

**Marcos Aurélio Santos da Silva**

Empresa Brasileira de Pesquisa Agropecuária –  
Embrapa Tabuleiros Costeiros  
(Aracaju, Sergipe, Brasil)  
marcoasilva.inf@gmail.com

**Assessing Capability and Power of a Socioterritorial Complex Systems**

**Avaliando Capacidade e Poder em Sistemas Complexos Socioterritoriais**

---

**ABSTRACT**

Empowerment of civil society, beyond its own value, seems to be a nice lever for the efficiency of sustainable development programs and the Brazilian government has embarked on this path. If economic results are quite easy to measure, this is not the case for the evolution of power relationships toward a better balance between social actors' positions. This article shows how to apply the SocLab framework, a modeling approach that considers power relationships within systems of organized action, to shed light on this issue in The Southern Rural Territory of Sergipe, Brazil. The simulation results of the model showed significant changes from 2010 to 2016 mainly in the capability, but also in the power of the Associations despite their internal problems to put into practice their ability of negotiation or even of real engagement in the territory.

**Keywords:** sociology of organized action; public policy assessment; agent-based system; complex system.

---

**RESUMO**

O empoderamento da sociedade civil, além de seu próprio valor, parece ser uma boa alavanca para a eficiência dos programas de desenvolvimento sustentável e o governo brasileiro embarcou nesse caminho. Se os resultados econômicos são facilmente mensuráveis, este não é o caso da evolução das relações de poder para um melhor equilíbrio entre as posições dos atores sociais. Este artigo mostra como aplicar a estrutura do SocLab, uma abordagem de modelagem que considera as relações de poder dentro de sistemas de ação organizada, para esclarecer tal questão no Território Rural Sul de Sergipe. Os resultados da simulação do modelo revelam mudanças significativas de 2010 a 2016, principalmente na capacidade, mas também no poder das Associações, apesar de seus problemas internos para colocar em prática a sua habilidade de negociação ou mesmo de engajamento real no território.

**Palavras-Chave:** sociologia da ação organizada; avaliação de políticas públicas; sistema baseado em agentes; sistema complexo.

Universidade Federal do Espírito Santo - UFES

**Endereço**

Av. Fernando Ferrari, 514, Goiabeiras  
29.075-910, Vitória-ES  
gestaoeconexoes@gmail.com  
gestaoeconexoes@ccje.ufes.br  
<http://www.periodicos.ufes.br/ppgadm>

**Coordenação**

Programa de Pós-Graduação em  
Administração (PPGADM/CCJE/UFES)

**Artigo**

Recebido em: 26/07/2019  
Aceito em: 31/08/2019  
Publicado em: 30/09/2019

## Introduction<sup>1</sup>

Since 2003, the Brazilian Federal Government has adopted the territorial development paradigm, that is focusing actions on quite small and highly coherent territorial units, as a strategy for sustainable rural development through two programs, coordinated by the Territorial Development Secretariat (SDT) of the Ministry of Agrarian Development (MDA): the National Development Program for Sustainable Development of Rural Territories (PRONAT) and the Territory of Citizenship Program (PTC) (Decreto de 25 de fevereiro, 2008; Ministério do Desenvolvimento Agrário [MDA], 2005). The key strategy of these programs to boost the efficient allocation of financial and material resources is to promote concertation in decision-making processes (Sabourin, 2015; Silva, 2015). The main instrument of this public policy is the creation, in each involved territory, of a Collegiate for Territorial Development (CODETER) which is responsible for local coordination of these programs and gathers the social actors to decide about their Rural Territory. The CODETER is intended to elaborate and deploy the Territorial Plan of Sustainable Rural Development (PTDRS), which details all necessary plans for the next years.

The decentralization of territorial management through local CODETERs aimed to change the power relationships among social actors for the empowerment of civil society (Silva, 2015; Silva, Medeiros, Manos, & Siqueira, 2014). As a consequence of these two public policies, Social movements were to increase their influence, majors of small cities realize that their traditional capacity to politically control their municipalities had been diminishing, and governmental agencies take this opportunity to increase the efficiency of their action. But, to what extent has it really happened? Assessing the success of this strategy for civil society empowerment requires evaluating changes in power relationships that actually occurred in rural territories.

The Southern Rural Territory of Sergipe, Brazil, benefits from the PRONAT and PTC programs and the social relationships between the actors engaged in the local PTDRS have been observed and analyzed at two moments: in 2010 and 2016. Thus, we can assess by comparison the changes that went with the implementation of these programs. These analyses have been performed in a formal way using the SocLab framework, an action-based computational formalization of the Sociology of Organized Action (Crozier, 1963; Crozier & Friedberg, 1980; Friedberg, 1996) for the study of cooperation and power relationships between actors in organizations, and more generally within Social Systems of Organized Action (SOA) (Sibertin-Blanc *et al.*, 2013). A brief review of the SocLab application on territorial studies can be found in Silva (2015).

## Material and methods

### The southern rural territory of Sergipe

The Southern Rural Territory of Sergipe (TRSS) has been established by the MDA in 2003 and reformulated in 2008 (Siqueira, Silva, & Aragão, 2010). The TRSS is composed of

---

<sup>1</sup> Uma versão preliminar deste artigo foi apresentada na 13th Annual Conference of the European Social Simulation Association (ESSA) que aconteceu na cidade de Dublin, Irlanda, em 2017.

twelve municipalities in the southern region of Sergipe State, Brazil. The main activities are the production of orange for the local agro-industry, the extensive livestock production, and the extraction of the mangaba, an exotic fruit, in the coast. Also noteworthy is the production of coconut, manioc, mango, tobacco, passion fruit, beans, and corn. In this region, predominates the small rural property with soils featuring low agricultural aptitude.

The TRSS's CODETER is composed of 72 members with voting rights. Each municipality nominates representatives for each of its six seats, three for the civil society and three for public institutions. The core management special group includes six members, in the same proportions. To provide TRSS's CODETER with logistical and organizational support, MDA contracted from 2008 to 2014 a territorial adviser, indicated by the members of the CODETER, responsible for the coordination and management of the CODETER. Since 2015, until 2017, the Territorial Development Nucleus (NEDET) played this role.

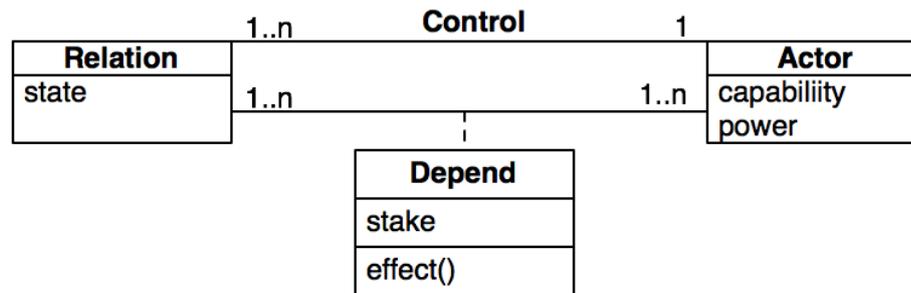
### The SocLab modeling and simulation framework

The SocLab framework formalizes and slightly extends the Sociology of Organized Action (SOA) introduced by Crozier and Friedberg (1980). Roughly speaking, this sociology proposes to reveal why people behave as they do in collective action contexts, as the results of power relationships based on the matching between actors' goals and the availability of needed resources. In fact, SOA defines any social organization as a Concrete System of Organized Action (CSOA), which encapsulates all social components such as social actors, relationships, goals, etc.

A SocLab model of a social systems based on the SOA theory includes a set of actors and a set of relations among them (Sibertin-Blanc *et al.*, 2013). Each actor corresponds to an individual or a group of individuals that is active in the social system and has some specific goals, a mix of its personal objectives and organizational roles. Of course, it needs to use some resources to reach these goals while most of these needed resources are controlled by other actors. Conversely, each actor controls some resources and so determines how they may be used by actors who need them to achieve their goals.

Each relation is founded on such a resource controlled by one actor and on which some actors depend for the achievement of their goals. Thus, actors are reciprocally dependent on each other, and the relations are instruments for expressing of their conflicts and cooperation. Each resource can generate more than one relation.

Figure 1 shows the SocLab metamodel of the structure of CSOA models. The state of a relation measures (on a scale of -10 to 10) how much the controller actor does cooperate or not with others by favoring or hindering accesses to the resource. In the dependence of an actor on a relation, the stake measures the importance of the resource for the actor; the more a resource is necessary to achieve an important goal, the higher the corresponding stake (on a scale of zero to ten, the stakes of every actor sums to ten). The effect function of a relation on an actor is a function that defines the usability of the resource according to the state of the relation, i.e. how much the behavior of the actor controlling the resource (x-axis) eases or impedes the depending actor to achieve his goals (y-axis).



**Figure 1.** UML Diagram of the Core Elements of the SocLab Framework

A state of a SocLab model is defined as a vector of all relation's states that is a fixed level of cooperation of actors with regard to others. In any configuration, every actor both provides to and gets from others some capacity to use resources needed to achieve goals. When the modeled social system is in a configuration  $s$ , where  $s_r$  denotes the state of the relation  $r$ , the capability of an actor  $a$  to achieve its goal is calculated as the sum of the values of effect functions over  $a$  of the relations that  $a$  depends weighted by its stakes, and power is the sum of effect of the relations that  $a$  controls, also weighted by its stakes, over others actors  $b$  which need it:

$$capability(a, s) = \sum_{r \in R} stake(a, r) \times effect_r(a, s_r) \quad (1)$$

$$power(a, s) = \sum_{b \in A} \sum_{r \in R, a \text{ controls } r} stake(b, r) \times effect_r(b, s_r) \quad (2)$$

where  $R$  is the set of relations, and  $A$  the set of actors.

Actors are assumed to be rational, that is to say, that their behavior is guided by their beliefs on the best way to achieve their goals, even if their rationality is limited. So, in the management of relations under its control, each actor cooperates to the extent of its possibilities in order to get from others access to relations it needs. The rationality of actors leads them to adopt quite steady behaviors, once they have found how to induce others to give them a satisfying capacity of action. The social actor game, which is the regulation process by which actors mutually adjust their behaviors to one another, produces configurations that are more or less frail balances between actors' positions and is based on a reinforcement learning process (Sutton & Barto, 1998).

To compute configurations that are likely to emerge from the regulation process, the SocLab platform includes a simulation engine which implements the social game and so computes which behavior each actor could adopt (Sibertin-Blanc & El Gemayel, 2013). To this end, a multi-agent implementation of SocLab models provides actors with rationality for playing the social actor game. Actor agents try, as a meta-goal, to get a high level of capability, i.e., to have the means needed to achieve their concrete goals. However, according to the bounded rationality assumption (Simon, 1984) they just look for a 'satisficing' level of capability, not an illusory optimal one. Within a joint learning process of trial and error, each actor maintains a dynamic level of aspiration, which is initiated at the maximum value of its capability and progressively comes closer to its current level, according

to a reality principle. Each actor also manages a dynamic rate between exploration and exploitation that determines the strength of its search for a higher level of capability.

A simulation ends when every actor has a capability that is over his level of aspiration and no longer seeks another behavior. It is a stationary state, actors manage the relations they control in such a way that everyone accepts its level of capability then, the organization can work in this way, a regulated configuration has been found. The length of a simulation, i.e. the number of steps necessary to reach a stationary state, indicates how difficult it is for actors to jointly find how to cooperate.

### Using SocLab to public policy assessment

In this paper the way we used SocLab to assess the public policy is fourfold. First, our social phenomenon is analyzed as a system, so all necessary components (social actors, relations, effect functions, etc.) and their connections must be identified in a systemic manner. Second, to model power relations in a real society you need to go beyond institutional relationships and dive into hiding coalitions and conflicts, so the SocLab framework systematizes this knowledge of our territory. Third, SocLab defines a series of sociological indicators (e.g., capability and power) that can be used directly to analyze power relations and the social structure and change over time considering some referential social system states. In this work it was considered two referential states, one where each social actor achieves the maximum capability and the other when the social system achieves equilibrium after simulation. Finally, according to the simulation results denoted by variation of actor's capability and relation's state, and the speed of the simulation process it is also possible to classify the social system structure as stated by Chapron (2012) as simple, complex, deterministic or multimodal. And doing so, evaluate the impact of the public policy over the Southern Rural Territory of Sergipe, Brazil.

### Data collection

The social system of the Southern Rural Territory of Sergipe was analyzed at two periods of reference: years 2010 and 2016. The analysis for the year 2010 is based on the reinterpretation of the works of (Silva, 2014; Silva *et al.*, 2014; Silva, Santos, Galina, Medeiros, & Almeida, 2016). For the year 2016, a documentary research, interviews with social actors and participation in meetings of the CODETER and thematic chambers were carried out from March 2016 to March 2017. The data consists mainly of record interviews, field notes, and collected documents.

### Model of the TRSS's CODETER

The modeled CSOA is the TRSS's CODETER and the social actors implicated in the elaboration of the PTDRS. It is worth noting that for each social actor, it was assigned only one resource, so each actor will control only one relation. For simplicity reasons, the name of each relation will be the name of the resource that the social actor controls.

## Social actors and their relations

Associations of producers gather small farmers or people who live in small rural villages. They are the formal representation of small rural communities and the main channel of communication and negotiation, since the 1980's, with small farmers and rural workers. Despite the low level of associativism and cooperativism in the region, the associations are growing in relevance on many concertation forums like those that the TRSS's CODETER. The Associations actor controls the relation access to rural area, as it gives (or not) access to the physical rural space. A restricted access means those associations are closed, politically or physically, to foreign interventions; a neutral access means that they are open to projects, but demand negotiations. An unrestricted access means that anyone can influence, develop projects or simply have access to the rural space of the association.

The City Hall is the lowest level of formal institutional organization and it is responsible for the management of the financial and material resources (e.g., Project of Infrastructure - Proinf) of the Rural Territory. In general, the major somehow opposes politically the social movements, the Unions, and the State/Federal politics, but due to formal obligations or strategical and temporal coalitions, it cooperates to some extent. The City Hall manages the relation he controls very strategically, trying to make it scarce if the project contravenes his aims, to be neutral if the project does not affect the municipality, or to make the relation freely available if the project matches the City Hall interests.

Brazilian Agricultural Research Corporation (Embrapa) is strongly committed in the Southern Rural Territory of Sergipe since 2008 through a number of R&D projects of technological diffusion and support for small farmers' concertation about agroecological practices. This relation is important, but not explicitly demanded by small farmers; they need more urgently technical assistance for day-by-day activities. Due to many difficulties in transferring technology, the role of Embrapa in the Territory had been diminished in the first period - 2010, but a stronger partnership with other social actors improved the perception of the Embrapa's role in the second period - 2016. A restricted offer of R&D projects means that Embrapa is being very selective about where, when and for whom it works, a neutral access to this relation means that projects are developed on demand, and a full access means that Embrapa is fully interested in new projects in the region whatever they are.

Landless Movement is a Marxist-inspired social movement originated in the 1980's. The main goal of this actor is to fight for a fair redistribution of underexploited rural properties to poor rural workers. It has a strong political power due to its organization, capacity of social mobilization and the existence of political representatives. This actor controls the relation sociopolitical mobilization in settlements; this means that settled people can be completely politically apathetic or strongly engaged with ideas and wills of this social movement.

Rural Unions are the main support for the rural workers, mainly for health assurance issues. They provide a strong support to the CODETER providing infrastructure (e.g., physical space, materials) for the plenary, and meetings of special groups. They also mobilize people politically and they are the main source of communication between rural workers and public agencies (e.g., Agricultural Development Company of Sergipe - Emdagro). In general, they cooperate mainly with Emdagro and Bank of Nordeste sharing data about rural workers, and, they have strong ties with the Landless Movement. The access to the relation controlled by this social actor, infrastructure, and social base engagement, can be very scarce due to local obstructions, including political opposition to projects, or completely at the disposal of key collaborators as the Landless Movement.

Emdagro is the State's Agency responsible for the technical assistance and rural extension for the development of almost all types of agricultural activities in Sergipe, but not in settlements from land reform. It were very active and important in the past - 2010, but right now are facing budgetary limitations and the technical assistance is very restricted due to lack of staff and material relations. Emdagro does not have enough tech and human resource capacity to embrace all needs of the region. Therefore, they must choose who or what group they will assist at first.

The Sustainable Development Company of the State of Sergipe (Pronese) had been very active between 2008 and 2012, mainly as the main adviser on projects financed by the World Bank. However, due to administrative reforms, this social actor is not active anymore. Pronese managed a very relevant relation, consulting on sustainable agricultural projects; it could be very accessible due to the flow of money from the World Bank, or very restricted due to a huge number of limitations such as quality of projects, educational level of small farmers, political struggle etc.

The Nucleus of Extension in Territorial Development (NEDET) is responsible for general consulting of the TRSS's CODETER, and for animation of the meetings and plenary sessions of the TRSS. NEDET is composed of three federal institutions: Federal University of Sergipe, Federal Institute of Sergipe and Embrapa. Created in 2015, it had been financed by the National Council for Scientific and Technological Development (CNPq) and his main goal in the TRSS is to coordinate the elaboration of the PTDRS. A restricted access to the relation controlled by the NEDET, general consulting, means that it focuses on very local projects (individualistic behavior of NEDET's members), and an unrestricted access means that the NEDET is fully engaged in more territorial projects (cooperative behavior).

### Dependencies of actors on relations

The CODETER is the place for concertation, communication and political manifestations of social actors. The Figure 2, that represents the model for the year of reference 2010, shows the dependencies of the social actors (in columns) on the relations (in rows). Each cell contains an effect function that describes the impact of the relation's state on the social actor and a number (stake) that represents the level of importance of the relation for the actor. The diagonal shows the dependency of the actor on the relation that he controls.

The stake of Associations to the relation it controls had been attributed a short value 2 because to achieve their goals this social actor needs multiples collaborations with the others and consequently its stakes had been distributed on other actors. The effect function of this auto relation is an inverted parable which means it searches to be in a comfortable position avoiding to be too socially closed or opened. In fact, the most important relation for Associations is the consulting on sustainable agricultural projects, where the stake had been given value 4. The Associations depends on support to elaborate projects able to receive national and international investments. This social actor also needs support from municipalities and from Emdagro. The effect functions to these relations are all linear and positive, meaning that it needs an unrestricted access to these relations.

The City Hall is a key social actor in the Territory because it has its own political positions that, sometimes, oppose the federal policies and, at the same time, it needs to support the PRONAT and other programs, by managing the financial and material resources. In general,

but not always, they oppose the Associations, the Landless Movement, and Rural Workers' Unions. The City Hall has the means to achieve its goals and this is the reason that the stake in their own relation had been given the value 3, as well as the relation controlled by the Associations because have access to this social actor means have some political influence over them. Then, a decreasing linear curve represents the effect function of the relation rural area of the social actor City Hall, so a completely open Associations is not good at all to the City Hall. The City Hall also has some conflicting relations with the Landless Movement (stake =1), Rural Union (stake=1) and a positive relation with Pronese (stake=2).

	Associations	City Hall	Landless Movement	Rural Union	Emdagro	Pronese
Rural area	 2.0	 3.0	 0.0	 2.0	 2.0	 3.0
Management of material and financial resources	 2.0	 3.0	 2.0	 2.0	 0.0	 3.0
Sociopolitical mobilization in settlements	 0.0	 1.0	 4.0	 1.0	 0.0	 1.0
Infrastructure and social base engagement	 0.0	 1.0	 2.0	 5.0	 4.0	 0.0
Technical Assistance and Rural Extension	 2.0	 0.0	 0.0	 0.0	 2.0	 1.0
Consulting on sustainable agricultural projects	 4.0	 2.0	 2.0	 0.0	 2.0	 2.0

**Figure 2.** Dependency of Actors (in column) on Relations They Depend On (in row), the Effect Functions and the Distribution of Stakes for the 2010 Year of Reference

For each effect function, the x-axis represents cooperativity in the management of the relation by its controlling actor, while the y-axis is the scale of the resulting effect on the dependent actor.

For the year of reference 2016, it had been elaborated another model, shown in Figure 3. In fact, six years of PRONAT in the Territory created many opportunities for social actors to establish new relationships, to change existent ones and to aggregate new social actors. The Embrapa, always present in the Territory showed to be a key player and it has been working on a huge increasing in agroecological activities that started in 2008 but can only be perceived nowadays. The Embrapa has a straight connection to the Landless Movement

because in settlements there is enough rural space and political consciousness to develop agroecological projects, so, this explains the highest stake to the relation sociopolitical mobilization in settlements. The stakes of the Emdagro associated to the relation rural area had been maintained.

**Figure 3.** Dependency of Actors (in column) on Relations They Depend On (in row), the Effect Functions and the Distribution of Stakes for the 2016 Year of Reference

	Associations	City Hall	Embrapa	Landless Movement	Rural Union	Emdagro	Nedet
Rural area	 2.0	 3.0	 2.0	 0.0	 2.0	 2.0	 3.0
Management of material and financial resources	 2.0	 2.0	 0.0	 1.0	 1.0	 0.0	 1.0
R&D projects	 1.0	 0.0	 2.0	 2.0	 0.0	 1.0	 1.0
Sociopolitical mobilization in settlements	 0.0	 2.0	 3.0	 3.0	 2.0	 0.0	 2.0
Infrastructure and social base engagement	 1.0	 1.0	 0.0	 2.0	 5.0	 2.0	 2.0
Technical Assistance and Rural Extension	 2.0	 0.0	 2.0	 0.0	 0.0	 4.0	 0.0
General consulting	 2.0	 2.0	 1.0	 2.0	 0.0	 1.0	 1.0

Analogously, all relations among social actors can be inferred from the Figure 2 for the year of reference 2010. Therefore, it is worth to note that, there is a clear opposition between the City Hall and a block composed of the Landless Movement and the Rural Union.

The Landless Movement inverted the effect function related to the relation controlled by the City Hall, but with a limited amplitude and stake. This corresponds to a political reorientation because it becomes more necessary to establish new partnerships with local

authorities, mainly in projects including shared relations. Facing changes in the country global politics, the Landless Movement is searching to reinforce alliances (Rural Unions, Embrapa). It had been given 2 stakes to its own relation and to the relation controlled by Embrapa. In fact, Embrapa is carrying out many projects in settlement areas, such as: creation of a social network for knowledge construction about Agroecology (40 small farmers share their experiences with each other); agroecological caravans; creation of the Sergipe's Agroecological Network; many diagnostic reports about agrarian systems, settlements, and small communities; approval of many research proposals to the TRSS.

## Simulation results

Tables 1 and 2 show the results of 50 simulations for each model (2010 and 2016). Table 1 presents average and standard deviation values for the final state of relations. It is worth to note that the rural area changes from a state of restriction toward a central value where it gets the best own capability; the standard deviation in the 2010 case comes from the two modes of this variable, around -9 and 0. Both in 2010 and in 2016, rural area is the only relation whose state does not maximize the power, the capability provided to other actors (to this, its state should be around 5), and this reveals a certain incapacity of Associations to help others to achieve their own goals, despite the increase of the access to the relation it controls. This also holds to a lesser extent for the general consulting relation in the year 2016. The states of other relations do not change significantly from 2010 to 2016.

Table 1

**Average and Standard Deviation of the State of Relations, at the Two Years of Reference 2010 and 2016**

Resource/Relation	Average		Standard deviation	
	2010	2016	2010	2016
Rural area	-5,58	-0,82	3,87	1,77
Management of material and financial resources	8,99	8,90	0,02	0,12
Sociopolitical mobilization in settlements	9,00	8,96	0,00	0,08
Infrastructure and social base engagement	8,99	8,99	0,02	0,02
Technical Assistance and Rural Extension	4,95	4,99	0,09	0,01
Consulting on sustainable agricultural projects	8,86		0,22	
R&D projects		6,96		0,07
General consulting		7,30		0,90

**Note.** Source: simulations data.

Table 2 shows the capability and power, in value and in proportion (regarding the range of value of each variable), of each actor for the two years of reference, 2010 and 2016. Associations increased its capability in proportion and, much more prominently, its power. This is due to the fact that, in 2016, it does no longer favor the City Hall to the detriment of other actors including itself.

The power shift in the Territory is mostly evidenced by changes in the position of City Hall, Landless Movement, and Rural Union. City Hall decreases severely its capability in value and in proportion, and the increase of its power is due to the removal of the negative

capability that it provided to Landless Movement and Rural Union in 2010. As for Landless Movement, its behavior shift to the period 2016 toward more collaborative relations produces positive effects, and the same holds for Rural Union. Regarding Emdagro, the other institutional actor with City Hall and Pronese, its capability decreases and the increase in power results from its withdrawal on itself.

Pronese, Embrapa, and NEDET presented limits to reach their full capability, and this represents exactly the real limitations of these social actors as human and material shortages, low level of rural workers education and low level of institutional integration of institutional powers.

Table 2

**Capability and Power of Actors, in Value and in Proportion, for the Two Years of Reference 2010 and 2016**

	Capability				Power			
	Value		Proportion (%)		Value		Proportion (%)	
	2010	2016	2010	2016	2010	2016	2010	2016
Associations	68.9	69.4	91.8	97.3	-16.9	13.4	42.7	77.0
CityHall	8.0	-21.4	54.4	38.1	36.0	42.7	100.0	99.4
LandlessMovement	53.8	71.3	79.9	98.3	45.0	63.9	100.0	100.0
RuralUnion	24.8	53.4	63.8	80.0	90.0	90.9	100.0	100.0
Emdagro	52.4	41.9	82.0	87.3	24.5	36.0	99.0	100.0
Pronese	41.9		74.4		71.2		99.4	
Embrapa		52.0		85.7		46.2		100.0
Nedet		51.4		81.1		24.8		90.6

**Note.** Source: simulations data.

## Conclusions

The social power unbalance is a reality of many regions in Brazil, e.g. in the Southern Rural Territory of Sergipe, and its understanding has been the focus of many academic and governmental studies (Silva, 2015). The Brazilian government originated the PRONAT and PTC public programs to better redistribute relations, and also for the empowerment of civil society. If the creation of an institutional arena of concertation, the CODETER, changed the way to design and make collective decisions regarding development issues, the effective empowerment of civil society deserves to be questioned.

On the basis of concrete investigations in the TRSS, this article provides a formal description of the power relationships that determine how actors engaged in the PTDRS both conflict and cooperate. A first benefit of using the SocLab approach is to have a formal representation of the knowledge about the relational structure of the SOA under study; it may be discussed among stakeholders and observers and, if it is not shared, the points of disagreement may be stated in an explicit way. The simulation results of the 2016 model are compliant with observations and it is considered as a faithful representation of TRSS.

In the evolution of social organization between 2010 and 2016, social actors have tended, while improving their understanding of the social game, to diminish conflicting relations, to establish new social networks, to reinforce others, to invite new social actors to

take part of the CODETER or to change from conflicting relationships toward collaborative behavior. Then, the simulation results of the 2016 model showed significant changes mainly in the capability, but also in the power of the Associations despite their internal problems to put into practice their ability of negotiation or even of real engagement in the territory. However, the comparison of simulation results of the 2010 and 2016 models leads to think that the Landless Movement and the Rural Union, actors that are most institutional than Associations, are the main winner of the changes that have operated between 2010 and 2016. Finally, according to the simulations results the social systems maintained itself as a simple and deterministic system from 2010 to 2016.

Therefore, considering that social change is a long-term endeavor, it can be concluded that the PRONAT and PTC were effective in the TRSS as the trigger of a new social dynamic.

## References

- Chapron, P. (2012). *Modélisation et analyse des organisations sociales: propriétés structurelles, régulation des comportements et évolutions*. Système multi-agents, Université de Toulouse 1, Français.
- Crozier, M. (1963). *Le phénomène bureaucratique*. Paris: Seuil.
- Crozier, M., & Friedberg, E. (1980). *Actors and systems: the politics of collective action*. Chicago: The University of Chicago.
- Decreto de 25 de fevereiro de 2008. Institui o Programa Territórios da Cidadania e dá outras providências. Recuperado de [http://www.planalto.gov.br/ccivil\\_03/\\_Ato2007-2010/2008/Dnn/Dnn11503.htm](http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2008/Dnn/Dnn11503.htm)
- Friedberg, E. (1996). *Power and rules: the organizational dynamics of collective action*. Avebury: Ashgate Publishing Company.
- Ministério do Desenvolvimento Agrário (2005). Referências para a gestão social de territórios rurais [Documento Institucional nº 3]. *Secretaria de Desenvolvimento Territorial*, Brasília, DF, Brasil.
- Sabourin, E. P. (2015). Politiques de développement rural territorial au Brésil: Entre participation et clientélisme. *Esprit Critique*, 21(1).
- Sibertin-Blanc, C., & El Gemayel, J. (2013). Boundedly rational agents playing the social actors game: how to reach cooperation. *Proceedings of the 2013 IEEE/WIC/ACM International Conference on Intelligent Agent Technology*, Atlanta, GA, USA. <https://doi.org/10.1109/WI-IAT.2013.135>
- Sibertin-Blanc, C., Roggero, P., Adreit, F., Baldet, B., Chapron, P., El-Gemayel, J., Mailliard, M., Sandri, S. (2013). SocLab: A framework for the modeling, simulation and analysis of power in social organizations. *Journal of Artificial Societies and Social Simulation*, 16(4), 1-24. <https://doi.org/10.18564/jasss.2278>
- Silva, M. A. S. da (2014). Modeling and simulation of a socioterritorial system: an exploratory

analysis of the southern rural territory of Sergipe, Brazil. *Proceedings of the Brazilian Workshop on Social Simulation*, São Paulo, SP, Brasil, 4.

Silva, M. A. S. da (2015). The territory as a complex social system. In B. A. Furtado, P. A. M. Sakowski, & M. H. Tóvolli (Eds.), *Modeling complex systems for public policies* (pp. 363-396). Brasília, Brasil: Institute for Applied Economic Research.

Silva, M. A. S. da, Medeiros, S. dos S., Manos, M. G. L., & Siqueira, E. R. de (2014). Modelagem social computacional como instrumento de análise de sistemas sociais territoriais complexos. *Campo – Território: Revista de Geografia Agrária*, 9(17), 55-85.

Silva, M. A. S. da, Santos, A. V., Galina, M. H., Medeiros, S. dos S., & Almeida, M. R. M. de (2016). Análise exploratória de simulações sociais computacionais por meio de estatística multivariada e mapas auto-organizáveis. *Scientia Plena*, 12(7), 1-18. <https://doi.org/10.14808/sci.plena.2016.071301>

Simon, H. A. (1984). *Models of bounded rationality: behavioral economics and business organization*. Boston: MIT Press.

Siqueira, E. R. de, Silva, M. A. S. da, & Aragão, A. G. de (2010). *O território rural centro-sul de Sergipe*. Aracaju: Embrapa Tabuleiros Costeiros.

Sutton, R. S., & Barto, A. G. (1998). *Reinforcement learning: an introduction*. Cambridge: MIT Press.

---

**Marcos Aurélio Santos da Silva**

Doutor em Computação (Inteligência Artificial) pela Universidade de Toulouse 1 Capitole, França. Mestre em Computação Aplicada pelo Instituto Nacional de Pesquisas Espaciais (INPE). Pesquisador da Empresa Brasileira de Pesquisa Agropecuária (Embrapa), atuando nas áreas de Geocomputação e Ciência Social Computacional aplicadas ao estudo de sistemas socioterritoriais e socioecológicos.

ORCID: <https://orcid.org/0000-0002-5367-2869>