Peer-reviewed version available at Forests 2019, 10, 272; doi:10.3390/f10030272

Article

Results-Based Forest Conservation Funding: Amazon Fund 10 Years Later, Lessons from the World's Largest REDD+ Program

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Abstract: Results-Based Funding (RBF) for Reducing Emissions from Deforestation and Forest Degradation (REDD+) has become an important instrument for channeling financial resources to forest conservation activities. At the same time, much literature on conservation funding is ambiguous about the effectiveness of existing RBF schemes. Many effectiveness evaluations follow a simplified version of the principal-agent model, although in practice the relation between aid providers and funding recipients is much more complex. As a consequence, intermediary steps of conservation funding are often not accounted for effectiveness studies. This research paper aims to provide a nuanced understanding of conservation funding by analyzing the allocation of financial resources for one of the largest RBF schemes for REDD+ in the world: the Brazilian Amazon Fund. As part of this analysis, this study has built a dataset of information on Amazon Fund projects at unprecedented detail in order to accurately reconstruct the allocation of financial resources across different stakeholders (i.e. governments, NGOs, research institutions), geographies and activities. The results show that stakeholders seem to hold preferences with respect to the type of activities that they support, thereby suggesting that project owners exert much influence on how deforestation reduction is to be attained. There are evidences that governmental organizations lack financial additionality of their projects, which renders the growing share of funding to this type of stakeholder particularly worrisome. By contrast, the geographical distribution of financial resources seemed to follow a more focused rationale as financial support tends to concentrate in areas where deforestation threats are highest. Overall, the allocation of the financial resources from the Amazon Fund reflects an arbitrary support of different projects that adopt very diverging theories of change that are not primarily concerned with attaining further deforestation reductions. As projects owners exert influence on funding effectiveness to some extent, the Amazon Fund may either seek to regulate the allocation of financial resources more actively or adopt funding effectiveness evaluations that account for this influence more comprehensively.

Keywords: REDD+; Amazon Fund; Results-Based Funding; benefit distribution; resource allocation; climate change funding; effectiveness.; forest conservation funding

1. Introduction

International allocation of funds to activities intended to funding forest conservation – directly or indirectly – is said to be a "highly cost-effective way of reducing greenhouse gas emissions on climate change" [1]. Among many types of financial mechanisms for pursuing this approach, Results-Based Funding (RBF) for Reducing Emissions from Deforestation and Forest Degradation (REDD, or REDD+ for a broader suite of activities) has become an important instrument for channeling financial resources to forest conservation activities [2,3]. RBF can be defined as the "transfer of money or material goods conditional upon taking a measurable action or achieving a predetermined

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performance target" [4-7]. The success of RBF instruments for REDD+ stems from political controversies related to initial REDD+ proposals that favored offset-based markets [8]. Particularly the Brazilian government has been known to challenge the use of markets on the basis of sovereignty concerns [6,9]. Instead, Brazil created the Amazon Fund in 2008 in order to receive results-based payments for achievements in deforestation reductions [10], which have plummeted between 2004 and 2012 [11-13]. Similar developments have also occurred in international forest governance debates as the Green Climate Fund became the central financial instrument for REDD+ [14], testifing the growing prevalence of RBF approaches in forest governance. Despite this dominance, the effectiveness of RBF has been challenged by scholars [5,7,15-18], while others have showed that donor and receiving countries and stakeholders often disagree on how to best evaluate these schemes and distribute the resources [19,20].

This research paper aims to enhance the understanding of intermediary stages of RBF for forest conservation by reconstructing the allocation of financial resources from the Brazilian Amazon Fund to individual projects and analyzing the underlying rationales behind this allocation. Between 2008 and 2017 the Amazon Fund has received more than USD 1,2 billion in donations, committed USD 667.3 million for the financial support of 96 approved projects and thereby represents the largest and most longstanding RBF initiatives in forest governance worldwide [10,13,21]. An analysis of financial resource allocation could therefore provide important lessons on the intermediary stages of RBF (as Amazon Fund) to REDD+ and other conservation purposes. Our analysis exposes the underlying intervention logics (or 'theory of change') adopted for redistributing financial resources, which is useful for identifying the main factors for successful or failing forest conservation funding. The remainder of this paper proceeds as follows. Section 2 reviews the literature on related resource allocations, including the theories of change, criteria for resource allocation, benefit-sharing mechanisms and impacts. Section 3 then outlines our approach and Section 4 presents data about the distribution of Amazon Fund resources. Section 5 concludes with our main findings and their implications for impact and policy making.

2. Aid Effectiveness and the Complex Relations between Service Providers and Service Users

Deforestation reduction [17,22] has been a relatively recent trend in the broader context of development aid that usually targeted health, education or biodiversity conservation [16,23]. Although using the same model, for REDD+ initiatives the literature generally refers to aid as funding, since the former seems to be charity while the last is close to the climate change concepts, where developed countries should fund initiatives of forest conservation to offset their historical emissions [2].

Although this aid could come in many forms, RBF has become an increasingly appealing approach due to its simplicity from both the donor and receiver sides. On the donor side, the payments are done based on the measurement of a result already achieved, reducing substantially the transactional risk. On the receiver side, RBF promises the transfer of resources with "no strings attached" as countries are able to decide on how to best invest the payments. Since receiving countries would want to receive an increasing volume of resources, they would be incentivized to invest the RBF proceedings in a way that reduces deforestation the most. A closer look, however, reveals that many of the issues that have plagued REDD+ and development aid more in general are still present in RBF, namely: benefit distribution, intervention design and effectiveness.

One of the key design choices around REDD+ programs concerns the definition of "who needs to be involved, whose interests are at stake, and the expected co-benefits and required safeguards"[19]. Moreover, their discussion of approaches to reducing tropical forest degradation highlights the importance of contextualizing local realities, responding to new knowledge and experience, and incorporate the full complexity of forest loss and degradation, among others [24,25]. Many scholars have highlighted the issues of equitable sharing of net benefits from REDD+ projects [e.g. 26,27]. For instance, Luttrell, Loft, Fernanda Gebara, Kweka, Brockhaus, Angelsen and Sunderlin [27] distinguish a number of possible rationales for the distribution of REDD+ benefits. They have emphasized: (1) actors with legal rights; (2) actors achieving reductions in emissions; (3) low-emitting

forest stewards; (4) actors incurring the costs of REDD+ implementation; (5) effective facilitators of REDD+ implementation; and (6) the poorest actors. They note great variation in how implementing countries apply these rationales, implying that this is a function of context, project design and the beneficiaries [see also 28]. Some scholars find that "equity can have significant positive feedback on program outcomes and legitimacy over the longer term" [26,28,29]. According to Vatn and Vedeld [30], market-based approaches were found to be the most problematic among governance structures, since they do not address equity. These observations suggest a theme of providing equal opportunities to stakeholders. Yet rigorous analysis and even merely comprehensive evaluations of net benefits and their distribution are scarce, in part because of the way decisions are made about distributions of resources within and across REDD+ projects [19].

Another key aspect of RBF is the choice, by the receiving country, of the interventions that will be supported by the programme. [27,31]. Weatherley-Singh and Gupta [32], for example, find that REDD+ activities must target directly the drivers of deforestation, such as forest fires and illegal logging, as well as structural drivers, such as changes in land tenure and land-use planning. Yet they argue that not all drivers are considered as most schemes do not address cattle ranching, corruption, roadbuilding and or commodities demands, among others [see also 29,33]. As important as the choice of the type of intervention is the definition of the territories that will be prioritized by REDD+. Wolosin, Breitfeller and Schaap [10] show that the geographical distribution of REDD+ finance can be explained to a large extent by priorities on tree cover, tree-cover loss and carbon emissions at national (70-94%) and subnational (58-72%) levels, though institutional capacity and political commitments have also been influential. Other work highlights significant gaps for specific priority areas. Some scholars point to areas in the Amazon region facing high deforestation pressure that are important for emissions and biodiversity [33-35]. Other scholars argue for additional investments in the network of protected areas given their importance to date in curbing deforestation and the risks from deforestation dynamics [36,37]. Still others argue that support should also consolidate pristine or intact or stable forests to ensure long-term conservation [e.g. 35]. While the majority of available literature strongly emphasizes improved protection of high-risk areas, at the least for prioritizing additional impacts in the short run, various goals play parts within comprehensive approaches to forest conservation.

Finally, different studies have pointed out that it is not clear that RBF leads to the efficient use of resources, as assumed initially. The proponents of RBF expected that since receiving countries have a direct financial incentive to reduce deforestation, they would strive to support actions on the ground that contribute directly to that aim. However, a closer look suggests that that empirical evidence on the effectiveness of RBF schemes is either lacking or points to contradictory effects [5], a problem already well known in relation to development aid [38]. On the one hand authors such as Restivo, Shandra and Sommer [17] argue that more bilateral aid from the United States Agency for International Development (USAID) has a lowering effect on forest loss. On the other hand, studies such as Hermanrud and de Soysa [22] report that forest conservation funding from Norway´s International Forest and Climate Initiative (NICFI), one of the largest aid initiatives in the world and the main donor to the Amazon Fund, has had no effect on forest degradation. In a similar line, Bare, Kauffman and Miller [18] for example, argue that forest conservation funding in sub-Saharan Africa "is not associated with reduced deforestation rates at the national scale" and even claim that short-term impacts had negative effects. All scholars agree, however, that the relations between aid and results are complex and therefore difficult to analyze.

The problem with evaluating the effectiveness of RBF initiatives is that the relations between service users (aid providers) and service providers (aid users) are much more complex than a simplified reading of the principal-agent model suggests. According to Paul [7], the contracted agency relationship is often one between the donor organization and a recipient organization or ministry, whereas results may come from other organizations that ultimately spend the financial resources from these donations but have no direct relation with the donor organization (i.e. non-contracted agency relation). In this respect, for example, the UN-REDD+ programme from the United Nations Development Program (UNDP) supports 94 projects in Cambodia, Sri Lanka, Panama,

Paraguay, Democratic Republic of the Congo and Nigeria. However, UNDP are directly related only to the governmental focal point of each country, relating only indirectly with the local beneficiary [53].

According to Van der Hoff, Rajão and Leroy [19] the indirect relations between financial donations, 'project performance' and deforestation rates underlie discursive tensions between donor and recipient countries. These tensions and conflicts suggest that the intermediary processes of forest conservation funding are poorly understood, particularly with respect to how they affect aid effectiveness. Addressing these conflicts requires new approaches to aid effectiveness evaluations that account for the complex relations of RBF for REDD+, particularly the intermediary stages of forest conservation funding. A possible response is to make transfers conditional upon desired results, as within well-implemented payments for ecosystem services (PES) approaches [28]. Scholars have noted that such conditions could also require environmental additionality, that is, provide more ecosystem services than without the activities [39,40]. In addition, REDD+ should be 'financially additional', beyond already planned funding [41]. While attractive, the idea of adding specific demands of additionality to RBF goes against the simplicity and "hands off" approach that made RBF popular in the first place.

The growing body of literature presented above presents valuable insights on how RBF should be designed and presents some its dilemmas and contradictory results. But while allot has been said about how large RBF programmes should look like, until recently we lacked a strong record of largescale schemes to look back and draw lessons from concrete experiences. This study provides the first comprehensive analysis of the first decade of the Amazon Fund, the world largest REDD+ RBF programme [42][43]. Our study aims to reveal the design choices adopted by the Fund by analyzing its resource distribution across beneficiaries, activities and geographies. While this study does not provide a quantitative impact analysis of the fund, it allows us to understand how the allocation of financial resources corresponds with various REDD+ design choices, as reflected in the available literature on REDD+, and the extent to which this may affect its long-term effectiveness. From this, this study draws lessons that could be used to improve the Amazon Fund in Brazil and others large RBF programmes.

3. Research Approach and Methodology

This research paper conceptualizes the Amazon Fund as an intermediary organization that links the forest conservation funding provided by donor organizations to the individual projects (see figure 1). Created in 2008, the Amazon Fund was the first large scale RBF programme to be implemented. As such, the fund played an important role in shaping the discussions around REDD+ at the United Nations Framework Convention on Climate Change (UNFCCC). For this reason, the UNFCCC's Warsaw Framework for REDD+ adopted to a large degree the *modus operadi* pioneered by Brazil. Financial donations to the Amazon Fund mainly come from Norway's International Climate and Forest Initiative (NICFI) and the German Development Bank (KfW). The Amazon Fund consists of a steering committee (COFA), which is responsible for establishing allocation guidelines, and a technical committee (CTFA), which is responsible for approving results in terms of reducing emissions from deforestation. The managing organization of the Amazon Fund is the Brazilian Development Bank (BNDES) and is responsible for the approval (or rejection) of submitted project proposals according to predefined guidelines as well as for the receipt and allocation of financial resources. Since 2015, BNDES has also become eligible to receive financial resources from the Green Climate Fund (decree 8.576/15), whereas other organizations like the government-owned bank Caixa Econômica Federal (CEF) and the Brazilian Biodiversity Fund (FUNBIO) may also become recipients. Financial resources are allocated to a wide variety of organizations. Federal government organizations include the Brazilian Agricultural Research Corporation (EMBRAPA), the Brazilian Institute for Space Research (INPE), the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) and the National Police Force (FNSP). Non-governmental organizations also abound and include the Sustainable Amazon Foundation (FAS), the Amazon Institute for Human and Environment (IMAZON), Amazon Environmental Research Institute (IPAM) and The

Nature Conservancy (TNC), between others. State governments organizations are mostly represented by the environmental or agricultural secretariats of the nine Brazilian states in the Legal Amazon, while some state secretariats outside this region were also recipients. Finally, municipal government secretariats and federal universities were also supported financially by the Amazon Fund.

Understanding how forest conservation funding to the Amazon Fund contributes to the effective reduction of emissions from deforestation and forest degradation involves connecting the project activities, each with a specific benefit sharing, geographies and supported activities, to the overall objective of emissions reduction. The Amazon Fund already provides an annual report that divides the funding distribution according to four broad categories: (1) monitoring and control, (2) land tenure regularization, (3) sustainable production, and (4) scientific and technological development [13]. However, to understand the allocation of financial resources in light of the design outlined above, it is necessary to further refine the available information from the Amazon Fund. For this purpose, we have built a project database with detailed information on the beneficiaries, activities and geographies that received financial resources from the Amazon Fund.

Our primary data source is the Amazon Fund´s website as well as its annual activity reports. We collected all data available on all of the 96 projects that received support between 2008 and 2017. This data includes project objectives, beneficiaries, implementing organization, territorial scope, committed and disbursed amounts, and activities conducted, among other information. Websites of project owners provided additional information. For the data refinement for providing geographical information, we used the municipality as the entity. In Brazil, municipalities reflect the smallest geographical unit for monitoring deforestation, applying public policies, allocating government resources and evaluating outcomes.

One of the main challenges of generating data at the municipal level is the variation of project target areas, which may involve biomes, river basins, protected areas or indigenous territories. Based on the available literature, we designed rules to determine the municipalities encompassed by each project (see diagram 1 in SupMat). When project disbursements cover multiple municipalities, we used a weight factor in order to determine the share of financial support that each municipality received (see table 2 in SupMat). After the geographical allocation of financial resources, we further categorized the dataset by main-component, which reflects the Amazon Fund´s theory of change. As projects may contribute to multiple main-components, we conducted one interview by email with an BNDES manager, the managing organization of the Amazon Fund, that replied a spreadsheet with the data dividing the investments of each Amazon Fund project by main-component. Finally, we further categorized the dataset by activity (also called specific-components). As a main-component can be composed by multiple activities, if more than one activity by main-component was verified, then the amounts was equally divided across them. The final database contains 10,493 lines of information structured by project, location, main-component and specific-component. The procedures for collecting and interpreting data, and constructing the database, are detailed in the supplements. The Amazon Fund accountability is in Brazilian Reais currency. All financial data were converted from Brazilian reais to US dollars by using the rate for the day they are received, which corresponds with the methodology used for the English publications of the Amazon Fund. For evaluate the additionality of the Brazilian governmental agencies budgets (accountable in Brazilian reais) with the Amazon Fund disbursements, we used an average exchange rate between 2009 and 2017, in order to reduce the effects of exchange rate fluctuation.

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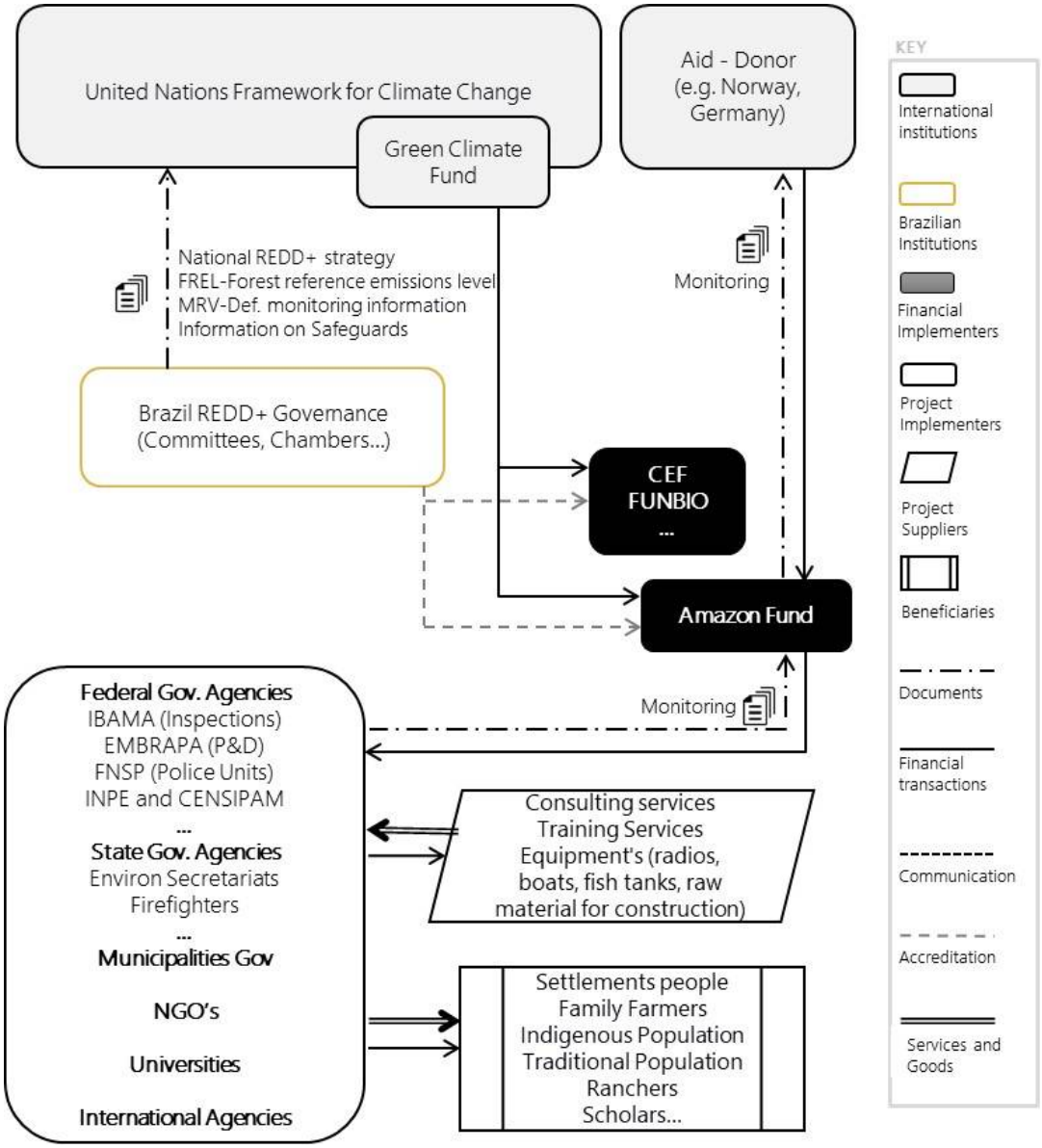

Figure 1. The Flows of Amazon Fund.

4. Results: Resource Allocations by the Amazon Fund

Currently, disbursements are made on the basis of criteria and guidelines updated biannually by COFA. The 2017-2018 document lists 14 minimum requirements that potential projects must meet, some (i.e. items B4, B5, B6, B7 and B14) determining conceptual boundaries of project activities. Projects also must demonstrate coherence with environmental and forest policies, most notably the national Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm), including its manifestations in state governments (PPCDs), and the national policy for Regenerating Native Vegetation (ProVeg) [44]. Projects are also evaluated with respect to coherence with Brazil's National REDD+ Strategy (ENREDD+), which in turn incorporates implementation of PPCDAm and compliance with the Brazilian Forest Code. Finally, projects are expected to be financially additional, i.e., go beyond existing public environmental budgets and other forms of finance. Given these rules, any organization may submit a project proposal to BNDES for financial resources.

4.1. Benefit distribution across Stakeholders

The distribution of financial commitments across stakeholders shows some variation across years (Fig.2, left panel). In 2017, over 95% of a total of USD 667.3 million went to state governments (USD 256.6 million) or NGOs (USD 241.1 million) or federal governments (USD 140.6 million), with their shares varying considerably per year. Of a total of USD 140.4 million in 2013, about 70% (or USD 102.9 million) went to projects of state governments that received almost no such commitments either two years earlier or two years later. This peak took place as a consequence to a change in the rule of the Amazon Fund that allowed the approval of larger "structural projects", as the implementation of the Rural Environmental Register (CAR). By contrast, commitments to NGOs projects were relatively stable over time, averaging USD 22 million until 2016, though rising to USD 44.5 million in 2017 (implying variation in NGOs' share). Commitments to federal government projects were also uneven, with slight peaks in 2012 and 2017 (USD 31.7 million, 41.2 million).

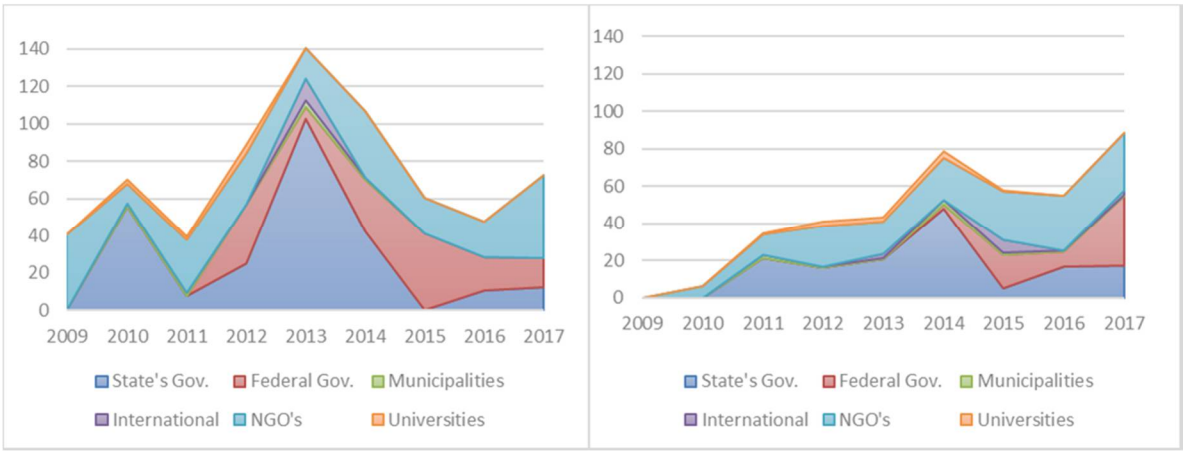

Figure 2. Annual committed (L) and disbursed (R) amounts per stakeholder (in million USD).

However, the ability of different stakeholders to approve projects with the Amazon Fund did not match their implementation capabilities. In the last decade only USD 405.3 of 667.3 million (i.e. 60.7 %) has been transferred to project owners. Average annual disbursements to state governments have hovered between USD 16 and 21 million in most years, with a sudden peak of USD 47.6 million in 2014 and then a sharp drop to USD 4.8 million in 2015. Disbursements to federal government increased exponentially from a small base of only USD 2.4 million even in 2014 to USD 37.7 million in 2017. Finally, disbursements to NGOs steadily increased from USD 6.4 million in 2010 to USD 30.7 million in 2017. From these three groups of beneficiaries, the Federal Government has been demonstrated the largest implementation gap, starting with a very low implementation rate and reaching the execution of only 47% of the committed values by 2017. This was followed by the State Governments, which spending rates stayed below 50%. Municipalities, Universities and NGOs, in contrast, presented a better implementation capacity, being able to invest most of the resources obtained from the Fund.

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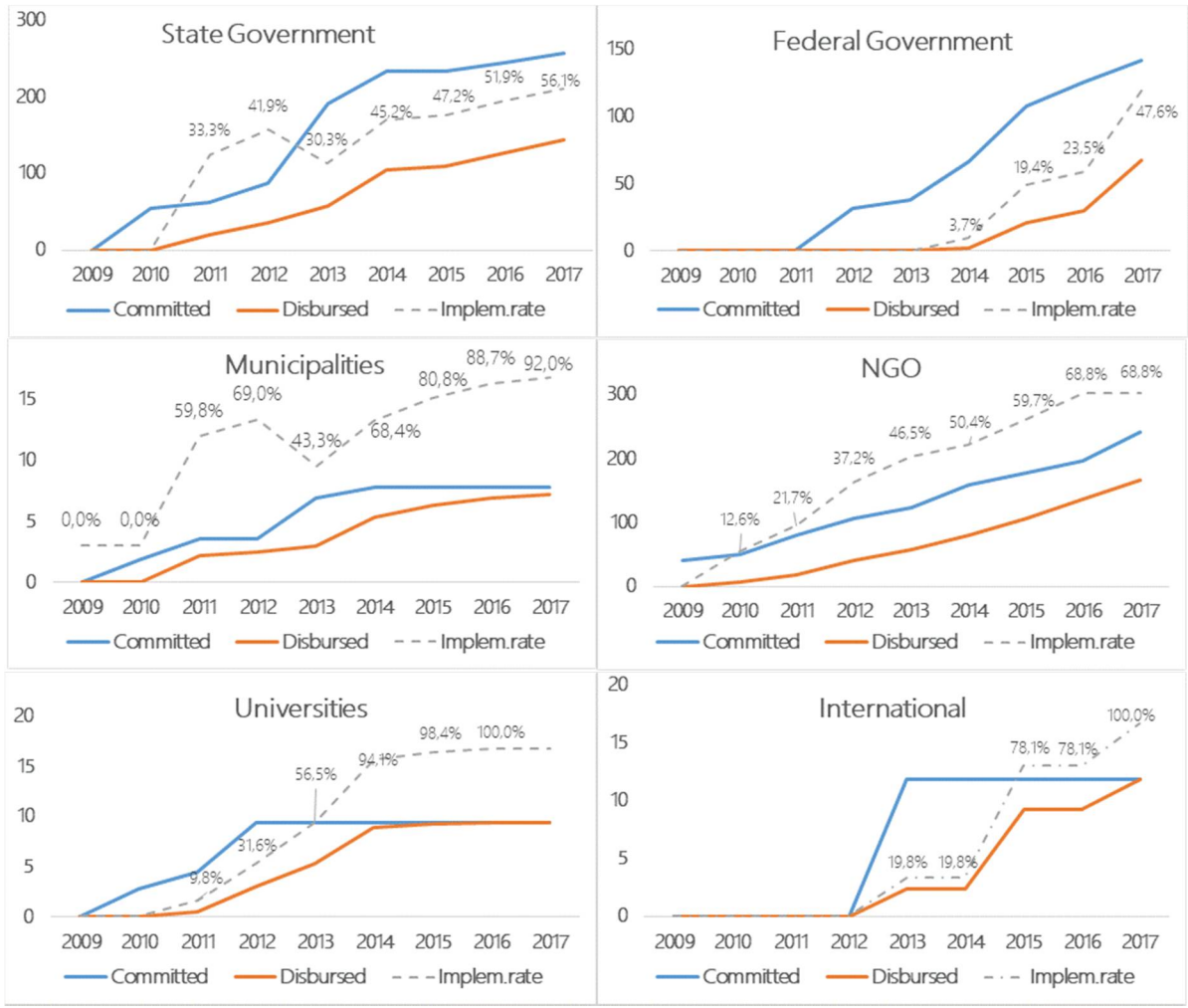

Figure 3. Implementation rates as disbursed divided by committed (consolidated amounts), by Stakeholder.

To understand these variations in disbursements, we must also consider the characteristics of the projects supported by the Fund. Federal government projects, for instance, were concentrated within eight projects involving six recipient agencies. Of the total amounts in this category, USD 64.3 million (i.e. 47.2%) went to organizations that develop satellite-based monitoring systems and provide information on deforestation trends, namely INPE and CENSIPAM. Another USD 35.9 million (i.e. 26.7%) went to organizations responsible for enforcing environmental laws and policies, namely IBAMA and FNSP. The remaining USD 40.5 million (i.e. 25.9%) went to EMBRAPA units to disseminate knowledge about sustainable production and recovery of degraded areas throughout Brazil, and to the SFB to the collection of information aiming increase the forest data available (see section 4.3). While the IBAMA manage to invest 17.5% of the funds received, by 2017 INPE and CENSIPAM used only 58.6%, implying that the development of radar-based monitoring system is lagging behind schedule.

The committed and disbursed peaks for state government projects in 2013 and 2014 (Fig.3) corresponds with contextual factors as well, including a surge in state government projects toward development and implementation of the Rural Environmental Register (CAR). CAR is a federal policy instrument introduced in 2012 with the adoption of the new Forest Code (law 12.651/2012) to enhance law enforcement capacity. Yet despite the federal law and a centralized national system, the registers must be executed at state or municipal level (art 29, §1). CAR implementation has therefore become a major concern for state governments, especially after the system went live in 2014 [45]. This

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can be seen in both spending and appeals to the Amazon Fund [13]. Within the 13 states that have approved projects, 85% of disbursements went to seven of the nine inside the Amazon Biome.

The linear increase in disbursements to NGOs reflects yet another set of contextual factors, in this case related to Amazon Fund process adjustments over time. Disbursements to projects were slow, to start, due to rigid assessment procedures intended to show professionalism, in the eyes of donor organizations and BNDES management, that also reflected some lack of understanding of project owners [13,19]. Minutes of COFA meetings indicate that, in response to these challenges, the Amazon Fund adopted a number of measures in order to facilitate and accelerate the disbursement process, including public calls for submitting project proposals. While the consequences of these responses are reflected in the linear increase in approved projects and disbursements to NGOs, the financial resources were not evenly distributed. We find that 80% of the disbursed amount was concentrated in half of the NGOs that received support from Amazon Fund, usually high-capacity and professional organizations, such as FAS, IMAZON, and TNC. (see figure 15 in SupMat).

In addition to exposing the implementation capability of different governmental agencies, a comparison between the disbursement of the Amazon Fund with the yearly government budget also reveals the ability of the Fund to foster additional actions. One of the key principles of the first donation contract between Norway and Brazil signed in 2008 was the warrant that the Amazon Fund would not replace but would be additional to tax payer funds [2,20,22,46] However, it is possible to observe that the increases in disbursements to federal agencies coincided with their decreasing governmental budgets, in particular after 2014 (Fig.4). This suggests the occurrence of a partial substitution for agency expenditure of taxpayer-funded budgets using the Amazon Fund. For instance, IBAMA's committed budgets to reduce deforestation, combat fires and conduct environmental inspections were reduced from USD 50.64 million in 2014 to USD 29.07 million in 2017, a shift occurring in parallel with rising disbursements from the Amazon Fund disbursement. Similarly, INPE´s budget fell from USD 84.5 million in 2010 to USD 43.63 million in 2017, alongside increasing disbursements from the Amazon Fund (USD 27.51 million) between 2015 and 2017. CENSIPAM shows similar trends. Those trends include rising implementation rates for turning federal commitments into disbursements, which increased from 3.7% in 2014 to 26.8% in 2017.

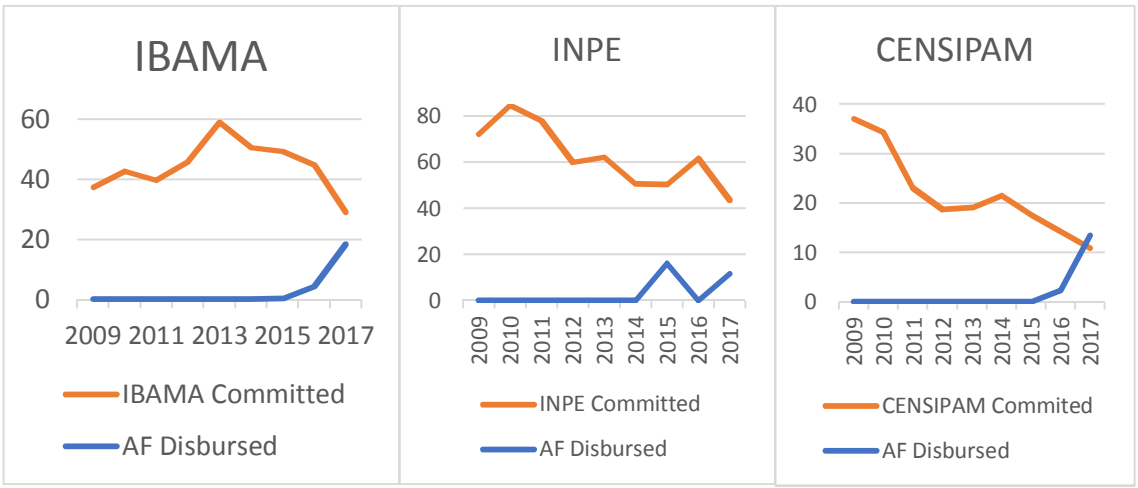

Figure 4. Comparison of Federal Committed Budgets with the Amazon Fund disbursements for INPE, IBAMA and CENSIPAM (used average 2009-2017 exchange rate: 2.434). Committed amounts represents the term in Portuguese 'Empenhado', an act that guarantees that there is the amount necessary to pay an assumed commitment and creates for the government the payment obligation.

These observations cannot by themselves confirm a direct causal relationship between the increasing financial disbursements from the Amazon Fund and the decreasing budgets of the recipient federal agencies. Furthermore, it should be highlighted that the period following 2015 witnessed one of Brazil's worse political, economic and fiscal crisis. At the same time, however, contextual factors seem to correspond with an interpretation that the forest conservation funding provided through the Amazon Fund lacks financial additionality, particularly considering the unfavorable political climate for environmental protection [47], more flexibility within forest legislation since 2012 [48], multiple bills for reducing environmental protection during election year 2018 and, as a consequence of all these factors, rising deforestation rates since 2014 [49].

4.2. Geographical distribution

Spatially, Amazon Fund allocations display is large concentration (Fig. 5a) in 64 municipalities along the (Fig. 5a) region stretching from the southeast of Pará towards the western regions in the Mato Grosso, Rondônia and Acre states, municipalities that contains, since 2000, the highest consolidated deforestation rates in Brazil. NGO and state projects explain much of this concentration (Fig. 5b and 5c), whereas federal projects had no significant contribution mainly due to their nationwide focus (Fig. 5c and 5d). State government projects are mostly responsible for monitoring and control (Fig. 5c), particularly through activities as structuring of environmental secretariats, CAR implementation, and training of firefighters (see section 4.3 for details). State governments that more actively sought the support of Amazon Fund for monitoring and control were Acre, Maranhão, Tocantins and Rondônia. Particularly Acre has a strong presence in investments in sustainable production spread throughout its territory. However, the Amazon Fund allocations did not systematically have privileged the municipalities that showed the recent highest deforestation rates. An analysis of the relation between yearly deforestation rates and disbursements of the 20 municipalities that received more by hectare, indicate that the support from the Amazon Fund tend to arrive in a context in which clearings have already been reduced substantially. Likewise, from the 10 municipalities with the higher deforestation rates in 2017, only 2 are amongst the top 100 receiving per/Ha considering the 775 municipalities from Legal Amazon (see table 3 and Figure 15 in SupMat).

Federal government projects are the most evenly distributed across the landscape, averaging below 26 USD/ha, which could be due to the all-encompassing nature of the GIS and remote sensing activities that these projects tend to promote. At the same time, disbursements to larger federal agencies, such as EMBRAPA, tend to concentrate in eight cities in the Legal Amazon, including Rio Branco, Manaus, Boa Vista and Macapá, where these agencies are located (Fig. 5d). Finally, while municipalities benefit indirectly from various types of support, direct support only went to 6 of the 772 municipalities in the Legal Amazon and amounted to only USD 7.8 million. Most of these resources (65.2%) went to the municipal government of Alta Floresta, in northern Mato Grosso. In addition, the Amazon Fund had also financed research of the state universities of Pará (in Belem) and Amazonas (in Manaus) as well as to the development of satellite-based monitoring systems by INPE (in Manaus).

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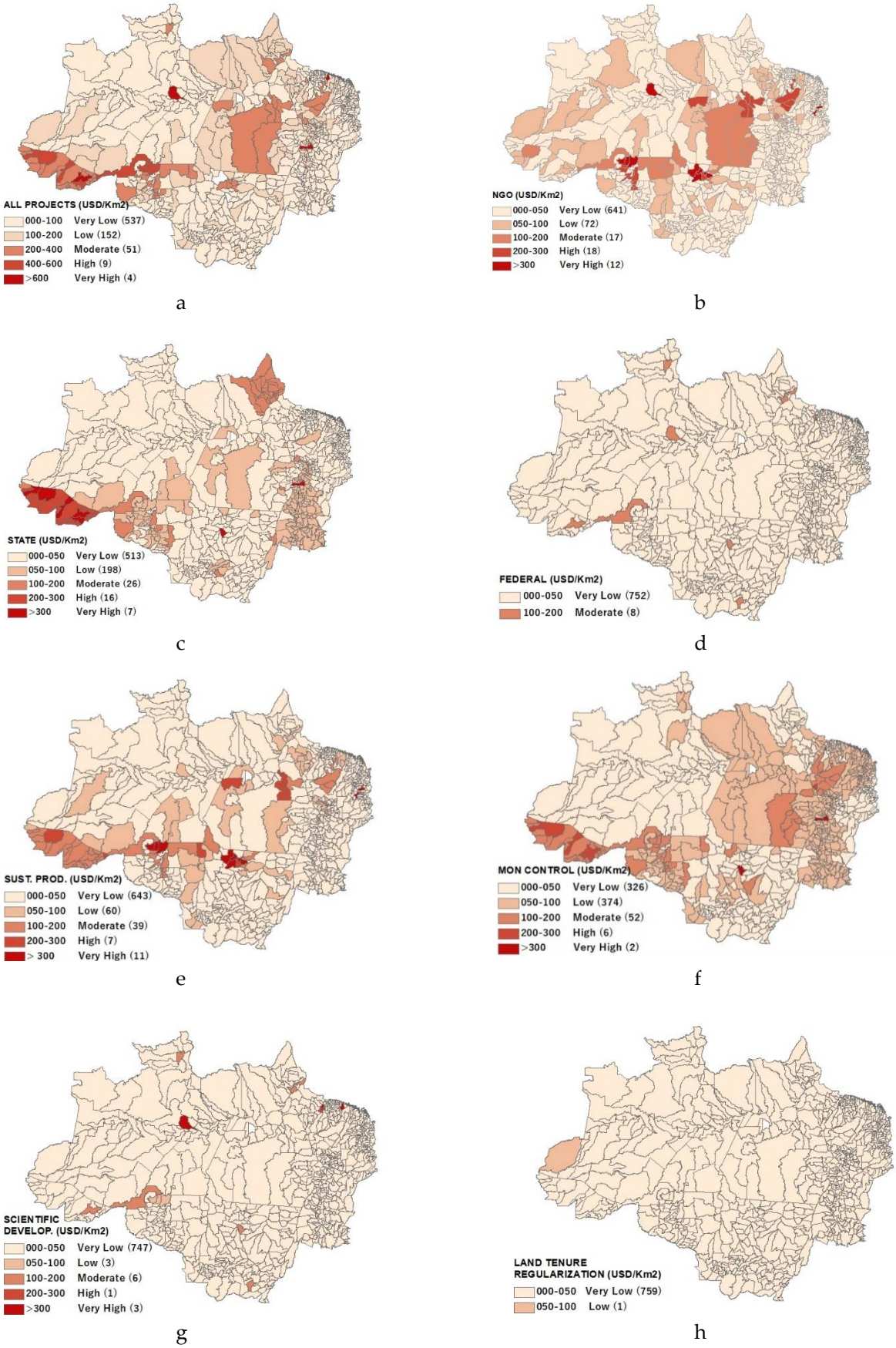

Figure 5. Spatial distribution of Amazon Fund investments per municipality by Stakeholder and by main-component.

388 *4.3. Distribution across Activities*

389 Almost half of total commitments (USD 667.3 million) has gone to monitoring and control (USD
390 326.7 million) while one third (USD 201.9 million) went to sustainable production (see figure 6 and
391 table 1). The latter category has been relatively steady over time, as have the small land tenure
392 commitments. By contrast, the large investments monitoring and control have been uneven over
393 time: starting slow with an average of USD 20.3 million in the first four years, peaking in 2013 at USD
394 94.0 million, and then settling at an average of USD 30.6 million from 2015 on (Fig.6 left panel).
395 Finally, nearly all commitments for scientific and technological development occurred in 2012 (USD
396 40.7 million).
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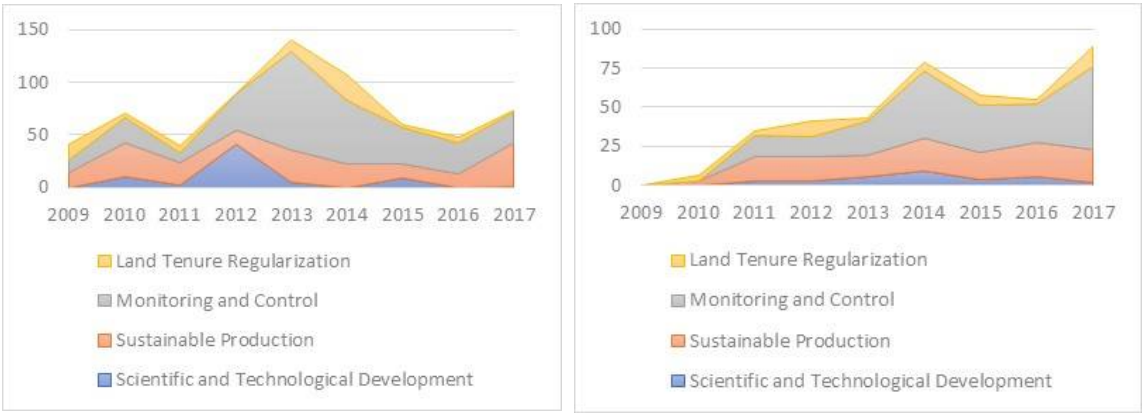

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399 **Figure 6.** Annual committed (L) and disbursed (R) amounts per main-component (in million USD).

400 Although slightly slower than noted above, actual disbursements to individual projects have
401 corresponded with commitments, with most disbursements going to monitoring and control (49.6%)
402 and sustainable production (31.9%). Monitoring and Control was responsible for most of the
403 variation (see right graph of figure 3), peaking in 2014 (USD 43.1 million) and 2017 (USD 53.5 million).
404 Disbursements for scientific and technological development have notably never really gotten much
405 traction, only slightly peaking in 2013 and 2014.

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Peer-reviewed version available at Forests 2019, 10, 272; doi:10.3390/f10030272

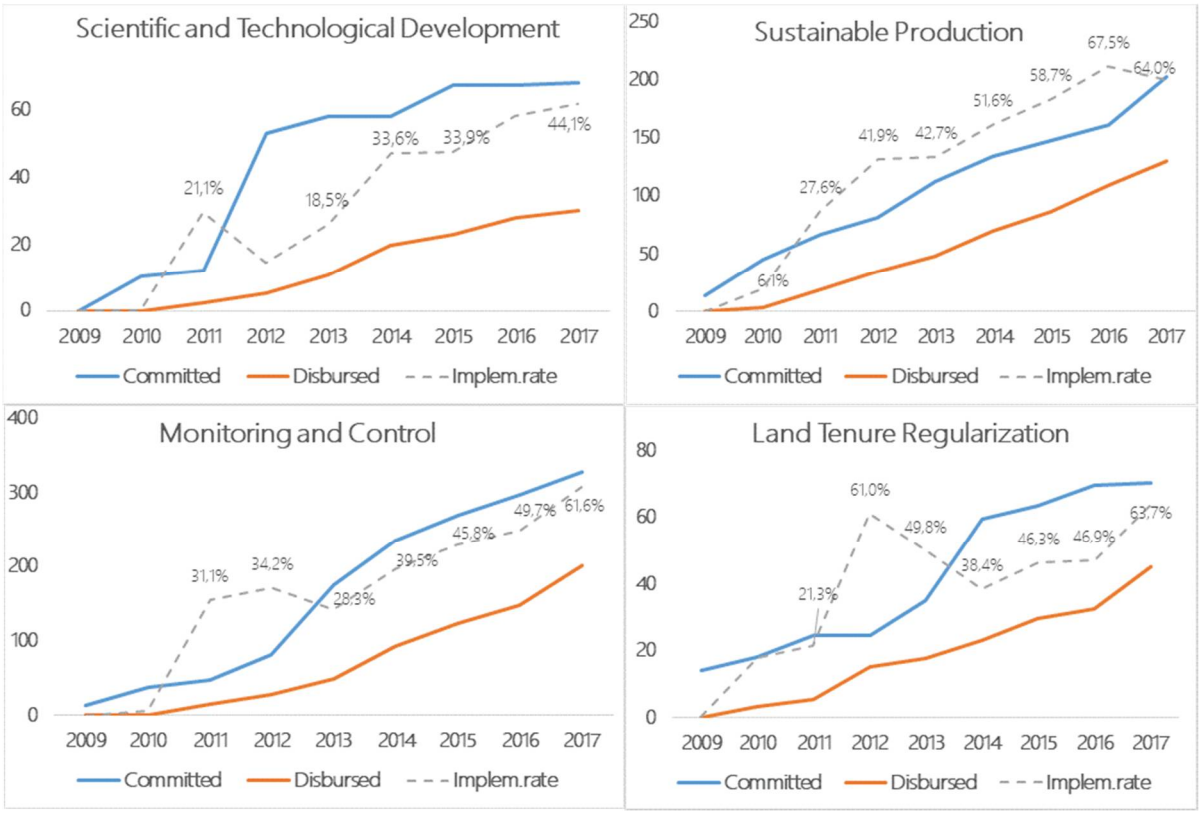

Figure 7. Implementation rates as disbursed divided by committed (consolidated amounts), by main-component.

Monitoring and control efforts involved mostly state and federal government projects (USD 187.1 million and USD 100.1 million, respectively). It was the only category, though, that included the unique international project supported by the AF aiming help develop the capacity to monitor deforestation in 8 neighboring countries that also contain the Amazon biome (USD 11.8 million). Yet most of the monitoring and control investments (USD 113,0 million) was allocated to CAR implementation. A large share of the funds provided for this activity (USD 102.5 million) was used by state governments to acquire equipment (GPS, computers, software) and provide training for effective processing of CAR proposals. Another share (USD 52 million) was invested in capacity-building of environmental secretariats for CAR implementation and other environmental policies, including the creation of municipal secretariats, the acquisition of cars and buildings, the hiring of employees and training in monitoring deforestation, landscape analysis, sustainable supply chains and measurement. In addition, some resources were used to promote CAR among landowners and to provide georeferencing services for landowners. A small amount went to development of a state system for granting environmental licensing to new businesses and companies. Therefore, in total 18% of the resources committed by the fund has been invested in the implementation of CAR.

Monitoring activities that were exclusively promoted by federal government organizations involved the improvement of satellite-based monitoring systems for fighting deforestation (PRODES and DETER, USD 76.1 million) and forest fires (PREVFOGO, USD 6.3 million). State governments also invested in forest fire combat (USD 32.5 million), but emphasized control activities (e.g. creation of firefighter units) rather than monitoring activities. Other investments by federal government organizations targeted the strengthening of law enforcement (USD 29.6 million) in two projects by IBAMA and FNSP, mostly spent on the acquisition of vehicles, helicopters, equipment and buildings. While NGOs received much financial support from the Amazon Fund (USD 241.1 million), their support to monitoring and control activities were relatively small (USD 11.6 million) and only involved CAR implementation.

In the category of sustainable production, resources mostly went to NGOs (USD 154.7 million) and state government organizations (USD 42.1 million) (see table 1). Nearly all state governments

investments went to the promotion of sustainable forest activities, acquisition of equipment (tanks, driers, processing units' machines, warehouses) and the provision of professional training and technical assistance (in pisciculture and aquaculture, nut and Açaí extraction, pasture management, as well as forestry and agroforestry systems). This suggests that the social benefits from the Amazon Fund in terms of rural poverty reduction and sustainable farming were carried out mostly by NGOs and state governments.

Investments in regularizing land tenure almost exclusively came from state governments (USD 23.8 million) and NGOs (USD 46.6 million), notably spending on territorial zoning and protected-area management and indigenous lands. This provides indirect benefits for indigenous peoples, quilombos (descendants from fugitive slaves), riverine people, smallholders and settlements. No such investments were federal. Federal governments did invest substantially in scientific and technological development, which involved field data collection by the Brazilian Forest Service (SFB) for building the National Forest Inventory (USD 31.7 million).

Universities, by contrast, invested most financial resources in scientific research (USD 4.7 million) and development of the research infrastructure (USD 3.9 million). For instance, one project from the Federal University of Pará conducted research for the development of new products from bioactive compounds of plants typical of the Amazon Biome (USD 0.7 million), and investments in the development of new forest products such as herbal medicines, cosmetics and food products, among others. Natura, a private cosmetics company from Brazil, announced in 2016 an investment of more than USD 70 million in biodiversity inputs as part of its Amazon Program that aims to develop a new line of products with origins in Amazon Biodiversity.

Table 1. Distribution of project approvals to Amazon Fund projects (USD).

ACTIVITIES	Stat. Gov.	Fed. Gov.	Mun.Gov	Int.	NGOs	Univ.	TOTAL
Scientific and Technological Development	**4.457.301**	**40.461.961**			**13.990.780**	**9.383.341**	**68.293.383**
Field collection and data inventory (Forest, Socioeconomic, Biodiversity, Maps)	1.771.039	31.709.135			366.095		33.846.268
Disseminate Environmental Education (Museum)					5.818.209		5.818.209
Development of New Forest Products						732.695	732.695
Develop environmental diagnoses and shared management tools, edit bulletins and publications					1.693.133	4.736.591	6.429.724
Investment in research infrastructure (Laboratories, equipment, facilities, universities)	1.771.039				1.263.966	3.914.055	6.949.059
Research on the production of native seedlings and techniques for reforestation of degraded areas, development of Demonstration Units (pilots) to disseminate knowledge *	915.224	8.752.827			4.849.377		14.517.427
Sustainable Production Activities	**41.186.376**		**5.984.174**		**154.736.705**		**201.907.255**
Economic Activities for Sustainable Forest Use and Recovery of Degraded Areas	41.186.376		5.984.174		154.736.705		201.907.255
Monitoring and Control	**187.105.638**	**100.146.294**	**1.788.272**	**11.791.988**	**25.845.426**		**326.677.619**
Structuring and strengthening of State and Municipal Environment Secretariats (Acquire infrastructure, training in Monitoring deforestation, Landscape Analysis, Sustainable Chain and Recovery Measure techniques)	52.018.486		1.376.210		14.254.668		58.656.955
Inspections, Enforcement and Environmental Police		29.571.660					29.571.660
Combat Forest Fires (States – Firefighters / Federal – GIS and Satellites)	32.543.336	6.282.451					38.825.788
Regularize the environmental situation or/and implement CAR	102.543.816		412.062		11.590.759		113.007.430

Improve Deforestation Monitoring System (GIS and Satellites) **		64.292.183		11.791.988			76.084.171
Land tenure regularization	23.829.953		62.995		46.552.443		70.445.392
Land Regularization of Small and Middle size properties (Tenure, Deeds)	1.141.031				3.219.703		4.360.735
Territorial and Ecological Zoning, strengthening and empowerment of PA and IT Management	22.688.922		62.995		43.332.740		66.084.657
Total	256.579.269	140.608.255	7.835.441	11.791.988	241.125.355	9.383.341	667.323.649

5. Amazon Fund design choices and effectiveness

The findings of our analysis of the recipient projects in the Brazilian Amazon Fund reflect a broad variety of stakeholders and activities. Following the categorization of Luttrell, Loft, Fernanda Gebara, Kweka, Brockhaus, Angelsen and Sunderlin [27], the recipient projects of the financial resources from the Amazon Fund often involve the largely indirect contributions of effective facilitators, legal rights holders, cost-incurring groups, forest stewards or poor communities. Moreover, the Amazon Fund's financial resources were channeled towards the direct and structural drivers of deforestation, but this was not proportional to the importance of addressing these drivers as argued by some scholars [e.g. 32]. Investment patterns tend to reflect specific relations between specific stakeholder groups and project activities. Although activities also vary considerably, there are some general patterns. Federal government organizations tend to invest in development of monitoring systems (45.7%) and inventory data (22.6%), which denotes a main concern with gaining control over deforestation dynamics. State government organizations tend to invest mostly in CAR implementation (40.1%) and capacity-building for state and municipal organizations (20.3%), thereby incurring many of the costs of federal policies. Finally, investments by NGOs have mainly benefited local communities that aim to adopt sustainable production activities (64.2%), but have also supported (more than federal or state government organizations) land tenure regularization projects (19.3%).

The geographical distribution of financial resources seemed to follow a more focused rationale. We found that many project organizations were located in municipalities with the highest consolidated deforestation rater of Brazil. For instance, NGO projects for territorial and ecological zoning, strengthening of PA and IT management as well sustainable production represent 30% of total disbursements from the Amazon Fund and were largely located in this region. Disbursements from the Amazon Fund to the three main recipient categories have generally benefited municipalities located in areas where deforestation threats are highest [50]. This observation only partially corresponds with findings by Wolosin, Breitfeller and Schaap [10] as we found no evidence of substantial contributions to areas with high tree cover, which are more commonly found in remote areas of the Amazon biome [35].

Within the pre-established main-components of the Amazon Fund, we also found variation in the activities that compose these categories. For instance, while most financial resources were channeled to the strengthening of monitoring and control activities by federal and state governments (USD 287.2 million), their investments have focused on monitoring activities like satellite imaging (USD 70.6 million) and CAR implementation (USD 102.5 million). This contrasts with the substantially smaller investments in control activities like combat forest fires (USD 32.5 million) or law enforcement (USD 29.6 million). This trend is representative of the broader resource allocation within the monitoring and control category. Similarly, investments in land regularization were mainly directed at indigenous territories and protected areas (USD 66.0 million), whereas smallholders (USD 4.3 million) received much less support. These findings suggest that financial resources are not evenly distributed across stakeholders, activities and geographies even within the main-components of the Amazon Fund.

Based on our findings on the variations in financial resource distribution, we argue that the project owners impose a substantial influence on the nature of activities that forest conservation

funding ultimately supports. The four main-components of the Amazon Fund, which aim drive the projects to deforestation reduction, had a limited influence in the activities developed. As projects owners exert influence on funding effectiveness to some extent, the Amazon Fund may either seek to regulate the allocation of financial resources more actively or adopt funding effectiveness evaluations that account for this influence more comprehensively. Corresponding with the study by Weatherley-Singh and Gupta [32], for example, the Amazon Fund restricts financial resource allocation to the four main-components of its theory of change, while not addressing alternative factors such as the impacts of cattle ranching, road construction, international demand for agricultural products or corruption. However, any project proposal that adheres to the project quality criteria and guidelines of the Amazon Fund [13] may become eligible for financial support. In other words, the Amazon Fund takes a more passive stance towards resource allocation after the criteria and guidelines are in place. This view accounts for the great variety of stakeholders, activities and geographies, as described above, since each stakeholder category seems to prefer a different investment strategy. Such behavior may ultimately undermine the effectiveness of conservation funding provided by Norwegian and German donor organizations, at least in terms of emissions reductions.

The influence of individual projects on decisions related to how financial resources will be allocated may have substantial impact on the effectiveness of forest conservation funding. As already argued in section 2, the Amazon Fund´s theory of change is generally geared towards deforestation reduction, but the design choices of individual projects are primarily directed at contributing to one or more main-components. The evaluation of a completed project in northern Mato Grosso [43], for instance, indicates that the project geared its intervention logic upon its contribution to the main-components "sustainable development" and "monitoring and control", and stated that the main contribution to emissions reductions was coming from "the restoration of native vegetation and pastures and the planting of native species in permanent protection areas". The extent to which such projects achieved emissions reductions was not stated in the report and would admittedly be a complex methodological endeavor. The leeway that projects have in contributing to these main-components, although important for attracting project proposals, accounts (at least partially) for the imbalanced allocation of financial resources discussed above and may undermine the Amazon Fund´s contribution to deforestation reduction to some extent.

It is important to note that this undermining of the Amazon Fund´s overall contribution is by no means intentional. At the same time, there are also indications that some projects require a more in depth evaluation. Particularly but not exclusively, projects from governmental organizations are under greater pressure from critical considerations of their contribution to emissions reductions. One may argue that investments in CAR implementation, for example, support more structural improvement of a nation-wide instrument that enhances monitoring capacity, but some studies point out that it is still unclear whether and to which extent this instrument indeed contribute to reducing deforestation [45,51]. In addition, our analysis indicates that federal government organizations (i.e. CENSIPAM, INPE and IBAMA) tend to lack financial additionality. Particularly the substitutive nature of Amazon Fund financial resources of IBAMA projects is worrying, because these investments often involve more direct contributions to reducing deforestation, most notably the enhancement of (the capacity for) environmental inspections and fire combat. While the lack of funding for law enforcement may have led to an even higher spike on deforestation rates, a country with a mature enough environmental governance should be able to grant a stable source of public funding by giving priority to this agenda.

6. Conclusions

Our analysis of financial resource allocation from the Amazon Fund to individual projects has provided a more nuanced understanding of the complexity of evaluating the effectiveness of conservation results-based funding. Perhaps the main challenge is to evaluate (and enhance) its effectiveness on the basis of a singular objective (i.e. emissions reductions from deforestation) while also taking into account the project-level complexity that influences the outcome. For instance, deforestation rates have been rising since 2013 despite increased disbursements from the Amazon

Fund, which already incite a more critical approach from aid provider organizations [19].The critiques on some governmental projects that address both effectiveness and financial additionality may further weaken the credibility of financial support from the Amazon Fund. The sustainable development activities in NGO projects seem to incite less critiques, but these projects require much closer scrutiny in order to understand the extent to which they indeed reduce deforestation. Our analysis confirms the argument by Van der Hoff, Rajão and Leroy [19] that the "demands for demonstrating the results of the Amazon Fund in scientifically rigorous manner are likely to become an important topic for donor countries". Alternatively, the Amazon Fund could adopt a more active approach to the allocation of financial resources, for example by prioritizing control activities, emphasizing projects in northern Mato Grosso and/or ensure additionality to governmental budgets by improving transparency on spending. This is especially important as the political climate in Brazil, United States and other countries has become more hostile to environmental interests [49,50,52].

Our analysis also helps to understand why empirical studies seem ambiguous about the effectiveness of forest conservation funding. As explained in section 3, BNDES' approach to distributing financial resources from the Amazon Fund to individual projects occurs based on the evaluation of project proposals from diverse organizations rather than a strategic selection of projects based on a predetermined theory of change. As a consequence, our findings show that disbursements by the Amazon Fund to individual projects reflect an arbitrary support of different projects that adhere to very diverging theories of change within a broader REDD+ and RBF strategy. Although this refutes any suggestion that BNDES pursues other interests than deforestation reduction, this arbitrariness of disbursements suggests that the Amazon Fund is not primarily concerned with attaining further deforestation reductions, but rather supports the broader policies that are or should be. The financial transactions to Amazon Fund, as an intermediary organization, are conditional on demonstrated achievements in reducing emissions from deforestation, whereas the conditions for redistribution require adherence to national policies. Although the Amazon Fund contributes to attaining REDD+ objectives to some extent, as an intermediary organization it is not responsible for this attainment and may therefore foment political controversy [19]. Similar processes may underlie some of the aid effectiveness studies [17,18,22], but empirical analysis will be necessary to verify this hypothesis. Finally, this article providing an on-the-ground reference point to reflect on the need of advancing the theoretical framework of RBF to include the intermediate stages of international forest conservation funding.

Supplementary Materials: See at the end of this file.

Author Contributions: Conceptualization, Juliano Correa, Richard van der Hoff and Raoni Rajão; Data curation, Juliano Correa; Formal analysis, Richard van der Hoff and Raoni Rajão; Investigation, Juliano Correa and Richard van der Hoff; Methodology: Juliano Correa and Raoni Rajão; Visualization, Raoni Rajão; Writing – review & editing, Juliano Correa, Richard van der Hoff and Raoni Rajão.

Funding: This research received no external funding.

Acknowledgments: We thank Alexander Pfaff from Duke University.

Conflicts of Interest: The authors declare no conflict of interest.

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Peer-reviewed version available at Forests 2019, 10, 272; doi:10.3390/f10030272

Supplementary Material

General approach to dataset Structuration

Our database was structured according to four categories: project, municipality, main component and activity (specific-component) (Fig. 8). Data collection for the different variables in these categories came from 5 different origins, namely (1) the website or annual reports of the Amazon Fund, (2) field research in BNDES, (3) Spatial information obtained from various sources (see Fig. 8) and processed with GIS software, (4) mathematical propositions based on decision rules, and (5) assumptions adopted by the authors of this study. In order to process and organize the data, we followed a series of steps, as depicted in Fig. 9.

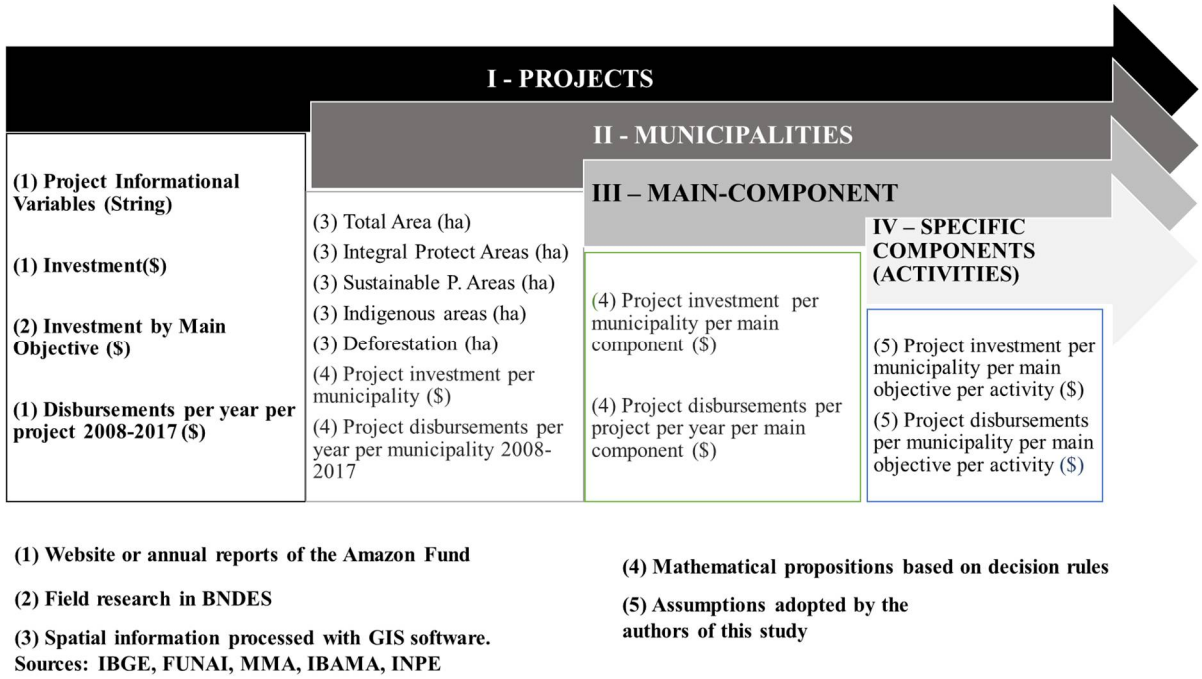

Figure 8 Model for Database Structuration.

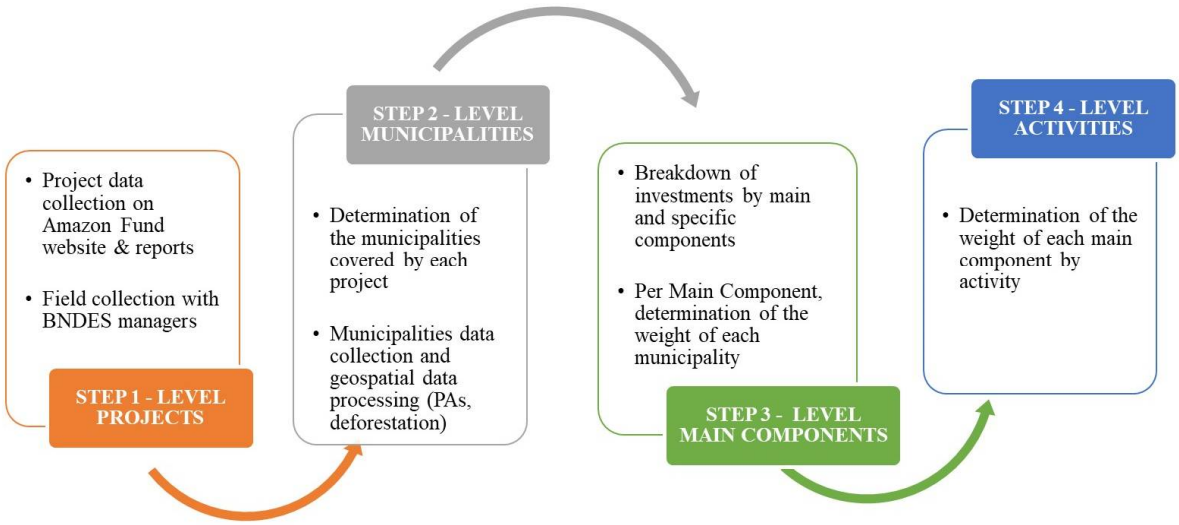

Figure 9 Steps to collect the variables.

Data Collection

In the initial step, the core source is the Amazon Fund website (Fig. 10). We collected all of the data available on all of the 96 projects. The variables included for the project level are:

- Stakeholder (Project Manager): Shows the name of the entities that receive the financial support and are responsible for the project implementation. Occasionally, secondary organizations are used to sub allocate the funds to several small associations without the formal structure required to receive funds directly from the Amazon Fund (e.g. local traditional population NGO's);
- Stakeholder category: Federal Government, States Government, Municipalities Government, NGO, Universities or International
- Territorial Scope (text characters): Represents the area covered by the project. It may be a state administrative region, one or several states, biomes, hydrographic basins, protected areas, indigenous territories;
- Beneficiary (text characters): Population that will be directly benefited by the project, like the traditional populations that live in the area, ranchers, indigenous people;
- Objective (text characters): reflects the project objectives;
- Total Cost of the Project (numeric): The total cost of the project is presented, that is, the sum of the amounts financed by the Amazon Fund added by the counterpart of project implementer;
- $AFInv_p$ – Amazon Fund investments per project p (numeric);
- Estimation Completion Data (numeric): Estimated duration of the project from the date that the project was signed with Amazon Fund;
- Date approved (date): Date of approval in the Amazon Fund;
- Date awarded (date): Contracted date, starting the project and disbursements;
- Disbursements (numeric / date): Amazon Fund disbursements for the project;
- D_{pt} - Disbursements per project per year (numeric), calculated as:

$$D_{pt} = \sum_{\substack{p=1 \\ y=2008}}^{\substack{p=96 \\ a=2017}} d_{pt}$$

where d reflects the disbursements from Amazon Fund to the project p, and $p \in \{1, 2, \dots, 96\}$ represents the 96 approved projects from Amazon Fund in the year t, and $t \in \{2008, 2009, \dots, 2017\}$.

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Figure 10 Individual Project Page on Amazon Fund website.

The Amazon Fund website only contains the supported amount per project, lacking information of how much was committed for each main component. we conducted one interview by email with an BNDES manager, the managing organization of the Amazon Fund, that replied a spreadsheet with the data dividing the investments of each Amazon Fund project by main component. Thus, the following variables were added to each project:

- Per project support to Main Component 1 (numeric): Sustainable Production Activities;
- Per project support to Main Component 2 (numeric): Land Tenure Regularization;
- Per project support to Main Component 3 (numeric): Monitoring and Control;
- Per project support to Main Component 4 (numeric): Scientific and Technological Development.

The sum of the values of these four columns, per project, should be the same as the variable $AFInv_p$ – Amazon Investments per project. This completes the database structuring for the level Projects as highlighted in Figure 11 in which there are 96 lines in the database, one for each approved project.

Figure 11 Database structured at Level I - Projects.

Dataset Structuration

Once all data was collected, we started to structure the dataset by defining which municipalities are encompassed by each project (step 2 in the overall process, see Fig. 9). The reliable information on the projects of the Amazon Fund at the municipal level are the basis for the construction of our research database. The information made available by the Amazon Fund through its annual activity reports and on its website, however, are organized by project. As the vast majority of these projects cover areas like watersheds, indigenous territories or environmental conservation units, they commonly encompass several municipalities.

One of the main challenges of this research, therefore, is to construct a database that distinguishes the municipalities that were considered by each project. For this purpose, we designed decision rules based on the literature to identify the municipalities that were covered by each project (PRn) of the Amazon Fund, which is visualized in diagram 1. We applied this tool to our primary data sources (see table 3). In addition, we added spatial data obtained from various Brazilian agencies (see table 2) that were processed with the ARGIS and Python packages in order to include, for each municipality (m) supported directly or indirectly by the Amazon Fund, the following variables:

A_m	Total area (ha) for the municipality m (Numeric);
PAi_m	Integral Protected area (ha) for the municipality m (Numeric);
PAs_m	Sustainable Protected area (ha) for the municipality m (Numeric);
IT_m	Indigenous Territory area (ha) for the municipality m (Numeric);
DE_m	Deforestation for the municipality m 2002-2017 (Numeric).

Table 2. Municipalities geospatial information sources.

GEOSPATIAL MAP (SHAPES)	RESPONSIBLE ENTITIES	PERIOD
Political Administrative Maps (Municipalities)	Geographic and Statistic Brazilian Institute - IBGE	2014
Legal Amazon Boundaries	Ministry of Environment - MMA	2008
Amazon Biome Boundaries	Ministry of Environment - MMA	2008
Indigenous Territories	Brazilian Environment Institute - IBAMA	2014
Protected Areas	Brazilian Environment Institute - IBAMA	2014
Deforestation	Project for Estimate the Amazon Deforestation – PRODES, developed by the National Institute of Space Research – INPE	2002-2017

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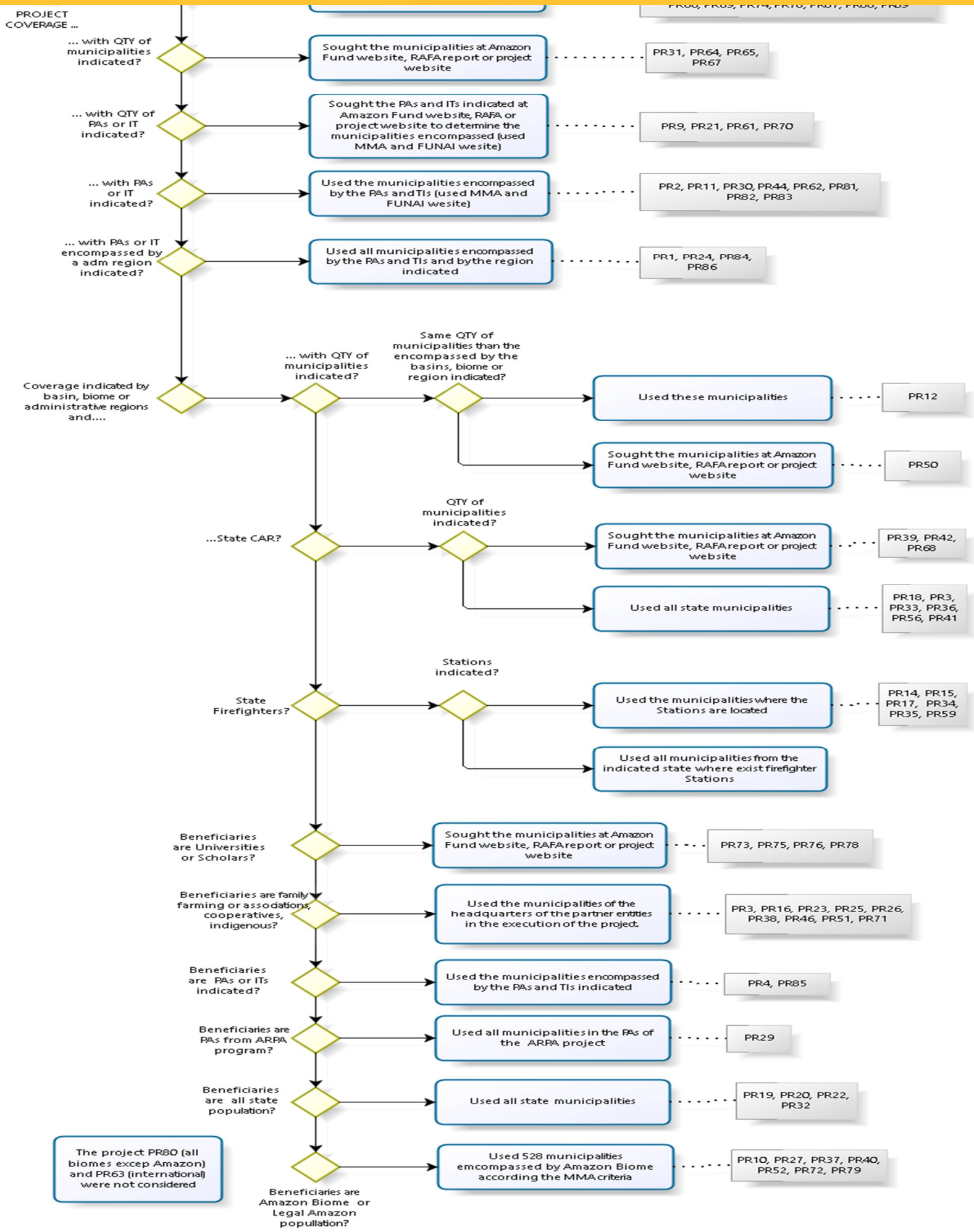

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800 **Table 3.** Municipalities Data Source.

INFORMATION	SOURCE	RESPONSIBLE ENTITY	PERIOD
Amazon Biome Municipalities	Ordinance n. 96 MMA 03/27/2008	Ministry of Environment- MMA	2008
Municipalities encompassed by Protected Areas	CNUC -Protected Areas National Registry	Ministry of Environment- MMA	2015
Municipalities encompassed by Indigenous Territories	Indigenous Territories National Registry	Indigenous National Foundation - FUNAI	2015
Municipalities from the administrative regions of Alto Acre, Baixo Acre and Purus	Acre in Numbers Report	Planning State Secretariat from - SEPLAM, state government of Acre	2013
Municipalities per Brazilian States	City System	Geographic and Statistic Brazilian Institute - IBGE	2015
Protected Areas Supported by ARPA Project	ARPA spreadsheet	Amazon Protected Areas Program - ARPA, Ministry of Environment - MMA	2015
Municipalities encompassed by State Protected Areas of Pará in the North Channel of the Amazon River	Report State Protected Areas of Para in the North Channel of the Amazon River	Institute of Man and Environment of the Amazon – IMAZON Geographic and Statistic Brazilian Institute - IBGE	2013
Green Municipalities Program of Pará	Website with the enrolled municipalities	Green Municipalities State Secretariat - SEPMV, state government of Pará	2017
Headquarters municipalities of associations and entities partners for the implementation of projects	Amazon Fund Annual Report - RAFA	National Bank of Socio-Economic Development - BNDES	2010, 2011, 2012, 2013, 2014
Municipalities encompassed by Amazon Fund projects	Amazon Fund Annual Website and annual Report - RAFA	National Bank of Socio-Economic Development - BNDES	2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017
List of critical municipalities for deforestation	Report MMA	Ministry of Environment - MMA	2014
Municipalities encompassed by Amazon Fund projects	Websites from the project managers entities	Several	2017

801 The next step for dataset structuration (step 3 in Fig. 9), is to identify the main components per
802 municipality for each project. Beyond the project information from the Amazon Fund website, each
803 project in the Amazon Fund presents a tree diagram to show their activities contribute to the main-
804 components of the Amazon Fund, which reflects their intervention logic or theory of change (see Fig.
805 13 for an example). In order to identify how the financial resources of each project were divided over
806 the main-components per municipality, we designed a second set of decision rules for determining
807 their weights, as shown in diagram 2. In this way, the following variables were added to the main-
808 component dataset (table 4):

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809 **Table 4.** Variables included in the main-component level.

Variable	Description	Formula
ω_{pmk}	Weight by project/municipality/main-component (numeric);	See table 5
D_{pmkt}	Annual disbursement by project/municipality/main-component (numeric);	$D_{pmkt} = \sum_{\substack{p=1 \\ k=1}}^{\substack{p=96 \\ m \\ t=2008}}^{\substack{k=4 \\ t=2017}} (D_{pt} \times \omega_{pmk})$
$AFInv_{pmk}$	Amazon Fund investments per project/municipality/main-component (numeric);	$AFInv_{pmk} = AFInv_p \times \omega_{pmk}$
$AFInv_m$	Amazon Fund investments per municipality (numeric);	$AFInv_m = \sum_{\substack{p=1 \\ k=1}}^{\substack{p=96 \\ m}}^{k=4} (AFInv_{pmk})$
$AFInv_{mk}$	Amazon Fund investments per municipality/main-component (numeric).	$AFInv_{mk} = \sum_{p=1}^{96} (AFInv_m \times \omega_{pmk})$

810 Variable ω_{pmk} represents the ratio of representation (%) to be applied for main-component k ($\in$
811 $\{1,2 \dots 4\}$) in municipality m that were supported by Amazon Fund project p ($\in \{1, 2, \dots, 96\}$) in
812 year t ($\in \{2008, 2009, \dots, 2017\}$). In accordance with the Amazon Fund´s theory of change, the main-
813 components include Sustainable Production Activities (k=1), Monitoring and Control (k=2), Land
814 Tenure Regularization (k=3), and Scientific and Technological Development (k=4). Monitoring and
815 Control projects are subdivided in CAR and no CAR. Finally, the Land Tenure Regularization
816 category was subdivided into activities exclusively related to indigenous territories (IT=1), protected
817 areas (PA=1), territorial and ecological zoning or land management, ($ORe g$=1), related to IT and PA
818 ($ITPA$=1), and other projects (Out=1). The formulas for these main-components are reflected in table
819 5.

820 **Table 5.** Weight calculations per main-component

k=n	Variation	Formula
k=1	No variation	$\omega_{pm1} = \frac{A_{pm} - PAi_{pm}}{\sum A_{pm} - PAi_{pm}}$
k=2	CAR, no CAR	$\omega_{pm2_{NO\_CAR}} = \frac{A_{pm}}{\sum A_{pm}} \cup \omega_{pm2_{CAR}} = \frac{A_{pm} - APi_{pm} - IT_{pm}}{\sum A_{pm} - APi_{pm} - IT_{pm}}$
k=3	$IT = 1$	$\omega_{pm3\ IT=1} = \frac{IT_{pm}}{\sum IT_{pm}}$
	$PA = 1$	$\omega_{pm3\ PA=1} = \frac{PAi_{pm} + PAs_{pm}}{\sum PAi_{pm} + PAs_{pm}}$
	$ORe g = 1$	$\omega_{pm3\ Oreg=1} = \frac{A_{pm} - PAi_{pm} - TI_{pm}}{\sum A_{pm} - PAi_{pm} - TI_m}$
	$ITPA = 1$	$\omega_{pm3\ ITPA=1} = \frac{PAi_{pm} + TI_{pm}}{\sum PAi_{pm} + TI_{pm}}$
	$Out = 1$	$\omega_{pm3\ Out=1} \frac{A_{pm}}{\sum A_{pm}}$
k=4		$\omega_{pm4} = \frac{A_{pm}}{\sum A_{pm}}$

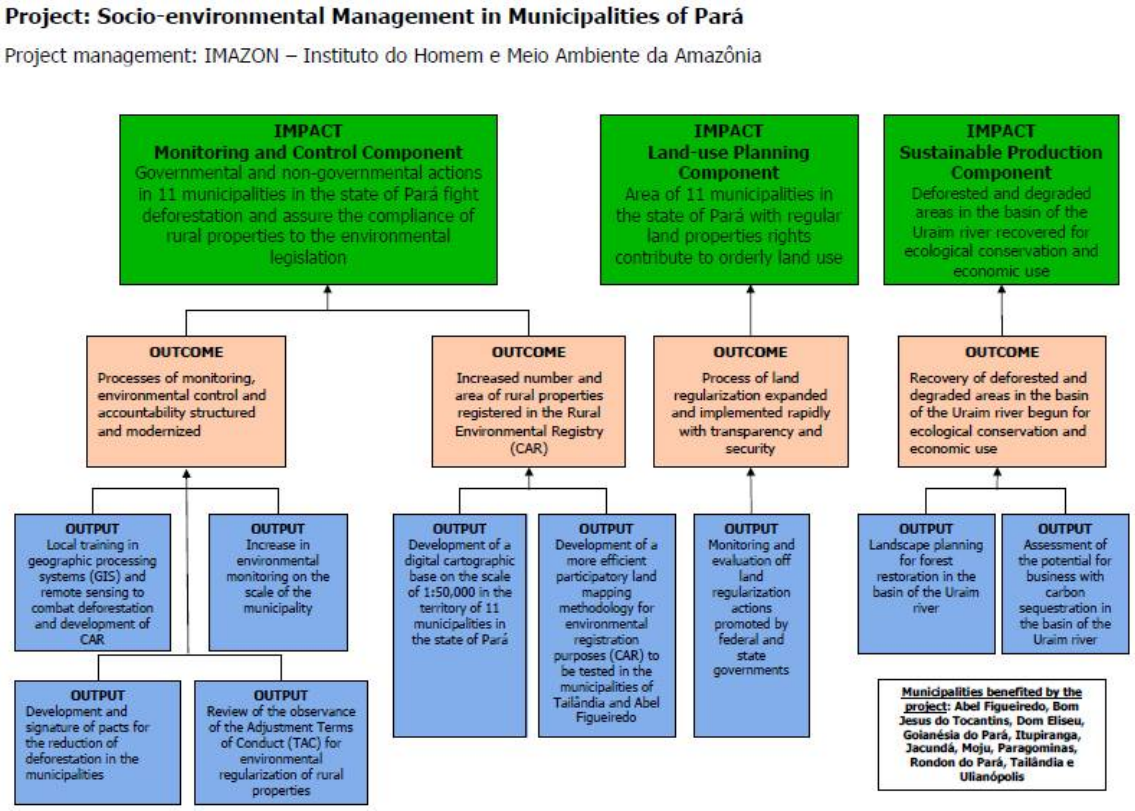
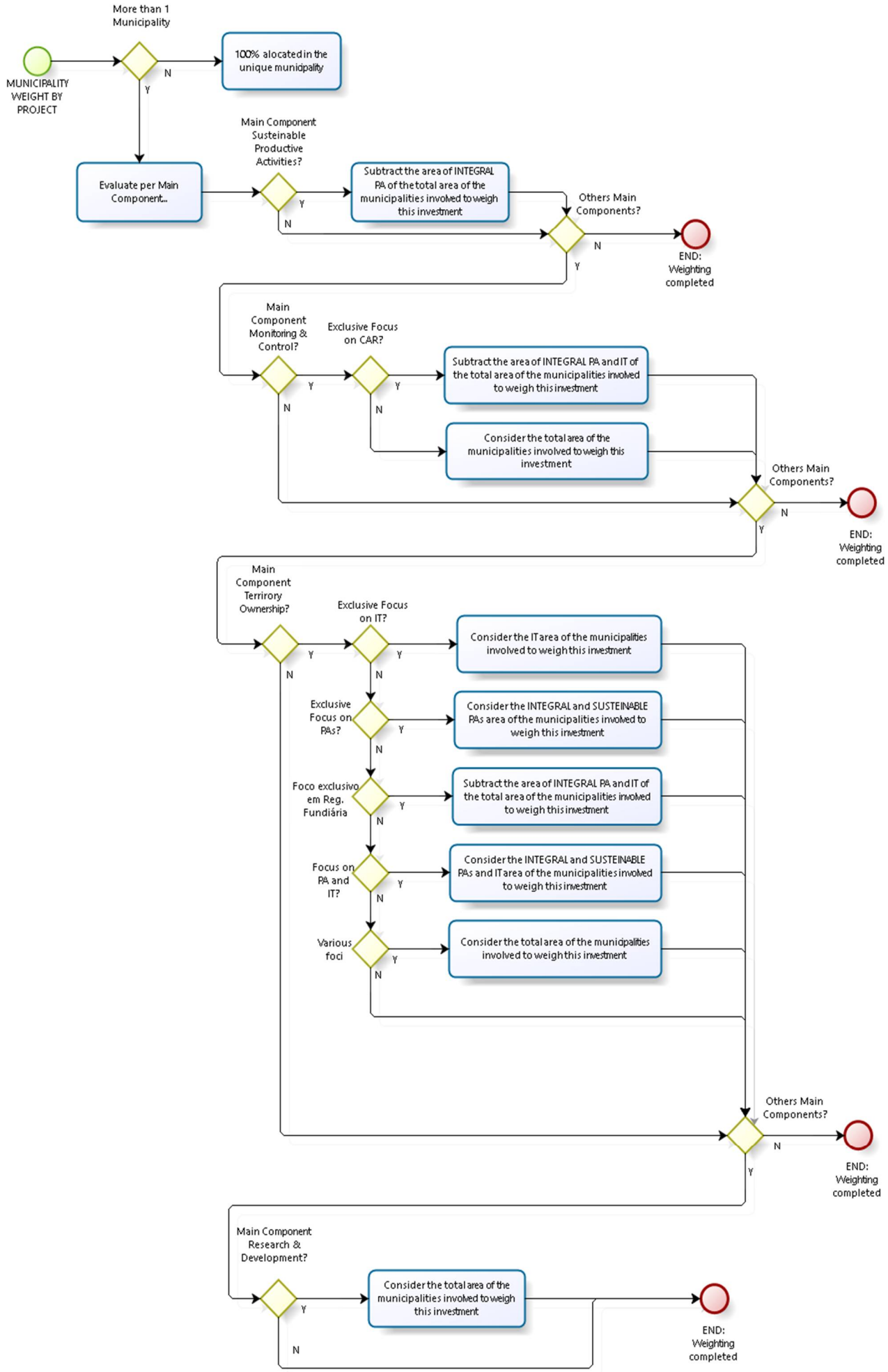


Figure 13 Project Tree.



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The final step for dataset structuration (step 4 in Fig. 9) concerns the break-down of the dataset by activity (also called specific-components). As a main-component can be composed by multiple activities, if more than one activity by main-component was verified, then the amounts was equally divided across them. The following variables were added:

Variable	Description	Formula
$FAInv_{pmka}$	Investment per project/municipality/main-component/activity (numeric);	$FAInv_{pmks} = \frac{FAInv_{pmk}}{Q}$
D_{pmka}	Annual disbursement per project/municipality/main-component/activity (numeric).	$Des_{pmks} = \frac{Des_{pmkt}}{Q}$

where Q is the quantity of activities s;

After the new rows and variables added, the final database structure now provides very detailed information on how the financial resources from the Amazon Fund were allocated to individual projects and the activities and municipalities that they support (see Fig. 14 for an impression).

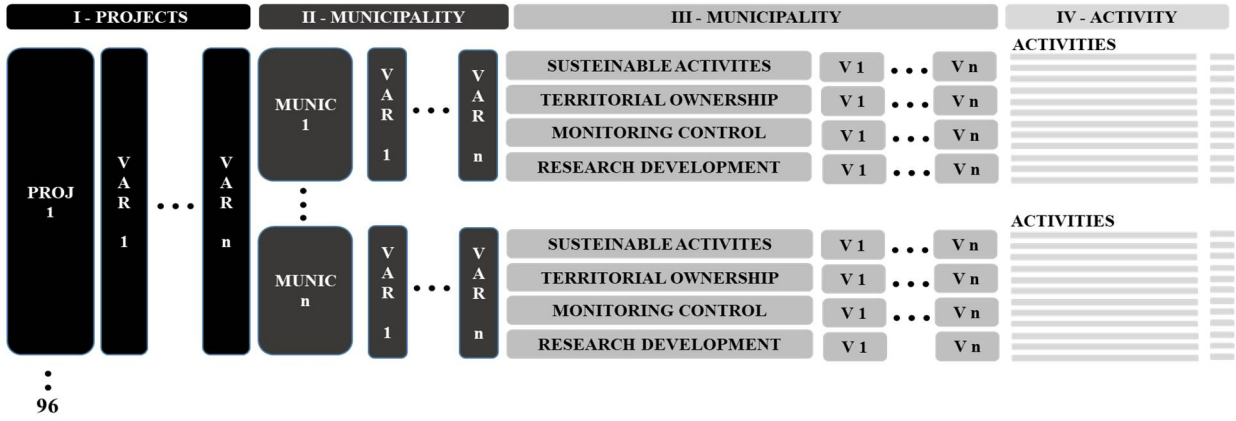
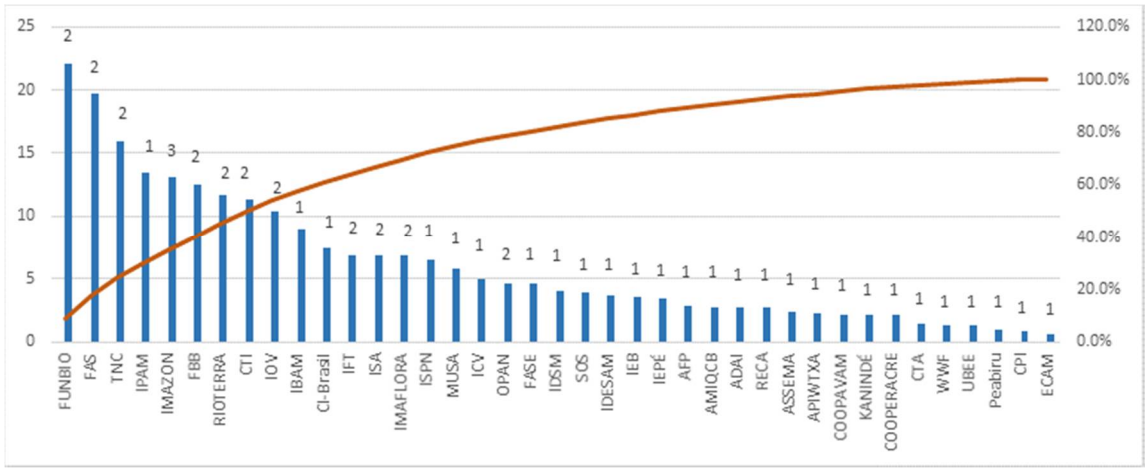


Figure 14 Final Database Structure.

Aditional graphs



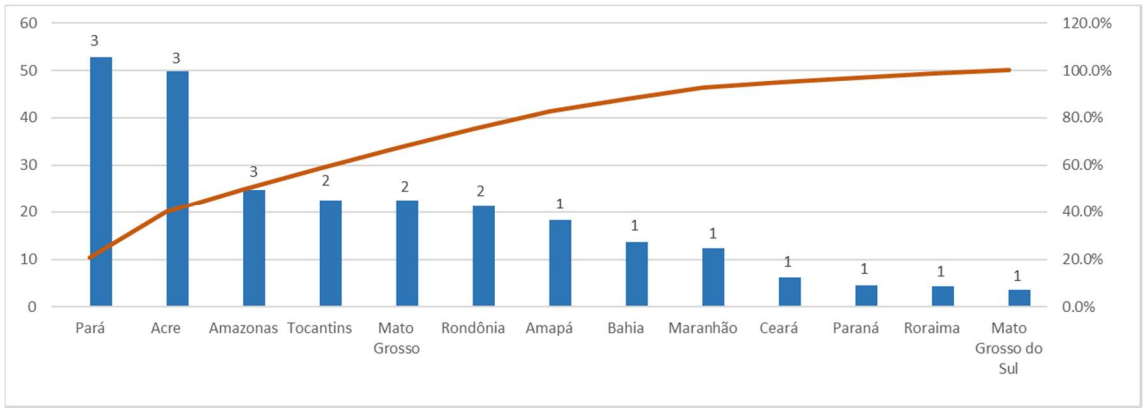


Figure 15 Pareto graft for NGO's and State projects (USD left bar and % of committed amounts right side).

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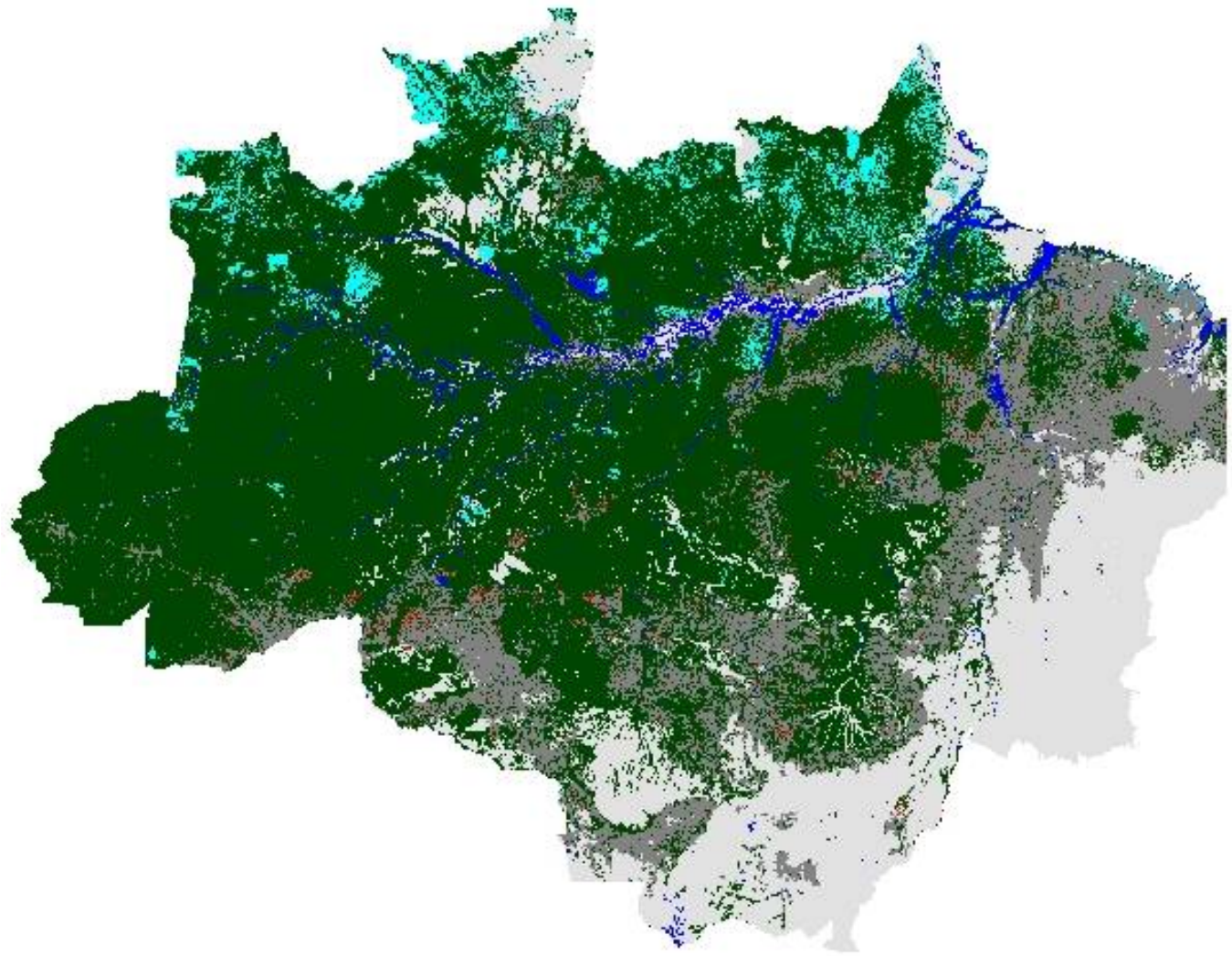

Figure 15 Deforestation in Legal Amazon, PRODES-INPE (2017).

Table 3. 10 Municipalities with the higher deforestation rates between 2016 to 2017. PRODES-INPE (2017)

Municipio	CodIbge	Estado	AreaKm2	Desmatado2017	Incremento 2016-2017	Taxa de Desmatamento 2016-2017
Nova Nazaré	5106174	MT	4042	413,6	211,6	0,511605416
Novo Aripuanã	1303304	AM	41452	1336,3	127,4	0,095337873
Senador José Porfírio	1507805	PA	14389	1040,2	98,9	0,09507787
Tonantins	1304237	AM	6619	93,4	8,1	0,086723769
Portel	1505809	PA	25425	2076,2	167,8	0,08082073
Recursolândia	1718501	TO	2230	41,7	3	0,071942446
Apuí	1300144	AM	54490	2460,2	170	0,069100073
Lábrea	1302405	AM	69672	4459,4	283,7	0,063618424
Trairão	1508050	PA	11997	1407,3	81,5	0,057912314
Medicilândia	1504455	PA	8272	2190,6	116,2	0,053044828

Limitations and considerations

Due to information gaps between the field surveys carried out by the BNDES and the information available on the Amazon Fund website, some premises are identified for the assembly of this database, as shown in Table 4.

852 **Table 4.** Research assumptions in response at divergences / limitations of data collection.

There is no value per principal component in field collection with BNDES	The value per main component from the field research at the BNDES worksheet were divided into 2 rows, inside and outside Amazon Biome	Project has more than 1 main component, with some of them ignored in the BNDES field collection	Project Name	Project Number	Author Premises
X			Sustainable Indigenous Amazon Project	2	Prorated 80% for the Main Component "Susteinable Activities" and 20% for "Terrirorial Ownership"
X			High Juruá	4	Prorated 80% for the Main Component "Susteinable Activities" and 20% for "Terrirorial Ownership"
X			Amazonia SAR	10	Prorated 80% for the Main Component "Monitoring & Control" and 20% for "P&D"
X			Value Chains in Indigenous Lands in Acre	11	100% on "Susteinable Acritivies", unique Main Component
X			Amazon Integrated Project	16	100% for "P&D", unique Main Component
			Sustainable Mato Grosso	21	Small divergence of R$0,4
		X	Banco do Brasil Foundation - Amazon Fund	26	Considering the value of the field research at the BNDES worksheet that considers 100% in the "Sustainable Activities" component, ignoring "Territorial Planning", "Monitoring & Control" and "Scientific Development" provided by the Amazon Fund website
			Agroforesty business - Jari		Project considered Canceled...
X			CAR Bahia	31	100% on "Monitoring & Control", unique Main Component
	X		CAR Tocantins	36	The prorated per Main Component was calculated considering the sum of the values inside and outside the Amazon Biome
X			Strengthening environmental management in the Amazon	38	Prorated 40% for the Main Component "Monitoring & Control", 40% for "Territorial Ownership" and 20% for "P&D"
X			Sustainable Bem Viver	44	Prorated 50% for the Main Component "Susteinable Activities" and 50% for "Terrirorial Ownership"
		X	IREHI – Taking Care of Territory	61	Considering the value of the field research at the BNDES worksheet that considers 100% in the "Sustainable Activities" component, ignoring "Territorial Ownership provided by the Amazon Fund website
		X	ARAPAIMA: Production Networks	62	Considering the value of the field research at the BNDES worksheet that considers 100% in the "Sustainable Activities" component, ignoring "Territorial Planning" provided by the Amazon Fund website
		X	Sustainable Environmental Management of Indigenous Lands in the State of Amazonas	65	Considering the value of the field research at the BNDES worksheet that considers 100% in the "Territorial Ownership" component, ignoring "Susteinable Acrivities" provided by the Amazon Fund website
		X	Strengthening Territorial and Environmental Management of Indigenous Land in the Amazon	70	Considering the value of the field research at the BNDES worksheet that considers 100% in the "Territorial Ownership" component, ignoring "Susteinable Acrivities" provided by the Amazon Fund website
X			Fruits from the Forest	71	100% on "Susteinable Acritivies", unique Main Component
X			Environmental Monitoring of Brazilian Biomes	80	Prorated 80% for the Main Component "Monitoring & Control" and 20% for "P&D"
X			Management and governance at Rio Negro Basin and Xingu - PGTAs	81	Prorated 50% for the Main Component "Susteinable Activities" and 50% for "Terrirorial Ownership"
X			Indigenous Territorial Management in the South of Amazonas State	82	Prorated 50% for the Main Component "Susteinable Activities" and 50% for "Terrirorial Ownership"
X			Consolidating Territorial and Environmental Management in Indigenous Lands	83	Prorated 50% for the Main Component "Susteinable Activities" and 50% for "Terrirorial Ownership"
X			Bolsa Floresta+	84	Prorated with same values than the Bolsa Floresta phase 1 Project
X			Valuable Forests - New business models for the Amazon	85	100% on "Susteinable Acritivies", unique Main Component
X			Communal Forests	86	100% on "Susteinable Acritivies", unique Main Component
X			Use of social technologies to reduce deforestation	87	100% on "Susteinable Acritivies", unique Main Component
X			Sustainable Tapajós	88	Prorated 90% for the Main Component "Susteinable Activities" and 10% for "Terrirorial Ownership"
X			Adding Value to Amazonian Socioproductive Chains	89	
X			Everlasting Forest	90	Prorated 90% for the Main Component "Susteinable Activities" and 10% for "R&D"
X			Sowing Rondônia	91	Prorated 80% for the Main Component "Susteinable Activities" and 20% for "Monitoring & Control"
X			Preserving the Babassu Forest	92	100% on "Susteinable Acritivies", unique Main Component
X			Forest Cities	93	Prorated 90% for the Main Component "Susteinable Activities" and 10% for "R&D"