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Representations and discourses: the role of local accounts and remote sensing in the formulation of Amazonia's environmental policy

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ABSTRACT

This paper discusses the dynamics behind the establishment of scientific representations (e.g. reports, measurements, experiments) to the detriment of local representations (e.g. oral accounts, metaphors, symbols) in environmental policy-making in the Global South. To this end, the paper attempts to understand why local accounts of the Amazon in recent decades have gradually been replaced by satellite-based remote sensing (RS) technology in the region's policy-making. RS technology is shown to provide representations that match policy-makers discourses as regards the importance of: *visibility*, since satellite images are believed to provide a transparent window from which the Amazon can be seen by policy-makers working from centres of power; *comprehensiveness*, since the data obtained through RS claims to represent the entire region; and *determinacy*, as forecasting and spatial correlation techniques establish deterministic links between particular factors (e.g. the presence of farmers, inflation) and environmental issues (e.g. increases in deforestation). From this examination, it is argued that rather than focusing on identifying the essential differences between local and scientific representation, more attention should be paid to how different kinds of representations are in harmony or conflict with historically rooted governance discourses. The article also indicates that in order to revalue local representations in environmental policy-making it is necessary to challenge particular discourses which are "taken-for-granted" in governance practices at the present time.

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1. Introduction

Since the 1980s, notions such as 'indigenous technical knowledge' (Warren, 1989), 'lay knowledge' (Wynne, 1996) and 'knowledge systems' (Reid et al., 2006) have been recognized as important aspects of modern environmental policy-making. After centuries of systematic "exclusion and disqualification of innumerable 'subjugated knowledges'" (Scott, 2011: p. 175), the importance of indigenous knowledge has now been reaffirmed in reports and declarations issued by influential multilateral bodies such as the United Nations and

the World Bank (Agrawal, 1995; Philip, 2001). However, despite this official recognition, in practice indigenous knowledge still plays only a marginal role in the formulation and enactment of environmental policies (Castro and Nielsen, 2001; Colchester, 2004; Harwell, 2000). This paper aims to explore the challenges involved in including local representations of reality (a smaller but important dimension of indigenous knowledge) in environmental policy-making by examining the role of remote sensing as well as local accounts of deforestation in the formulation of environmental policies in the Brazilian Amazon rainforest. With this objective, the study draws inspiration

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from the work of Michel Foucault and presents an analysis of the discourse surrounding the governance of the Amazon in the last four decades. It will be argued that local and scientific representations of social and environmental reality should be seen as different, but not because of their intrinsic characteristics. In contrast, local and scientific representations are differentiated through the operation of governmental discourses which establish the rules of good environmental governance. Based on the case study, the content and consequences of these discourses will be delineated, and from this alternative scenarios will be considered.

The paper is organized as follows. The next section provides a brief literature review of the notions of scientific and local representations and their role in environmental policy-making. The third section outlines the research approach adopted by this study and reveals the sources and methods used to constitute its empirical basis. The fourth section explains the historical context in which remote sensing technology was introduced into the Amazon and compares the discourses adopted by policy-makers in Brazil with the modern scientific and governmental discourses, as defined by Foucault and other authors. The final section then concludes the paper by setting out the implications of this study for ongoing debates concerning the clash between local and scientific representations as well as the challenges involved in including local representation in environmental policy-making.

2. Local and scientific representations in policy-making

One of the crucial challenges in the formulation of environmental policy is that most of the entities being examined (e.g. land, population, biodiversity, pollution) cannot be physically present at the moment of the discussion. Thus, policy-making usually involves the need to create and use representations (i.e. words, utterances, symbols, images) which are able to stand for phenomenon that is too large, distant or subtle to be physically brought into the room (Brown, 2009). Historically, the task of creating representations in environmental policy-making has largely been the domain of scientists (Kwa, 1987; Sarewitz, 2004). Among the various kinds of scientific representations used in environmental policy-making in recent decades, satellite-based remote sensing (RS) and geographic information systems (GIS) have played a prominent role. Following the development of GIS in the 1960s and the launch of the first civil RS satellite in the 1970s, these technologies have rapidly become a key data source in the elaboration of policies concerning the exploitation of natural resources, and more recently, in environmental conservation (Leimgruber et al., 2005). Because of the affinity between GIS, RS, quantitative geography and positivism, many of the supporters of these technologies have suggested that the data thus produced can be deemed neutral and a rigorous reflection of the world (Abler, 1993; Esty and Porter, 2005; Wise and Craglia, 2008).

As a reaction to the rapid diffusion of and enthusiasm for these technologies, researchers from different fields have assessed the claims of the supporters of these scientific representations in a critical way. Some authors have pointed

out that the effects of remote sensing technology and geographic information systems are far from deterministic, and depend to a large degree on the social and organizational context in which they are introduced (Barrett et al., 2001; Carton and Thissen, 2009; Georgiadou et al., 2009; Richter et al., 2010; Sahay and Robey, 1996). Other studies have shown that the positivist epistemology embedded in GIS and RS objectifies a complex social reality so that it becomes an impoverished abstract space of pixels, numbers and symbols. Consequently, it is often the case that GIS and RS are unable to deliver the sort of all-inclusive knowledge of the territory promised by their supporters (Kwan, 2002; Pickles, 2004; Roberts and Schein, 1995; Zubrow, 2003). Some studies have also added a political dimension to this epistemological critique by emphasizing the role of remote sensing technology, maps and related scientific representations to achieve the control of local populations and natural resources (Aitken and Michel, 1995; Crampton and Elden, 2007; Harding, 2011; Harvey, 1984; Scott, 1998; Sheppard, 2005; Sletto, 2002; Turnhout and Boonman-Berson, 2011). Harwell's (2000) case about the use of remote sensing technology in the Indonesian rainforest illustrates this issue very well. She compared how environmental activists, international donors and the government used RS to support their own version of a series of fires that devastated the country in 1998. She noticed, for instance, that the Indonesian government used RS to develop an analysis that blamed the fires on El Niño (a natural weather occurrence), while environmental non-governmental organizations blamed large palm tree plantations owned by a group with close ties to senior officials. However, since the debates were centred on RS-based representations, the accounts provided by local farmers were ignored, preventing them from influencing ongoing policy-making debates. Harwell notes, however, that the exclusion of local voices is not a coincidence, but rather, "is a modality of power that most effectively serves the needs of urbanites, demographers, planners, administrators and strategists, and obfuscates alternative realities" (Harwell, 2000: p. 234).

According to these and other similar lines of critique, different authors have proposed concepts such as 'post-normal science' (Funtowicz and Ravetz, 1993), 'indigenous technical knowledge' (Gadgil et al., 1993), 'lay knowledge' (Wynne, 1996), 'knowledge systems' (Reid et al., 2006) and 'civic science' (Backstrand, 2003). A common feature of these concepts is the questioning of the superiority of scientific representations in relation to local representations, namely signs and utterances used by the members of a specific social group (i.e. East End Londoners or Amazonian Rikbaktsa) to evoke images of absent entities in other people's minds. In most cases these local representations take the form of oral accounts. However, local representations may also be recorded and presented in pictures, videos and ethnographical accounts which have been obtained through close contact with local populations. Some studies have endeavoured to understand the relationship between local and scientific representations (and related forms of knowledge) by attempting to identify their differences at a fundamental level (for detailed reviews see Agrawal, 1995; Scott, 2011). The key differences singled out by these studies include the following: local representations focus on issues that are pertinent to the

local communities due to their economic or cultural relevance, while scientific representations tend to be involved with issues of concern for the scientific and policy-making community (Warren, 1989); scientific representations and related concepts attempt to attain universal validity and a high degree of mobility, while local representations depend more heavily on the social context from which they originated in order to acquire their meaning (Lévi-Strauss, 1966); scientific representations are obtained through rigorous and totalizing methodologies, while local representations are the outcome of fortuitous engagements with the natural environment (Rapport, 1979 as cited in Scott, 2011); local representations are often oral and based on the perspective of the people living in a certain area, whereas scientific representations are predominantly written and based on a point of view that is often alien to the inhabitants of the areas represented (Johnson, 1992); the use of scientific representations tend to increase the gap between the powerful and the powerless, while the use of local representations is more egalitarian (Pickles, 1995).

Clearly the body of literature examining the differences between local and scientific representations as well as related implications has provided important insights into the dangers relating to an overemphasis on scientific representation and the disqualification of local representations. However, as Agrawal (1995) and Chrisman (2005) pointed out, many studies in this literature suggest the existence of essential differences between these types of representations. As a reaction to this, from the mid-1990s onwards many studies have proposed alternatives to essentialist understandings of representations. Starting with Science and Technology Studies, empirical studies of scientific practices have dismantled the claim that science is universally valid and untainted by human subjectivity or politics, and have demonstrated how the construction of scientific representations relies heavily upon local arrangements, skills and practices (Collins, 1985; Daston, 1992; Latour, 1987). From this perspective, some authors have shown that the idea of scientific representations being inherently universal, abstract and objective, while local representations are inherently local, concrete and subjective is fallacious (Agrawal, 1995; Dove, 2006; Harding, 2011; Sahlins, 1995). More specifically, in relation to maps and remote sensing-based representations, it has been demonstrated that the generation and interpretation of scientific representations, such as with maps, depends as much on shared practices as local representations do (Kitchin and Dodge, 2007; Pickles, 2004). It has also been shown how local representations of the territory may be not only concrete but also highly abstract and sophisticated (Scott, 2011; Verran, 2002). In addition to this, scientific and local representations could well be complementary in the context of environmental policy-making rather than always in conflict (Fry, 2011; Puri, 2007).

In theory the essentialist differences that separate local and scientific representations have been dismantled, yet we are still faced with a situation whereby scientific representations are systematically privileged at the expense of local ones (Backstrand, 2003; Harwell, 2000). In this context, it is important to go beyond the debate of whether local and scientific representations are essentially different, and to attempt to understand when and how they are *made* different

in the context of environmental policy-making and how to address this situation. This article proposes that the work of Michel Foucault on the implications of discourses can provide further insights into the relationship between scientific and local representations in policy-making while avoiding the essentialist pitfalls already indicated by the literature. The next section therefore provides a brief description of how his ideas have inspired the research approach adopted in this study.

3. Research approach

Discourses can be defined from a Foucauldian perspective as “systematically organized sets of statements which give expression to the meanings and values of an institution. Beyond that, they define, describe, and delimit what is possible to say and not possible to say (and by extension – what to do or not to do) with respect to the area of concern of that institution” (Kress, 1985: p. 7). This definition contains elements that are particularly relevant to this study. It states that only the statements conforming to the established discourses are deemed “truthful”. Thus, representations, as with any form of statement, rely on dominant discourses in order to acquire their validity, while the representations that do not fit are silenced in different ways (Foucault, 2002). While this point resonates with much of the literature mentioned above in terms of the relationship between political dynamics and scientific representations, Foucault’s viewpoint stands out in a subtle but important way. For him, the effects of power, such as the exclusions brought about by dominant discourses, should not be seen as necessarily negative and avoidable with strategies such as the inclusion of local representations in policy-making. For Foucault, power is everywhere: it is a repressive as well as a productive force without which knowledge and meaning would not be possible. Thus, the same discourses that grant a higher epistemological status to a certain type of representation (e.g. satellite images) rather than others (e.g. local accounts) not only generate an effect of marginalization and domination, but also facilitate the emergence of knowledge and a social order (Foucault, 1977a, 2002). Therefore, rather than merely denouncing the existence of power, Foucault calls for a detailed understanding of the ways in which power and knowledge are closely intertwined (Foucault, 1977b).

The characterization of a discourse and the delineation of its relationship to different types of representations is no trivial task and often require the adoption of a wide range of research methods. Different strands of discourse analysis have focused on subjective positions, grammatical structure, genre and the orderliness of contemporary written texts and oral utterances (Fairclough, 1985; Johnstone, 2008; Van Leeuwen, 2008). Here, in accordance with Foucault, I have tried to identify and characterize the discourses of the Brazilian government:

[N]ot from the point of view of the individuals who are speaking, nor from the point of view of the formal structures of what they are saying, but from the point of view of the rules that come into play in the very existence of

such discourse: [...the conditions necessary] to give it, at the time when it was written and accepted, value and practical application [as a valid governmental discourse] (Foucault, 2002: p. XIV–XV).

In particular, this study attempted to identify the relationship between key representations of social and environmental reality (e.g. local accounts, scientific studies, satellite imagery) and discourses relating to the formulation and enforcement of territorial policies for the Brazilian Amazon between the end of the 1960s and 2010. The data for this analysis has been obtained from both textual sources and interviews. The former are an obvious choice in the study of discourses over time; in contrast to oral accounts, which may alter as people change their concerns and perspectives, documents can easily be stored in their original form for later consultation. Thus, the analysis of books, internal documents (e.g. letters, reports, studies), news articles and legal texts (e.g. policies, laws, fines) created in the last four decades provides an important source of material for the identification of the discourses about the role of representations in the Amazon. The main documental sources for this study were scientific articles and reports by scientists from the National Space Research Institute (INPE) and the United Nations Food and Agriculture Organization (FAO), the two Plans for National Integration (PIN) from the 1970s and 1980s, the Plan Our Nature (Nossa Natureza) from 1988, the Plans for the Prevention and Control of Deforestation (PPCDAm) from 2004 and 2009 and the Brazilian Forest Code from 1965 (including its many modifications).

In addition to textual sources, this study has also drawn upon 85 semi-structured interviews held in Brazil between June 2007 and August 2009, these being conducted for the most part in Brasília (the country's political capital) and Mato Grosso in the south-western section of the Amazon rainforest. In conducting these interviews, this research aimed to collect untold stories of policy-making and law enforcement practices and from this to obtain a richer picture of governance discourses in Brazil. Most interviewees were selected because of their role in the formulation and enforcement of environmental policies, with a smaller but relevant selection of informants from local communities who were directly affected by these policies (see Table 1). For instance, it was

possible to conduct formal interviews with five officials who had written the PPCDAm document (the main policy in operation during the fieldwork), including the Minister of the Environment behind the plan. Similarly, at Mato Grosso's Environmental Agency (SEMA), I interviewed the Secretary for the Environment and met in different occasions the senior officials immediately involved in enforcing and formulating policies and introducing new remote sensing technologies. Additionally, at the National Congress I held interviews with three congressmen and two legal assistants who were directly involved in the formation of the Amazonian policy. Finally, at INPE I was able to interview the president of the institution, the Director of the Earth Observation Department, the current Coordinator of the Amazon and the majority of other scientists who had previously occupied these roles. In relation to the local population, I interviewed and conducted participant observation with soybean farmers and members from an indigenous group in a reserve in the north-western section of Mato Grosso.

In most cases I was able to use a voice recorder while taking notes as a backup. When the informants did not authorize the use of voice recorders or I judged that its use might hinder the interview, detailed notes were taken. Since the vast majority of interviews were conducted in Portuguese and the research was based in a British university, it was necessary to translate the excerpts from the recordings into English in addition to all the notes before conducting the analysis. The corpus of textual and interview data collected in this study was analysed in an iterative way: it started with the identification of common themes and the insertion of codes into the text with the assistance of qualitative data analysis software. In particular, during this phase the analysis I focused on identifying common lexica (e.g. deforestation point, map-image), normative statements (e.g. "forest rangers cannot be trusted"), metaphors (e.g. "remote sensing opened our eyes") and particular problems (e.g. legal loopholes, increasing deforestation). When necessary, the analytical process returned to the first stage in order to reanalyse the empirical data and investigate specific research threads. In order to consider the elements identified above in relation to the their broader historical context, the study drew upon authoritative analysis of the discourses of modern science and the modern state (Daston, 1992; Haraway, 1991; Lefebvre, 1974/1991; Pickles, 2004; Scott, 1998; Stone, 1989). It was particular important for this research the analysis of Michel Foucault of the role of Panopticism (and related forms of visibility) and biopower (and related holistic and deterministic representations) in contemporary governmentality (Foucault, 1977a, 2002). The next section presents and discusses the main finding of this research based on the approach outlined above.

Table 1 – Number of interviews divided by organization and location.

	Interviews
Institution	
Federal Environmental Agency	15
Ministry of the Environment	12
Mato Grosso's Environmental Agency	12
National Institute for Space Research	10
National Congress	5
Other governmental agencies	13
Local population	11
Non-governmental organizations	7
Location	
São Paulo	10
Distrito Federal	36
Mato Grosso	36
Other	3

4. Local and scientific representations of the Amazon

The 1980s was an intense period for environmental activism in the Amazon. An alliance between grassroots movements, scientists, politicians, journalists and celebrities was able to give global prominence to an issue that had been largely invisible before. A famous article from *Time* magazine captures

the effervescence of this period. The cover picture, instead of showing roads as a symbol of development, as in many articles in the 1970s, presented them as the conductor of a skull-shaped fire devouring the forest and its animals (Time, 1989). At the centre of this and other representations of the Amazon that were particularly influential during that period are striking pictures of burnt fields and dead animals and the voices of prominent local activists – representations that are closely linked to the local perspective of those living in the region and suffering the consequences of deforestation. These activists included the Indian chief Raoni Metuktire, the rubber tapper Chico Mendes and other local leaders that became international environmental icons. It was partially due to such local representations that the international community turned against the Brazilian government and important protected areas were created (Keck and Sikkink, 1998). Today the representations of the Amazon used by policy-makers in documents such as the Plan for the Prevention and Control of Deforestation in the Amazon could not be more different (Brasil, 2004). In place of the pictures of the Amazon taken from the ground-level perspective of its inhabitants are satellite images and deforestation maps. Similarly, instead of emotional accounts of local leaders, these reports are now dominated by distant and objective assessments in the form of the numbers and graphs created in many cases without the need to travel to the region in person. This prompts one to question why representations of the Amazon featuring local voices and images have been slowly sidelined in favour of remotely sensed and numeric representations in recent decades. Moreover, what can this process tell us about the challenges involved in including not only scientific but also local representations in environmental policy-making in the Global South?

As seen above, by depicting local representations as subjective and contextual, and by showing scientific representations as objective and universal, we may end up only offering justifications for the exclusion of the former rather than understanding the problem at hand. Therefore, an examination of the differences between local and scientific representation from an essentialist perspective is unlikely to offer satisfactory answers to these questions. In the analysis proposed below, we offer an alternative direction, and examine instead the ways in which policy-makers referred to local and scientific representations in their discourses. From this analysis emerged that three partially overlapping discourses have been central to shaping the relationship between representation and policy-making in the Brazilian Amazon. In particular, the presence of discourses concerning the importance of visibility, comprehensiveness and determinacy within the Brazilian governance discourse have contributed to the qualification and the exclusion of different types of representations from policy-making.

4.1. Visibility

The first governance discourse found in the Brazilian government which helps to explain the diffusion of scientific representations at the expense of local ones can be defined as the discourse of visibility. This discourse is largely characterized by affirmations that ensure the superiority of

the sense of sight over other ways of representing and knowing the Amazon, and by the related idea that it is crucial to “see” the territory in order to govern it. The presence and influence of the discourse of visibility is particularly evident when we consider how the government disqualified the non-visual local representation of the Amazon following the introduction of satellite-based remote sensing technology. Shortly after the arrival of the Portuguese on Brazilian shores in the 16th century, many expeditions were organized with the aim of exploring the interior. Some of these, such as the one launched by Antonio Raposos Tavares o Velho in 1648, went as far as the Peruvian border and the mouth of the Amazon river, while others created Cuiabá, Manáus and other important settlements at the heart of the Amazon. At the root of early governance practices were local representations of space that were produced over the centuries by the native indigenous populations and generously offered via the transmission of oral traditions to the newly arrived Portuguese and their decedents (Ribeiro, 1995). During my visit to an indigenous reserve in the northwest of Mato Grosso, a Rikbaktsa hunter provided an example of the relevance of these local representations to the portrayal of environmental problems (see Fig. 1). While referring to the scarcity of bush meat in nearby forests and the location of his current hunting grounds, he elaborated on a local representation that used references such as river names (i.e. “Rio do Sangue”, blood river), aspects of the landscape (i.e. “mata fechada”, dense forest) and distances in terms of walking days. This suggests that long before the arrival of satellite-based remote sensing technologies, its inhabitants and explorers already knew and represented the Amazon using local accounts.



Fig. 1 – A member from the Rikbaktsa people showing his traditional hunting weapons.

Official reports and interviews with actors directly involved in the development of remote sensing technology in Brazil ignored these local representations and argued instead that the use of this technology was crucial to make the region visible and known to the government. In this regard, *Pereira (1971: p. 90)*, one of the masterminds of Brazil's Forestry Code, commented that the use of remote sensing technology in the Amazon was essential for "separat[ing] the legend from reality [...] and revealing] the secrets that nobody knows". Similarly, a senior scientist actively involved in the development of Brazil's remote sensing technologies stated in his interview that the government invested in remote sensing technology because "during the 1970s the Amazon was seen as a vast and mostly unknown area". Many informants also confirmed the link between the introduction of remote sensing and the visibility of the Amazon in relation to current policy-making practices. A common metaphor used in their interviews to comment on the effects in their work of the introduction of DETER (a satellite-based monitoring system) in 2004 was that of a blind person who was able to "see the Amazon" for the first time. The following excerpts illustrate the widespread presence of this discourse in relation to aspects of the environmental governance of the Amazon, these ranging from the formulation of policies to the enforcement of the law:

I don't really know if they changed the way they do deforestation or if that is because only now we are seeing with the satellite that this is going on (Senior official from Mato Grosso's Environmental Agency)

Last month we saw the deforestation growing and growing in this part of the Amazon. I've prepared a power point presentation showing the issue and sent it to IBAMA's [Federal Environmental Agency] president and other people there. (Senior scientist from the National Space Research Institute)

We still have difficulties to follow if people respect the law. It would be ideal to follow this in real time...you plug yourself [in a satellite] somewhere in order to be able to see what is going on in the area (Attorney from the Federal Environmental Agency)

The excerpts above suggest that for the senior officials currently involved in creating the policies towards the Amazon, the region was a complete mystery before the introduction of satellite-based representations. However, if we consider the use of local representations by the inhabitants and early explorers of the Amazon it emerges that it was not the lack of representations of the Amazon that rendered the region "unknown" to modern policy-makers, but rather the exclusion mechanisms operated by the visibility discourse mentioned above. These exclusion mechanisms largely functioned at three different levels. The first mechanism concerned the practices required to interpret representations and use them in a policy-making context. In order to understand and use the local reference mentioned by the Rikbaktsa hunter, the policy-maker would need to know how

to identify specific rivers, the average distance that local guides could walk or row down a river each day and the differences between the different types of forests. Since this type of knowledge is mostly absent in the centres of power, these local representations are often considered too context-dependent to be useful to government officials. However, an interpretation of visual scientific representations of the region also requires the presence of shared practices and related background knowledge (*Kitchin and Dodge, 2007; Pickles, 2004*). Nevertheless, despite this similarity between local and scientific representations, only the knowledge of how to interpret satellite images and maps was deemed a basic skill of officials involved in the governance of the Amazon. This issue was evident, for instance, when an official complained that "sixty percent of our forest rangers do not have the complete elementary education [...] sometimes it is difficult to some agents to interpret the satellite images and the deforestation polygons generated by DETER [a satellite-based monitoring system]". This suggests that the prevalence of the visibility discourse creates a situation in which the knowledge base required for the interpretation of scientific representations becomes 'taken-for-granted', while the knowledge needed to understand local representations is considered exotic or even irrelevant for policy-making.

Secondly, even though both local and scientific representations provided useful ways to know about and travel within the region, scientific representations were regarded as being superior to local ones. It is possible to trace this belief to the project of early modern philosophers, such as René Descartes, to create a new epistemology that is capable of breaking with the superstitions of the past. To this end, their project emphasized vision because of its apparent ability to produce objective and verifiable knowledge without the need for the other highly subjective senses and the use of the imagination (*Brown, 2009; Daston, 1992; Haraway, 1991; Pickles, 2004*). It is possible to discern a similar parallel between local and scientific representations of the Amazon. The first are based mainly on oral accounts that rely for their use and construction on a much broader use of the senses. Think, for instance, on how the sense of hearing, touch and smell are crucial for travelling through dense forests using traditional oral based accounts of the territory. In contrast, the second are based on satellite images, maps and other representations that promise a detached and solely visual understanding of the Amazon. In this context, the visibility discourse disqualifies local representations based on oral accounts of the Amazon as mere "legend", while visual scientific representations are expected to reveal the Amazon as it is, without the interference of human subjectivity.

Finally, the exclusion mechanisms of the visibility discourse also served a specific political purpose in Brazil. When referring to cases ranging from prisons to factories, *Foucault (1977a)* argued that in the pre-modern era, the population was perceived from the point of view of the state as a mass of anonymous faces. With the rise of the modern state, this situation has changed and the visibility of the objects under control (i.e. population, territory, resources) has become one of the main "traps" through which the state exercises its power. It is possible to argue that the sort of visibility offered by satellite images and other scientific representations has helped the government control the

inhabitants of the Amazon in a similar way. In contrast to the decentralized and contextualized use of local representations, the scientific representations of the Amazon offer a simplified version of the region's reality that facilitates its legibility from afar. Hence, the use of satellite images does not require the active involvement of locals in order to establish a governmental gaze that aims to impose order onto the territory (Scott, 1998). It was probably through this kind of logic that a director from the Ministry of Environment attributed recent reductions in deforestation to remote sensing technology being able to expose the wrongdoings of farmers and local governments and make them aware of the fact that they are being watched. Therefore, it is possible to argue that local representations were disqualified by Brazilian policy-makers not because of their inability to represent the territory, but due to a conflict with a visibility discourse that seeks to obtain a privileged position for the government to know and control the Amazon in a centralized way.

4.2. Comprehensiveness

Another governance discourse found in the Brazilian context which helps to explain the diffusion of scientific representations to the detriment of local ones relates to the importance of obtaining a comprehensive grasp of the territory. In its most general form, this discourse was manifested in the tendency of many officials and scientists to refer to the whole "Legal Amazon", as their object of concern rather than to specific areas or populations. Relating to this discourse, there is also an over-centralization of policy-making activities in Brasília. Therefore, despite recent efforts to bring the state governments to the round-table, the main decisions concerning the Amazon are still made by the federal government in a way that tends to treat the region as a homogeneous whole. The effects of the comprehensiveness discourse in relation to the adoption of representations in policy-making were particularly evident in the arguments used by the Brazilian government to justify the way they dismissed the initial calls from grass-root movements and anthropologists to stop the colonization policies in the Amazon. In the early 1970s the negative effects of the colonization projects on the local population were highlighted by different anthropologists and journalists conducting fieldwork in the region. These local representations included oral testimonies of the violence and suffering caused by deforestation and the despair of the local populations. The account provided by Bourne (1978) concerning the effects of colonization on the Mayurura and other recently contacted indigenous populations provides a good illustration of these representations:

Here the contact was taking place in the worst fashion, the tribe was being evicted from its traditional lands, and their numbers had dropped in three years from 2000 to 400. Lucena said that the tribe was killing both male and female children in what can only be seen as a desperate act of suicide. As [the anthropologist] P. David Price, working with the much encroached-upon Nambiquara put it, "Their attitude is better dead than Brazilian" (Bourne, 1978: p. 243).

Even though these local representations played an important role in the creation of protected areas (see below) and in the emergence of public concern in relation to the Amazon (Keck, 2001), they were unable to stop the expansion of the Brazilian colonization policies in the first half of the 1980s (Hecht and Cockburn, 1989; Mello, 2006). It is possible to argue that the main reason for this failure lies in the fact that these local representations only concerned the effects of deforestation in a restricted portion of the Amazon. For this reason, policy-makers dismissed the relevance of these representations and did not feel compelled to change their policies in relation to the whole of the Amazon. This exclusion mechanism is evident in declarations from groups of scientists that at the time were closely aligned to the Brazilian government. For instance, a deforestation assessment carried out by INPE concluded that the public could rest assured since "the current level of deforestation can be considered low if we consider the total surface [of the Amazon...]" (Tardin et al., 1980: p. 10). During the same period, scientists from FAO explicitly disqualified the contribution of local representations of deforestation for not offering "the factual and quantitative data that could allow for a sound estimate of the magnitude of the problem" (FAO, 1981). In an interview with the British newspaper *The Times*, they went even further and considered that local representations which suggested that the Amazon rainforest was under threat were "speculative [...] excessive and misdirected" (Clayton, 1982).

The colonization and related environmental policy towards the Amazon changed radically, however, when the groups defending the environmentalist agenda were able to produce comprehensive scientific representations. In the 1980s, different "green" scientists started using remote sensing technology as a key data source to study the effects of colonization policies in the Amazon. One of the pioneering studies on this topic was that of Philip Fearnside in 1982. In his article, he argued that instead of following a linear growth trend (as claimed by the government), deforestation was more likely to be already following an exponential trend. In this way, he predicted that if the government's policies remained unchanged, the whole Amazon rainforest would be gone by the end of the century. Fearnside was well aware of the power stemming from the comprehensive character of his representation of the Amazon. In fact, he explicitly pointed out that the scientific representation contained in his paper "collide[d] with one of the Amazon's great illusions: the illusion of infinite size" (Fearnside, 1982: p. 82) – an affirmation that would be unfeasible if this sort of representation was not able to claim the ability to stand for the whole Amazon. Indeed, following this and other studies, by the end of the 1980s, the government finally "recogniz[ed] the gravity of the [then] current tendencies of the occupation process of the Amazon" and suspended its main colonization policies (Brasil, 1988 as cited in Mello, 2006: p. 69).

The importance of the comprehensiveness discourse in the Brazilian government becomes clearer when considered in connection with the broader modernist governmental discourse in which it is located. Different authors have pointed out that the modern governmental discourse often places emphasis on rational and centralized policies which target the territory and its population as a unit, whether this is a city, a

region or the whole world (Asdal, 2008; Foucault, 2003; Scott, 1998; Turnhout and Boonman-Berson, 2011). However, since these objects of governance surpass the human scale, the search for comprehensive representations has also become an essential part of policy-makers' claims of rationality (Lefebvre, 1974/1991; Pickles, 2004; Soderstrom, 1996). It is not a coincidence that the word "plan" is understood today as meaning both a comprehensive scientific representation (i.e. the plan of the Amazonian territory) and a rational step-by-step guide on how to reach a desired future (i.e. the plan to prevent and control deforestation) (Pickles, 2004). In the light of this, it is possible to argue that the dismissal of local accounts of the effects of deforestation, and the greater resonance of Amazon-wide scientific representation are not a simple matter of depicting the different sub-regions of the Amazon – something a multi-sited ethnography or a well-articulated meeting of the peoples of the forest could also accomplish. Rather, this exclusion mechanism took place because only scientific representations based on satellite images were able to present themselves on a holistic scale where policy-makers believed legitimate rational decisions could be made.

4.3. Determinacy

The third and final discourse that helps explain the success of remote sensing in Brazil concerns the search for deterministic representations, namely representations that can simultaneously explain reality and mathematically control the outcome of policies. More generally, the presence of the determinacy discourse was evident in the importance given by policy-makers to the mathematical models that were capable of generating future deforestation scenarios for the Amazon. Fearnside's (1982) study mentioned above was followed by a long stream of studies that adopted increasingly sophisticated models to evaluate the cause of past deforestation and to simulate the outcome of different policy alternatives (e.g. Aguiar et al., 2007; Kirby et al., 2006; Pfaff, 1999; Soares-Filho et al., 2006). Some of these representations, such as a map created by Laurance et al. (2001) showing the consequences of road building projects in Amazon by 2020, prompted political crises and the reconsideration of governmental policies.

In addition to shaping the policies concerning the whole Amazon, more recently the determinacy discourse and the related preference towards scientific representations could also be found in local policies. The presence of the determinacy discourse in these policies is particularly significant because it has led to the replacement of local representations by scientific ones in a policy arena where the former had played an important role in the past. Local representations, such as ethnographic accounts, political manifestos and journalistic reports had played a key role in the creation of protected areas in the Brazilian Amazon between the 1960s and 1980s (Garfield, 2004; Keck and Sikkink, 1998; Zhouri, 2004). An important example of the role of local representations in the creation of protected areas could be seen in the 1980s in the state of Acre, in the Western portion of the Brazilian Amazon (Revkin, 2004). In this case, what started as a local clash between rubber tappers and cattle ranchers became a political crisis involving the Brazilian government

and the international community. This escalation was due in large part to the local representations provided by the trade union leader Chico Mendes and his supporters. The images and declarations of Chico Mendes recorded in the documentary "The Decade of Destruction" by Adrian Cowbell and broadcast on U.S. TV station PBS are a good example of these representations. In one section of the documentary, Chico Mendes explained: "the farmers intend to take over all this land, but we have no intention of giving our land to them. Our fight is for the defence of the rubber and Brazilian nut tree. We are taking this fight to the end because we won't allow our forest to be destroyed". Following his assassination, the declarations foretelling his own death and other related local representations gained a new significance and become a key element in the creation of a large extractive reserve in the region that was named after him.

The analysis of policy documents and scientific studies, and interviews with senior officials suggest that from the early 2000s onwards the decisions concerning the creation of new protection areas in Brazil have been increasingly based on scientific representations at the expense of local representations. Drawing upon detailed digital maps of deforestation produced by the Brazilian government, different scientists have started to analyse mathematically the relationship between protected areas and deforestation. These studies showed that deforestation figures within protected areas were not only ten times lower than in nearby lands, but the areas also acted as barriers against the expansion of deforestation (e.g. Nepstad et al., 2006; Soares-Filho et al., 2010). Policy-makers confirmed in their interviews that the causal stories provided by these scientific representations have been very influential in their practices, replacing to a large extent the need for local representations as the starting point for the creation of new protected areas. For instance, an ex-director of the Ministry of the Environment suggested that local representations, such as reports based on accounts from indigenous populations and studies indicating the presence of endangered species, were often used only as mere excuses to justify a decision already taken based mainly on scientific representations from satellite images. Over the last fifty years, policy-makers in Indonesia, the United States and other countries have also given greater importance to scientific arguments over nationalistic and aesthetic reasons for the creation of protected areas (Adams and Mulligan, 2003; Colchester, 2004; Jepson and Whittaker, 2002). The Brazilian case stands out, however, because a single form of scientific representation as well as related arguments are becoming more prevalent than others. Therefore, even though biodiversity assessments (Sutherland, 2000) and traditional land use and occupancy mapping (Chapin et al., 2005) are still used, the final decision would seem to be increasingly based on mathematical models that match the determinacy discourse.

A map created using the same data available to policy-makers provides further evidence of the relation between the determinacy discourse and the creation of protected areas. In Fig. 2 it is possible to notice that from 2004 onwards the total area under environmental protection has doubled in size (see hatched areas), and now covers 54% of the remaining forests of the Brazilian Amazon (Soares-Filho et al., 2010). In addition to this, it can also be observed in the map that the new

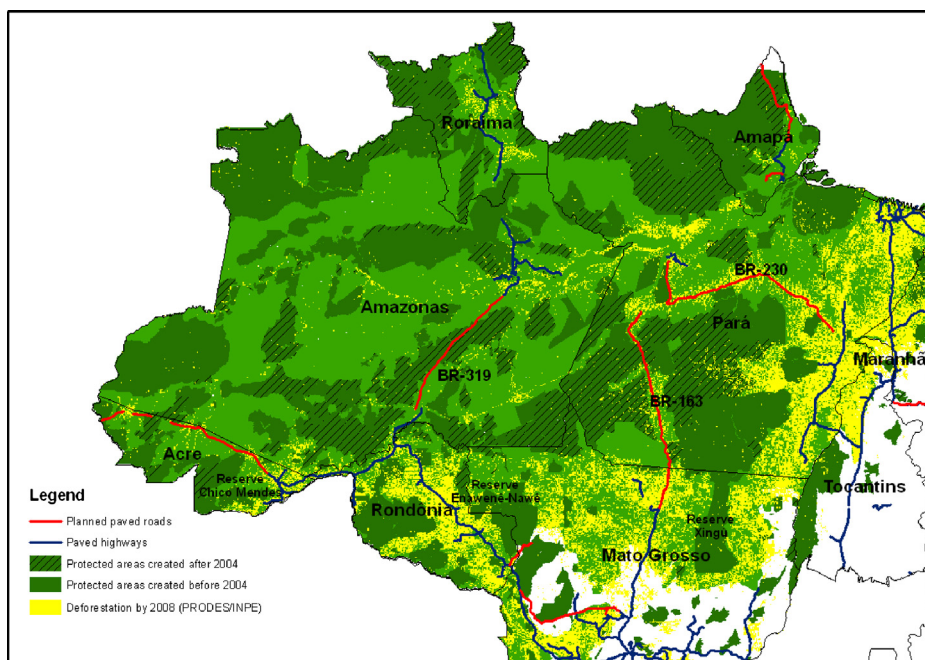


Fig. 2 – Map showing deforestation patterns, main roads and protected areas in the Amazon.

Source: IBAMA, PRODES/INPE and IBGE 2010.

conservation areas are mostly located in the arch of deforestation or alongside planned paved roads (see BR-163 and BR-319) – areas that scientific representations have indicated as being particularly vulnerable. In the meantime, important local representations have been ignored or only played marginal roles in decisions concerning the location of new protected areas. For instance, officials from FUNAI (the National Indian Foundation) and members from indigenous populations from the northwest of Mato Grosso reported in their interviews that the construction of small hydroelectric plants in the river Juruena led to a drastic drop in fish stocks. Because of this and for other reasons, the local indigenous populations such as the Enawene-Nawe have been fighting for the extension of their lands and for the removal of the hydroelectric plants. However, the accounts of these indigenous groups do not seem to have led to any significant change. Since my last visit to the region in 2009, no new protected area was created in the region. Moreover, the government has continued its plans and is currently building more hydroelectric plants.

The maps and the mathematical models behind them also reveal other aspects of the deterministic discourse. In contrast to the hand-written maps or oral accounts of the region, the representation above is not the outcome of the work of a craftsman or a local guide, but the visual rendition of remotely sensed data; for every spot on the map shown in Fig. 1, there is a corresponding mathematical symbol containing information such as the year, total area, geographical coordinates and land use (i.e. deforestation or forest) as well as the land type (i.e. whether it is protected or not). Based on the aggregation and mathematical analysis of these symbols, this scientific representation plays a dual role as a deterministic entity. Firstly, it provides a clear account of the Amazon “as it is”

and the problem it faces (see the yellow patterns of deforestation in Fig. 1). Secondly, and most importantly, the correlations and predictions based on this representation provide the solutions to these problems in a deterministic and unambiguous way (see the differences in yellow patterns between the protected and non-protected areas). Foucault (2003) argued that the importance of “forecasts, statistical estimates, and overall measures” lies in the fact that they operate “at the level at which these general phenomena [e.g. longevity, epidemics, environmental factors] are determined, to intervene at the level of their generality” (ibid: p. 246). Hence, scientific representations based on mathematical symbols at the same time create a given phenomenon and provide the tools to control it. From this examination it has emerged that the deterministic discourse has a double-edged effect. On the one hand, it excludes local representations for their uncertain character. On the other hand it allows the construction of representations which provide causal stories of deforestation with which both the problem at hand and its solution are laid out to policy-makers in an objective and deterministic manner (Stone, 1989).

5. Concluding remarks

At this point it is possible to return to the questions and the debates that have motivated this paper. The analysis proposed above has shown that the introduction of remote sensing technology did not take place in a social vacuum. In contrast, before the possibility of obtaining images from outer space was fully realized, the discourses concerning the importance of visibility, comprehensiveness and determinacy found a privileged place in the minds and practices of policy-makers in Brazil. From this it has emerged that it

is insufficient to analyse the shift from local to scientific representations in the Amazon as the outcome of the inherent characteristics of these representations or as the result of explicit attempts to subdue and delegitimize local voices (e.g. Aitken and Michel, 1995; Harding, 2011; Harwell, 2000). While these considerations are important, this article has shown that this shift also emerged from the consonance and dissonance that different types of representation had in relation to the dominant governance discourses. Thus, it suggests that the literature on local and scientific representations should go beyond epistemological and political criticisms of scientific representations based on the identification of essentialist issues and differences (Agrawal, 1995; Chrisman, 2005).

It is indisputable the fact that local representations have plenty to offer to environmental policy-making. Much of my empirical research in Brazil has been dedicated to exposing the dangers involved in the overreliance on scientific representations, and the importance of hearing the voices of the local population and lower ranking officials in the formulation and enforcement of deforestation control policies. Therefore, the issues raised by different authors concerning the inability of scientific representations to capture the richness of social life are still very relevant (Pickles, 1995; Scott, 1998; Zubrow, 2003). The analysis provided suggests, however, that it is only possible to appreciate the limitations and potentialities of local representations and scientific representations in policy-making when they are assessed in the context of the discourses in which they are mobilized. In particular, while local representations may provide richer accounts concerning the social dynamics of a specific territory, they are not able to scale-up to the level nor to travel to the places in which modern policy-making usually takes place. At the same time and despite all their problems, maps, deforestation rates and other scientific representations of the Amazon closely match the discourses concerning the importance of visibility, comprehensiveness and determinacy in policy-making. However, these discourses should not be solely understood as being negative because of their exclusionary effects in relation to local representations. In contrast, the power effects stemming from these discourses and the related widespread adoption of scientific representations have a productive effect enabling the Amazon to be a visible and knowable entity. In this way, deforestation is presented as a problem affecting the whole of the Amazon, and causal stories are created whereby policies appear to have a deterministic effect over the territory. Here, it would seem to be the case that while power produces knowledge (since governmental discourse is able to legitimize certain representations of the Amazon), knowledge also produces power (since these discourses produce an Amazon that is manageable by the state) (Foucault, 1977b, 2003).

This consideration leads to the second question posited at the beginning of this paper, namely how should the challenges involved in introducing local voices in environmental policy-making be tackled? If the focus is shifted from the inherent limitations/promises of different types of representations towards the role of governance discourses, it follows that any successful intervention aimed at revaluing local representations should not only challenge the idea of the inherent superiority of

science, but also the discourses of governance supporting the exclusive use of scientific representations. In other words, it is possible to argue that in order to position local representations as a central element in environmental policy-making, we should also attempt to challenge the discourses of visibility, compressibility and determinacy that provide their legitimacy.

This means that it is important to go beyond the “seeing to believe” stance that is typical of current evidence-based approaches to policy-making and accept as valid the accounts of the people who are directly facing environmental problems. This implies not only the adoption of participatory approaches but also the creation of a governmental discourse which states that different epistemologies can be equally valid in environmental policy-making. It should also be possible to challenge the idea that the “whole” is the only scale whereby valid environmental policies can be created. This implies abandoning large-scale and top-down approaches to policy-making, and envisioning decentralized governance systems in which local groups have the autonomy to set priorities and to (partially) self-regulate their relationship with the environment. Finally, the idea that environmental policies should always be deterministic in their effects must also be challenged. The effects of policies created to tackle environmental problems are often more difficult to measure and predict than is suggested by the mathematical models in use today. In this context, governments should be ready to accept the unruly nature of environmental problems and create solutions in an experimental and emergent manner. In sum, what is needed is the development of alternative governance discourses in line with the assertion that instead of insisting on performing “the god-trick of seeing everything from nowhere”, policy-makers should embrace discourses that allow “partial, locatable, critical knowledge sustaining the possibility of webs of connections called solidarity in politics and shared conversations in epistemology” (Haraway, 1991: pp. 189–191).

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