

# **The Preservation the Amazon Forest by Clearing Property Rights Potential Conflicts: an Experiment using FFP**

**Bastiaan REYDON, the Netherlands and Brazil**

## **SUMMARY**

The burning and the deforestation of the Brazilian Amazon forest that has been highlighted recently and occurs mostly on public or undesignated land. This has been traditionally the main way to grab land, speculate and simultaneously the way to prove ownership by its occupation. The absence of mapping, registration and an effective regulation of land property in Brazil and particularly in the Amazon plays a very important role in its deforestation and the amount of this kind of land in the country.

This article, besides the Brazilian deforestations characteristics, will evidences that clear landholders rights diminishes deforestation and proposes based on concrete case of participatory clarification of land rights in forest regions using Fit for Purpose methodology helps forest preservation. The article shows an example of a methodology that clarifies the small landholders and other traditional population rights and so diminishes the its potential deforestation.

**Key word:** deforestation, land administration, participatory mapping,

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## INTRODUCTION

The burning and the deforestation of the Brazilian Amazon forest has been highlighted recently on the international press, as it plays an important role on the global climate equilibrium and on the emission of Global Warming Gases, important part of the Sustainable Development Goals (SDG).

The issue has quite some attention from the literature, in many kinds of analysis, but what has been showed<sup>1</sup> is that it occurs mostly on public land or undesignated land. This has been traditionally the main way to grab land and simultaneously the way to prove ownership by its occupation. The absence of mapping, registration and an effective regulation of land property in Brazil and particularly in Amazonia plays a very important role in its deforestation as has been showed by Reydon et al (2019).

Since this century specific policies have destinated large amounts of land to Indigenous peoples and to Protected areas, summing to about 205,8 million ha representing 24,2 % of the Brazilian surface<sup>2</sup> and are the ones that most protects the forest in Brazil. International literature<sup>3</sup>, shows that recognized property rights plays an important role in the preservation of the forests, mostly in Latin America.

This article, besides the characteristics of deforestation and of the lack of land administration in Brazil, will show examples of concrete action to clarify property rights and avoid conflicts around land in forest areas.

The article will be divided into three items that are:

- a) Deforestation in the Brazilian Amazon: quantification, importance and characteristics
- b) Evidences of the relation between deforestation and lack of clear property rights in Brazil and in the Amazon region;
- c) Concrete case of participatory clarification of land rights in forest regions using Fit for Purpose methodology to help forest preservation.

From the study it is expected to mainstream methodologies to clarify small landholders ownership and other traditional population landholders rights as well as diminish potential conflicts over undesignated public land. It also aims to find ways to improve the legislation and the institutional setting to make clarification of property rights easier and so help maintaining the Amazonian rain forest.

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<sup>1</sup> Moutinho, P., Guerra, R., Azevedo-Ramos, C. (2016)

<sup>2</sup> Se for details on the land amount for each category: SPAROVEK, G et al (2019).

<sup>3</sup> Robinson, B. E., et al. (2014).

## 1. DEFORESTATION OF THE AMAZON RAINFOREST

The persistently high levels of deforestation in the Amazon region is related to the lack of an answer to the agrarian question in Brazil, particularly the regulation of land ownership. Graph 1, based on satellite images, demonstrates that the deforestation in Amazonia in recent years is in the region of 6.4 to 7.4 million hectares, dropping to less than 5,000 km<sup>2</sup> in 2012, which represents a substantial improvement. However, it is still a high level of deforestation for a biome like Amazonian, for its biodiversity, its role in worlds climate equilibrium and as the main source of rainwater that makes agriculture with no irrigation possible in the Central and Southern regions of Brazil<sup>4</sup>.

Numerous studies<sup>5</sup> have evaluated the causes of deforestation in the Brazilian Amazon. One such study, by Moutinho et al. (2016), lists the six main factors as follows: a) The growth acceleration plan (PAC) and infrastructure works; b) growth in the demand for commodities (meat and grain); c) unsustainable policy on rural settlements (Agrarian Reform); d) inadequate application of the Forestry Code; e) lobbying by Agribusiness in the National Congress, and f) land ownership ambiguities and the existence of undesignated public forests. Margulis (2000), in more general terms, states that the main drivers of deforestation are:

- a. Increase in profits linked to the use of land in Amazonia;
- b. Accessibility of public policies and loans for the region;
- c. Installation of infrastructure for access to frontier areas;
- d. Phases of GDP growth;

For Reydon et al (2019), while not disagreeing with the aforementioned conclusions, stresses that the mechanism of Amazon deforestation is the product of the traditional form of continuous expansion of the agricultural frontier in Brazil, with the occupation of (private or public) virgin lands, the legal extraction of timber, the introduction of extensive livestock farming<sup>6</sup> and, subsequently, the development of a more modern agriculture & livestock sector. These economic activities exercise the role of generating income, legitimizing short-term occupation by new landowners, virtually without the need for resources<sup>7</sup>. In the long run, the

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<sup>4</sup> Foley, J. A. et al (2007) shows this in a very clear way.

<sup>5</sup> Moutinho et al (2016) observes that: "A vast body of literature discusses the principal drivers of deforestation in the Brazilian Amazon (Nepstad et al., 2001; Kaimowitz et al., 2004; Fearnside, 2005; Etter et al., 2006; Scouvar et al., 2008; Boucher et al., 2011; Guerra, 2014; Nepstad et al., 2014; Azevedo-Ramos et al., 2015). There is still, however, no consensus concerning which intervention was the most effective in prompting the dramatic reduction in deforestation in the region since 2005."

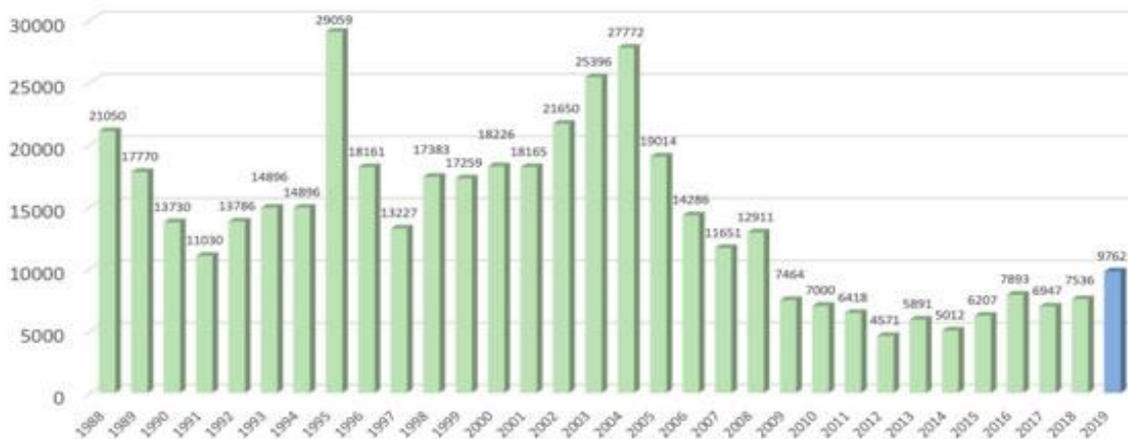
<sup>6</sup> Reydon (2011) shows that the main driver of the transformation to livestock farming is, on the one hand, the existence of a lot of vacant land capable of being expropriated, linked to the possibility of introducing livestock, at low cost, rendering deforestation an unbeatable capital appreciation strategy. A survey conducted by the National Institute for Space Research (INPE) showed that 62.2 % of the near 720,000 km<sup>2</sup> clearance of forest, was occupied by pastureland.

<sup>7</sup> It is frequently these same occupiers who make use of slave labor.

land remains with more intensive livestock farming or, if there is demand, it will be converted to cultivating grain or other economic activities.

However, what is important for occupation or deforestation is the existence of an expectation that there will be demand for this land<sup>8</sup>, to be used at some point in the future, causing its price to rise significantly. The closer it is to being used productively, the higher the land value appreciation.

Graph 1. Annual deforestation in the Legal Amazon (Km<sup>2</sup> a year)



Source: PRODES<sup>9</sup> (2020)

The macro policies as the turnarounds and the changing governments in Brazil influenced the deforestation level. After 2014, the federal government's macro policies changed towards economic austerity oriented policies. In 2016 there was a major turmoil with the impeachment or coup (depending on one's point of view) that resulted in institutional instability and the deposition of Dilma Rousseff. From 2016 onward, the austerity pattern on macro policies became more intense and, in relation to the deforestation, also coupled with a conservative push against social and environmental policies – the result is a weakened agency capacity especially through cuts in environmental, social and science related governmental branches (Petherick, 2017; Magalhães, 2017). After the Bolsonaro's election in 2018 with an anti-environmental, anti-indigenous people and pro-deforestation speech the area deforested in the Amazon increased again as can be seen in the Graphic 1.

<sup>8</sup> This is the result of increases in the price of beef, soy or even of reports that Brazil is going to be the largest alcohol producer in the world. In recent times, these factors have converged, causing the demand for land to grow even more, as well as its price, encouraging deforestation.

<sup>9</sup> INPE-PRODES (2020) Observação da Terra- A estimativa da taxa de desmatamento por corte raso para a Amazônia Legal em 2019 é de 9.762 km<sup>2</sup>in: <http://terrabrasilis.dpi.inpe.br/en/home-page/>.

## 2. DEFORESTATION AND PROPERTY RIGHTS: SOME EVIDENCES

So to diminish the deforestation in the Amazon biome, besides the more general policies that impact the whole of the Amazonian region, there is a need to fine tune the policies linked to the land ownership or responsibility. So it is important to have a clear vision of what kind of properties are deforesting in order to establish clear policies.

The only existing information are estimations based on satellite images. As can be seen in the table 2 from Moutinho (2018), deforestation occurred, until the year of 2015, mostly, where land rights were not clearly established, that is on: land with no information, federal and state land. Of the total deforestation these three categories summed in 2015 up to 37,6 % and in 2016 this participation diminished to 25,1 %. The reasons for this are not known, but as can be seen for the previous years it oscillates quite a bit.

Besides that, what is important to highlight from this table is that private landowners deforested more in 2016 reaching 2462 km<sup>2</sup>, 35,5% of the total. It is expected that all that deforestation on private properties is legal, but that is still not possible to confirm. Because in the Amazon Biome the private properties have to maintain 80 % of its property in forest as the Forest Code of 2012 established.

According to Azevedo-Ramos and Moutinho (2018), other land governance absence evidence is that currently a massive block of Brazilian Amazon forests is not under effective supervision by a designated public agency, increasing the risk of continued land grabbing. These undesignated public lands, from 2010 to 2015, represent 25% of the accumulated deforestation in Amazon forestlands.

The other important information from table 2 is that the smallest amount of deforestation happens on Indigenous land, and in all kinds of conservation units and protected areas. So it is clear that the main effort to maintain the Amazon forest is related the clearing of property rights: giving out titles to private owners, establishing clear boundaries to the indigenous peoples land and the protected areas and have a good mapped cadastre of all that to enforce the forest code and its protection rules.

**Table 2.** Deforested area in the Amazon by land title category from 2012 to 2016.

Agrarian Category	2012		2013		2014		2015		2016	
	(Km <sup>2</sup> )	(%)								
Indigenous Lands	168	3,8	170	3,2	71	1,6	62	1,2	88	1,3
Federal Conservation Unit	175	4	187	3,5	120	2,8	184	3,5	201	2,9
State Conservation Unit	117	2,7	175	3,3	174	4	233	4,4	322	4,6
Environmental Protection Areas	124	2,8	228	4,3	202	4,6	245	4,7	207	3,0

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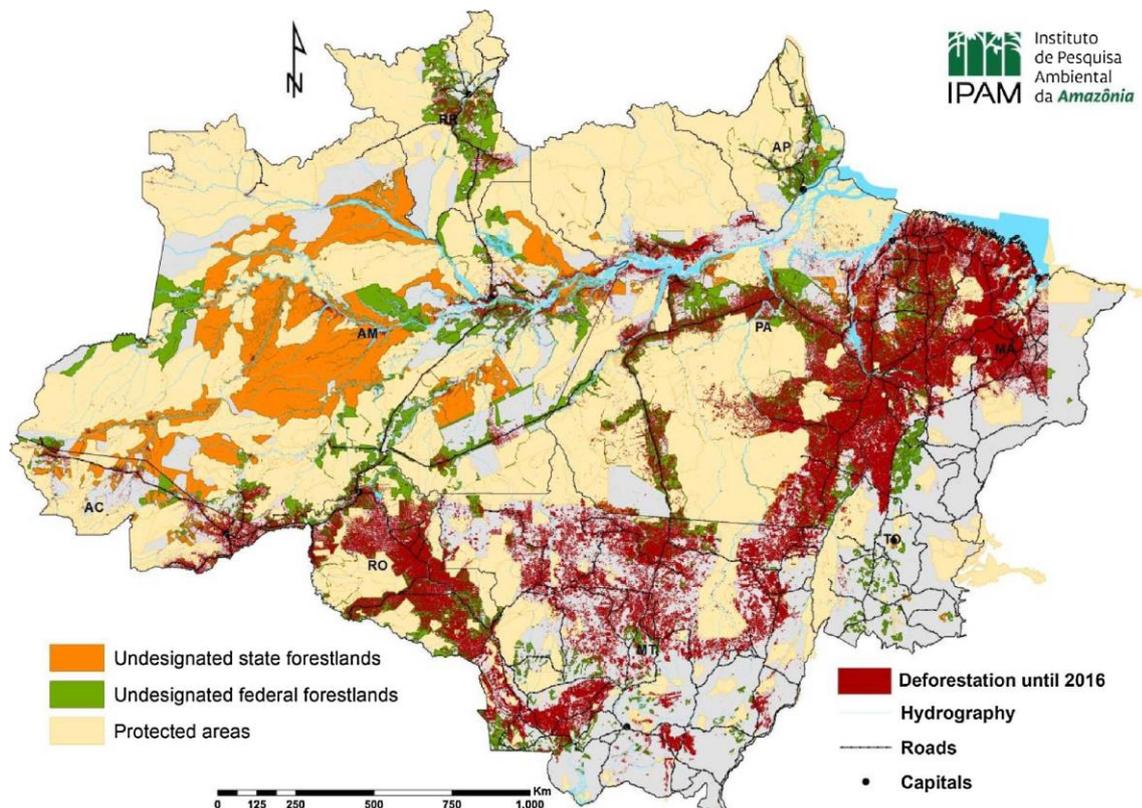
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Rural Settlements	1239	28,3	1518	28,7	1269	29,2	1437	27,3	1986	28,6
Private properties	986	22,5	1,009	0	883	20,3	1113	21,2	2462	35,5
Fedral Public Lands	574	13,1	743	14,1	584	13,4	670	12,7	855	12,3
State Public Lands	15	0,3	31	0,6	0	0	7	0,1	59	0,9
No information	982	22,4	1222	23,1	1047	24,1	1306	24,8	758	10,9
Grand total	4381	100.0	5282	100.0	5350	100.0	5256	100.0	6938	100,0

Source: Moutinho et al. (2018).

Only knowing what kind of land has been deforested is insufficient, to try to avoid more deforestation: there is a need to know the amount of land that is under risk in each of these kinds. One effort was made by Azevedo-Ramos, C., Moutinho P. (2018:125) were they stated “*What is not widely known is that 70 million hectares ha of that public land – an area nearly twice the size of Germany (Fig. 1) – remains undesignated*”. So they estimated that there are around 70 million ha that are not yet designated and that there should be a specific policy for its protection, avoiding its deforestation. But the ownership, passion or responsibility over those 70 million ha are not clearly defined in that paper. On figure 1 it can be clearly seen that these areas are mostly in rather accessible areas where deforestation happens easily. But this definition of public forests is not very precise, as it comes from the cadaster from the Serviço Florestal Brasileiro. Mostly there are people on those areas and there is a need to know what is the real agrarian situation of it land under risk of deforestation.

**Figure 1. Public forests of the Brazilian Legal Amazon and its 70 million hectares of undesignated forestlands.**



Source: SFB, 2016 apud Azevedo-Ramos, C., Moutinho P. (2018 )

Sparoveck et al (2019) using other sources and also satellite images were able to estimate the different kinds of properties existing in the total area of Brazil, showed in table 3. The table that integrates all information existing in the country makes it possible to start understanding the real Brazilian agrarian situation. One important information that comes out of the table 3, for our purposes, is that 196,056 million ha have no clear destination as they are undesignated and unregistered land<sup>10</sup>. So those are the areas that are mostly under pressure for occupation, conflicts and deforestation. So the clearing the ownership rights of these area is very important to avoid new problems.

**Table 3. Area and number of units of Brazilian land tenure categories.**

Land tenure category	Area (ha)	%	Number	%
Indigenous Reserves	112,412,239	13.2%	600	0.0%

<sup>10</sup> Public lands that have not been designated to a final use. Sparoveck (2019) findings differs from the 65,5 million ha of undesignated forest lands in the Amazon found by Azevedo-Ramos and Moutinho (2018) due to the hierarchy rules adopted, where Forests type B have a low level of priority and are classified as other categories. Forests Type B are Federal or States lands covered with forests which final designations have not been decided yet. They are under the administration of the Brazilian Forest Service (SFB). Besides that the Sparoveck (2019) estimations are relative to the whole country. But surely most of the undesignated and unregistered land is the Amazon region.

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Conservation Unit <sup>11</sup>	93,403,026	11.0%	1,337	0.0%
Communitary Territory	1,779,373	0.2%	815	0.0%
Military	3,006,965	0.4%	104	0.0%
Rural Settlement	41,736,096	4.9%	7,547	0.2%
Undesignated lands	54,599,607	6.4%	22,016	0.5%
<i>Total Public Land</i>	306,937,306	36.1%	32,419	1%
Private property from CAR <sup>12</sup>				
Small	83,400,520	9.8%	3,805,698	79.0%
Medium	42,077,338	4.9%	167,537	3.5%
Large	48,366,589	5.7%	34,779	0.7%
Private property from SIGEF <sup>13</sup>				
Small	12,700,175	1.5%	206,070	4.3%
Medium	41,551,394	4.9%	110,830	2.3%
Large	134,531,227	15.8%	62,677	1.3%
Private property from Terra Legal Program	9,830,630	1.2%	116,854	2.4%
Quilombola Territory	3,117,971	0.4%	378	0.0%
<i>Total Private Land</i>	375,575,843	44.2%	4,504,823	94%
Unregistered land	141,454,569	16.6%		
Transportation network, Urban area and Water bodies	26,310,500	3.1%	280,692	5.8%
<b>Total Brazil</b>	<b>850,278,218</b>	<b>100.0%</b>	<b>4,817,934</b>	<b>100%</b>

Source: Sparoveck (2019)

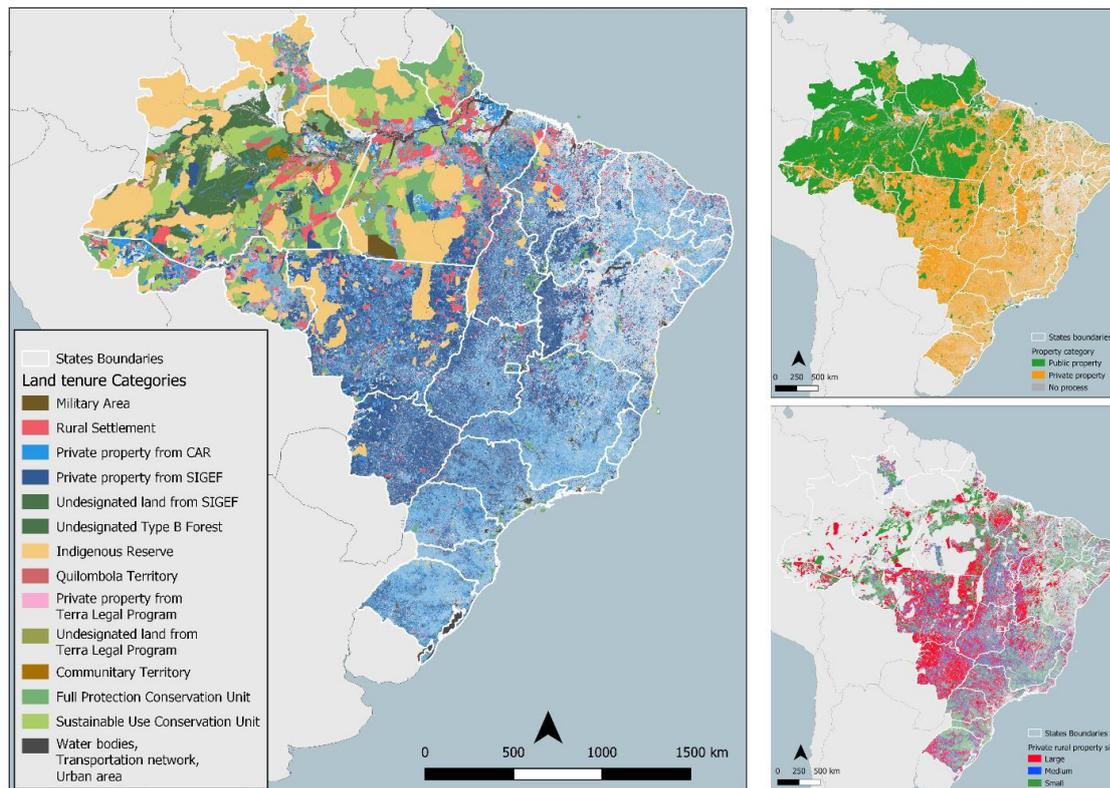
To have an idea of its location the best way is to look at the map 2 below where most of those areas are in the Amazon region. So what is clear is that the need of clear property rights and a good land administration system plays a very important role in protecting the forests.

## MAP 2. - Image of the Atlas of Brazilian Agriculture

<sup>11</sup> We excluded APAs from the conservation unit category. APA (area of environmental protection) is a type of conservation unit of sustainable use which may occur in areas of public or private domain that allow human occupation and economic activities, including intensive agriculture. Its creation does not imply on expropriation of private land ownership. It sums 44 million ha. Its inclusion would confuse interpretation of land ownership and overlaps as it necessarily coincides with other land tenure categories.

<sup>12</sup> Cadastro Ambiental Rural (Rural environmental registry).

<sup>13</sup> Sistema de Gestão Fundiária – INCRA (Land tenure management system from INCRA).



**Source:** Atlas da Agropecuária Brasileira – IMAFLORA, 2019.

### 3. WHY GOOD LAND ADMINISTRATION REDUCES DEFORESTATION

In Reydon et al (2019) it was possible to show that lack of a good land administration system in Brazil is a large problem and plays an important role in deforestation.

Araujo et al (2009), when analyzing the Brazilian Amazon rainforest, finds that insecure property rights have a positive impact on deforestation in the period 1988-2000 and, therefore, guaranteeing clear and secure rights on rural land ownership could decrease or avoid future deforestation.

In the same vein, Assunção et al (2015) calculates avoided deforestation in the same region through public policies coordinated between various levels of government and shows that in the period 2004-2009 about 59% of the predicted deforestation was avoided for this reason.

Finally, a meta-analysis study (Robinson et al, 2014), made with more than 118 published articles, contributes to the conclusion that land tenure security is significantly associated with lower rates of deforestation, adding that this occurs regardless of the specific land access regime (tenure, property, customary systems, etc.).

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In Brown et al (2016), through a very different approach, the authors analyze the effects of land occupation on deforestation in Brazil, reaching the conclusion that, in an environment of low security of property titles and policies that value land deforestation relative to land with forest, occupations have a direct influence on deforestation, including occupations in a given municipality affect deforestation in adjacent areas.

More than one analyzed study deals with the forms of governance of forests and indigenous communities and their impacts on deforestation. Blackman et al (2017), analyzes one of these cases in Peru and concludes that the titling of these communities reduced deforestation by two thirds in a period of 2 years after the program.

Fernandes (2018) showed, with systematic review methodology<sup>14</sup>, that improvements in Land Governance has very important proven positive impacts on economic development, more specifically on the next economic aspects: a) production, productivity and access to credit; b) diminishing of poverty c) dynamization of land markets. But also has large impacts on women's rights over land and on the environment protection (deforestation and erosion decrease).

Reydon et al (2019:8-9) concluded that:

*Land governance will not solve the problem of deforestation in Amazonia, but it is a prerequisite<sup>15</sup> for addressing the problem. As for the vacant lands, registration, by permitting the State to identify and control them will make inappropriate private appropriation and deforestation very difficult. It will also make it possible to use these vacant lands in the execution of agrarian policy in Brazil, through organized colonization, agrarian reform and others.*

*On private land, effective, participative governance will, based on knowledge of the actual situation, allow for a discussion of priorities for use and adequate enforcement, planning and regulation of soil use. Moreover, through zoning and other compulsory tools, it will prevent deforestation and will certainly limit land speculation, which is the main cause of deforestation.*

In conclusion Reydon et al (2019) proposed that what is needed to diminish rain forest deforestation, mainly in the Amazon, but also in other regions is:

- a. an improvement in the Land Administration/Governance System, mostly the cadaster and register systems (CNIR, SIGEF, SINTER, CAR and others) so that every landholder can be identified.

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<sup>14</sup> Systematic review methodology consist in: “[...] studies which synthesize [sic] all the existing high-quality evidence using transparent methods to give the best possible, generalizable statements about what is known” (WADDINGTON et al, 2012, p. 360).

<sup>15</sup> Taking the payment for environmental services and land governance as a pre-requisite as an example, Robinson et al. (2014) in a seminal article about land tenure and forest conservation, argues that: “However, in light of PES programs and REDD, where future incentives are tied to particular land use-based outcomes (e.g. maintain forest), the security of tenure is crucial to influence landholders’ decision-making. (...). Therefore, security is necessary to prevent deforestation through market-based conservation mechanisms, but alone does not necessarily protect forests.”

- b. The regularization of ownership similar to the Terra Legal has to be continued and amplified to public land that are under the States responsibility.

The main existing argument is that the areas are too big and with the existing technology is not possible to identify all right holders rights in the Amazon region. The next item is showing a case in Colombia where these rights were clarified and the possibility of preservation of the forest enlarged strongly. In this region the Fit for Purpose methodology was used in a very creative way.

## **4. LAND RIGHTS CLARIFICATION CASE: AN EXAMPLE USING FFP FOR AREA UNDER DEFORESTATION PRESSURE**

### **4.1. Introduction**

As showed before ,forests areas are mostly based on a mixture of different property rights, from different state levels rights, passing through many communal rights, private rights and others and so it needs a strong interventions to solve the controversies and establish clear rights in a participatory way. For that an important analytical step was done with the creation of the Fit for Purpose methodology that Ennemark et al (2014:6) proposed as:

*“the approach used for building land administration systems in less developed countries should be flexible and focused on citizens’ needs, such as providing security of tenure and control of land use, rather than focusing on top-end technical solutions and high accuracy surveys.” A fit-for-purpose approach includes the following elements:*

- *Flexible in the spatial data capture approaches to provide for varying use and occupation.*
- *Inclusive in scope to cover all tenure and all land.*
- *Participatory in approach to data capture and use to ensure community support.*
- *Affordable for the government to establish and operate, and for society to use.*
- *Reliable in terms of information that is authoritative and up-to-date.*
- *Attainable in relation to establishing the system within a short timeframe and within available resources.*
- *Upgradeable with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities.*

*A country's legal and institutional framework must be revised to apply the elements of the fit-for-purpose approach. This means that the fit-for-purpose approach must be enshrined in law, it must still be implemented within a robust land governance framework, and the information must be made accessible to all users.*

## **4.2 Background to the case of Cumaribo in Colombia<sup>16</sup>**

The Santa Teresita del Tuparro Indigenous Protected Area is located in Cumaribo, Vichada. It was constituted as a special reserve by INCORA through resolution 206 of 1978, in this resolution they specify that the reserve has an area of land of 180,000 Ha. For the year 1983, resolution 047 is issued in which they confer the character legal guard. The boundaries of Santa Teresita are specified in the resolution, most of these are artificial boundaries, such as rivers and pipes. However, in the southern area of the shelter the boundary described says "following the course of the reel that connects Gaviotas with Santa Rita", which spatially is not exact. This is what brought in problems, insecurity and conflict over land as different landholders/owners were claiming the same land. With that the pressure over the land and the risk of deforestation increased largely.

A first meeting was held with leaders of around 30 communities from the resguardo Santa Teresita del Tuparro. They indicated that they have been losing land of their ancestors to the military base and farmers that are on the borders of the reserve. They showed old maps they had kept from the constitutions of the reserve (figure 2). A meeting with the colonies (the farmers) was also held where they stated that they all have official papers of their parcels and that the indigenous are invading their land.

A map with the parcels in the current cadastre was used to identify the conflict and the actors in the area. However, the cadastre does not show the reality, there is no overlap and therefore does not help to understand the real land dispute. Therefore, to understand the dispute on the southern boundary of the indigenous reserve Santa Teresita del Tuparro and the adjacent parcels of farmers (colonos), the situation was mapped using the Fit for Purpose methodology.

In figure 2 can be seen the location from the Cumaribo municipality, the area of the indigenous peoples protected area, the measurements done using GPS antennas of Trimble (R2) by the Indigenous leader and the other stakeholders.

## **4.3. The images and field work**

As the idea of the FFP method is to measure parcels as efficient as possible, optical and radar images were obtained and reviewed to see to what extent they could be used. Some of

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<sup>16</sup> This part is very much based on Molendijk, M; Reydon, B (2020). report from project Land and Peace in Colombia.

the official titles that were found stated that the road that goes south of the reserve is the boundary of the reserve. However, looking at the reality nowadays, there is not only one road. There is a network of at least 20 informal ways running south of the reserve. Therefore, satellite images or orthophotos could not be used in this case and so it was necessary to let these boundaries be indicated in the field itself.

### *Field data collection*

For this process step standard software is used, the Esri Collector App. Parameters in this app are set in such a way that the data collection can be done according to the Colombian definition of LADM. The project team has tight connections to the development team of the collector app in order to discuss bugs and functional demands, but on this part the project does not develop software component by itself.



Figure 2. Pictures from the Indigenous land reservation area and of the application of the methodology

Also points where there is a change of neighbour of parcels and points that cannot be seen in the images had to be measured in the field. Many boundary points of the parcels were small landmarks in the field that were put there by the farmers themselves. These landmarks were not visible on the images and could only be measured in the field. Other limits of the parcels could be indicated by satellite imagery. Images as Google Earth and Esri Imagery have been used to globally indicate where the boundaries of the parcels are. Often creeks are dividing the parcels and the approximate stream of these creeks could be seen on the image. The points that were taken in the field were measured with GPS antennas of Trimble (R2). These antennas give a sub metric accuracy since it has a correction in real time, based on a satellite connection (RTX correction). With these antennas, the main points were measured to construct the parcels.

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The boundary of the indigenous reserve Santa Teresita was indicated by one of the elders of the reserve Horacio Bonilla. He was present when the reserve was constituted, and the boundaries were set. A group of Kadaster/ITC and the Universidad Distrital followed the indications of where the limit passed according to the indigenous leader and measured the points with GPS. There were no specific landmarks, but the indigenous used visual objects in the field, like streams or trees to define the boundary.

Other groups of the project went to measure the surrounding parcels that were in dispute with the reserve. The focus of the measurements with the farmers was on the northern boundary of the parcels, the part that is adjacent to Santa Teresita. However, the whole parcel was measured to be able to identify other issues with the parcels. The land holders indicated the limits of their parcels which were also measured by GPS. Using all the measured points and the visible streams on the images, a map of the parcels and reserve was made.

Besides the spatial data, also personal and legal data on the land holders was collected with the ESRI app that was developed for that aim. Personal data was taken, with pictures of the ID and the people themselves. Legal data was taken by describing the history of how the person had obtained the parcel with date and adding pictures of all the formal and informal documents that the land holder possessed.

Part of the exercise was digitalizing the titles that existed. Of the parcels that were measured in this pilot, 4 of them had a registered title. These documents were digitalized by reconstructing the textual description of the boundaries that was found in the titles. In case that there was a usable map, this map was georeferenced using visual objects that could be seen in the satellite image. Without guaranteeing a high precision, all these parcels could be reconstructed.

At the same time Trimble phones were used in order to test whether these devices could be used without an external GNSS antenna. The devices are very rugged and very appropriate for using in rough terrain. However they turned out not to give sufficient precision, compared to Colombian standards.

#### *Post-processing of field data*

With the collector app parcels are measured as closed polygons. This implies that each common parcel boundary was measured twice. ITC en Universidad Distrital developed dedicated software for post-processing. With this software double collected boundaries can be combined to one common boundary, taking into account the precision of the measurement of the collected boundary points.

#### **4.4. Public Inspection**

Some days after the measurements in the field, the Public Inspection was held in one of the local churches in Cumaribo. At this event the indigenous leaders and the owners of the surrounding parcels were invited to discuss the results of the measurements. Using all the information that was collected with the app.

The dispute between the indigenous and farmers was visualized by showing them the maps (figure 3 and 4) of the measured parcels. A large overlap of sometimes 500 hectares between the reserve and the parcels was displayed. The fact that there was now real and accurate data on the perceived limits helped to show what is exact part of the land that the dispute was about.

The fact that the given titles were causing the problem made the local parties understand that the land dispute is not caused only by themselves but is part of a bigger problem. As a result, some indigenous leaders and farmers came together to try to solve the dispute.

All this information was officially submitted to the Department of Indigenous Affairs of the Agencia Nacional de Tierras in Bogotá, but until this day they have not responded to the matter. After showing the measured parcels, the parcels that were reconstructed by the titles were shown. This revealed that these titles were already claiming overlapping land. The state, in this case INCORA/INCODER, gave out the same piece of land to the indigenous, to the military base and to the farmers.

From all this the rights were clearer, the communities were happily engaged in fighting for their rights and with that surely the areas would be more protected.

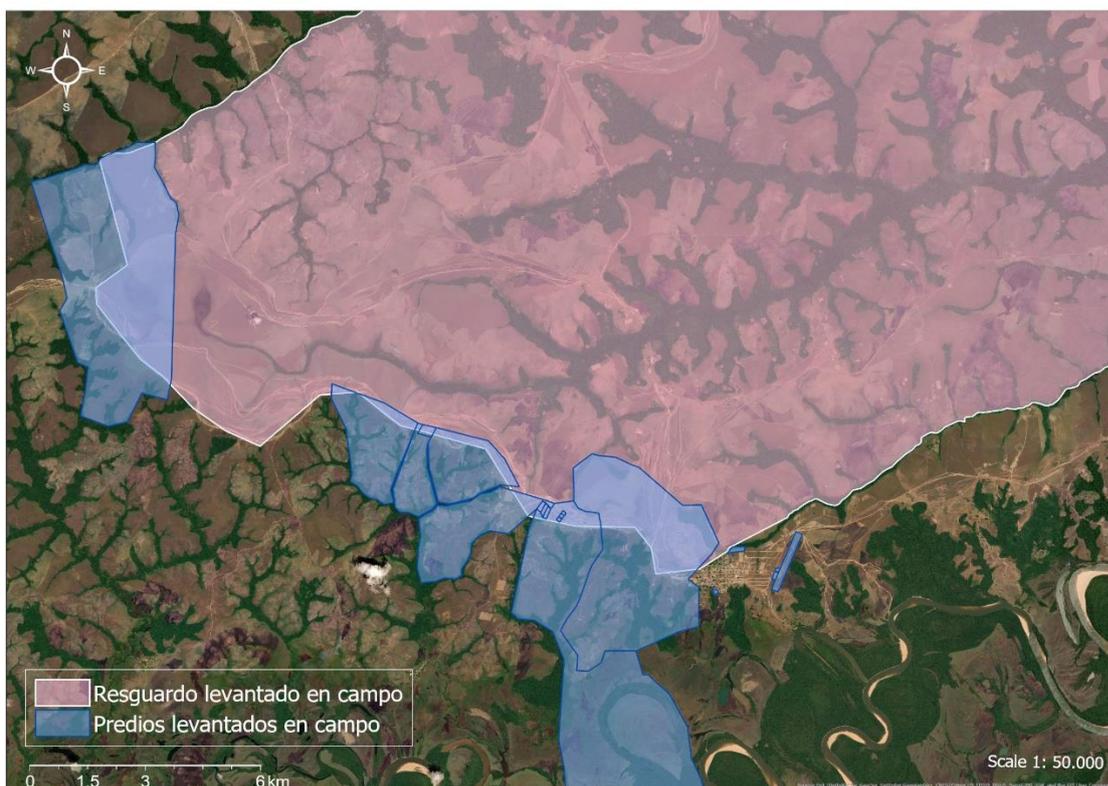


Figure 3. Georeferenced map from the resguardo Santa Teresita del Tuparro with the overlapping measured parcels.

## FINAL REMARKS

As the burning and the deforestation of the Brazilian Amazon forest and other rain forests in the world plays such an important role on the global climate equilibrium and on the emission of Global Warming Gases, its control plays an very important role in this moment in which the Sustainable Development Goals (SDG) have to be achieved.

The article started showing that the deforestation in the Amazon has grown again in 2019 and that it occurs mostly on public land or undesignated land. Based on new studies it was possible to show that in the Brazilian these kinds of lands sums up to near 200 million ha, about 25 % of the Brazilian surface. Not all of that is in the Amazon region or with forest on top of it, but in the Amazon region it is the type of land that is grabbed, deforested and use for speculative reasons.

After that the article evidenced based on case studies form international literature that clear property rights is essential to the preservation of primary forests all around the globe. The article concluded by showing one case of participatory clarification of land rights in forest regions using Fit for Purpose methodology to help forest preservation.

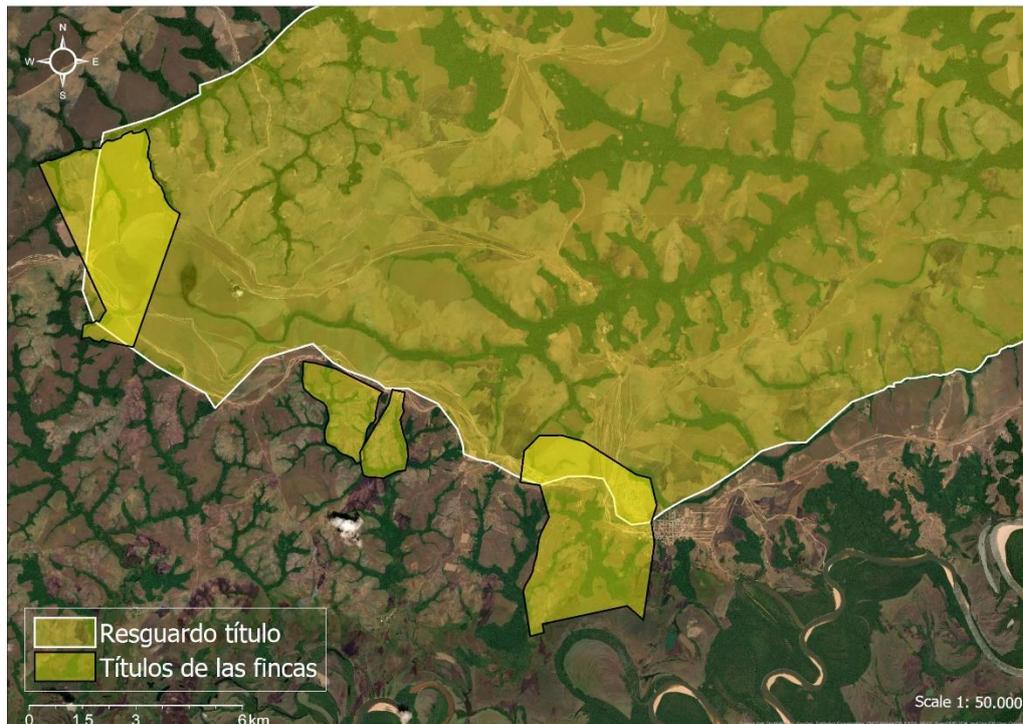


Figure 4. Legal map showing the titles overlapping from its concessions.

From the study it is expected to mainstream methodologies to clarify small landholders ownership, traditional population landholders rights as well as diminish potential conflicts over

undesigned public land. It also aims to find ways to improve the legislation and the institutional setting to make clarification of property rights easier and so help maintaining the Amazonian rain forest.

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