



Modeling indigenous tribes' land rights with ISO 19152 LADM: A case from Brazil



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ABSTRACT

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 people 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 issues, 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 been extended to include Brazilian land administration experts.

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

The existing international convention on indigenous rights, by the International Labour Organisation (ILO) of 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 packages. 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 contextualized Use Case Diagram is displayed (not currently part of the LADM standard).

Finally, 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 to broadened 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 modeling of other types of spatial units and related rights, until a complete, multipurpose, country profile LADM.BR is reached that can underpin an integrated cadastre. It can be equally used to test implementation prototypes, using current or experimental geographic information technologies and spatial databases.

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Background

The Amazon has the largest area covered by rainforests on the earth. A large part of these forests fall within the national

boundary of Brazil. In recent decades, especially during 1970s, under the military rule, economic driven expansion reached the northern and western parts of Brazil while penetrating the Amazon which among others caused serious deforestation in that area. The Brazilian Census 2010 counted 896,917 people who declared to be indigenous in about 305 ethnic groups, speaking 274 different languages. From the total indigenous population officially recognized by the government (Decree #22/91 and Decree #1775/96), almost 517,000 (57.7%) lives within indigenous land. 94.9% of this

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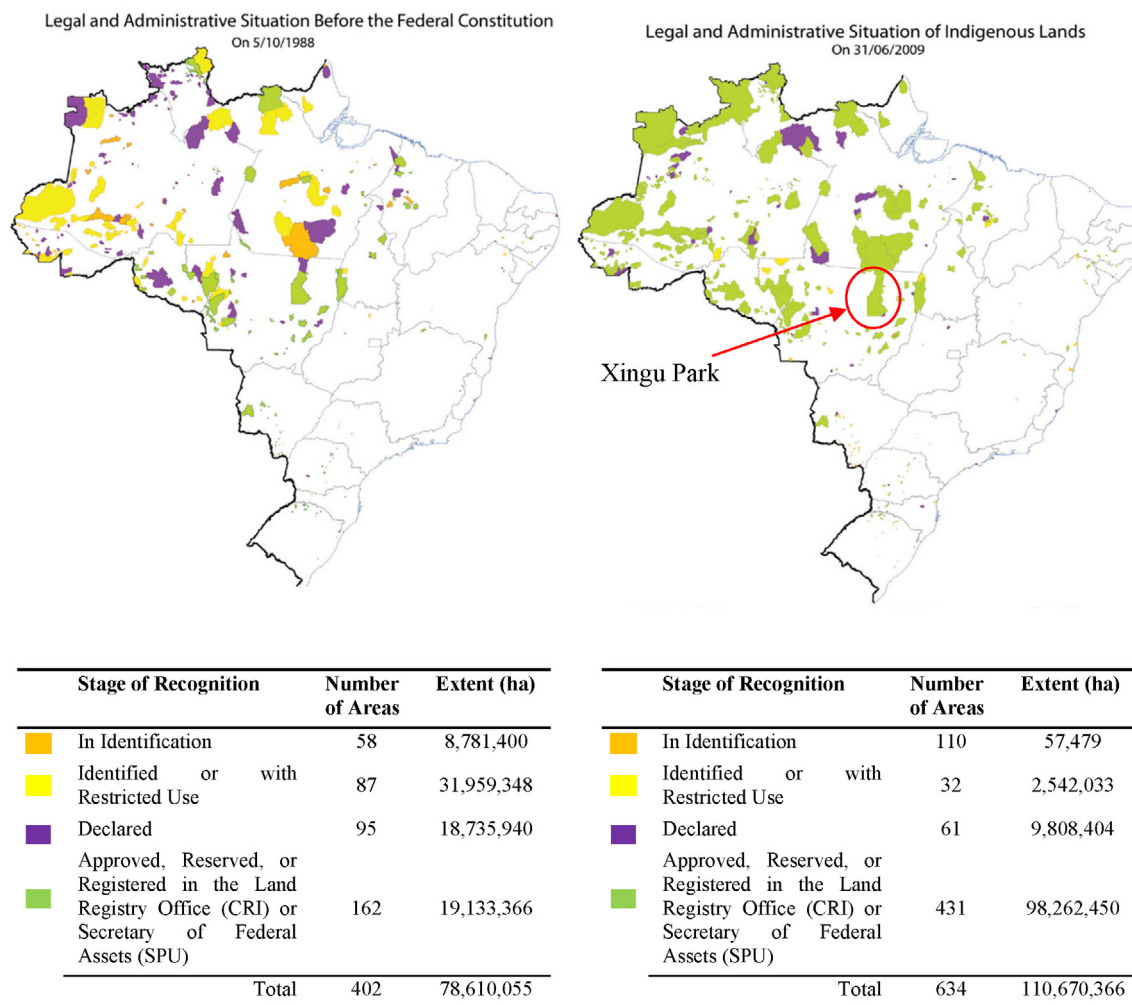


Fig. 1. Changes in Legal and Administrative Situation of Indigenous lands pre and post Federal Constitution of 1988.

Source: Santilli (2010).

indigenous population, lives in rural areas. Around 379,000 (42.3%) lives outside the indigenous land and 78.7% of this population lives in urban area (IBGE, 2010). The habitats are spread across Brazil but are mostly concentrated in and around the Amazon region. The economic expansion 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 1980s, 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 a number of regularization steps to reach the final legal and administrative situation (see Fig. 3).

As illustrated in Fig. 1 by Santilli (2010) from Socio-Environmental Institute (ISA) 2009 report, the legal and administrative situation of the indigenous land before the Federal Constitution (1988) and in 2009 displays a significant differentiation of approved and registered indigenous land.

The indigenous land regularization in Brazil is a bureaucratic and slow process. Some of the indigenous land such as the Marãiwat-sédé (Xavante tribe) located in the Northwest of Brazil had the land claim for decades. On the other hand in Fig. 1, it can be noticed that the Xingu Indigenous Park, created by Decree # 50.455/61, by 2009

had almost all the indigenous land approved and registered. Violent land disputes between non-indigenous and indigenous with overlapping claims to land rights is a fact that cannot be hidden. This problem is increased by the fact that no integrated cadastre of the country exists, and thus it is not easy to even see that claims are overlapping, regardless of the exact legal nature of each. Another problematic issue on indigenous land, caused by third parties, is the deforestation process, which is caused by massive logging of trees, both for their lumber value as well as for clearing the land for large scale economic investments.

Carneiro et al. (2011, 2012) discuss that the territorial occupation and land management of the 2D and 3D Cadastres in Brazil is complexity. Rural cadastral system is centralized and managed by the Federal Government through INCRA. Before 2011, rural property was registered by declaration. The land description was literal and declarative with no control over the accuracy of declarations neither with connection to the rules of land surveying. It opened windows for illegal occupation on public lands and possibilities for overlapping titles of ownership on the same parcel, and different types of ownership across more than one parcel.

This paper aims to define the indigenous land rights in Brazil, as described under various laws, in 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.

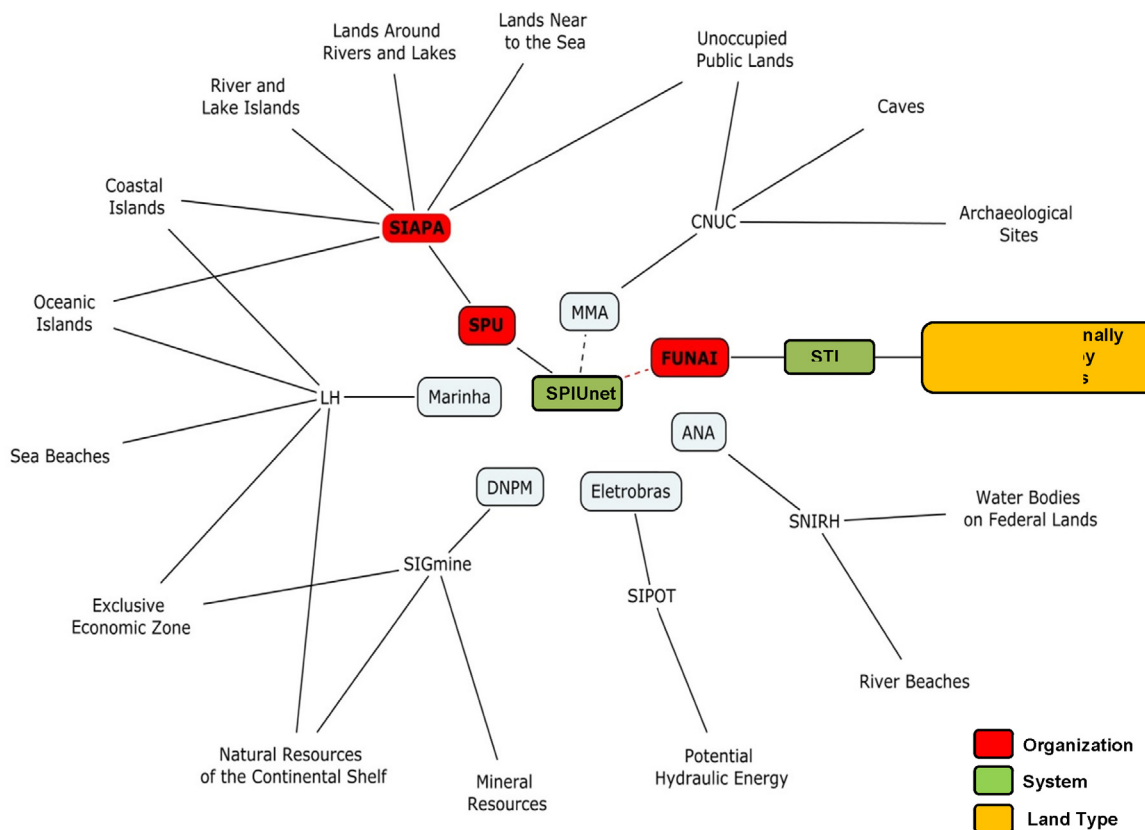


Fig. 2. Indicates the ¹institutions involved on the Cadastre of public lands in Brazil: SPU, MMA, FUNAI, ANA, Eletrobras DNPM, Marinha.

International legislation on indigenous rights

According to International Labour Organization (ILO) Convention 169 (ILO, 2003), elements for the indigenous and tribal peoples' 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, Article 15 of ILO Convention 169 highlights that they shall be safeguarded. These rights for the indigenous people 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.

The LADM based approach

LADM

A reference model for the land administration domain has been defined as the ISO 19152 International Standard "Land Administration Domain Model" (LADM). It covers 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 (1) parties (people and organizations), (2) basic administrative units, (3) rights, responsibilities, and restrictions (ownership rights), and (4) 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, and provides a basis for national and regional profiles. It enables the combining of land administration information from different sources in a coherent manner (ISO 19152).

Public land cadastre in Brazil

The Brazilian Land Administration System is characterized by the land registry office, responsible for the legal information, and the independent rural and urban cadastral systems. The rural cadastral system is under federal responsibility, administered by INCRA – National Institute of Colonization and Land Reform, however, it is the responsibility of each municipality to manage the urban cadastres, which are established primarily for tax purposes (although a tendency for multipurpose use has risen in recent years).

After years of social pressure, the Law # 10.267/01 promised the end to the illegal appropriation of public lands. Next to establishing the geo-referencing of rural parcels, this law dealt with other imperative points: the exchange of information with the land registry office, essential environmental and land regularization actions, and the creation of the National Cadastre of Rural Properties (CNIR), a national centralized cadastral system for rural properties. CNIR includes information sharing with other existing cadastres for different types of land issues: environmental, indigenous lands and public federal lands – each with its own base of

¹ SPU – Secretary of Patrimony of the Union; MMA – Brazilian Ministry of the Environment; FUNAI – National Foundation for Indigenous Affairs; ANA – National Water Agency; Eletrobras – Brazilian electric utilities company; DNPM – National Department of Mineral Production; Marinha – Brazilian Navy.

descriptive and geographic information. Until the present moment, the CNIR has not been effectively implemented.

For the public lands, which contain such diverse land types as land around larger waters, mineral resources, indigenous land and archeological sites, different institutions are independently responsible for its own specific cadastral systems. The state's public lands are under the responsibility of state land institutions while the federal public lands are administered by *Secretary of Patrimony of the Union (SPU)* and other institutions, as shown in Fig. 2. It can be noticed in Fig. 2 that the cadastral systems are not integrated and there is no sharing of information between these institutions. As a consequence, the management and control of the land use and ownership of public land is impaired.

Fig. 2 shows that indigenous lands are recorded at the STI (*Traditional Land Cadastre*) under FUNAI and they also are recorded on the SPIUNet (*Management System of the Special Use of the Federal Properties*) under SPU. The issue is further complex because indigenous lands may be contained within environmental conservation units, which are recorded on CNUC (*National Cadastre of Protected Environmental Areas*) under MMA or if there are mineral rights on the indigenous land, licensing for mining is recorded on the SIGMine cadastral system under DNPM. Also, it can be noticed that there is no integration between these systems and one type of federal public land can be overseen/recorded by multiple agencies. In addition to these federal lands, there are also state and municipal public lands that are administered by regional and local land administrations.

To understand the management of public lands in Brazil requires in-depth studies on specific topics. The present research aims to contribute to the modeling of the regularization of indigenous lands through the LADM process, which can be seen as one of such studies. This is just one of many steps needed to come to a complete integrated rural cadastre for Brazil.

Application to the Brazilian indigenous context

The following sections give the Brazilian definitions and respective legal sources of the stakeholders, the territories and the land relations affected. For each of sub-categories used, the relevant LADM class it belongs to is given between brackets behind it. The descriptive text is complemented with UML dynamic (Use Case and Activity) and static (Class and Object) diagrams at appropriate places.

In Section “Stakeholder definitions” we focus on the stakeholders, both indigenous tribes and government agencies involved. In Section “Spatial unit definitions” we focus on the spatial units at different levels, both tribal lands and smaller units within those. In Section “People-to-land relation definitions” we focus on the different people-to-land relations, including rights, restrictions and responsibilities, and we conclude with the source documents. In Section “Indigenous forest rights class diagram” all of this is brought together in the newly prepared class diagram for this context.

Stakeholder definitions

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 Statute (“*Estatuto do Índio*”, Law #6001/73) fully complies with the ILO Convention.

Article #1 of Decree #5051/2004 defines indigenous tribes within an independent country, according to the set of social,

Table 1

List of involved governmental agencies and respective existing cadastral system.

Purpose/category	Agencies	Cadastral system	Admin. level
Public lands	FUNAI ^a , SPU ^a	STI, SPIUNet	Federal
Legal	Land Registry Office ^a		Local
Agrarian	INCRA	SNCR, CNIR, SIGEF	Federal
Environmental	IBAMA/SFB/MMA	CNFP, CAR	Federal

^a Mandatory agencies in the indigenous land regularization.

cultural and economic conditions that can distinguish them from other sectors of the national collectivity.

Law #6001/73 defines an indigenous as any individual of pre-Colombian descent who identifies him- or herself and is identified as belonging to an ethnic group with cultural characteristics which distinguish him/her from national society.

The following list clarifies the key concepts about indigenous identification:

- Pre-Colombian descent: 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 is not 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.

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, are summarized in Table 1 (Paixão, 2010). Below the agencies are described in more detailed on their foundational decree (or law) and main aim, and identified through the acronyms provided in Table 1.

National Foundation for Indigenous Affairs (FUNAI)

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 Patrimony of the Union (SPU)

Secretary of Patrimony of the Union (SPU) is in charge of all federal lands – mostly responsible for the officially occupied federal lands and buildings. Besides that is in charge of the land near to the sea and around the rivers and lakes, among others (see Fig. 2). Currently there are two cadastral systems managed by SPU: Integrated Asset Management System (SIAPA) for the dominial properties (*imóveis dominiais*), and the Management System of the Special Use of the Federal Properties (SPIUNet). The SIAPA aims to keep updated and operating the inventory of federal lands for the management of the collection of revenues owed by the use of the properties of the Union. While SPIUNet manage the use of special-use goods such as

buildings used by the government to activities, indigenous lands, protected environmental areas. These cadastres do not contain geographical information and serious problems of inconsistency and lack of updating are present.

Land Registry office

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).

Institute of Colonization and Land Reform (INCRA)

Institute of Colonization and Land Reform (INCRA) is the agency nominated to operate the rural cadastre system in Brazil, including rural properties which only have rights of occupation (“posse”). Currently, *National Rural Cadastre System (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. The Automated System for Land Management (SIGEF) was created to record and efficiently certificate the rural properties supporting the rural land regularization.

Brazilian Institute of Environment and Renewable Natural Resources (IBAMA)

Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) has responsibility for recording federal national parks and environmental protection areas such as “Reserva Legal”. IBAMA is under *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. CAR contains geo-referenced information of the environmental protect areas. 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. *Brazilian Forestry Service (SFB)* is in charge of managing public forests, classifying the forests that are inside public lands and archives the areas where forests have been lost.

Use Case context for nodal agencies

The UML Use Case Diagram in Fig. 3 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 also 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.

Spatial unit definitions

Tribal land (LA_SpatialUnitGroup)

Article 231 of the Brazilian Constitution of 1988 mentions that indigenous lands are inalienable and unavailable, and imprescriptible to the natural resource preservation. As Hutchison et al. (2005) commented, it also reinforces the pre-existing rights of

indigenous people to their traditional lands, independent of its official recognition by the government.

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 (da Cunha Almeida et al., 2005).

By unofficial report of June 2014 (ISA, 2014), from the 693 indigenous lands, 122 are still to be studied to identify the size of the land that will be demarcated. Also 421 indigenous lands were regulated and legally registered to which 306 were located on the “Amazonia Legal” (i.e., in all 9 Northern states in the Amazon Basin). 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. The final step is the indigenous land registration on the land registrar office and the land inventory at the Secretary of Federal Assets – Ministry of Planning (SPU).

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.

People-to-land relation definitions

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 the cutting of wood, fishing and hunting and overall, the right to exploit the natural resources existing in these lands.

The property right retained 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 rights of permanent possession and exclusive usufruct to the indigenous communities.

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.

Brazilian Land Administration concerning Indigenous Forest Rights

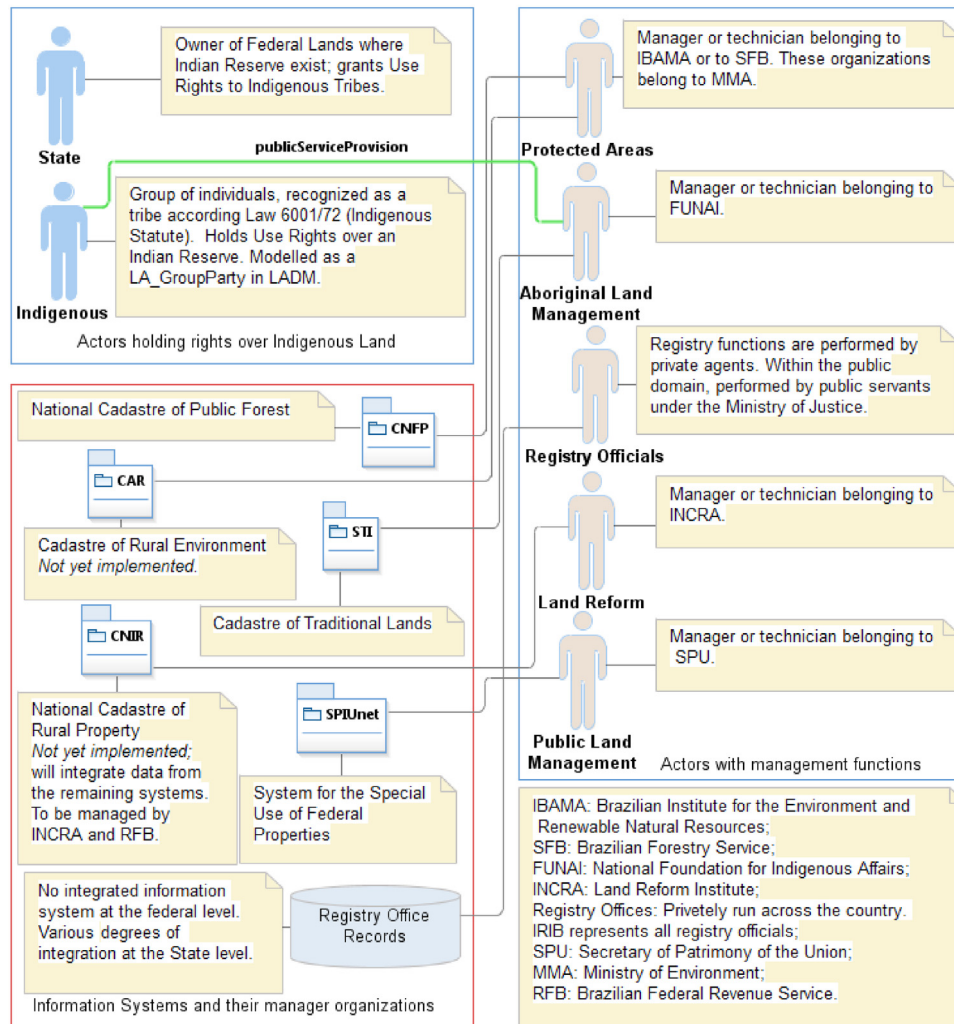


Fig. 3. Context for indigenous forest rights (UML Use Case).

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 cutting and selling of certain tree species. The indigenous can grow plantations, clear cut the forest for farmland 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 Mining Code (Decree-Law #227/67) establishes a clear distinction in the legal process to be applied to industrial mining (“*lavra*”) 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. According to the Indigenous Statute (Art. #44), “*garimpo*” is exclusive to indigenous people. The legislation in force #1,610/1996, # 7099/2006 and # 5,265/2009 says that exploration mining in indigenous land is allowed by private or state sector since it is proved by geological surveys conducted by the federal government that the existence of mineral deposits justifies its economic

exploitation. Royalties (2–4%) will be given to funds of Indigenous protection.

Curi (2007) commented that in 2005 there were 1835 requests for mineral search (mineral interests) filed at the National Department of Mineral Production (DNPM) before the Constitution of 1988. In some situations, the area requested for mineral prospection pass 90% of the area of the indigenous lands (e.g., Roosevelt Indigenous land); in others the requested mineral prospection were located in indigenous lands not yet regularized by FUNAI. The problem discussed has a temporal context. The Federal Constitution 1988 established that mineral exploration concession overlapping an indigenous land should not occur (Batista, 2005). Also the 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 “*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.

6.3 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.

Decree # 7747/12 establish the National Territorial Policy and Environmental Management of Indigenous Lands – PNGATI, whose guidelines for territorial protection and natural resources:

- promote the protection, monitoring, surveillance and environmental monitoring of indigenous lands and their boundaries,
- contribute to the protection of natural resources of indigenous lands in the delimitation process,
- promote the development, organization and dissemination of information on the environmental situation of indigenous lands, with the participation of indigenous peoples,
- to promote actions for the protection and recovery of springs, streams and springs Essential indigenous peoples, others.

Sources (LA_SpatialSource, LA_AdministrativeSource)

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

- Creation and operation of CNIR 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) Decree #1775/96 represented in Fig. 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 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 boundaries surveyed under 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 party 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.

Indigenous forest rights class diagram

The preceding sections defined the broader context of the components to be considered for the modeling 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 Figs. 4 and 5). 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 Fig. 6 reflects the currently used model, 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, another type of spatial units shall also be considered, namely those which impose public regulations on the environment.

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

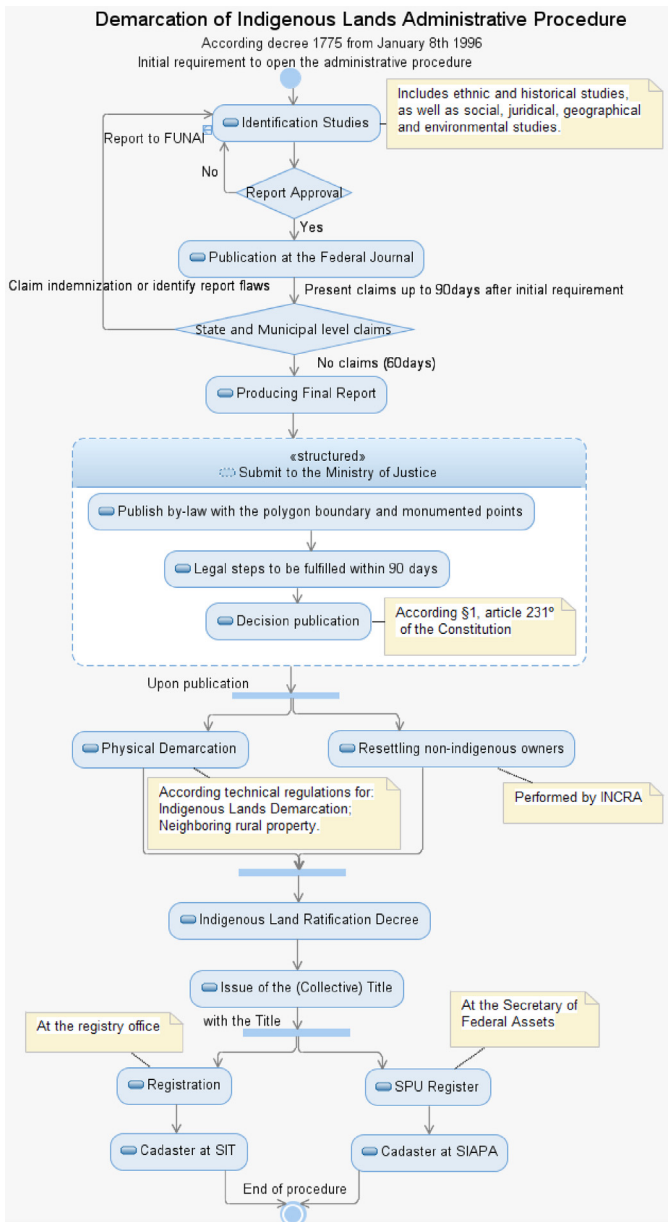


Fig. 4. Indigenous lands procedure (UML Activity).

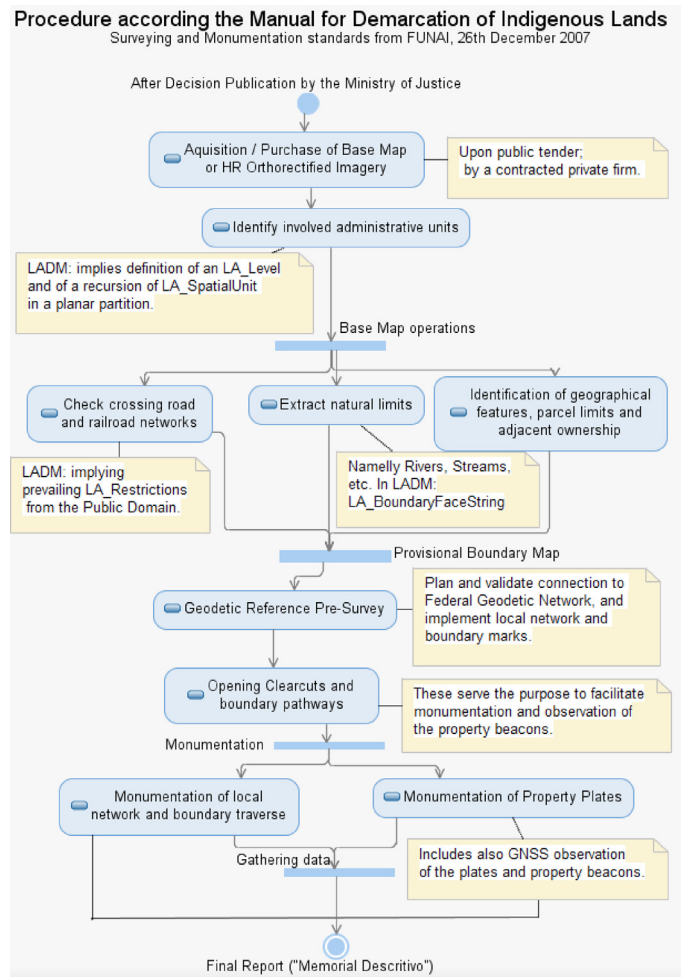


Fig. 5. Detailed indigenous physical lands demarcation procedure.

Spatial dimensions of indigenous rights in the federal constitution 1988

The law does not explicitly mention the spatial and temporal dimensions of the rights and other aspects. However, some aspects are worth mentioning in this section:

1. Constitutional Act 231 recognizes the original rights of indigenous community over land traditionally occupied by them. This means recognition of rights could include land use or access to spatially demarcated piece of land on federal land. After the Constitution of 1988 these are considered null, without any legal effect, acts which have as their object the occupation, the domain and ownership of indigenous lands. 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. Ferraz Junior (2004) explains that the terms "traditionally occupied" means a natural habitat with ecological relationships with the land in terms of use, believes and traditions, while "land possession by indigenous" has no temporal dimension since it is applied to the circumstance where there is not a recognition of a previous land title upon the claimed land; a different definition

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, and it is assumed that in the majority of cases this is a single polygon in 2D. The model, however, allows the association of more Spatial Units, e.g., when exclaves are present. A specialized class is defined for the LA_Point, in order to comply with the specifics of FUNAI regulations for the demarcation of indigenous lands.

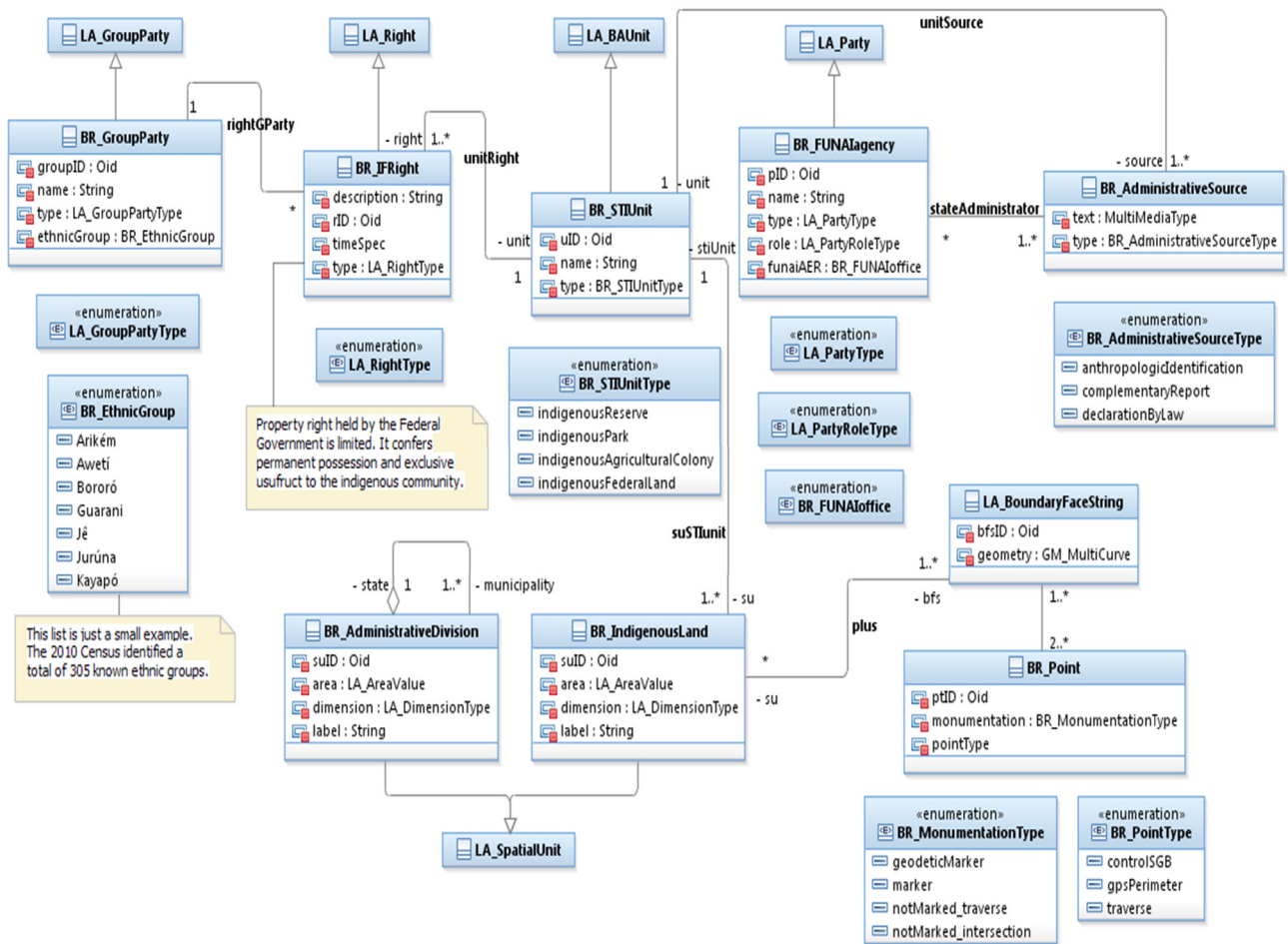


Fig. 6. Indigenous forest rights class diagram.

as used in the Civil Code that needs to be legitimated (e.g. adverse possession).

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.

After 2011, when Law #10.267 was created, the obligation to georeference all rural properties and correlate information

between the INCRA and the Land Registry were determined. The surveyor must submit technical papers and corresponding documentation to INCRA to certify that the geometric definition of the rural property limits does not overlap any other coordinates appearing on the georeferenced cadastre. Only after certification, is the survey appraised by the Land Registry which is responsible for overseeing the accuracy of true right of ownership. This is because INCRA’s certification of technical work does not include recognition of ownership for the geometric unit certified; nor does it imply accuracy of the limits and boundaries of that unit. By report of January 2014 (INCRA, 2014), INCRA had certified about 70,000 georeferenced rural properties across Brazil, representing 1.24% of the total 5.498.505 of the Rural Properties existing on the Brazilian territory (INCRA, 2012).

Paixão et al. (2012) pointed issues that have been impacting the development of 3D cadastre in Brazil: incompleteness of 2D spatial data, inconsistent geographical unit definition among the institutions, absent and/or fraudulent legal documentation to prove the land ownership. For Carneiro et al. (2011, 2012) 3D Cadastre in Brazil depends on the success of the multipurpose cadastre model and consolidation of the national spatial data infrastructure ‘INDE’, since this is the organization responsible for coordinating territorial data from multiple sources and institutions and setting the standards for exchanging that data.

For further development of cadastral system in Brazil, if the INCRA Land Management System is integrated with the land registrar office, this would allow as a first step for rights, restrictions and responsibilities (RRR) on an indigenous land to be tracked efficiently over the time.

Table 2
Authority and legal aspects for process under current land demarcation and under PEC215/2000.

	Current land demarcation process under Decree # 1775/1996	Demarcation process under PEC215/2000
Authority	Under executive branch: FUNAI under the Ministry of Justice and the President of the Republic.	Under legislative branch: National Congress could exclusively approve the land demarcation (traditionally occupied by indigenous people) and could request ratification of indigenous lands previously demarcated (changing the Article 49 of the Federal Constitution 1988)
Legal	Lands traditionally occupied by indigenous peoples, which have <i>rights recognized even before a law or act to declare that they, are assets of the Union (direito originário)</i> Indigenous land are inalienable and not disposable assets; the rights over them are imprescriptible	Indigenous lands considered as goods of the States of the Federation by considering the “relevant public interest” (Changed by the proposed legislation PLP 227/12) Indigenous land are inalienable and not disposable assets; the rights over them are imprescriptible only after land demarcation has been approved by the Congress (changing the Article 231 of the Federal Constitution 1988)

Indigenous lands demarcation procedure

This administrative procedure is considered the key in the modeling of Brazilian Indigenous Lands, and follows from the Use Case diagram in Fig. 3. The high level modeling depicts the fundamental steps at the Spatial Unit and Administrative components, as an UML Activity Diagram (Fig. 4). 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 enter it into the register (the legal situation) and the 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 (land registry office)) 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. CNIR has not been implemented yet, even 13 years after the legislation was established, but over this period of time, INCRA has been showing improvements to speed up the process of the land regularization with creation of the sub-systems, standardized procedures for the surveying, operational guidelines, etc. 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 (Fig. 5).

The discussion among indigenous people, farmers and government was raised in 2013 because of the Proposed Constitutional Amendment, “PEC 215/2000”. This proposal intends to modify the indigenous land demarcation process. Currently the indigenous land demarcation is an assignment of the executive branch, led by FUNAI under the Ministry of Justice and the President of the Republic. If the PEC 215/2000 is approved, the demarcations process will be under the National Congress. The comparison between the existing demarcation process and the one proposed on the PEC 215/200 is described in Table 2.

The proposal PEC 215/2000, also imposes that federal agencies other than the FUNAI, such as the Brazilian Agricultural Research Corporation (Embrapa) and the Ministries of Rural Development and Agriculture (MDA), are consulted on the impacts of the new land demarcation of indigenous territories.

da Cunha Almeida et al. (2005) remind that from a legal perspective, the demarcation of indigenous lands recognizes existing rights that were constitutionally provided for and secured by art. 25 of Law # 6,001/73, enabling the natives to their respective permanent possession of those lands, and exclusive use of the riches of the soil, rivers and lakes existing therein (art. 231 of the Constitution).

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 modeled 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.

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. Brazil initiated the National Spatial Data Infrastructure (NSDI) in 2008 (Decree #6,666) with the aim to be fully implemented in 2020. Data policy, standards and specifications are already implemented, both geospatial data from INCRA (under Law 10.267/2001) and FUNAI (under Law # 1.775/1996) are planned to be incorporated to the NSDI via the SIG Brasil geoportal (CINDE, 2010).

Other benefits of the use of LADM in Brazil are to allow interoperability and data sharing based on a common, internationally accepted, data model. It could be a great accomplishment since the Nodal Agencies are independent 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. In this way it would become clear much earlier that two claims are overlapping and should not both be legally registered in different systems. Thus avoiding conflicts later on (if both claims are already made it will help to show them, but solving the conflict will still need mediation between the parties or a decision by a higher authority or court).

With the implementation of the CNIR, created by law in 2001 and never implemented so far, 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 manner to protect indigenous rights by identifying, accepting and demarcating their claims in a scientific manner. It is required to further develop the modeling 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 more 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 presented 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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