

Modelling Brazilian Indigenous Tribes Land Rights with ISO 19152 LADM

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Key words: Legal, ISO 19152 LADM, Brazilian Indigenous Tribes Land Rights, Spatial

SUMMARY

The issue of indigenous land rights is a particularly pressing political and socio-economical issue in contemporaneous Brazil. Violent land disputes between non-indigenous land ownership and indigenous with overlapping claims to land rights is a complex problem. It has been caused by the bureaucratic and slow process of land adjudication that generates insecure property rights leading to the violent land disputes. Another problematic issue on indigenous land is the deforestation process. Motivated by such pressing framework, and using the experience and results obtained in a previous paper on indigenous forest rights in India, where a recent Act of law defined the situation, the initial team of authors has grown to include Brazilian land administration experts.

This paper aims to define the indigenous land rights in Brazil, as described under various laws having the same legal power, under the framework of ISO 19152 Land Administration Domain Model, with an emphasis on the spatial dimensions of the definitions.

The existing international legislation on indigenous land rights, by ILO and the United Nations, is referred as a basis for the national legislation enacted in Brazil.

This background review of existing international and national legislation framework supported the following step of establishing the legal sources and definitions for a number of core LADM classes, concerning the Parties, Legal & Administrative and Spatial Units components. The descriptive text is then complemented with UML diagrams. This is a fundamental step in defining an LADM specialized model for the situation of indigenous land rights in Brazil. From this first description, a context Use Case (not currently part of the LADM standard) is displayed.

Finally, some conclusions and recommendation regarding future research are presented. It is expected that the publication of the situation of indigenous land rights by using the LADM framework, as presented here for Brazil, and previously for India, can contribute for enlarged discussions by land administration experts worldwide. This is one of the first initiatives (for Brazil) in the use of a specialized model, and in the future can be expanded in order to achieve the modelling of other types of spatial units and related rights, until an multipurpose LADM_BR is reached. It can be equally used to test implementation prototypes, using current or experimental geographic information technologies and spatial databases.

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1. BACKGROUND

The Amazon has the largest area coverage of rainforests on the earth. A large part of these forests come under the national boundary of Brazil. In recent decades, especially during 1970's, under the military rule, economic drive expansion reached the northern and western parts of Brazil while penetrating the Amazon. The Brazilian Census 2010 counted 896,917 people who declare to be indigenous in about 305 ethnic groups, speaking 274 different languages. Officially recognized by the government (Decree #22/91 and Decree #1775/96), from the total indigenous population, almost 517,000 (57.7%) lives within indigenous land. 94.9% of this indigenous population, lives in rural areas. Around 379,000 (42.3%) lives outside the indigenous land and 78.74% of this population lives in urban area (IBGE, 2010). The habitats are spread across Brazil but are mostly concentrated in and around Amazon region. The expansion of economic motives brought many of these ethnic groups in direct conflict with the people who were pursuing their own economic interests on the land historically claimed by these ethnic groups.

In the late 1980's, Brazil became a democratic country and adopted a new federal constitution. The Federal Constitution of 1988 recognized the cultural plurality of indigenous people's social organizations and the collective character of these people. The constitution also conferred upon them permanent land rights. To really effectuate this constitutional protection, the indigenous lands have to go through an amount of regularization steps to reach the final legal and administrative situation (see Figure 3).

Santilli (2010) illustrates from ISA 2009 data the legal and administrative situation of the indigenous land before the Federal Constitution (1988) and in 2009. According to the author, before the Federal Constitution of 1988 there were 402 indigenous land parcels from which 182 were approved or regulated, and in 2009, the total of indigenous land were 634 and the approved or regulated were 431, representing an increase of 57.7% of the total indigenous land and 136.8% of the approved or regulated in 2009. D'Agostino (2013) said that unofficial report from FUNAI in May 2013 elevated the total indigenous land parcels to 672 and the approved or regulated indigenous land parcels to 440.

The Indigenous land regularization in Brazil is a bureaucratic and slow process. Some of the indigenous land such as the Marãiwatsédé (Xavante tribe) located in the Northwest of Brazil had the land claim for decades. The Marãiwatsédé land claim of 165,000 hectares started in 1960, the indigenous land was declared in 1992 (FUNAI Legislation #9/92), demarcated from 1993-98 after land conflict with non-indigenous (7 thousand people approximately) and 22 latifundiários (large farmers) living inside the land claimed by the Marãiwatsédé be solved. The President signed the approval (homologação) in 1998. In 2005, INCRA started to record the families of non-indigenous for expropriation, in 2007 Ministry of Justice determines the expropriation

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process (desintrusão) which only started in 2012. The regularization finally finished in January 2013 (Marãiwatsédé, 2013).

Violent land disputes between non-indigenous land ownership and indigenous with overlapping claims to land rights is a fact that cannot be hidden. Another problematic issue on indigenous land, caused by third parties, is the deforestation process.

This paper aims to define the indigenous land rights in Brazil, as described under various laws having the same legal power, under the framework of ISO 19152 Land Administration Domain Model, with an emphasis on the spatial dimensions of the resources involved and the rights claimed over these resources.

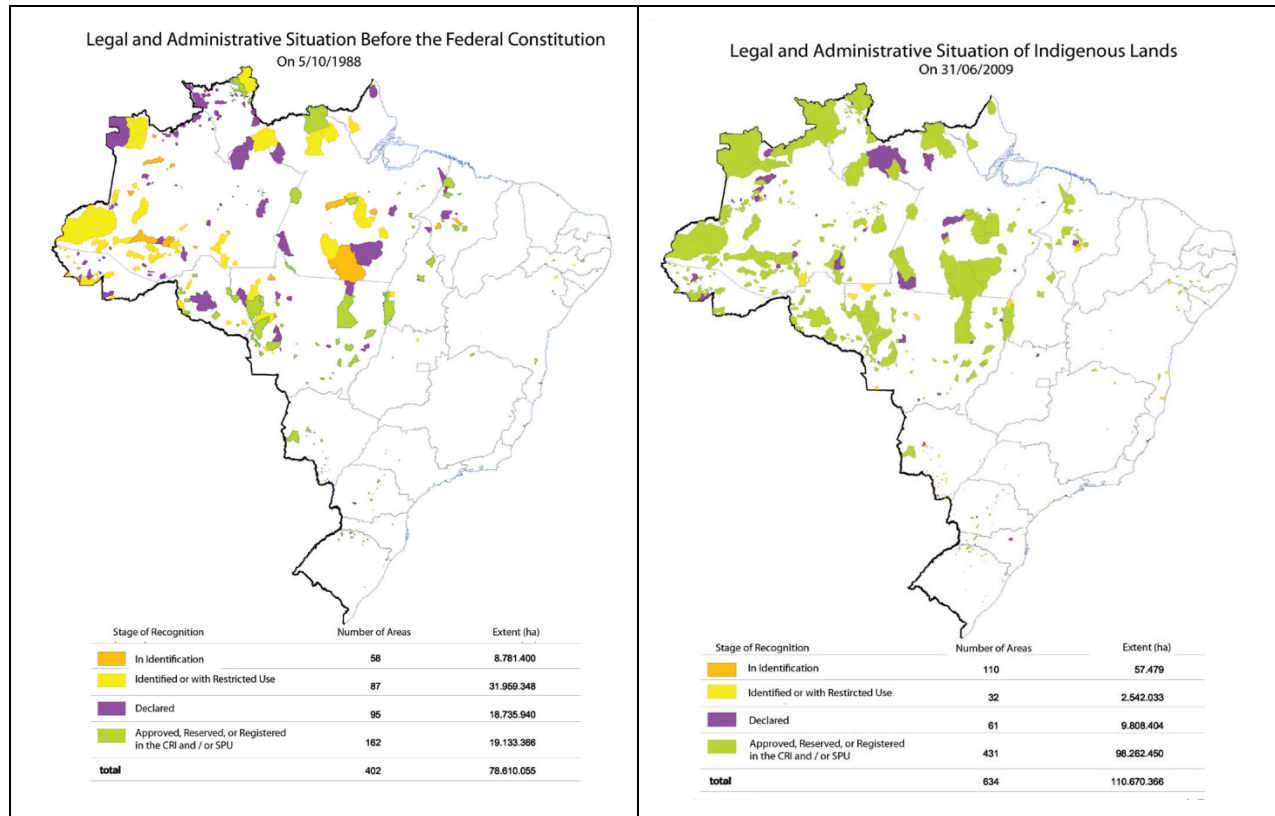


Figure 1: Changes in Legal and Administrative Situation pre and post Federal Constitution of 1988
Source: Marcio Santilli, 2010

2. INDIGENOUS INTERNATIONAL LEGISLATION

According to International Labour Organization (ILO) Convention 169 (ILO, 2003), elements for the indigenous and tribal people's land protection include recognizing traditional land rights of ownership and possession in individual and collective modes.

In what concerns natural resources pertaining to the indigenous' lands, the Article 15 of the ILO Convention 169 highlights that they shall be safeguarded. These rights for the indigenous people

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include use, management and conservation of these resources. Article 6 of the same Convention says that, before licenses are granted for the timber exploration and exploitation, provision shall be made for the Act concerning the administration of public forests (ILO, 2010). The 2007 UN Declaration on the Rights of Indigenous Peoples (UNDRIP) re-enforced the ILO Convention 169 with regard to land rights.

3. DEFINITIONS UNDER VARIOUS BRAZILIAN LAWS

The ISO 1952 International Standard defines a reference Land Administration Domain Model (LADM) covering basic information-related components of land administration (including those over water and land, and elements above and below the surface of the earth). It provides an abstract, conceptual model with four packages related to parties (people and organizations), basic administrative units, rights, responsibilities, and restrictions (ownership rights), spatial units (parcels, and the legal space of buildings and utility networks), spatial sources (surveying), and spatial representations (geometry and topology). It provides terminology for land administration, based on various national and international systems, that is as simple as possible in order to be useful in practice. The terminology allows a shared description of different formal or informal practices and procedures in various jurisdictions provides a basis for national and regional profiles; and enables the combining of land administration information from different sources in a coherent manner (ISO 19152:2012, Geographic Information-LADM, 2012).

The following sections define the Brazilian definitions (and respective legal sources) for a number of core LADM classes, concerning the Parties, Legal & Administrative and Spatial Units components. The descriptive text is then complemented with UML dynamic (Use Case and Activity) and static (Class and Object) diagrams.

3.1 Indigenous Tribes / Ethnic Groups (LA_GroupParty)

The identification and definition of ethnic groups is a dynamic social process. FUNAI follows the criteria of both self-declaration and consciousness of indigenous identity and their acceptance by the ethnic group, based on ILO Convention 169. The Decree #5051/2004 and Indigenous Statutes (“*Estatuto do Índio*”, Law #6001/73) fully comply with the ILO Convention.

Article #1 of Decree #5051/2004 defines Indigenous Tribes within an independent country, according to the set of social, cultural and economic conditions which can distinguish them from other sectors of the national collectivity.

Law #6001/73 (Indigenous Statute) defines an indigenous as any individual of pre-Colombian ascent which identifies itself and is identified as belonging to an ethnic group with cultural characteristics which distinguish him / her from national society.

As clarified by (Batista, 2008), to be an indigenous, the individual or tribe does not require different biological characteristics, a traditional language or a *modus vivendi* (implies an accommodation between disputing parties to allow life to go on) according pre-Colombian cultural patterns. The self-identification to an indigenous community is the key to this definition, according to archaeologists, historians and anthropologists.

The following list clarifies the key concepts about indigenous identification:

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- Pre-Colombian ascent: not based on race. As genealogy is difficult to prove, this resides in an historical link perceived within the group.
- Self-identification: the anthropological criterion. A social organization where the individuals recognize they belong to; only the tribe or ethnic group can define who is or isn't part of the group.
- Cultural patterns: do not define the group, rather they are a product which varies in time and space.

The Federal Constitution of 1988 does not define criteria for indigenous identity, but only establish competence for the State to define the boundaries of indigenous lands and guarantee the basic rights of indigenous people.

To the reported 305 ethnic groups counted during the Census 2010, 274 different languages have been identified (IBGE, 2010). The isolated indigenous, who are claimed to never had contact with non-indigenous are unknown; no one knows for sure who they are, where they are, how many and what languages they speak. FUNAI under the Department of Isolated Indigenous estimates that the majority is still living in Amazon. Besides, there are a number of groups in process of being recognized their indigenous nature.

As an example of the big diversity of ethnic groups, a few are referred below, grouped into linguistic families (ISA, 2000):

- Tupí: Tupí Guaraní, Arikém, Awetí, Jurúna, Mawé, Mondé, Mundurukú, Puroborá, Ramaráma e Tuparí.
- Macro-Jê: Jê, Maxakalí, Krenák, Yathê, Karajá, Ofayé, Guató, Rikbaktsá e Boróro.
- Other languages: Guarani, Kayapó, Maku, Nambikwara, Tiriyó, Waiwai e Yanomami.

3.2 Nodal Agencies (LA_Party)

Having as starting point to identify the land administration and management stakeholders, those government agencies which can be involved in the settling of land disputes in indigenous lands, the following Table 1 was produced (Paixão, 2010):

Table 1 – List of involved governmental agencies and respective existing cadastral system

Purpose/ Category	Agencies	Cadastral System
Environmental	IBAMA/ SFB/MMA	CNFP, CAR
Agrarian	INCRA	SNCR, CNIR
Public lands	*FUNAI, *SPU	STI, SIAPA
Legal	*Land Registry Office	

* Mandatory agencies in the indigenous land regularization

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The following paragraphs identify the agencies through the acronyms provided in Table 2, their foundational decree (or law) and main aim.

***National Foundation for Indigenous Affairs (FUNAI)** was created with the establishment of the Indigenous Statute (Law #6001/73) with the responsibility to promote and protect indigenous people and ensure protection of indigenous lands. It also develops national strategies related to group's way of life, development and integration with society. To support judicial and administrative processes of land demarcation, land regularization, land control and land planning, FUNAI created the *Traditional Land Cadastre (STI, "Sistema de Terras Indígenas")*.

***Secretary of Federal Assets (SPU)** works with public lands that are occupied but without legal ownership ("terras sem dono"). They belong, by definition, to the National Commonwealth whether they are administered by federal or provincial agencies. To help administer these public lands, SPU created the *Integrated System for Patrimonial Management (SIAPA)*. The goal of the SIAPA is to identify and register public lands; it includes identification of the landholders who have legal occupancy.

***Land Registry office** is a notarial system (although operated privately); it is composed of autonomous registries which are controlled by the Ministry of Justice, which also creates technical regulations to standardize legal transactions. The Civil Code states that property rights do not exist if the property is not registered (Melo, 2006).

Land Reform Institute (INCRA) is the agency nominated to operate the rural cadastre system in Brazil, including rural properties which only have rights of occupation ("posse"). The *National Rural Cadastre System (SNCR)* was created by Law #5868/72 and also required a declaratory description for fiscal purposes. Currently, SNCR is the agrarian regularization cadastral system used to support land distribution and land reform in Brazil. *National Cadastre for Rural Properties (CNIR)* was created in 2001 by the new legislation for geo-referencing rural properties (Law #10267/01), but it has not been implemented. CNIR is a multi-purpose cadastre that will integrate legal (tenure information), fiscal (value information) and agrarian (land use and management) and environmental (protected areas) databases.

Brazilian Ministry of the Environment (MMA) has a mission to promote the adoption of principles and strategies for the protection and restoration of the environment; for the sustainable use of natural resources. *Cadastre of Rural Environment (CAR)* was created in 2012 by the Law #12651/12 (Art. 3 and 55 of the New Forestry Code) under MMA responsibility. Indigenous land will be recorded in the CAR with the purpose to control the agro-forestation exploration and the management of water resources in these preserved areas. Once implemented, CAR will carry also information of the regulated indigenous land. This is another important system to be integrated with CNIR once it will be implemented.

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3.2.1 Use Case Context for Nodal Agencies

The UML Use Case Diagram in Figure 2 defines the context for the Cases of Surveying and Registering Indigenous Lands, showing the main Actors intervening in such Cases. The respective Information Systems are equally shown, along with the associations to the Actors responsible for their use and update. These are the Actors defined as having management functions, and all of them were identified and described in the preceding paragraphs about the Nodal Agencies. The context is ascribed to Indigenous (Land) Rights; this way the Actors and the Systems dealing with private property outside federal lands holding indigenous tribes, being it rural or urban, were left out from the diagrams.

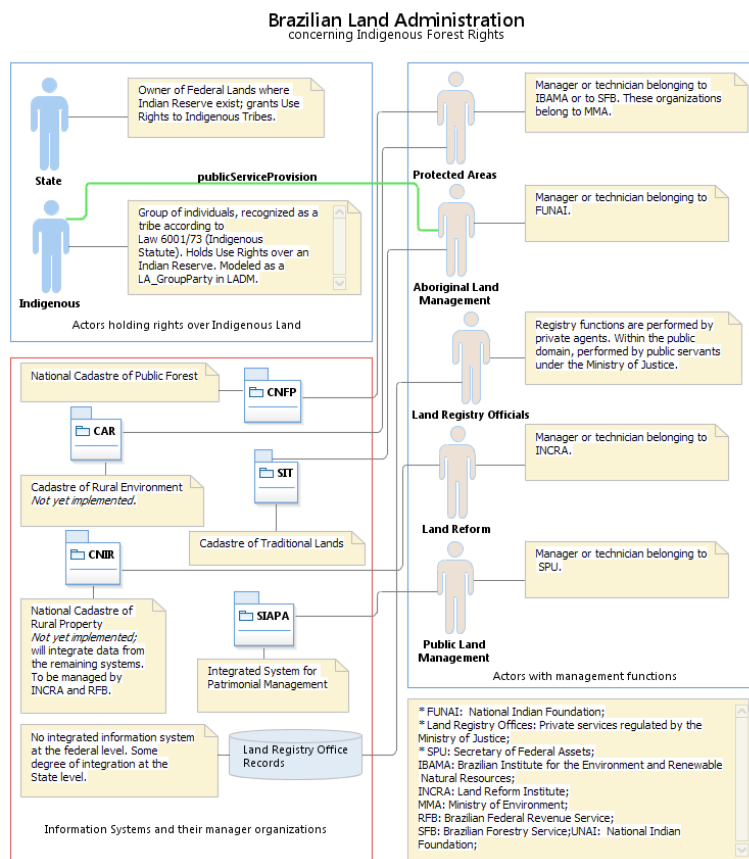


Figure 2 - Context for Indigenous Forest Rights (UML Use Case)

3.2.2 Indigenous Lands Demarcation Procedure

This administrative procedure is considered the key in the modeling of Brazilian Indigenous Lands, and follows from the Use Case context diagram in Figure 2. The high level modeling depicts the fundamental steps at the Spatial Unit and Administrative components, as an UML

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Activity Diagram (Figure 3). The procedure has several decision points and synchronization steps, shown by the forks and joins. There are also a number of administrative documents and legislative steps at different levels of government, which must be fulfilled in order to finally register (the legal situation) and cadaster (the set of elements defining the Spatial Unit or Units). These last steps are done both at the public (SIAPA system) and private under Ministry of Justice domains.

This Activity Diagram describes the actual situation and does not represent a proposal for the future CNIR integrated system, neither an even higher level of integration. The different activities set the requirements for a number of LADM classes, and further classes can be identified after specifying a first level of detail, in particular covering the “Physical Demarcation” action (Figure 4).

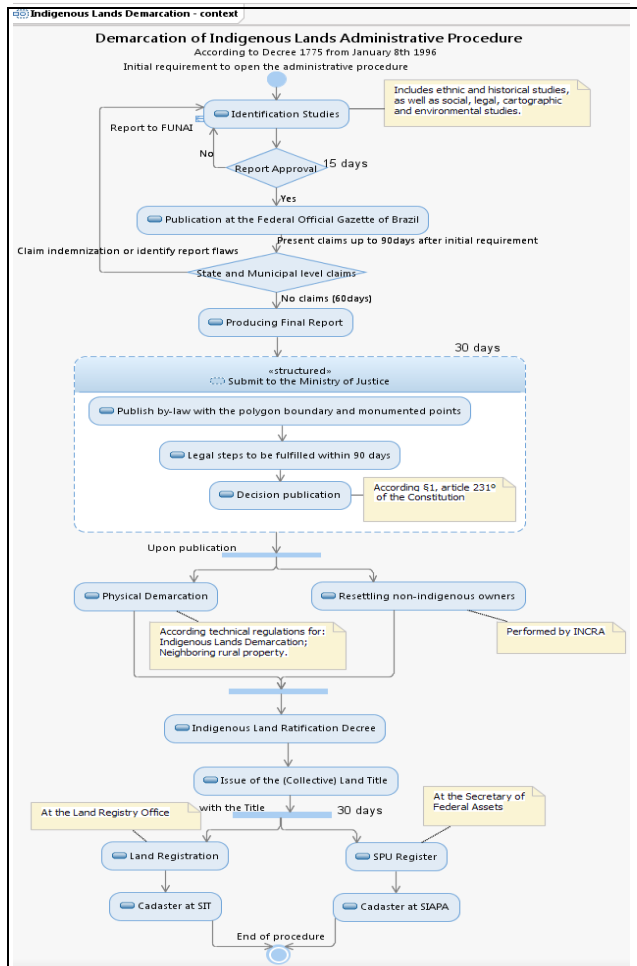


Figure 3 - Indigenous Lands Procedure (UML Activity)

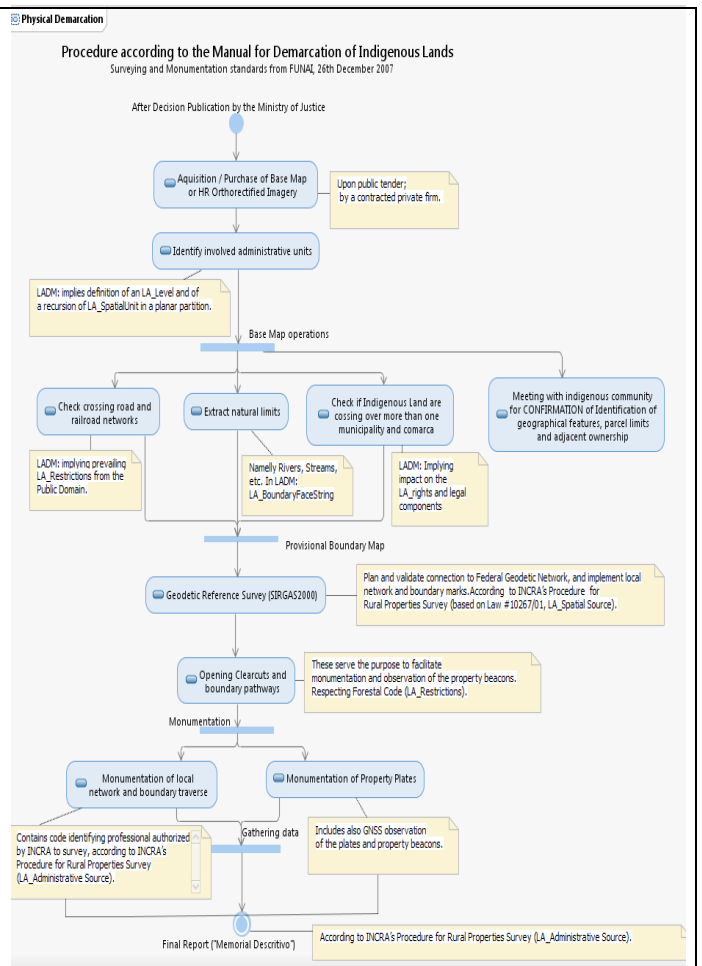


Figure 4 – Detailed Indigenous Physical Lands Demarcation Procedure

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3.3 Tribal Land (LA_SpatialUnitGroup)

Almeida et al. (2005) comment that based on the Brazilian Constitution of 1988 and Law #6001/73, the usufruct of indigenous lands is an exclusive of individuals belonging to an ethnic group. Use rights such as fishing, game or harvesting are forbidden to non-indigenous, as well as farming or mining activities.

Table 2 - Phase of the Indigenous Land Regularization Process by May 2013

Phase of the Indigenous Land Regularization Process	Number of Indigenous Land	Description
Lands in Study	115	Anthropological, historical, land tenure, cartographic and environmental studies are conducted to support the delimitation of indigenous land.
Delimited	30	Indigenous land which had studies (above) published in the Federal Official Gazette of Brazil (<i>Diário Oficial da União</i>) by FUNAI and are under review by the Ministry of Justice for the issuance of a Declaratory Ruling of the Traditional Indigenous Possession.
Declared	51	Justice Minister declares to the exclusive use rights for the indigenous and lands are authorized to be demarcated. The Declaration Statement is made after approval of the study by FUNAI and proves that indigenous lands are traditional (this step is considered as the landmark of regularization).
Approved (Homologada)	12	Land has already been demarcated and had their boundaries limits approved by the President but is not yet registered.
Regulated	428	Lands are fully regularized with registration in the Land Registry Office under the nomination of the Federal Government and at Federal Heritage Service through the Secretary of Federal Assets - Ministry of Planning (SPU), having already gone through all the steps above.
Indian Reserve	36	Lands donated by others (third party), acquired or expropriated by the Federal Government. The Indian Reserve should not be confused with the traditional ownership. They are not subject to the procedures previously described
Total	672	

Source: FUNAI - Unofficial Report in May 2013

The Article 231 of the Brazilian Constitution of 1988 mentioned that indigenous lands are inalienable and unavailable, and imprescriptible to the natural resource preservation. As Hutchison et al. (2005) comment, it also reinforces the pre-existing rights of indigenous people to their traditional lands, independent of its official recognition by the government.

Unofficial data from the National Indian Foundation (FUNAI) published in June 2013 reported that from the 672 indigenous lands recorded in the institution, 115 is still to be studied to identify

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the size of the land that will be demarcated, 428 indigenous lands are regulated (D'Agostino, 2013), see Table 2. The study and delimitation phases are made by a technical working group composed by technical staff from FUNAI, INCRA and / or the local State Land Institute.

Data from PRODES 2010 – Deforestation Survey of Amazonia, shows that the top 20 of deforested indigenous lands are occupied by third parties (mainly soya farmers) or under pressure of lumbermen. As an example of such lands one can cite Apyterewa and Alto Rio Guamá (State of Pará), Awá and Araribóia (State of Maranhão) or Maraiwatsede and Kayabi (State of Mato Grosso). All of them are fully registered at the SPU and the land registry office.

3.4 Habitat / Villages (LA_SpatialUnitGroup)

The Indigenous Statute (Law #6001/73) defines that Federal Lands can be delimited in any part of the territory, where possession and occupation by indigenous groups is recognized. Here, they can live and obtain means of subsistence, with use and usufruct rights to the natural resources within. These Federal Lands can assume any one of the following types:

- a) Indigenous Reserve - An area to be used as the habitat of indigenous groups, having the sufficient means of subsistence.
- b) Indigenous Park - Area under indigenous possession, in which their degree of integration allows Federal assistance in economic, educational and health means, while preserving flora and fauna and the natural landscape of the region.
- c) Indigenous Agricultural Colony - Area used for the development of agricultural exploration (farming and livestock), administered by the indigenous affairs organization (presently, FUNAI). These colonies have a mixed settlement of indigenous groups and non-indigenous individuals.
- d) Indigenous Federal Territory - It is an administrative unit directly under Federal Administration of the “União Brasileira”. It is required that, within this unit, at least a third of the population is indigenous.

3.5 Legal Component; Rights (LA_Rights)

Indigenous lands are the property of the Federal Government but the rights include usufruct, covering the riches of the soil, rivers and the lakes existing therein (Brazilian Civil Code Art. #43, I; Indigenous Statute (Art. #44). The usufruct rights cover thus the cutting of wood, fishing and hunting and overall, the right to exploit the natural resources existing in these lands.

The property right detained by the Federal Government is not applied to the full extent as defined in civil law, giving that it is abdicating of the enjoyment and fruition covered by such property right. This is done by conferring (derived) rights of permanent possession and exclusive usufruct to the indigenous communities.

3.6 Restrictions (LA_Restrictions, Administrative Servitude)

Art. #231 of the Constitution, on mining rights, states that it is possible for a third party to acquire such use rights in indigenous lands, provided an approval has been given by the community and the National Congress.

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According to ISA (2000), there are a number of legal conditions to be obeyed in order to commercially use forestry resources in indigenous lands. Such commercial activities must obey, at first hand, to the related environmental legislation. This legislation includes the Forestry Code (Law #7754/89 revoked by Law# 12651/12), which imposes a series of restrictions seeking for the sustainability of forestry operations and forbids the cut and selling of certain tree species. The indigenous can grow plantations, clear cut the forest for farmland (“roças”) and build villages, even in permanent preservation areas as defined by the Forestry Code.

Law #11460/2007 forbids the growth of genetically modified organisms in indigenous lands.

The Constitution establishes a clear distinction in the legal process to be applied to industrial mining and to traditional mining (“garimpo”). Mining by third parties obeys to specific conditions; on the other hand, traditional mining by third parties over indigenous lands is completely forbidden. The Mining Code (Decree-Law #227/67) defines precisely what the techniques are and which types of minerals shall be considered “garimpo”, and what is considered industrial mining (“lavra”).

The Constitution (Art. #176) says that the property of ore deposits, under industrial mining or not, and remaining mineral resources including hydraulic power generation, constitute property that is different from that of the soil, regarding their exploration and use, and belong to the Union (Brazilian Federation), being granted to the concessionaire the products of the mining process.

Law #7805/89, regulating the regime of traditional mining (“garimpo”), explicitly states in Art. #23 that the permit obtained through this law is not applicable to indigenous lands.

As referred in the previous section concerning rights, indigenous groups hold usufruct over Federal Lands recognized as Indigenous Lands, and thus are allowed to hunt and fish (amongst other use rights), provided those activities are for their own use and as means of subsistence. However, if there is a commercial purpose in such activities, then they are restricted through the environmental legislation. Environmental Crime Law #9605/98 exempts from environmental crime penalties traditional activities of hunting, fishing and minerals extraction.

Forests within indigenous land can only be exploited by the indigenous themselves, and complying with a sustainable handling. The New Forestry Code (Law #12651/2012) defines *sustainable handling* as the management of forest resources in respect of the ecosystem sustainability mechanisms. This includes, jointly or as alternatives, the use of multiple woodland species, multiple flora products and sub-products, or other forestry goods and services.

3.7 Responsibilities (LA_Responsibilities)

According to ISA (2000), the preservation of environmental resources in indigenous lands is fundamental to assure the survival of future generations, as well as to maintain possession and control by indigenous communities over activities and projects developed in their lands. The indigenous groups shall promote the economic and environmental sustainability, not being dependent from any third parties in doing so.

The Indigenous Statute (Art. #8) states the nullity of any juridical business between indigenous and third parties which are harmful for the indigenous, or where their harmful effects are unknown to the indigenous, due to cultural differences.

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According to the Decree #1141/94, actions related to environmental protection to maintain the physical occupancy of aboriginal tribes and their culture are related to:

I - Environmental Assessment, to report on the situation as a basis for required interventions;

II - Recovery monitoring and control, for areas where a process of degradation of natural resources has been in place;

III - Environmental control over activities potentially or effectively modifying the environment, even those developed outside the boundary of affected indigenous lands;

IV - Environmental education, adapted to the indigenous communities and non-indigenous communities in their surroundings, with the aim to protect the environment of indigenous and adjacent lands;

V - Identification and transfer of indigenous and non-indigenous technologies which are considered appropriate from the environmental and anthropological points of view.

3.8 Source (LA_SpatialSource, LA_AdministrativeSource)

For the rural cadastre, the establishment of the Law #10267/01 is the benchmark. There are three key elements that should be highlighted in the Law #10267/01 (Carneiro, 2003):

- Creation and operation of CNIR (the new integrated cadastre) under INCRA and RFB responsibility – It is a multipurpose geographic cadastre available to public and private users;
- Establishment of the geo-referencing requirement for the CNIR - It is a unique document identifying parcels using the geographical coordinates referenced to the Brazilian Geodetic System. Traditionally this has been the South American Datum 1969 (SAD69). Since 2004 the Geocentric Reference System for the Americas (SIRGAS2000) has been designed to replace SAD69 and is currently in implementation;
- Information interchange of INCRA (rural cadastral system) and Registry office (land registration) - The responsibility of the registry office is to report to INCRA on a monthly basis all changes to real property records. This information will then be entered into CNIR, making a well defined and regularly updated cadastre and avoiding the need for periodic updating exercises.

FUNAI Law # 14/96 established some rules for the report of land identification and delimitation, which includes:

a) a decree signed by the president, appending the indigenous land information, has an effective declaration of federal government land ownership. After its registration at the registry office, no private ownership can be claimed upon the referred area;b) the concept of "lands traditionally inhabited by the Indians" are based on areas "inhabited by them on a permanent basis"; areas "used for their productive activities"; areas "essential to the preservation of environmental resources necessary for their well-being"; and areas "for its physical and cultural reproduction, according to their uses, customs and traditions";

c)The Decree #1775/96 represented in Figure 3 states that the demarcation process shall start with an Anthropological report supported by ethnic-historical, sociological, cartographic, and environmental and land tenure diagnostics. Indigenous people shall participate in all steps of the

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demarcation process. In case of land claim, third parties must provide evidences of their occupation for further compensation.

FUNAI Law #3/12 regulates the issuing of the administrative certificate (“Atestado Administrativo”) and the boundary survey declaration (“Declaração de Reconhecimento de Limites”) documents, which refer to the location of the rural parcel related to indigenous lands.

This legislation establishes that a copy of the report of the boundary limits surveyed under the Law #10267/01 and maps requested to be sent to INCRA for the Rural Property geo-referencing System (future CNIR system) should also be sent to FUNAI. The administrative certificate aim is to certify the geographic location and shape of third parties parcels, in relation to formalized indigenous lands or under a delimitation procedure. The boundary survey declaration aims to supply, to owners of rural parcels, a mere certification that boundaries with adjacent Federal Lands and with permanent possession granted to indigenous people are respected.

3.9 Indigenous Lands Class and Object Diagrams

The preceding sections defined the broader context of the components to be considered for the modelling of indigenous forest rights, within the Brazilian Land Administration System. In this section, the focus is centered on the structural components needed by FUNAI in order to record the results of the demarcation procedure (shown in Figure 3 and 4). This leads to a specialized LADM based model using the specifications in (ISO, 2012), to be considered in a future version of the existing STI traditional lands system.

The class diagram in Figure 5 reflects the current modelling stage, and is thus incomplete. From the LADM point of view, it makes a simplification and does not consider the division into different packages. It also simplifies the legal component, showing just the main (derived) right which is held by the indigenous tribes. Specific restrictions and responsibilities should be taken into account, given that a fully regulated Indigenous Land is registered both at the public (SIAPA) and private (Ministry of Justice (Land Registry Offices)) domains. Resulting from this last fact, other type of spatial units shall be considered, namely those which impose public regulations on the environment.

3.9.1 Indigenous Forest Rights Class Diagram

The correspondence of the specialized classes (showing the “BR” prefix for Brazil) with the LADM is explicitly shown by the generalization associations. Most of the elements were preserved from the domain model, and changes correspond to new attributes, new code lists and restricted cardinalities amongst associations. Due to the narrow focus of the model, only FUNAI is represented as a Nodal Agency, having a “stateAdministrator” role in relation to the Administrative Source documents. The indigenous community is represented through a specialization from the LA_GroupParty. A specialized LA_Right class, called BR_IFRight, defines the fundamental right held by the indigenous community over the indigenous lands. The specialized Basic Administrative Unit BR_STI Unit keeps a record of this and (possibly) other rights and restrictions, in association to the indigenous community (the subject side) and the Spatial Unit(s) (the object side). This last one is represented by the BR_IndigenousLand class,

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4. SPATIAL DIMENSIONS OF INDIGENOUS RIGHTS IN THE FEDERAL CONSTITUTION 1988

The act does not explicitly mention about the spatial and temporal dimensions of the Rights and other aspects. However, some aspects are worth of mentioning under this section:

1. Constitutional Act 231 states to recognize the original rights of indigenous community over land traditionally occupied by them. This means recognition of rights could include ownership or access to spatially demarcated piece of land. The term ‘traditionally occupied’ brings the reference to a vague time-spec element into the rights claim.
2. It is stated that the lands traditionally occupied by indigenous people are their permanent possession. This means recognizing all the rights of the indigenous people over a spatially demarcated piece of land without any temporal changes in the future.
3. It is stated that the indigenous people have exclusive right to use the resources of the soil, rivers and lakes of those lands which are traditionally occupied by their community. This gives a spatial (2D and 3D) extension to the rights of indigenous people through these resources.
4. The Federal Government (represented by FUNAI) is stated as responsible to demarcate and protect all properties of indigenous people. This demarcation means the process of defining spatial boundaries.
5. In a very clear differentiation of resources in two and three dimension of space, Article 176 clearly states that the mineral deposits and potential forms of hydraulic energy are properties distinct from the soil properties, for the purpose of exploitation or use.
6. Article 176 states that mineral deposits and potential forms of hydraulic energy belong to the Federal Government. However Article 231 states that use of such resources in indigenous land can only occur after authorization by the National Congress and consultation with the affected communities assuring that communities will participate in the proceeds of the exploitation, as set forth by law. This consultation right and share in the proceeds from the exploitation of resources extend the virtual rights of indigenous communities in two and three dimensions of space through the existence of exploited resources.

5. CONCLUSIONS AND RECOMMENDATIONS

This paper shows that even though each case of indigenous land claim has specific needs, there is a common ground in the land regularization procedure that could be modelled with LADM, focussing on the land demarcation and land claim administrative steps. The fact that Brazilian private law is based on the Civil Law could be an opportunity to and could facilitate the design of a land administration system since there are a variety of laws created. Unfortunately sometimes the legislation is not enforced, and it turns into one more bureaucratic step within land administration.

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The development of a conceptual schema could bring a common understanding within the domain of land administration for all the Nodal Agencies involved in the Indigenous Land Regularization in Brazil, especially for FUNAI, to whom the Indigenous interests are entrusted. The standard models of the rights, restrictions and responsibilities and their geospatial and/or geometric information component could potentially improve the bureaucracy of the administrative procedures that the indigenous land claims needs to go through. Besides it can be a way to clearly define responsibilities for maintenance of specific data to be achieved.

Other benefits of the use of LADM in Brazil are to allow interoperability and data sharing based on a common data model. It could be a great accomplishment since the Nodal Agencies are independents and not integrated; as consequence, land information can be duplicated and inconsistent in existing cadastral systems, impacting even more at the identification of the property rights.

With the implementation of the CNIR, created by law in 2001 and never implemented, there is a hope that the Nodal Agencies will be integrated and land information will not be duplicated and inconsistent, helping administering and exerting indigenous land rights.

We recommend conducting studies with systematic approaches like LADM so that there could be a model or a mixed approach model prepared, even as a conceptual prototype, which can cover all the efforts in an integrated way to protect indigenous rights by identifying, accepting and demarcating their claims in a scientific manner. It is required to further develop the modelling phase, using various approaches including focus on spatial dimensions involved, to analyze how the land demarcation process could be improved and the administrative procedures could be less bureaucratic and efficient.

A recommended approach building upon the LADM, as initiated in this paper, should include several levels of UML dynamic (Use Case and Activity) diagrams, in order to capture and discuss existing requirements. Also, as present in the LADM standard, instance level or Object diagrams should be produced in order to communicate how the model effectively responds to (at least) the most frequent situations. Such a systematic approach is particularly useful when previous UML or even legacy models are not available, although existing formal requirements are published through the law and technical regulations. In the specific case of this research, such an approach was found most useful by the different co-authors, giving their different backgrounds (some knowing about LADM but nothing about Brazilian Indigenous Land Rights, and the opposite).

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Silvane Paixão holds PhD in Land Administration and Land Information Management with emphases in Brazilian Rural Cadastral System. She had published some papers about the Brazilian land administration issues. She has worked as a GIS expert in Brazil in projects related to the poverty, community development, health and urban planning. Dr. Paixão taught cadastral survey at Federal University of Pernambuco (UFPE), Brazil and was teacher assistant at University of New Brunswick (UNB) – Canada in disciplines related to Land Administration and Land Economics. Currently, she is working as Project Coordinator and GIS Analyst for the Faculty of Medicine – Dalhousie University.

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