



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017



IMPROVING LAND ADMINISTRATION IN BRAZIL: RE-ENGINEERING CADASTRE USING LADM

THIAGO MARRA, KILDER BARBOSA, OSCAR OLIVEIRA, EDUARDO OLIVEIRA
INCRA, Brazil
thiago.marra@incra.gov.br

**Paper prepared for presentation at the
“2017 WORLD BANK CONFERENCE ON LAND AND POVERTY”
The World Bank - Washington DC, March 20-24, 2017**

Copyright 2017 by author(s). All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Rev. 1.2



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017



Abstract

Brazilian recent advances in rural cadastre are noticeable. However, there are important issues that must be addressed to support land rights recognition, conciliate conflicts and control land use. To face these challenges, is being developed a project to redefine the cadastre in Brazil. The directives of the project are: (i) represent the diversity of land tenure rights in Brazil; (ii) include new methodologies of collecting cadastral data; (iii) link levels of precision with tenure situations; (iv) create ways to improve the precision of cadastral data in time; (v) review the technology used to manage the cadastre data; (vi) refine priority areas that should be targeted by a systematic approach; (vii) design a model that could be used for rural and urban areas.

It is assumed that, despite the institutional issues that could rise, it could be a great opportunity to sum institutional efforts in the same direction and provide a more effective land cadastre to Brazilian society.

Key words: cadastre, land tenure, land administration, LADM, Brazil



1. INTRODUCTION

Despite the advances in Brazilian economy in past decades, with a great role played by the exportation of agribusiness commodities, the land administration in the country still struggles with some primary issues. It is recognized that there are difficulties in granting land tenure rights and securing them. The formal land tenure system is far from a large amount of area and the people who occupy it, often in informal and fragile conditions, what makes them susceptible to violence related to land grabbing.

This situation is far more intense in Brazilian Amazon, with over 50 million hectares of public land without (or unknown) destination, associated to valuable resources in dispute. In general, the conflicts emerge with more intensity from the expansion of production areas and with large infrastructure projects over traditional possessions in different land tenure situations. For example: small farmers occupying public land, fisherman and other traditional communities, like quilombolas (groups and families of descendants of slaves) and indigenous.

Brazilian governments have been made efforts to recognize these land rights but, still today, as the agribusiness frontier expands, violent conflicts emerge. According to Pastoral Land Commission (CPT), conflicts for land still cause about 30 deaths per year since 2010. In 2014 there were 36 homicides related to land conflicts (CPT, 2015).

The most common way to recognize individual and collective land rights is granting land titles under some conditions. That was made about four decades ago in Brazilian Amazon, still under the military regime, in a massive colonization process. It is estimated that 120,000 titles were emitted. The poor control over the clauses in titles, title frauds, corruption, lack of transparency, high cost of bureaucracy, and even the expectation of population that the title itself was enough to grant the formal domain were some reasons to the maintenance of low formality. Informal transferences of ownership were made over the time, disrespecting the clause of inalienability, for example.

It could be reasonable to think that the main problem was the lack of formality itself. However, even when titles were authentic and properly registered, other issues came out. For example, the



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017



emission of titles with technical mistakes, like the overlapping between a title emitted by a national authority over one issued by a state. In this case, rights could be registered related to the same land, because Registry did not have the proper technical support to check the location of land that was described in the title. Why?

Among other issues, one is clear: because an essential component of Land Administration was missing, a “map-based cadastre”, one that enables to control if the boundaries of a parcel are in conflict with another one. In other words: the lack of a Cadastral System, based on the spatial representation of land, that should cover (at least the most of) the territory without overlaps or gaps, have been a hard limitation in Brazil.

2. CHALLENGES FOR CADASTRE IN BRAZIL

2.1 Legal Issues

From the legal perspective, there are several legal acts creating cadastres that not necessarily make reference to each other. Therefore, it could be said that the cadastres created by law do not correspond to integrated parts that compound a whole. There is not a cadastral system in Brazil, at clear designed one. The chart below lists some cadastres created by law in Brazil:

Main Object	Name	Scope	Urban /Rural	Legal Act	Institution	Purpose
Land tenure	National Cadastre of Rural Land - CNIR	Federal	Rural	Law 10.267/2011	INCRA, RFB (revenue federal agency), Registry	Support taxation, supervision of land social function and knowledge of land distribution
Land tenure	Land Cadastre and Registry System - SICART + Multipurpose Technical Cadastre - CTM	Municipal	Urban	Portaria 511/2009 - Ministry of Cities	Municipality, Registry	Creation, establishment and updating of official and systematic territorial inventory of the city (multipurpose by definition)
Land tribute	Cafir	Federal	Rural	Law 9.393/1996	RFB	Taxation of rural property - ITR
Land tribute	Multipurpose Technical	Municipal	Rural or	Portaria 511/2009 -	Municipality	Creation, establishment and updating of official and



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017



	Cadastre - CTM		Urban	Ministry of Cities		systematic territorial inventory of the municipality
Land use and occupation	Rural Cadastre National System - SNCR	Federal	Rural or Urban	Law 5.868/1972	INCRA	Promote integration and systematization of data collection, research and treatment of data and information on the use and ownership of land (Decree 72,106 / 73)
Public forests	Public Forests National Cadastre	Federal	Rural	Law 11.284/2006	Brazilian Forest Service SFB / Ministry of Environment MMA	Management of public forests for sustainable production
Land use	Environmental Rural Cadastre - CAR	Federal / State	Rural	Law 12.651/2012	Ministry of Environment MMA, Environmental State Agencies OEMAs	Sustainable development (Law 12,651 / 2012). Collect environmental attributes for monitoring and enforcement.
Federal estate	"Cadastro dos bens dominiais da União"	Federal	Rural or Urban	Law 9.636/1998	Patrimony Secretary SPU	Characterize the federal public assets and keep your registration.
Conservation lands	National Conservation Units Cadastre - CNUC	Federal	Rural or Urban	Law 9.985/2000	Ministry of Environment MMA	Keep information about the conservation areas, including endangered species, tenure situation, water resources, climate, soil, socio-cultural and anthropological aspects.

Table 1: Cadastres created by law in Brazil (adapted from Marra et al, 2015)

2.2 Organizational Issues

From the organizational perspective, first point to consider is that the management of cadastre is divided for rural and urban areas. The rural cadastre is competence of the National Institute of Colonization and Land Reform (INCRA), while urban cadastre is responsibility of municipalities.

According to IBGE, Brazilian Institute of Geography and Statistics, in Brazil there are 5,570 municipalities, with high heterogeneity. For example: Altamira, in state of Pará, has an area of 15,953,373 ha (bigger than Portugal), 108,382 inhabitants and a GDP per capita of about



US\$3,000; and São Paulo city, with 152,298 ha, 11,967,825 inhabitants and over US\$10,000 of GDP per capita. These two municipalities have the same formal role to build their territorial cadastres and integrate it to the Registry, as recommended by the regulation 511 of Ministry of Cities.

Besides the great economic and territorial differences among the Brazilian municipalities, there is the dynamic behavior of the boundaries between rural and urban areas. These boundaries are ruled by municipal regulations and, therefore, the spatial representation should be provided by the municipalities. However, as could be expected, only few of them are capable to keep an infrastructure enough to do so.

At the same time, there are no definitions by National Cartography Commission (Concar) about standards for cadastral data production, modeling or representation. This step is still not implemented by the National Spatial Data Infrastructure (INDE), officially instituted in 2008.

Additionally, there are questions about the competence distributions among the rural cadastres, cited in Table 1. Cadastres do not use data from each other. For example: fiscal or environmental cadastres do not use the cadastral information based on surveying and linked with Registry. This limitation keeps different official information about the same objects, and brings confusion to the administration. This situation was recognized in 2015, by the Federal Union Accounts Court (TCU), an organization related to the Brazilian National Congress, in a report about governance of non urban soils (CEDRAZ; RODRIGUES; BUGARIN, 2015).

2.3 Operational Issues

Since 2001, due to the 10,267 act, the cadastre in rural areas is in a paradigm shift, from an address location based system to a georeferenced one, based on land surveying, attached to technical responsibilities and linked to the Registry. This was discussed on a preview work (Marra et al, 2015), and comprehend a series of reviews in regulations and operational processes.

Thanks to the advances made, the rural cadastre coverage is growing faster in past 2 years. The conversion of the old analog based process to a digital one, operated in a web platform, raised the monthly average inclusion of georeferenced areas up to 10 times. There were inserted almost 300,000 parcels in total (considering occupation areas). Over 50% are able to be linked with



Registry information, corresponding to over than 100 million hectares. However, it is mandatory to speed up this growth even more to fulfill the needs of land management in Brazil.

However, the cadastral update is not systematic, what means that the surveying of parcels is not made covering the territory continuously, neighbor by neighbor. The process is mandatory depending on the size of the land parcel. Bigger parcels enter first. Nowadays, parcels over 100 hectares have to be georeferenced when is needed to update the situation of the immovable property in the Registry. Just in 2023 it will be mandatory for all areas, according to Decree 4449.

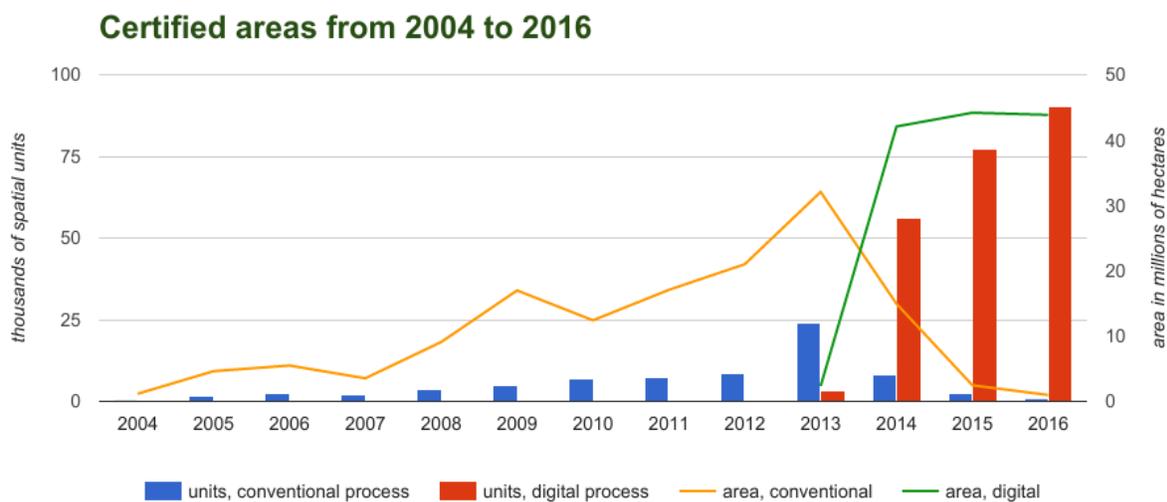


Illustration 1: Evolution of certification in numbers: spatial units by year

Other considerable issue is the cost of cadastral data production: the georeferencing process. With the modernization of rural cadastral system, the time spent in analysis is now counted in minutes, against months or years for the old standard. The Illustration 1 shows the contrast between the conventional and the digital processes. Despite this, the land surveying according to the actual standards still is costly. In terms of time and money, it is not affordable for the greater part of landowners in Brazil (or occupants, in case of informal possession). The number of professionals available on the market is still low: about 10,000 active surveyors, what is less than a half of Germany, for example (CSDILA, 2016).



At the same time, the highly heterogeneous socioeconomic and natural conditions of the rural areas in Brazil make the requirements of each region different. Some areas have much higher value than others, then the owners require surveyings with more precision and detail. As the standards of precision are usually established considering these cases, the surveying apparently would not be viable for areas with lower market price, that often are that ones that require a deeper intervention from Land Management, for example, to become more productive, eventually with proper recognition of informal land tenure rights.

3. DIRECTIVES FOR A NATIONAL LAND CADASTRE

To face these challenges is being developed a proposal to improve the cadastre in Brazil. The main directives of the project are discussed ahead.

3.1 Conceptual Schema

It is been considered that the main issue behind the lack of integration among land organizations in Brazil is the misunderstanding about the concept of Cadastre and its role in Land Administration. In order to overcome this, the conceptual schema of the project is based on a review of academic and technical papers about Cadastre and Land Administration worldwide in the last 20 years, starting with the Cadastre 2014 initiative (Kaufmann and Steudler, 1998) and, further, the role of Cadastre in Land Registration Systems (Zevenbergen, 2002), the development of Land Administration concepts (UNECE, 1996; Enemark, 2004) and models, like Core Cadastral Domain Model – CCDM (Oosterom, 2006), Social Tenure Domain Model – STDM (Augustinus, 2010) and Land Administration Domain Model – LADM (ISO 19152:2012; Lemmen, Oosterom, Bennett, 2015); crowdsourcing experiences and Fit-For-Purpose Land Administration (FIG, 2014b); Land Governance (Deininger, 2010; FAO, 2012) as well the further developed Assessment Framework – LGAF; and the Spatial Enabled Society paradigm (FIG 2014a).

The understanding of these references and the specific legal, organizational and operational context of Cadastre in Brazil, allowed to evaluate what could be done to improve the situation. The first point is to share the same basic concepts among the Land Administration organizations.



For example, in Brazil, the common understanding of land cadastre does not relate it to the geospatial representation of land parcels. Other example: it is not recognized that there should be one basic cadastral reference to other specific purposes in land administration, covering one administrative area.

Sharing the concept of Cadastre that allows the legal independence of organizations and, at the same time, the integration via SDI, is a fundamental step to reach consensus and make the further adjustments possible among the land administration organizations, including eventual reorganization in attributions.

3.2 Broader Tenure Scope

The actual rural cadastral systems consider two tenure conditions in a formal level (property and possession by title) and one status that represents all possible informal situations (possession by simple occupation). It is necessary to expand the cadastral model used today to cover the range of land tenure rights in Brazil (UN Habitat, 2008):

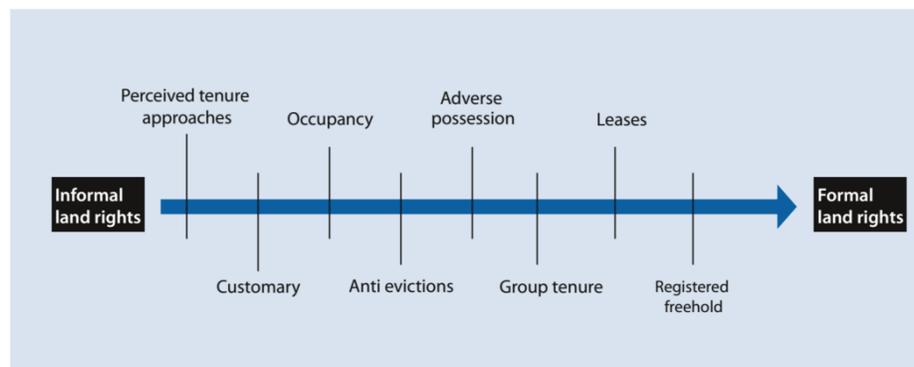


Illustration 2: Continuum of land rights

The main problem is the variety of possible situations of informal/social/cultural based tenure rights. The strategy to cover these situations is flexibility. Not just about the inclusion of cheaper and faster acquisition methods, nor the involvement of community, but how to collect and update the tenure code lists, and to represent them in a coherent way.



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017

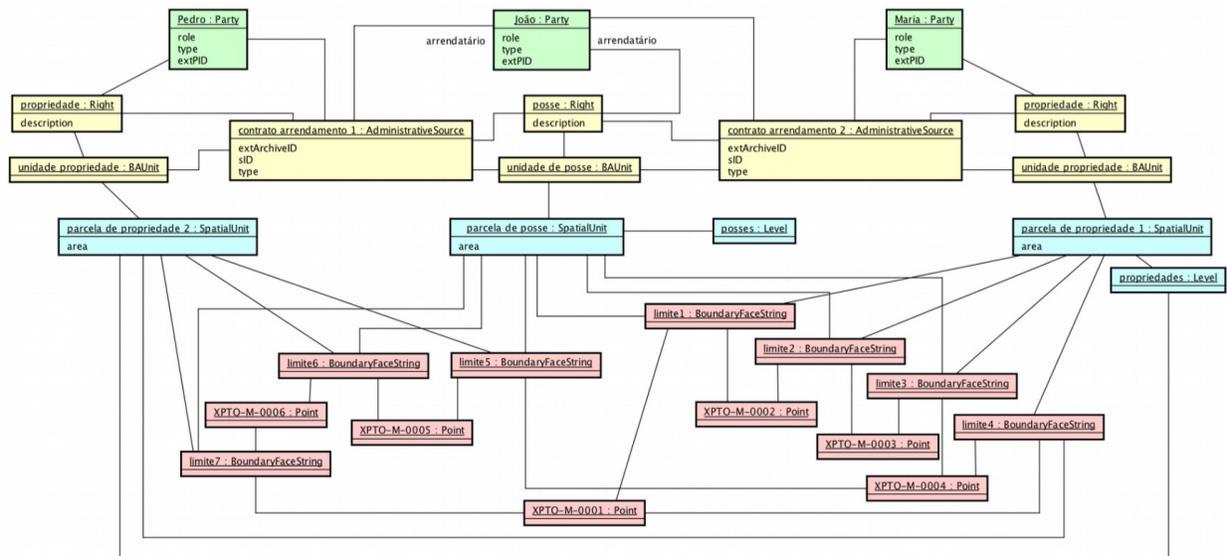


Illustration 3: Class diagram based on LADM representing two properties and one possession

The LADM has shown powerful capabilities to represent situations like the case of Illustration 3, in which one spatial unit is object of a possession right, and shares the same topological primitives with two parcels object of different property rights. This is particularly important considering the possibility of composing spatial units with boundaries from different classes, as discussed ahead.

From the authority perspective, the proposed solution is to include institutions responsible for that task of recognition, that could be called land tenure authorities, organized in levels. Each level is related to a tenure group, as shown in Table 2.

These institutions will endorse the relations of rights declared by the parties or informed by the data producers, and necessarily have a territorial presence closer to the citizens. The roles and levels of data producers will be discussed ahead.

It should be possible to record different relationships, recognized by different institutions, at the same time, to the same area. This is a key feature of the system, using topology spatial data structure.



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017



Tenure Group	Land Tenure Authority
Formal Domain	Registry, Notaries, Judicial System, Public Land Institutions (Federal and State levels) and other agencies directly responsible for management of public land of common use (roads, public squares, navigable rivers etc).
Public Concessions	Public institutions responsible for management and concession of public land to other parties like: productive settlements in public land, traditional populations in conservation units etc.
Social Tenure (Informal)	Organized civil society: associations, unions, NGO's...

Table 2: Land tenure recognition authorities

3.3 Data Acquisition

Consists in reviewing the actual regulations (used for rural areas) and including new methodologies for cadastral data acquisition. This will expand the options over the conventional techniques of surveying, enabling other actors to provide cadastral data, like in crowdsourcing.

The data acquisition methods will be organized in three classes:

Class	Producers	Methods
A	Credentialed professionals with technical liability	Conventional cadastral data acquisition methods, like GNSS, topography and aerophotogrametry, used in specific situations and precision levels, with technical liability associated. Inclusion of new methods, like the use of Unmanned Aerial Vehicles (UAVs).
B	The same as in Class A, plus: public servants designated to the task by a public institution	More accessible methods, like navigation receivers, tablets and smartphones, without precision control nor technical liability.
C	The same as in Classes A and B plus: Citizen (as in <i>crowdsourcing</i>)	Data extraction from imagery (orbital remote sensing platforms), directly in a web interface.

Table 3: Classes of data production



3.4 Linking Purpose and Cost

Establish the proper link between the method of data production and the tenure situation, considering the precision required for each one.

Classes	Levels		
	1	2	3...
A	X	X	X
B		X	X
C			X

Table 4: Relation between classes and levels

3.5 Evolution

Create migration rules to improve the precision of cadastral data in time, when required. The transition between classes must be promoted progressively, accumulating the efforts and technological advances.

3.6 Technology

Review the web platform used to manage the rural cadastre data, improving its capabilities and scaling performance. This concerns the possibility to operate in clusters, based on different cadastral zones.

3.7 Collect Priority

As the resources are scarce, is necessary to define priority areas that should be inserted in cadastre using a systematic approach. Studies are being made to identify these areas, considering, in special, conflicts.

3.8 Cadastre Continuity in Space and Time

Design data and process models that could be used for rural and urban areas, covering the territory as a whole. This way make the processes simpler, with standardized methods and validation.

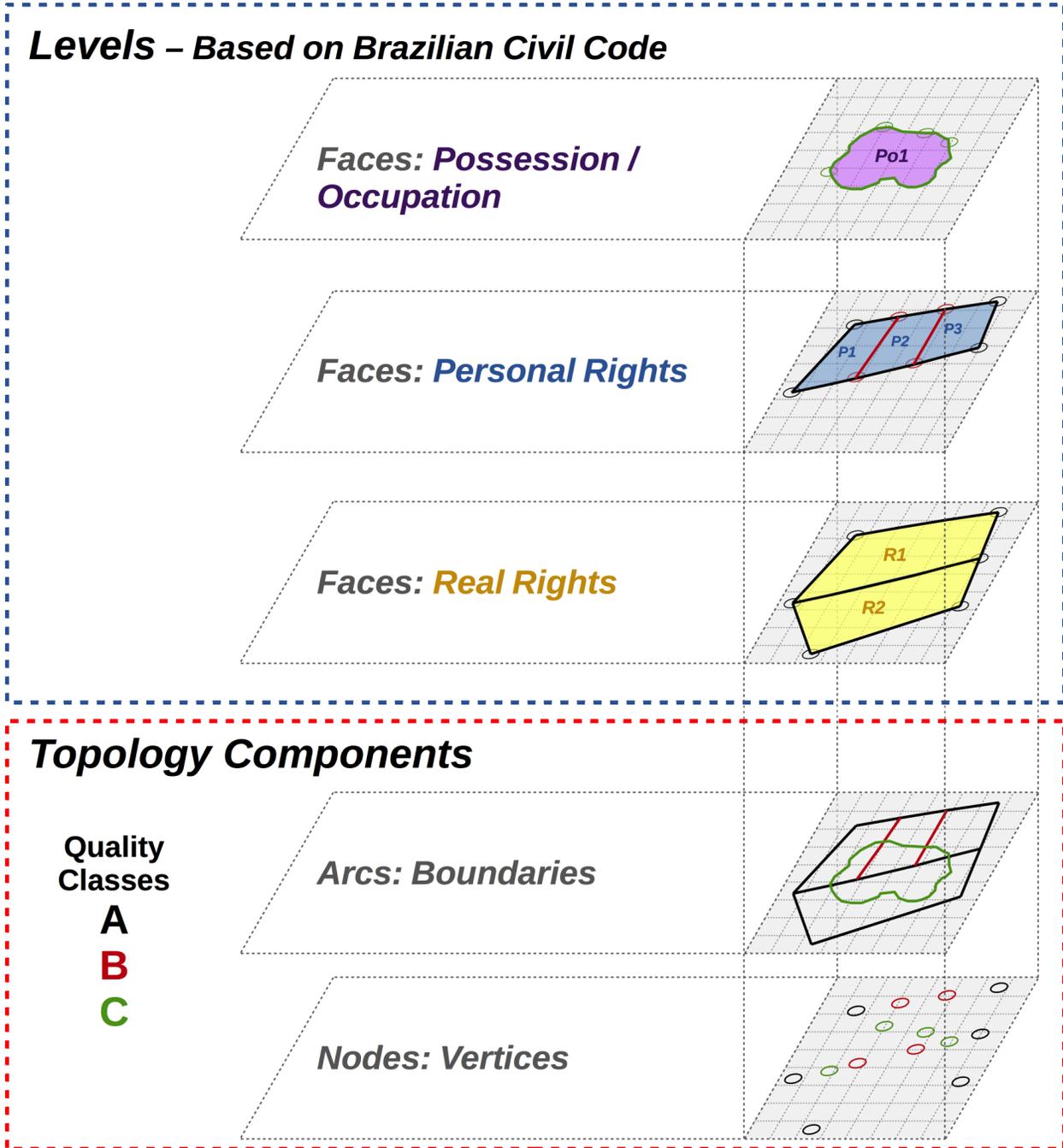


Illustration 4: Proposed spatial representation of rights in levels based on Brazilian Civil Code



4. CONCLUSION

Considering the challenges discussed before, is clear that changes must be made in the current land administration sector in Brazil, in order to attend the Voluntary Guidelines on the Responsible Governance of Tenure of Land (FAO, 2012). One inevitable way is to strengthen the efforts to produce and organize different and isolated cadastres in one cadastral system.

In this context, it is been developed the project of the National Land Cadastre. Based on previous success cases and new references like LADM (ISO 19152:2012), incorporating the fit-for-purpose concept it will be possible to represent continuously the tenure condition of the Brazilian territory in few years, with affordable cost and the high effectiveness. The results will be progressively improved in precision and consolidation of land tenure authorities, linked to the system.

It is expected that with this project, it should be possible to have better land management, addressing issues like land tenure rights recognition, conflicts resolution, use and environmental control, urban expansion, patrimonial management among many others.

It is assumed, despite the institutional issues that could rise, that it should be a good opportunity to sum efforts in the same direction and provide this tool for Brazilian society.



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017



REFERENCES

Augustinus, C. (2010). Social Tenure Domain Model: What It Can Mean for the Land Industry and the Poor, XXIV FIG International Congress 2010. Sydney, Australia. Barry, M., (2005). Talking Titler Multimedia Land Management System. 5th FIG Regional Conference, Land Administration and Good Governance, Accra, Ghana, March 8-11, 2006.

Bogaerts, T., & Zevenbergen, J. (2001). Cadastral systems – alternatives. Computers, Environment and Urban Systems, 25(4), 325-337.

Cedraz, A.; Rodrigues, W. A.; Bugarin, P. S. Tc 011.713/2015-1. Brasília: [s.n.], 2015. Available at
<http://portal3.tcu.gov.br/portal/page/portal/TCU/imprensa/noticias/noticias_arquivos/011.713-2015-1_MAPA_E_MMA_solos_comp.pdf>.

CPT - Comissão Pastoral da Terra (2014). Conflitos no Campo - Brasil 2014. Available at
<http://www.cidades.gov.br/images/stories/ArquivosSNPU/Biblioteca/PlanelamentoUrbano/Portaria_511_PROEXT.pdf>.

CSDILA - Centre for Spatial Data Infrastructures & Land Administration (2016). Cadastral Template 2.0. Available at: <<http://www.cadastraltemplate.org/germany.php>>

Deininger, K. et al. (2010). Innovations in land rights recognition, administration, and governance. Washington DC: The World Bank, GLTN, FIG, and FAO.

Enemark, S. (2004). Land administration systems - managing rights, restrictions and responsibilities in land. Hyderabad, India: [s.n.]. p. 1-5.

FAO - Food and Agriculture Organization (2012). Voluntary guidelines on the responsible governance of tenure of land, fisheries and forests in the context of national food security. FAO, Rome, Italy.

FIG - International Federation of Surveyors (2010). The Social Tenure Domain Model – A Pro Poor Land Tool. Author: C.H.J. Lemmen. FIG Report. Joint FIG/UN-Habitat/GLTN Publication, FIG Publication No 52. International Federation of Surveyors, Copenhagen, Denmark.

FIG - International Federation of Surveyors, (2014a). CADASTRE 2014 and Beyond. Ed. Daniel Steudler. International Federation of Surveyors (FIG).

FIG - International Federation of Surveyors, (2014b). Fit-For-Purpose Land Administration. Authors: Enemark, S., Bell, K.C., Lemmen, C.H.J. and McLaren, R. FIG Guide. Joint FIG/World Bank Publication. FIG Publication No 60. International Federation of Surveyors and The World Bank, Copenhagen, Denmark.

FIG - International Federation of Surveyors. (1995). The FIG statement on the cadastre.



Responsible Land Governance: Towards an Evidence Based Approach

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 20-24, 2017



Belconnen, A.C.T.: International Federation of Surveyors (FIG).

ISO 19152:2012. Geographic information – Land Administration Domain Model (LADM), Geneva, Switzerland.

Kaufmann, J., Steudler, D. (1998). Cadastre 2014 - A vision for future cadastral system, Working Group 1 of FIG Commission 7, Rüdlingen, Switzerland.

Lemmen, C., Augustinus, C., Du Plessis, J., Laarakker, P., De Zeeuw, K., Saers, P. (2015). The Operationalisation of the Continuum of Land Rights at Country Level. Paper presented to the Annual World Bank Conference on Land and Poverty, Washington DC, US, March 2015.

Lemmen, C., van Oosterom, P., Bennett, R. (2015). The land administration domain model. Land use policy, 2015. v. 49, p. 535–545. Available at:
<<http://dx.doi.org/10.1016/j.landusepol.2015.01.014>>.

Lemmen, C., van Oosterom, P., Thompson, R., Hespanha, J. P. and Uitermark, H. (2010). The Modelling of Spatial Units (Parcels) in the Land Administration Domain Model (LADM). In: Proceedings of the XXIV FIG International Congress 2010, April 2010, Sydney, 28 p.

Marra, T., Barbosa, K., Oliveira, E. (2015). Brazil Towards an Effective Cadastre with Sigef. Proceedings: Conference on Land and Poverty, Washington-DC, USA. World Bank, 2015.

Oosterom, P. Van et al. (2006). The core cadastral domain model. Computers, environment and urban systems. v. 30, n. 5, p. 627–660.

UNECE. (1996). Land administration guidelines – with special reference to countries in transition. Geneva: United Nations.

UN-Habitat, (2008). Secure land rights for all. UN-Habitat, Nairobi, Kenya.

UN-Habitat/GLTN/IIRR, (2012). Handling land: innovative tools for land governance and secure tenure. UN- Habitat/GLTN/IIRR Nairobi, Kenya.

ZEVENBERGEN, J. (2002). Systems of land registration, aspects and effects. [S.l.]: Technical University of Delft. ISBN 9061322774.



Tables

Cadastral created by law in Brazil (adapted from Marra et al, 2015).....	5
Land tenure recognition authorities.....	11
Classes of data production.....	11
Relation between classes and levels.....	12

Illustrations

Evolution of certification in numbers: spatial units by year.....	7
Continuum of land rights.....	9
Class diagram based on LADM representing two properties and one possession.....	10
Proposed spatial representation of rights in levels based on Brazilian Civil Code.....	13