001; Kolk, 1998; Lemos & Roberts, 2008; Moran, 1996). In particular, these studies show how traditional activism practices such as protests, political lobbying, inside jobs by technocrats, and engaging with the mass media have forced Brazilian politicians to acknowledge the importance of preserving the Amazon and take measures to reduce deforestation, even if only provisionally and erratically (as evidenced by the 2015 and 2016 hike in deforestation).

While the importance of traditional activism practices is undeniable, studies tend to ignore emerging forms of activism related to increased governmental data transparency. In general, transparency refers to 'the degree to which information is available to outsiders that enables them to have informed voice in decision and/or to assess the decisions made by insiders' (Florini, 2007, p. 5). Data transparency is increasingly seen as a way to promote a new model of 'open data' leading to 'open government.' It is believed to increase engagement among citizens, thus rendering governments more accountable for their actions. Specific to the case of tropical deforestation is the expectation that the development of satellite-based monitoring systems with open data would bring 'a new area of transparency in forest governance' and as a consequence increase environmental protection (Baker & Williamson, 2006; Davis, Fonseca, & Câmara, 2009; Fuller, 2006). Yet, 'open data' do not deterministically translate into transparency, openness and government accountability. Instead, a growing number of studies have pointed out that open data only enables transparency in connection with concrete data practices by NGOs, government officials, and local groups (Hoppe, 2011; Manovich, 2013; Rajão & Georgiadou, 2014; Venturini et al., 2014). It is therefore important, to understand (environmental) activism in a datafied world with respect to emerging open data practices; it would be wrong to consider data as a standalone force able to bring societal change.

The goal of this article is to attend to the role of open data in environmental activism and policy-making practices in the Amazon, while avoiding the technologically deterministic narratives often found in the technical literature on open data and satellite monitoring. With this purpose, we analyze how social movements engaged with PRODES (1988–2003) and DETER (2004–Present), two satellite-based monitoring systems developed by the Brazilian Institute for Space Research (INPE). The next section presents an overview of sociomaterial approaches in order to propose a theoretical lens for understanding open data. This will be followed by a description of the emergence and transformation of open data monitoring systems in Brazil and practices related to campaigning and the creation of policies against deforestation in the Brazilian Amazon. From this case study, it will be argued that monitoring data does not simply represent deforestation in the Amazon. Instead different publics (e.g. social activists, policy-makers) and data configurations (e.g. spatial and temporal aggregation

levels) produce different objects (e.g. a threatened Amazon, a successful policy) and subjects (e.g. an unresponsive government, influential environmental campaigners).

The materiality of data and social activism

An emerging body of literature has put forward a representationalist critique of open data in both its epistemological and political senses. In relation to the epistemological dimension of open data, many studies criticize the notion that data represent the world in an objective and unbiased way (Fung, Mary, & David, 2007; Georgiadou, Lungo, & Richter, 2013; Hood, 2011). In particular, these studies show that open data initiatives do not simply provide transparent windows that allow citizens to 'see' environmental and social realities as they 'are'. Instead, the meaning and form of open data are the outcome of a series of complex and conflictual practices (Schrock, 2016). For instance, it is through the work of experts from non-governmental organizations that government data may become evidence of misconduct and provide the ground for public action. Such practices include processes of data definition, data collection, data compiling, data storing, data processing, data mining, and data visualization that entail sometimes controversial interpretive and framing practices (Gitelman & Jackson, 2013; Hoppe, 2011; Manovich, 2013; Rajão & Georgiadou, 2014; Venturini et al., 2014).

In relation to the political dimension of open data, some studies also show that, in contrast to the triumphalist accounts that dominate the literature, open data can generate negative effects and hinder the very democratic practices that they were supposed to support (Biermann & Gupta, 2011; Hood, 2011). This concerns, for instance, situations in which the increasing availability of data enables new forms of social control, or when data are used in instrumental ways to foster specific political agendas. From this assertion, other studies emphasize that open data initiatives should be understood in close relation to broader historical changes, such as the rise of the risk society and globalization (Boström, Klintman, & Micheletti, 2008; Mol, 2008). Along the same line, many studies criticize the notion that the mere availability of open data is going to improve political representation of citizen voices and citizen engagement in public matters. What is at stake here is the myth that 'big data' deterministically allow new and better forms of social accountability since they provide the basis for better forms of public engagement and scrutiny (Boyd & Crawford, 2012). This belief entails that different publics can draw upon open data for evidence-based policy-making and hold politicians and bureaucrats accountable for not representing the public properly (Nowotny, 2007). In contrast to this view, critical scholars have pointed out that open data only support democratic processes if they are used by digitally literate citizens (Isin & Ruppert, 2015). Otherwise, open data are (at most) just machine readable data-sets in an online repository. Similar to earlier arguments on the digital divide (Couldry, 2008; Selwyn, 2004; Warschauer, 2003), it can be argued that the potential connectivity to open data platforms is largely meaningless if most citizens lack the literacy skills to (critically) engage with open data.

It is hence important to consider not only open data but also social activists, namely, 'literate' citizens that form publics that can act as a 'spokesperson' (Callon, 1986) for the data and translate it for interpretation by a community or society. The ways in which 'meaningful engagement' is constituted may of course be contested. A new generation of technically skilled activists has emerged, becoming 'essential change agents in urban environments' (Schrock, 2016, p. 2). Social movements may be assembled as 'networked publics,' that is, individuals that are increasingly interconnected with each other; technology is hence affording particular ways of engagement (Baym & Boyd, 2012). According to Couldry, Livingstone, and Markham (2007) these 'public connections' not only are increasingly mediated by media technologies but also constitute a precondition for civic tech engagement. Similarly, social movements are organized, constructed, and produced by and through (media) technologies and associated open data. Hence, the increasing availability of open data is transforming both social activism and policy-making.

The critical literature on the epistemological and political aspects of data has been able to fruitfully highlight the limitations of the mainstream concepts concerning the role of (open) data in society (Milan,

2013; Milan & Gutierrez, 2015; Schrock & Shaffer, 2017). Yet, to some extent, both the mainstream and critical bodies of literature depart from a similar position in that they conceptualize social activists and governments as static entities that are mediated by open data in different ways. Similarly, when discussing how data represent the world or facilitate political representation, both bodies of literature assume the existence of an external world or a public that is somehow mediated by open data. In doing so, the current literature on the topic does not pay enough attention to the ways in which different entities come to be constituted and transformed through open data practices. Most importantly, this representationalist conception of open data often fails to understand how the materiality and agency of data (and not only of human actors) is involved in the 'ongoing reconfigurations of the world' (Barad, 2007).

Central to our line of enquiry is the work of Karen Barad and Lucy Suchman. Barad (2007) describes the 'goal' of her approach as '[working on] thinking about the ways in which particular entanglements matter to the production of subjects and objects' (p. 232). She argues in her 'agential realist' approach that 'relata' in a network are mutually constitutive. Her notion of relata is grounded in the assumption that the world is not populated with independently existing entities but rather that subjects and objects come into being through relations: 'relations do not follow relata, [but] the other way around' (pp. 136–137). The notion of 'intra-action' that Barad coined here does not just acknowledge the interaction and relational effects of network actors but emphasizes the fact that they do not pre-exist their 'intra-action' as independent entities (p. 33): 'relata do not pre-exist their relations; rather relata-with-in-phenomena emerge through specific intra-actions' (p. 140). Hence, it is important to realize that not only do government data, scientists, policy-makers, and satellites come to be related in some kind of network, but they come to be produced through their association as particular subjects and objects.

In contrast to traditional Actor-Network Theory (ANT) approaches that propose a 'generalized symmetry' across human and non-human actors, we follow here Lucy Suchman (2007) who argued for a 'rearticulation' of asymmetry (or dissymmetry). A rearticulation that recovers 'certain subject-object positionings – even orderings – among persons and artefacts and their consequences' (p. 269) while at the same time recognizes 'hybrids, cyborgs, and quasi-objects' that have been made visible through STS. In her thoughtful considerations, Suchman (2007) asks: 'How might we reconceptualize the granting of agency in a way that at once locates the particular accountability of human actors, while recognizing their inseparability from the sociomaterial networks through which they are constituted' (p. 270)?

Hence, when following Barad's notion of intra-action, we are aware that although humans and non-humans constitute each other, they do so in different ways. As Suchman (2007) argues: 'Persons and artifacts do not constitute each other *in the same way* [...] Differences include the fact that, in the case of technological assemblages, persons just are those actants who configure material-semiotic networks, however much we may be simultaneously incorporated into and through them' (p. 270, emphasis in original).

Barad's framework is particularly helpful to understanding how different agencies are intra-actively entangled and co-constitutive. Such objects and subjects are performed through their intra-action and do not exist outside the material-discursive practices that enact them. In this article, we expand on the literature on the performance of transparency and open data by highlighting the agency of not only human actors (e.g. scientists, policy-makers, journalists) but also of non-human actors (e.g. computer models, data structures, algorithms, satellites, visualizations) and associated practices (Harris, 2011; McDermott, 2010; Meijer, 2013). Hence, within our framework we understand transparency as a relation that is produced through open government data practices of various actors such as policy-makers, scientists, NGOs, and citizens. In particular, we argue that it is crucial to understand such practices as material-discursive (Barad, 2007).

The data for this analysis have been obtained from both textual sources and interviews. The documents analyzed include books, official documents (e.g. letters, reports, studies), news articles, and legal texts (e.g. policies, laws, fines) created in the last four decades. This paper also draws upon an ongoing longitudinal study of the interface between science and deforestation reduction and climate

policies in Brazil. As part of this study, this paper is based on a subset of a corpus of 113 semi-structured interviews held in Brazil between June 2007 and 2017, these being conducted for the most part in Brasília (the country's political capital), São José dos Campos (location of the headquarters of the Brazilian National Institute for Space Research (INPE)) and Mato Grosso, in the southwestern section of the Amazon rainforest. Over the years, this study evolved from mere observation into active engagement with social movements. Currently, the first author is a member of the Brazilian Forest Code Observatory, Brazilian Climate Change Forum and has co-authored articles and policy reports in collaboration with the Amazon Environmental Research Institute (IPAM), one of Brazil's most prominent NGOs. In conducting interviews, participatory observation, and action research, the author was able to obtain an in-depth understanding of the sociomaterial practices of environmental activists, scientists, policy-makers, and law enforcers in Brazil.

Deforestation data and its publics

Yearly deforestation data and environmental crises

The calls from scientists and activists to save the Amazon rainforest in the 1970s were not considered pressing by Brazil's policy-makers. The first demands to save the rainforest from environmental activists were based on journalistic and anthropological accounts and studies in biology focusing only on a specific patch of forest or population (Bourne, 1978; Davis, 1977; Denevan, 1973). Even though these accounts played an important role in the emergence of public concern about the Amazon, they were unable to stop the expansion of Brazil's colonization policies in the first half of the 1980s (Hecht & Cockburn, 1989; Mello, 2006). Private international capital was keen to take advantage of the business opportunities in the region and the generous tax breaks and subsidies offered by the government in the second plan for national development (PND II) during the second half of the 1970s. Large corporations from developed countries were directly involved in running a series of activities in the Amazon rainforest, including mining (e.g. U.S. Steel), cattle ranching (e.g. Volkswagen, Nestlé), logging (by various Japanese corporations), and paper production (Little, 2001; Oren, 1987; Parayil & Tong, 1998). Furthermore, against the recommendations of anthropologists hired by the World Bank to evaluate the impact of projects on the native indigenous population (Price, 1989), this and other multilateral organizations provided substantial loans for the construction of roads, dams, mines, and the execution of colonization projects in the Amazon during the 1980s (Hecht, 1989, p. 116).

One of the explanations for the limited reach of traditional environmental activist practices during the 1970s and early 1980s was their inability to counter the official narrative of the Brazilian Government based on satellite data. For instance, a deforestation assessment carried out by INPE concluded that there was no reason to be alarmed about the Amazon because 'the current level of deforestation can be considered low if we consider the total surface [of the region ...]' (Tardin et al., 1980, p. 10). During the same period, scientists from the United Nation's Food and Agriculture Organization (FAO) also explicitly disqualified the claims from environmental activists for not offering 'the factual and quantitative data that could allow for a sound estimate of the magnitude of the problem' (FAO, 1981). In a newspaper interview, FAO experts went even further and considered that evidence brought by social movements was 'speculative [...] excessive and misdirected' (Clayton, 1982).

The situation in relation to the Amazon was very different from the end of the 1980s onward. NGOs were able to successfully lobby the World Bank to stop the disbursement of loans to Brazil and influenced in the creation of the program *Nossa Natureza* (Hecht & Cockburn, 1989; Keck & Sikkink, 1998). With this policy for the first time, the Brazilian Government 'recogniz[ed] the gravity of the current tendencies of the occupation process of the Amazon' and showed a willingness to change it (Brazil, 1988 cited in Mello, 2006, p. 69). The measures relating to *Nossa Natureza* included a series of presidential decrees creating new national parks, establishing environmental education projects, setting new regulations concerning the use of chemical products in agriculture and, most importantly, abolishing subsidies toward cattle ranching, which had long been considered to be the

main driver of deforestation in the Amazon (Browder, 1988). Five months later, the government also created the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) and provided considerable financial resources in order to intensify the law enforcement activities to control deforestation in the region. The contribution of traditional environmental activism practices in this process is well documented. What is less clear is the contribution of the growing availability of satellite-based deforestation data provided by the Brazilian National Institute for Space Research (INPE) to social activism.

Since the 1970s, the Brazilian Government has been using satellites to estimate deforestation levels, mostly as a way to monitor the implementation of colonization policies in the region. However, in 1989, following the wave of controversies concerning the actual extent and rate of deforestation in the region, the government ordered the Brazilian National Space Research Institute (INPE) to create PRODES, a program to calculate the deforestation in the Amazon on a yearly basis aggregated by state. In years with low deforestation rates, the issue tends to attract relatively little attention from the mass media and is used mostly by the Brazilian Government to boost its environmental profile. However, when deforestation is on the rise, social movements have used PRODES' aggregated data to press the government into action. For this reason, it is possible to observe that hikes in PRODES' deforestation rates are often followed by direct policy responses. These include the increase in the level of mandatory conservation levels in private properties in 1996 and the creation of the Plan to Control and Fight Deforestation (PPCDAm) in 2003. In this respect, the 'peaks' themselves are perceived by government officials as a request to act; the visualization of data then 'demands' action prior to any direct interference of external stakeholders, given the long history of environmental campaigning based on PRODES data. For this reason, it has been very important for senior officials from the Ministry of Environment to know the deforestation rate numbers in advance, in order to inform environmental activists and mitigate the political consequences of bad news. It is thus possible to observe that deforestation data is directly translated into action (Figure 1).

A number of factors help to explain why PRODES' aggregated figures have rapidly gained a central role in the Amazonian policy debates. Firstly, in contrast to anthropological and ecological studies, which were only able to make truthful claims about a specific patch of rainforest, PRODES' Amazon-wide figures are able to refer to the present and future process of deforestation as a whole. Secondly, in contrast to local assessments and narratives from the indigenous population, which may be considered biased and dramatic, the figures of deforestation have the appearance of objectivity and scientific rigor

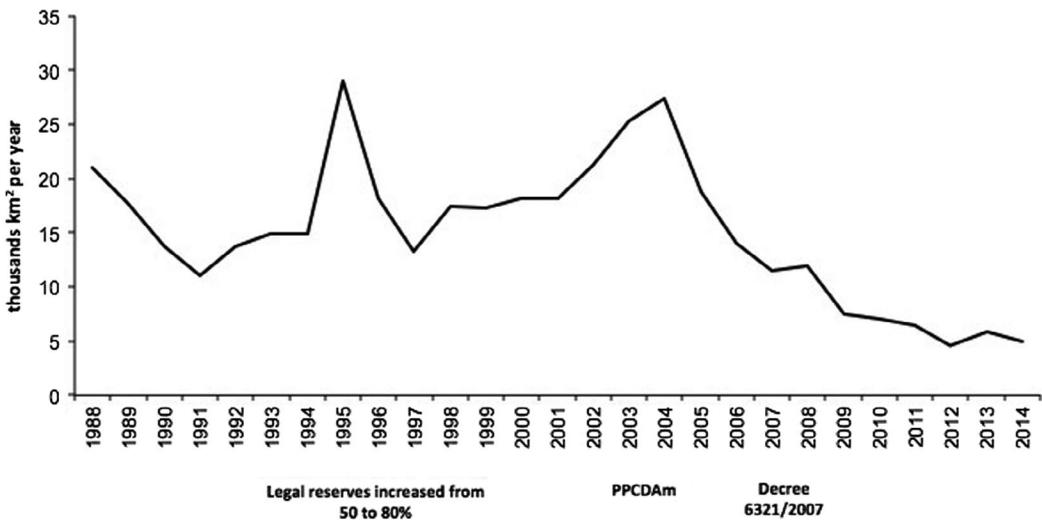


Figure 1. Annual deforestation rates calculated by INPE through PRODES, a satellite-based monitoring system.

which appeals to policy-makers (Rajão, 2013). The provision of aggregated yearly deforestation data subsequently transformed the Amazon rainforest from a source of industrial progress represented through the level of deforestation into a fragile ecosystem that could one day be completely destroyed. Conversely, the use of such data changed the politics of deforestation in the Amazon by empowering environmental activists to place pressure on the government, and pushing the government to make claims about the effectiveness of its policies (Rajão & Georgiadou, 2014).

Data disaggregation and god's eye view of the Amazon

While the aggregated yearly deforestation rates of PRODES have been very influential in policy-making, environmental activists were concerned with the lack of detail of the data provided by INPE. During the late 1990s, some scientists from INPE recognized the importance of providing full access to PRODES' disaggregated data to environmental NGOs, journalists, and the broader academic community. However, these initial attempts failed due to the prominence of a view within the government that the deforestation maps were sensitive information from a national security point of view. For this reason, a few research groups in the United States, such as NASA and the Smithsonian Tropical Research Institute invested considerable resources in deriving disaggregated deforestation maps from satellite images, in practice replicating the work already done by INPE on a yearly basis (Laurance et al., 2001; Skole & Tucker, 1993). Yet this data had important limitations: since data were available only for specific time periods, different research groups used incompatible methodologies and the data access was restricted to a few well-resourced universities in the U.S. For this reason, most environmental NGOs, journalists, and scientists still had to rely exclusively on the yearly deforestation figures provided by INPE. Consequently, the analyses of the causes and spatial dynamics of deforestation remained the exclusive domain of the Brazilian Government and a few research groups in the global North.

The situation started to change with the election of the president Luis Ignacio Lula da Silva in 2002 and the arrival of Marina Silva at the Ministry of Environment. In contrast to previous ministers, Marina had very close connections to environmental NGOs and demanded to make PRODES disaggregated data accessible to civil society. Thanks to this political support, some of INPE's more progressive researchers decided to publish the entire PRODES disaggregated data-set online. By making PRODES' disaggregated deforestation maps available, INPE expanded access to satellite-based deforestation analysis. According to different interviewees, the availability of disaggregated deforestation data revolutionized the role of environmental activists in Brazil and the ways in which they operate. For example, the director of a very influential environmental NGOs remarked that:

As it is done today, anyone can download that [the disaggregated deforestation data] and work it on their own way. Therefore, society started being invited to analyze the [deforestation] results jointly with the government. [...] This brings greater transparency and allows for a much more productive way for society and the private sector to put pressure on the government to reduce deforestation. This is why we can now say that 'we are watching you [the government]'.

A good example of how disaggregated deforestation data reconfigured environmental activism is provided by the *Instituto Socio-Ambiental* (ISA), an NGO with good visibility within the Ministry of the Environment. ISA superimposed INPE's data on the maps of conservation areas and indigenous reserves, and found that deforestation in protected areas is almost 10 times lower than in other areas, thus acting as a barrier for the expansion of deforestation (ISA, 2003). This initial finding was further confirmed by a series of other more detailed studies drawing upon the same data-set offered by INPE (Ferreira, Venticinque, & Almeida, 2005). In particular, these subsequent studies described protected areas as 'barriers' to forest cutting and fires along the 'arc of deforestation' – the front line of forest destruction moving north from the south and southeast of the Amazon (Ferreira et al., 2005; Nepstad et al., 2006; Soares-Filho et al., 2010) (Figure 2).

The spatial analysis enabled by PRODES' disaggregated data contributed to a reframing of the role of protection areas from the protection of endangered populations and biodiversity to a strategy of reducing or even containing the expansion of the agricultural frontier in the Amazon. This

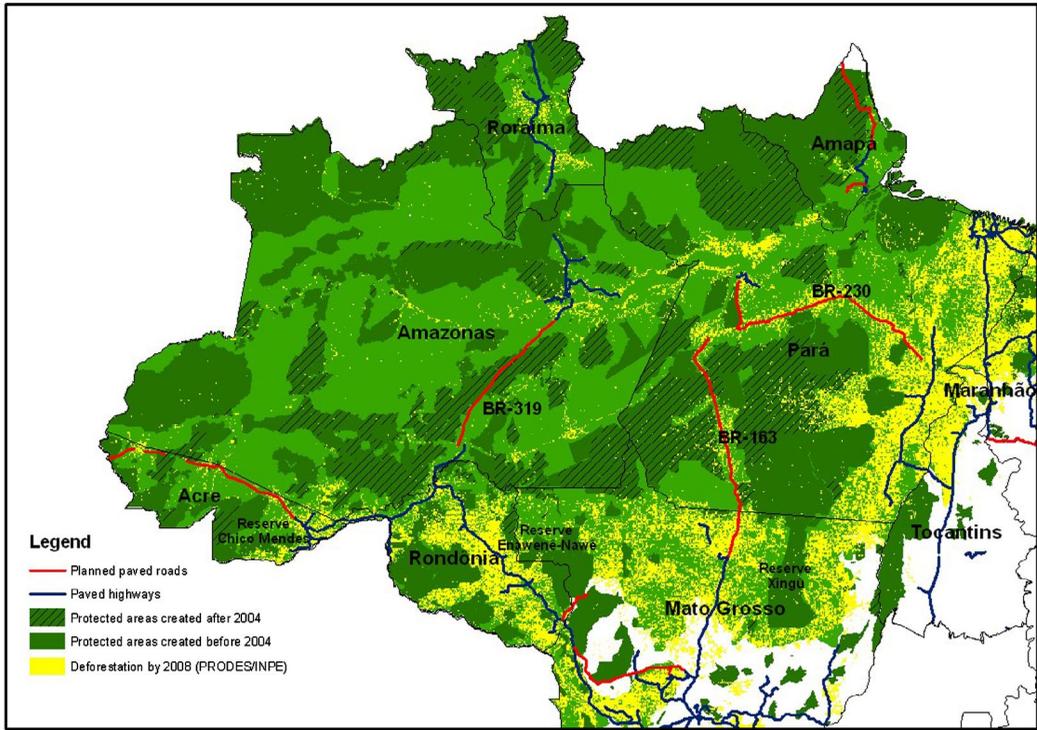


Figure 2. Map showing deforestation patterns, main roads, and protected areas in the Amazon. Source: IBAMA, PRODES/INPE, and IBGE 2010.

new rationale for the creation of protected areas has been very influential in the formulation of the PPCDAm, the Plan for the Prevention and Control of Deforestation in the Amazon launched in 2004. One of the ex-directors of the Ministry of the Environment directly involved in the formulation and implementation of the PPCDAm confirmed that the creation of new conservation areas based on PRODES' disaggregated data was undoubtedly one of the two main components of the plan. The results of this policy can be seen in a representation of the Amazon that was created using the same geographic information system application and disaggregated data adopted by policy-makers (see Figure 2). Here, the first feature to notice is the substantial increase in the number of protected areas after 2004 (hatched areas). Moreover, it is also possible to see in the map that while most pre-2004 protected areas were created away from the agricultural frontier or in areas traditionally inhabited by forest dwellers, the new conservation areas are mostly located in the arc of deforestation or alongside planned paved roads (see BR-163 and BR-319) – areas which the analysis of the disaggregated deforestation data had indicated to be particularly vulnerable (Laurance et al., 2001; Pfaff, 1999).

Hence, the practices related to the availability of PRODES' disaggregated data have allowed the analysis of the spatial determinants of deforestation by a much wider group of environmental activists. Thanks to this, NGOs were able to counter the official discourse of the government by providing their own independent analysis of the causes of deforestation in the previous year only a few days after the release of the PRODES figures. In this way, an increasingly large group of environmental activists were able to monitor the Amazon with the same 'god's eye perspective' that until then was the exclusive domain of a few. At the same time, the Amazon has also been transformed into an arena for policy activism, from a region with people, plants, and animals suffering the consequences of deforestation to a set of deterministic spatial relations self-evident in a digital map (Rajão, 2013).

Real-time deforestation control

The consolidation of PRODES during the 1990s and the opening up of the system in 2003 have played a key role in the subsequent creation of policies toward the Amazon. Furthermore, by making PRODES' data an indispensable, central point in the position of new policies, the Brazilian Government was able to ensure better control over how the situation of the Amazon was understood by local and international actors. Yet, according to different informants, there was a growing discontent from IBAMA, the federal environmental agency, and some NGOs more engaged in the protection of the rainforest at the local level, with respect to both the time it took for INPE to release its deforestation rates and the frequency of its studies. As a senior official explains, before DETER, 'INPE's monitoring system used to take almost two years to release deforestation data, when it was too late to plan anything.' It was in response to these criticisms that INPE decided to develop DETER, a monitoring system aiming to detect deforestation in 'real time,' allowing IBAMA and state-level environmental agencies to catch the perpetrators 'in the act.' In contrast to PRODES, which uses high-resolution by low-frequency Landsat TM imagery, DETER uses medium resolution images from NASA (U.S. National Aeronautics and Space Administration) satellites Terra and Aqua to obtain daily snapshots of the Amazon. Based on these images, INPE scientists and image interpreters provide a set of deforestation alerts every 15 days, indicating the geographical coordinates of recently detected deforestation, which can be seen online by governmental agencies as well as the general public (see www.inpe.br/deter). INPE also calculated monthly aggregates of deforestation, with its access was restricted to governmental officials because INPE scientists considered this data to be prone to error due to the low resolution of the satellite images drawn from DETER.

Participant and direct observation conducted by the first author of this paper with forest rangers in the Amazon showed that in fact DETER plays a key role in the enforcement of environmental laws in the region. Even though the rangers do not use DETER to conduct the type of 'real time' deforestation control imagined by INPE's scientists and senior officials from the Ministry of Environment, the development of this system has proven to be central for the coordination of law enforcement actions in the Amazon (Rajão & Vurdubakis, 2013). The identification of possible targets and the planning and coordination of missions at the local level are the IBAMA activities where DETER has had the most visible impact. In describing the changes brought about through the introduction of DETER, officials often described the period before GIS as the time when IBAMA was 'blindfolded,' so that it had to rely on its 'forestry instinct' (i.e. sixth sense of where to go) or simply to be at the mercy of luck, since small teams of forest rangers have to cover areas as large as England. Furthermore, even though IBAMA has a toll-free telephone number to receive anonymous reports of environmental crimes, the tips are often misleading or not sufficiently detailed. On a more general level, a similar issue was also reported in relation to the planning and coordination of missions. Because the regional managers did not know in a timely manner in which municipalities/areas most of the deforestation was taking place, they were often unable to position their personnel in a strategic and effective way.

For these officials, the introduction of DETER was an eye opener, both metaphorically and literally. They reported that with the introduction of GIS at a local level and the availability of deforestation data at a higher temporal frequency, IBAMA 'started being able to see deforestation while it was happening, and not the final result of deforestation,' as an IBAMA senior forest ranger explained, echoing the opinion of many rangers and managers. By observing the practices of local managers and rangers, it was possible 'to see' that real-time data provided by DETER has clearly become a central piece in law enforcement coordination efforts. Nevertheless, DETER remained marginal in discussions concerning policy-making and was not embraced during this period by environmental activists.

The real-time data and political pressure

In contrast to PRODES, at first DETER had achieved only a marginal role in relation to policy-making. In this regard, an INPE scientist recalled that in 2004, a few months after the creation of DETER, the

monthly deforestation estimates were indicating a steep increase in the rate of deforestation. INPE scientists used private channels to warn the ministry of environment to no avail. Some journalists and members from NGOs also used their technical skills to manually aggregate DETER's deforestation data, but due to lack of legitimacy their voices were also disregarded by the central government. As a consequence of this, the government failed to respond to the growing trend and was faced with an increase in total deforestation as was shown in PRODES estimates published in the following year. This experience was very frustrating to INPE scientists directly involved with DETER, as one of them recalls in the following excerpt:

I was losing sleep at night during this period. I was sleeping less than two hours and I was tearing out my hair. I called the director of the Ministry of Environment and said on different occasions, 'You are not doing a thing about this. We [DETER] have already delivered to you more than 13,000 [ha of deforestation]!!!' 'But 13,000 is not much' he used to reply. But it was June and we knew it was too soon for such high accumulative numbers for the year. [...] They [IBAMA and the Ministry of Environment] did not hear us ... Finally, some guys from IBAMA called me and asked 'Can you tell me again what is the web address of DETER?'. 'Well, ok, I replied, and gave the address WWW, and so on. Then again in July they asked for the address and I got really pissed off about this.

In the following years, there was a gradual decrease in the levels of deforestation in the Amazon, partially due to the gains in effectiveness that DETER provided to forest rangers working in the region. But in 2007, DETER's monthly estimates showed that deforestation levels started to rise again and INPE scientists feared that their internal warnings would be ignored as in 2004. This time, however, the same group of scientists that promoted the opening up of PRODES decided that it was time to disclose DETER's monthly aggregates to the general public as a way to wake up the government and avoid the negative scenario that took place before. As in the case of PRODES, the opening up of DETER's aggregates was also a risky strategy. In contrast to PRODES' high level of precision, DETER's low-resolution images can only provide an alert indicating that some sort of disturbance has taken place in the forest. For this reason, INPE scientists feared that some of DETER's aggregates may be taken to be precise measurements rather than indicative alerts by the general public. Nonetheless, they decided that it was worth taking the risk since many scientists felt that they had a moral obligation to keep the public informed of what was going on in relation to the Amazon, fearing that they might be held accountable if the lack of transparency led to some form of government negligence.

When last year [2007] deforestation started to pick up speed due to the increase in the number of fires in the region, we remembered what happened in 2004. We were about to get bashed either way: for anticipating the rest and being the first to shout, or for not giving the alarm. As vigilantes [of the Amazon] we may sin by making some mistakes, but we cannot sin by omission.

The strategy adopted by INPE scientists generated its intended results. Following the publication of DETER's monthly aggregates, the new measurement was rapidly adopted by different actors as a way to evaluate the situation of the Amazon and the effectiveness of governments policy. For instance, NGOs such as IPAM (Amazon Environmental Research Institute) and ISA (Socio-Environmental Institute) started using DETER's monthly data in a way similar to PRODES's annual figures, and placed pressure on the government to respond to increasing deforestation trends. As a consequence, some of Brazil's most important newspapers started to report DETER's monthly figures on a regular basis, alongside interviews and interpretations of this data by prominent environmental activists. A few months after the emergence of this new sociomaterial arrangement senior officials from the Ministry of the Environment passed a series of new regulations that created a 'black list' and restricted the provision of loans to farmers in municipalities that showed a high level of deforestation. This new regulation was praised as the first action of the government that was able to punish deforesters directly by increasing the cost of production and blocking the access to the capital needed to increase crop areas. Not all stakeholders were happy with this outcome, however.

The growing policy relevance of PRODES' but also DETER's aggregated figures was also evident during the 2014 presidential elections. While deforestation rates have been reduced steadily in recent years, DETER's figures have been rising since March 2014. During the two months preceding the elections, INPE suddenly stopped releasing DETER's deforestation figures on a monthly basis. The

government justified this delay by saying that DETER's disaggregated data were being used by criminals in the Amazon to anticipate the actions of forest rangers. However, an article in *Folha de São Paulo*, one of Brazil's most influential newspapers, argued that the data were purposefully kept from public knowledge due to the government's fear that the rising deforestation could turn the election in favor of the candidate Marina Silva (now in the opposition) and hinder the reelection of Dilma Rousseff, who left office in 2016 following a impeachment process (Leite & Talento, 2014).

The events narrated above suggest that while the regular disclosure of DETER's monthly deforestation rates has boosted the policy relevance of this monitoring system, the release of methodologically problematic real-time data (despite all the warnings attached) opened INPE's flank to attacks from other parts of the Brazilian Government. These attacks, however, should not be regarded as inherent to the scientific weakness of DETER's estimates, but rather to their political strength in the hands of environmental activists. If the publication of DETER's aggregates led to no major change, then the system would have kept its status as a marginal policy-making tool and would have been ignored by Mato Grosso officials and the federal government during the elections.

Discussion and conclusion

The case study above described how the data and policy-making configurations have intra-acted in order to produce and transform subject-object relations. Following the creation of PRODES (aggregate) the Amazon rainforest came to be perceived as a finite resource, and deforestation became something measurable and thus manageable (Figure 1). Similarly, the government became a villain or hero depending on the ups and downs of the published accounts of deforestation data. With the disaggregation of PRODES, the Amazon became a map indicating the spatiality of deforestation, which can be acted upon in deterministic ways by stopping the building of roads and creating protected areas (Figure 2). With the real-time disaggregated monitoring data provided by DETER, the Amazon is not only an object of policy-making but also of policy intervention in a targeted manner, as the data allowed forest rangers to become an effective force in reducing deforestation. And again, with the aggregation of DETER the policy-making has intensified and the government is now called upon to publicly account on a monthly basis for variations in deforestation (Figure 3).

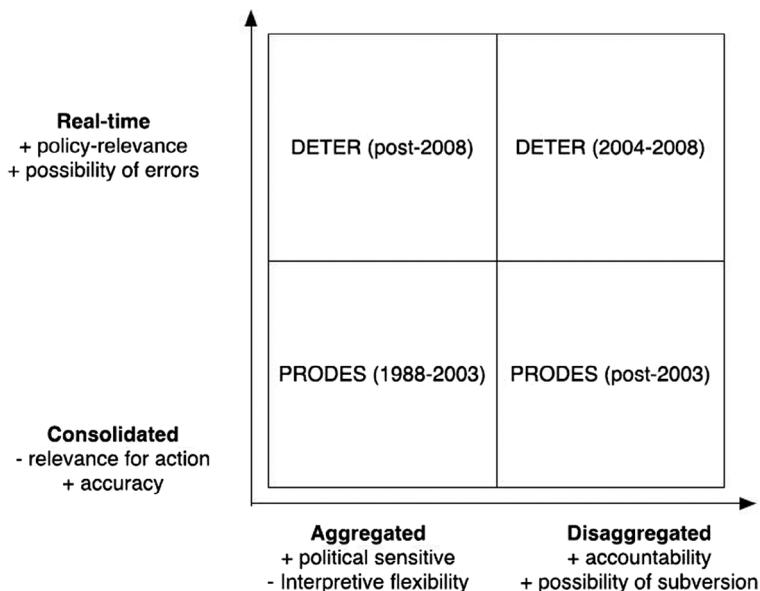


Figure 3. Overview of PRODES/DETER and the materiality/temporality of data.

The empirical material supports an important assertion about what the data allow environmental NGOs, policy-makers, or scientists to 'see.' Several times, interviewees referred to PRODES' ability to make deforestation visible, to allow policy-makers or the public to 'see' deforestation. For DETER this notion of 'seeing' placed certain demands; it became apparent that in order to 'see' deforestation through DETER, the data needed to be interpreted 'in the right way,' meaning that certain types of expertise were required in order to judge the data appropriately. Likewise, while PRODES aggregated deforestation rates enabled actors to perceive the overall trend, NGOs also demanded disaggregated deforestation maps in order to understand how deforestation was taking place in the territory. Hence, as discussed above, is the question not so much about what can be 'seen' (as if the data were a window to the Amazon that directly allowed observation of deforestation), but rather that different data configurations are representing deforestation through different sets of complex material-discursive practices. Moreover, with any given data-set only particular types of deforestation can be made visible, making other types invisible (e.g. recent vs. consolidated deforestation, and rates vs. maps).

At the same time, the scientists, environmental activists, or policy-makers perform their identities through particular data practices. This means that their data practices enable them to assume particular subject positions (always in relation to data and its particular representational affordances of the Amazon and its potential deforestation). For example, environmental activists need to assemble different types of expertise in order to make use of open data. Similarly, scientists perform their role within a configuration of scientific practice and open data that allows for public scrutiny of 'real-time' deforestation and associated actions by government. Through the opening of PRODES data, new publics can emerge, and environmental activism becomes a highly skilled activity in which controversial data-sets need to be interpreted with scientific rigor in order to account for potential errors. Similarly, the aggregation of DETER's data, while not a scientifically sound option, allowed social movements to pressure the government into action based on an easily readable deforestation rate. The relation between data and policy-making has thus been constantly reconfigured as a practice that is not only based on the rationale of 'data-driven decision making' but in negotiating different data practices and different forms of data interpretation.

As demonstrated above, data are not 'raw' but rather are collected, compiled, made accessible, etc. within particular work arrangements. The openness of data is performative as it depends on the skills, expertise, and the knowledge of data providers and users: There is a technical dimension (for example with respect to algorithms), but also a thematic dimension (for example with respect to understanding the context in which data were produced, processed, stored and may be further used). This has important implications for the design of studies, policy recommendations, but also public discourses.

Furthermore, the case examined here implies that actors such as environmental activists, open government data, policy-makers, scientists, and visualizations are not just independent entities that become associated through environmental policy-making. Rather, they are produced and (re)-configured in intra-action. Actors are made within the networks in which they operate: Civil society actors, scientists, and policy-makers come to be produced in particular ways and as particular subjects through the data (transparency) practices in which they are engaged and through which they are constituted (e.g. as knowledgeable environmental activists or as an unresponsive government). In this view, transparency initiatives and the publication of government data do not provide a 'window' to the organization of government, making internal aspects visible, but rather they reconfigure processes of producing information 'intended to fit the auspices of the review' (Neyland, 2007, p. 499). Such processes may then produce and are produced by particular material arrangements (including the collection, structuring, processing and visualizing of data) and may (successfully) enact transparent accounts of government.

Based on these arguments, we argue that it is important to consider not only data openness, but also what kinds of data and what kinds of uses this data enable when evaluating and planning data transparency initiatives. Here the materiality of (open) data (e.g. that what comes to matter) is articulated on the level of aggregation (e.g. regional figures vs. individual events) and its temporality (e.g.

yearly consolidations vs. near real-time releases). Such articulations come to matter as they enable data practices that produce particular subjects and objects which would not be possible otherwise. Beyond this, the case shows that pressures for accountability result in different kinds of disclosure, and disclosure practices facilitate different types of uses. Importantly then, the practices which define, collect, compile, store, process, mine, and visualize data, need to be understood as part of material-discursive practice bundles where activists strive to engage in policy-making. In our case study, we demonstrate how the aggregation level of published data invites multiple actors to develop their own data practices (e.g. NGOs to enrich or curate data sets) and how these then impact decisively on environmental policy-making practices. Such practices can hence only be understood in relation to the data practices that produce certain social realities about deforestation. For this reason, these different material configurations and data assemblages are not mere technical choices, but instead are part of political struggles between different social groups striving to shape the relation between data transparency and policy-making.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The authors thank FAPEMIG, CNPq, IPAM/NORAD, CLUA, University of Bremen, ifib and ZeMKI for providing the institutional and financial support for this research.

Notes on contributors

Raoni Rajão is a tenured professor in Environmental Management and Social Studies of Science & Technology in the Department of Production Engineering at the Federal University of Minas Gerais (UFMG) in Brazil, and coordinator of the Environmental Services Management Lab (LAGESA) at the same institution. His research interests cross post-colonial studies, environmental economics, political ecology and science studies with a particular focus on climate and forest policies in Brazil.

Juliane Jarke is a postdoctoral researcher at the Institute for Information Management Bremen (ifib) and the Centre for Media, Communication and Information Research (ZeMKI) at the University of Bremen. She is Co-PI in the EU-funded innovation action MobileAge on Participatory Design in Civic Tech and Open Data. Juliane holds a PhD in Organisation, Work and Technology from Lancaster University Management School. Her background is in Informatics (BSc), Philosophy (MA) and IT Management & Organisational Change (MSc).

ORCID

Raoni Rajão  <http://orcid.org/0000-0002-1133-4837>

Juliane Jarke  <http://orcid.org/0000-0001-8349-2298>

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