Identification and systems methodologies for territorial delimitation[1]

Identificación y metodologías de sistemas para la delimitación de territorios

Iván Montoya R.[2, 4] and Alexandra Montoya R.[3]

ABSTRACT

This document identifies the main issues affecting the delimitation of territories and explores the conceptual approaches for describing the relationship of the territories understood as organizations with their environment. Subsequently, we studied the systems methodologies known as soft systems methodology, SSM, and complex adaptive systems, CAS. Finally, the advantages of systemic approaches to territorial delimitation are shown.

Key words: soft systems methodology, complex adaptive systems, territorial delimitation.

RESUMEN

El presente documento identifica los principales aspectos que inciden en la delimitación de territorios, y explora los principales enfoques conceptuales que permiten describir la relación de los territorios entendidos como organizaciones, con su entorno. Posteriormente, se estudian las metodologías de sistemas conocidas como sistemas suaves y sistemas complejos adaptables, finalmente, se señalan las ventajas para la identificación territorial que estos enfoques sistémicos aportan.

Palabras clave: metodología de sistemas blandos, sistemas complejos adaptables, delimitación de territorios.

Introduction: the notion of territory

Strategies to guide "development" have been modified throughout history according to the understanding of the complexity of their relationships and interactions and to the inherent changes and evolutions of societies. In these, the "territory" is presented as a category "…called on to synthesize, within a coherent framework of interpretation and management, many of the elements that constitute the new strategies of rural development…" (Ribero and Echeverri, 1998).

The concept of territory, from the social sciences, has been the object of controversy and discussion (Pérez, 2001; Montresor, 2002; Mora-Alfaro, 2006). For some, territory is conceived as the sacred place where certain cultural traditions exist, implying pre-established guidelines and norms to act upon it; this is – after all – a view of territory exerted from a tradition (E.g., religious). For others, territory "is a political category with an institutional sense and, hence, it is the object of specific ordering, which determines it as a political-administrative division category determined by a body of water, a mountain range, or some natural circumstance that determines a political limit (Solarte, 2003; Rubiano, 2005).

A central aspect on the notion of territory (Ceña *et al.*, 2007) is that it implies intentionality in its definition. This intentionality can be represented from purely determinist and nomothetic foci, like the neoclassic, to idiographic approaches that seek a specific study of the particularities of the social delimitations conducted. An alternative lies in addressing the territory as a systemic problem that can be approached through the methodologies of adaptable complex systems or soft systems.

This document seeks to explore the use of soft systems and adaptable complex systems methodologies to address the problem of identifying territory as a complex, intentionally defined unit.

Methodology

To reach the objective proposed, the document explores the main approaches that study the interaction of the organization with its surroundings, which should also be done by a territory. For this, the neoclassic and neo-Schumpeterian evolutionist approaches are studied, as well as the systems approaches. After relating the principal aspects for each of these approaches, the document centers on revealing

the advantages of the soft systems and adaptable complex systems methodologies.

The interaction of the organization with the environment

Figure 1 presents the four approaches mentioned; these refer to several ways of focusing the problem of the organization's interaction with the environment:

On one side, the neoclassic approach is contrasted to the cognitive contribution that enriches the evolutional economic approaches and the adaptable complex systems; then we identify how the enactive approach is compatible with the adaptable complex systems because of its inductive character taking distance from deductive approaches.

The contribution of the neoclassic approach

In the neoclassic approach of the organization, and according to Lara (2008), what matters are individuals and their average behavior, within a situation of natural convergence to the general equilibrium, for which the adjustment process and time leading from the initial state to the final state does not – analytically – bear major relevance. Lara (2008) holds that this is thus because, in the first place, the agents optimally select *ex ante* different goods or scenarios, given that they have a limited capacity to process information. And, in the second place, because the information processed by the agents is clear and computable, which gives way for "instant" adjustment processes. Thus, the organization is a "black box" constructed on the methodological assumption that the players make decisions "as if" their exclusive objective were to maximize the benefit or utility (Lara, 2008).

Revéiz (2007) warns of the dissatisfaction generated by the neoclassic economy, with the strengthening of schools and networks from the new institutional economy, the European association for the evolutionary political economy and the Santa Fe Institute, since 1984, in the following central assumptions that have been broadly debated by these communities:

1. On the methodological individualism and the economic interaction: The neoclassic approach does not examine the interaction of social classes, networks, or correlations of the political forces; it only explores the conduct of the individual players, in a manner that does not specify how decisions are made or their network conduct (Revéiz, 2007).

2. Individuals maximize on their own interest subject to restrictions. The author mentions that the conducts and decisions are not necessarily the result of individual processes but also of group processes (Revéiz, 2007).

3. Agents do not directly interact amongst themselves (Revéiz, 2007).

4. The neoclassic theory analyzes the economic system as a whole: it must be cautioned that the information revolution leads to the search of global equilibrium of the economic system, where the attributes and interrelations among agents are considered (Revéiz, 2007).

According to Simon (1957), reduction of rationality and maximization permits the neoclassic economist to ignore the psychological and cognitive aspects of decision making, while Dosi and Marengo (1994) state that reduction
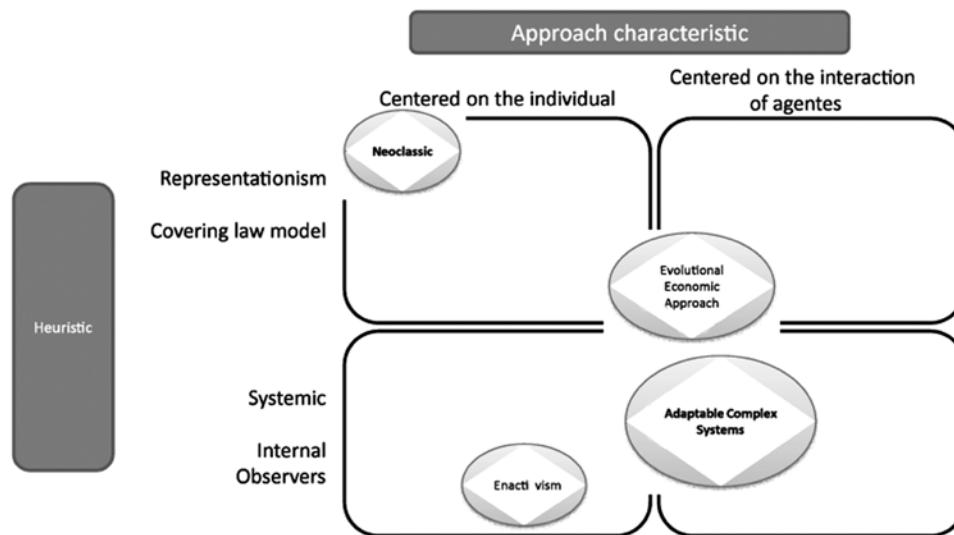

FIGURE 1. Interpretations on the organization-environment interaction. Source: adaptation by Arrow, 1974; Varela *et al*., 1991; Tsoukas and Knudsen, 2002; Kauffman, 2003; Holland, 2004; Witt, 2008.

of all market coordination modes expels the theme of organization from the economic theory. In essence, say the authors, that if we abandon the restrictive assumption of perfect information and symmetry among agents, the organizational forms interest due to incentives, information flow, and behavior, which differ according to each system's "particular institutional infrastructure." Particularly, if the performance of each system rests on the dynamics of specific learning by individuals or groups of them (like companies), the institutional architecture affects the scope and the rate at which learning can occur (Dosi and Marengo, 1994).

In this regard, Aoki (1986, 2010) has delved into coordination modes different from those of market. In relation to this form of learning as processing, Dosi and Marengo (1994) state that the neoclassic theory of decision making, and its extensions, represents decision makers through their information partition, which constitutes their skills in processing information. This partition incorporates the agent's knowledge on his/her operating scenario and becomes the framework through which the agent may classify information received from the environment and calculate the probabilities according to the conceivable events expected to happen. Thus, the Bayesian theorem is the rational form of coherent incorporation of new decisions within said framework, and maximization of the expected utility is the rational criterion to make decisions, which is coherent with the distribution of probability. These partitions turn out to be isomorphic with the "real world", and are assumed as given, for which Bayesian learning only refers to the elaboration and modification of the framework of guidelines and procedures to optimize the use of information, leaving aside the problem of representation (Dosi and Marengo, 1994).

The evolutionist economic approach (Neo-Schumpeterian)

The precursor contribution by Nelson and Winter (1982), integrates the notions of organizational knowledge and routines (Becker, 2004; Becker *et al.*, 2005) with that of competitive dynamic environments. For the authors, the company is understood as a repository of knowledge that is represented by routines[5] guiding the organizational action. According to Dosi *et al.* (2002), the difference

between capabilities and routines is specifically related to the differences between two types of behaviors: the first, that of organizational capabilities, is related to deliberate, strategic, and intentional planning; in contrast with the second, that of routines, which is related to quasi-automatic performance at the low operational level. Said difference, according to the authors, shows that these two behaviors coexist and, at the same time, generate the historical and idiosyncratic trajectories for each company. Thus, the authors state that the variety among companies permits operating the mechanism of competency selected among companies with their respective differences.

The core argument resides in suggesting that the companies benefit from the current routine, as long as economic outcomes remain above a given expected target level. Only when retribution falls bellow expected do companies commit to exploration activities in the search for better alternatives. The aspiration target levels can be subject to adaptation (Gigerenzer and Selten, 2001) and change according to the experience and imitation of other agents (March, 1988; Dosi and Marengo, 1994). Lara (2008) suggests that in this neo-Schumpeterian tradition, and specifically in Nelson and Winter (1982), in the concept of routine a surplus of "automatic" action nature has been emphasized, which has led to a dead-end street concept. Organizations centered on routines results short-sighted and trapped in search processes limited to the closeness of their local knowledge. Lara holds that by thus posing the problem, the possibilities of attaining the nature of learning and of the agent are scarce, in part because there is allusion to weak and organic forms of rationality[6].

According to these arguments, it may be said that the main point of debate in the advancements of the cognitive approach and the neo-Schumpeterian current of economic evolutionism is that of conceiving the organization as a partially programmed or entirely programmed entity, respectively, through working routines, which finally ignores the role of the organizational hierarchy and the involvement of individual players in said hierarchy, through a micro-founded homogenizing mechanism that results

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[5]   In Witt's opinion (2008), for Nelson and Winter (1982) the organizational routine is a selection unit in economic contexts and he indicates that while Schumpeter (1934) did not back the crucial assumption of his innovation hypothesis as an instrument for competition, the concept of organizational routine filled the void. This notion was derived from the work by March and Simon (1958) and Cyert and March (1963), and then synthesized in Nelson and Winter (1982), and taken in analogy to the gene types in biology.

[6]   In Lara (2009) and continuing the argument by Williamson (1989), the author holds that another difficulty in the work by Nelson and Winter is that they assume weak and organic rationality forms. Weak if compared to the strong – maximizing – form of rationality from the neoclassic approach, and organic, because the evolutionary theory attributes forms of rationality, in the first place, not to individual agents, but to the organization. Lara (2008, 2009) shows the need to recognize the double causality between the individual and the organization to properly understand the problem of problem solving and the cognitive approach.

ambiguous and unenlightening[7] (Ocasio, 1997; Tripsas and Gavetti, 2000; Gavetti, 2005; Gavetti *et al.*, 2007; Lara, 2009). However, the theoretical proposals of the cognitive approach and the neo-Schumpeterian current preserve common elements. Among these, we can highlight: i) the relevance of limited rationality; ii) the cumulative character of learning; iii) the importance of routines and norms as elements that guarantee certain inertia that favors persistence over time of the organization and the consistency of the individual behaviors and motivations of its members; iv) the role of the resolution of weakly defined problems in the adaptation; v) the operability of the retention, variation, and selection mechanisms, and vi) the limited processing capacity.

These approaches are distanced by the preference for the neo-Schumpeterian current of an agent programmed by organizational routines.

This approach of the neo-Schumpeterian current includes the following aspects:

- It keeps the organization centered on routines, anchored on the search for knowledge, within the vicinity of what is known. In Lara's opinion (2009), this search turns out to be blind, compared to recent contributions in the cognitive focus, as that of the adaptable complex systems (Maya *et al.*, 2008).

- It is not enriched by the study of the interactions among individuals within organizations, and rather adopts an organic rationality that obscures the organization and reduces it to its mere structure of routines, norms, and corporate culture.

- Hence, it maintains an epistemological approximation closet o the deductive model, as far as the replication of structures from which the organization's functions are derived, and hinders the inductive analysis of the interactions among individuals within them.

- It obscures the role of the organizational hierarchies.

These points are covered in good measure by the proposal made from the contribution in adaptable complex systems. The following section presents the points of debate of the approach in adaptable complex systems with economic evolutionism.

The adaptable complex systems approach

The approach of adaptable complex systems, also known as "emerging computing" (Holland, 2005), assumes that the agents with limited information do not have an adequate algorithm or device to solve complex problems. And this last is thus, given that it is not possible to know beforehand the space of possibilities, which can be affected by agent's scores (Brian, 2001; Castañeda, 2009).

The focus supposes the agents can adjust their behavior to reach their objectives of survival and reproduction, through learning processes (Stacey, 1995), which they manage to carry out by initially having some very simple and rudimentary guidelines, which turn out unsuited for problem solving (Dosi and Marengo, 1994).

The conjecture in this focus is that the procedures for problem solving are properties emerging from the interactions, also involving the mutation and recombination of those distributed basic rudimentary guidelines, often based on related knowledge – but hardly coded, experience, and interpretation frameworks. The crucial point of this perspective is that learning implies adaptation and discovery of procedures of problem solving that cannot be automatically derived or of information on the states of the world or of the solution concept. The empirical counterpart of these procedures comprises a broad range of organizational tasks (Dosi and Marengo, 1994)[8].

Regarding learning processes, Holland (2005) suggests that learning takes place within the space of representations and cannot be reduced to a simple processing of information. Because the environment is made up of agents (Holland,

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[7] The routines operate as behavioral patterns that tend to be tacit and function in inconsistent manner. The approach is confusing because it makes these routines equivalent to supposed "genes" for the organization, without considering the ways of relating amongst individuals and their social hierarchy structures. An illustrative example may be seen with the players in a volley ball game in which each player tacitly and unconsciously knows his/her job in each of the positions on the playing field. This knowledge does not by itself explain the team strategy in which there is leadership, control mechanisms, and hierarchical social structures among the players. Because of this, it is said that the approach is confusing to explain the micro-foundation and the hierarchical relationships within organizations.

[8] Dosi and Marengo (1994) point to some coincidences with evolutionist approaches of this way of viewing the world: (1) The difference between the process and the contents of learning is not clear, which is a point of coincidence with Nelson and Winter (1982) and Dosi *et al.* (2002); (2) The "competencies" summarize the effectiveness of the procedures to solve specific problems of the company. The "dynamic competencies" discussed by Teece *et al.* (1997) related to the procedures of the highest level related to the search for new problems and new procedures to solve problems; and (3) Its focus on the companies as problem-solving entities may agree with Williamson (1989) where it is stated that companies are economizers of transaction costs.

2004) interactions will be numerous and the system complex. There, the agents in their interaction with others[9] must define sets of world states they can represent as equivalent to perform an action, which is evaluated by a credit system (Holland, 2004)[10].

Regarding learning in complex adaptable systems CAS, Gell-Mann (2002) states that these systems learn and evolve just as human beings do, and that collective entities and organizations are in themselves complex systems, composed of a great number of active elements (agents) that interact amongst themselves, via specific mechanisms and properties, such as those suggested by Holland (2004)[11]. For Anderson (1999), the complex adaptable systems will be composed of agents with diverse behavior schemes that have the possibility of evolving and learning interactively.

The main distinction with regard to work in the neo-Schumpeterian approach, from the contribution in adaptable complex systems, is the possibility the agents and the agent aggregates (meta agents) have to face uncertainty when constructing internal models, coinciding in their internal models, and conducting *ex ante* learning, due to their possibility of solving problems through interaction and emergence of internal simulation skills of action sequences, originated by the competition and cooperation of these models. Also, the possibility of forming aggregates, which with established adaptation mechanisms can form complex agents with internal organizational hierarchies[12].

The proposal of complex adaptable systems favors the possibilities of *ex ante* learning through the use of internal models and offers explanations on the processes of emergence and conformation of meta-agents, construction blocks, and internal models within the framework of a Darwinian explanation program (Lara, 2009). In this sense, Lara (2009) indicates that the proposal of adaptable complex systems is important, because even though the agent is programmed, it also has rational skills to face uncertainty upon elaborating expectations on the structure and dynamics of the world, for which the agent should be represented with imagination, will, and conscience.

Given its compatible character with the inductive approach, the enactivism approach can be framed without much difficulty on the agent's conception on complex adaptable systems, under the image of an autonomous agent. This extension brings on the challenges of including the agents' self-organizational discourse in their environment, under a conception anchored in temporary space manner to the relationships between an agent or multi-agent and his environment, which brings a profound elaboration of the problem of viability of such within its environment.

The contributions of the systems approaches

The concept of system refers to a theoretical model that considers the organic and inorganic phenomena embedded in structures with its environment in motion. Organizations, understood as systems, can involve tasks, interactions, and feelings in relationship to a dynamic environment (Checkland and Scholes, 1990). Kast and Rosenzweig consider that the organizational system is made up of subsystems: technological, of goals and values or strategic, psychosocial or human/cultural, and structural, in counter position to the classical theory. The intersection of these subsystems, which are immersed in the exchange of energy, materials, and information, could originate the administrative or directive subsystem (Montoya, 1999).

The orientation under which the systems methodologies can account for processes of adaptation to the environment, life cycles, and factors affecting the viability of the systems, starts from the observation of complex "worlds" in which the role of the observer is decisive, given that it is the observer who is

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[9] When learning takes place within a multi-agent configuration, it also requires the coordination of learning processes of multiple individuals. The members of an organization generally have diverse representations of the environment they confront. This multiplicity of representations requires implementing some mechanisms whose task is to reconcile current or potential conflicts (Dosi and Marengo, 1994).

[10] The credit system will affect the rules of behavior. These rules will be selected, added, modified and eliminated through selection processes, and a procedure can be established to discern on the utility of the rules (Dosi and Marengo, 1994; Holland, 2004).

[11] Among the mechanisms, there is the use of labels (which facilitate the visibility of internal and external properties with the purpose of favoring the selective interaction), the use of internal models (limited samples of the environment system that permit carrying out *ex ante* learning activities) which are one of the main attributes in the proposal of complex systems, and the use of construction blocks (the adaptable complex system can break down into parts complex scenes and regroup the components in combined manner, which offer it the possibility of reusing combinations to represent itself *ex ante* upon new unknown situations).

[12] It is very important to highlight that the neo-Schumpeterian approach has continued making very relevant contributions for the economic discipline. Both seminal works, as well as recent contributions stress to warn that the space of decision possibilities is limited in its options, no merely by the real impossibility of the analysis of possibilities, but also because of the rigidity generated in the organizations. In this sense, the contribution of routines is transcendental, as a guiding mechanism of the decision, with evident economies, in light of the study of the immense possibilities. Recent

works are focused on showing the processes of evolution of routines and their micro-founding perspectives, as suggested in the current work. The richness for the researcher lies in linking the novelty of learning from the anticipation offered by the adaptable complex systems, with the wealth of analysis of routines and its relevant explanation on how the organization manages to enter into the decision, with a limited capacity for analyzing the possibilities.
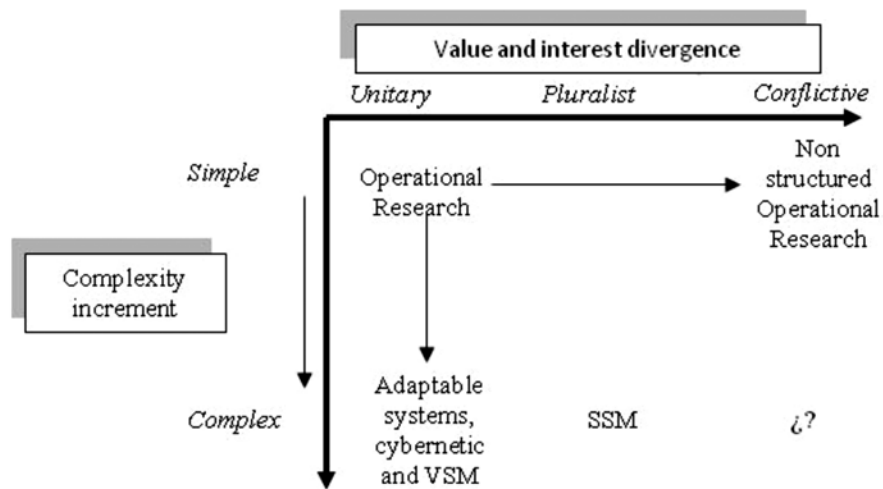
FIGURE 2. Systemic approaches according to Jackson (1994). Source: Jackson (1994).

in charge of identifying different forms of systems in diverse types of environments or realms. Thus, the observer defines the system, that is "…the entity being studied, identified by an observer, who cannot separate from such as two distinct things…" (Checkland and Scholes, 1990).

The definition of a system will be given by an observer, who establishes an interpretation, and confers onto it a structure and particular characteristics. This configuration is attributed to knowledge based on said observer's experience. Jackson (1994) classifies the contributions of systemic thought, as shown in Fig. 2.

SSM systems

Checkland and Scholes in the soft systems methodology (SSM) propose the possibility of defining systems by identifying the units or entities they denominate as "holons" or "alls" with defined purpose. These units establish a definition of reality according to the observer's experience and view of the world (Checkland and Scholes, 1990).

The soft approaches for solving problematic situations are recognized in literature mainly in the works by Ackoff, Churchman, and Checkland, among others. The first two offer conceptual approaches and principles on themes related with solving problematic situations, planning, and studying organizations as complex systems.

The soft systems methodology by Peter Checkland is a research approach aimed at participation-action to solve problematic situations considered poorly structured, as defined by Simon, or diffuse. That is, where a clearly definable feasible optimal objective cannot be determined, but where there is an implicit necessity to improve a situation

considered problematic. SSM is then an approach to define problems in which there is no clarity or no existence of consensus on the objective that should be achieved. With this approach, say Checkland and Scholes (1990), the action researcher has two hopes: "that the framework generates insights relating to the problems perceived and that they lead to practical help within the situation; and that the experiences of using the framework permit such to be gradually improved". In summary, the success of the SSM resides in that it consists of a methodology to raise problems, both in the phases of "What" and "How", with a wide range to incorporate tools to its basic structure.

To address the *problematic of defining systems* (suffice it to say, the entity to be studied, identified by an observer, who cannot separate from such as two distinct things), Checkland and Scholes suggest as a methodological option that which is presented in Fig. 3.

From this perspective, the problem of systemic thought can be centered on the conception of holons[13], or definitions of "all" with a defined purpose or identified entities, which establish a limitation of the perceived reality, generating opposing dialogical notions[14], between that circumscribed and that left out, which are mutually fed through circular causalities (Montoya, 1999). These causalities arise from the very process of observation and definition of reality, and while they are opposing, they are mutually produced and are susceptible to comprising a sole concept from

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[13] The term Holon is attributed to Koestrel, (Checkland, 2001).
[14] The dialogical notions are those of opposing character that arise when establishing a process of observation, from the observer's particular position.
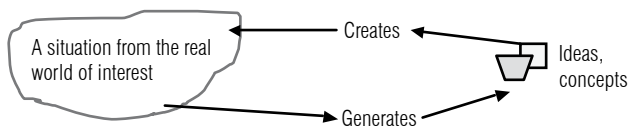
FIGURE 3. Methodological approach employed for the purpose of addressing the problematic of defining systems. Source: Checkland and Scholes (1990).

the integrating point of view, making said contradiction relative. The idea of the organization as a Holon presents it in mutual circular production with its environment. These disjunctions, from the observation process in the perception of the observer, require, in turn, a projection of research toward the action of intervention or interaction with reality, which is desirable to affect.

The basic argument for SSM, (Macadam and Packham, 1989; Nidumolu *et al.*, 2006) is that the observer's perception of the world is affected by a filter or a frame of reference given by its internal structure or preconceived ideas and that the source of many of those ideas is the perceived world that constitutes "reality". Hence, the observer permanently interprets the world using ideas whose source is the world perceived within a process of mutual creation. The methodology, thus, is a conscious thought about its own processes.

For the authors of the methodology, the situations observed in the organizations showed people involved in complex actions giving it sense or defined purpose beyond the instinctive. The people involved in the action with defined purpose also had the hope of acting with "purpose" to improve a problematic situation. Hence, the idea arose of taking a group of activities connected amongst them so that they constituted a whole with defined purpose with a particular type of system (Checkland and Scholes, 1990).

Human activity systems are defined in such a way that they satisfy the characteristics of a whole, according to the principles of systems thought. Defined human activity systems have as an emerging property the quality of pursuing the purpose of the whole and are conceived within a hierarchy of systems. Consequently, the system with defined purpose must contain a structure and activities related to communication and control to allow the system to adapt and survive in a changing environment, and nourish from learning.

Another crucial characteristic of a human activity system establishes that the description with a defined purpose must be made from some declared perspective or view of the world. This suggests, in principle, that there are many pertinent and controversial systems and that the interpretation which gives rise to the system may be exclusive of a particular observer or of a group with a collective view. This means that in the face of a problematic situation multiple perspectives of the solution will always be available and these are more evident when activities are executed with a defined purpose. (Checkland and Scholes, 1990).

Concretely, the SSM (Petkov *et al.*, 2007) is an inquiry systemic process that also uses the systems models. The methodology is presented as an inquiry system where the human activity systems with defined purpose are recognized and modeled, which are pertinent to improve the situation. The systems are defined, modeled, and compared to the perceived problematic situation, to generate a debate about what should be done in the face of the situation, bearing in mind the "what's" and the "how's". The process bears in mind both the nature, as well as the core ideas of the thought systems.
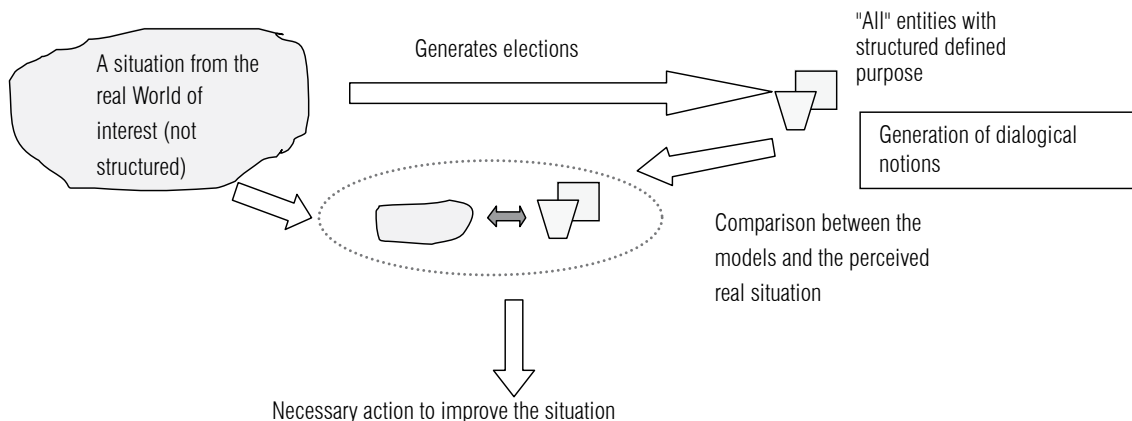

FIGURE 4. Deployment of the methodological approach proposed by SSM. Source: Checkland and Scholes (1990).

The methodology is initially an intervention tool with seven clearly identifiable stages.

The methodology covers the stages mentioned in the graphic, so that a territory can be named as a problematic situation. Thereafter, a reflection and anticipation exercise is conducted that permits the internal and external analysis of the territory upon its relationships. Then, these types of internal and external relationships and interactions are suggested and broadened through the development of detailed models of interaction and alternatives are proposed to enhance diverse versions of interaction and intervention models. Later, elections are made that best correspond with the intentionality of the players of the territory and according to how they compare with the real world, and, finally, some type of result to be developed is suggested.

The territory as a soft system

The territory can be proposed as a complex system with a defined purpose, which is observed from a comprehensive view, the historical, social, cultural, political processes that make up a complex structure of relationships toward the interior and toward its environment. When observing complex "worlds", observers tend to identify different forms of systems in diverse types of environments or realms. Because of the possibility of defining systems as reflection tools, it is possible to study diverse limitations of human and/or social activities, identifying their necessities as "open systems".

Likewise, we can note their processes of adaptation to the environment, their life cycles and devices toward the organization, the factors that influence upon their viability, among others, in such a way that the objectives, structures and efficiency become subsidiary in light of the survival problems and other "new" necessities.

Complex Adaptable Systems

The emergence of complex systems (Dooley and Van de Ven, 1999), comes from the interaction of individual elements through simple guidelines, where each element can conduct free displacement or action, but their interaction with the remaining elements is limited by the possibility of contact with nearby elements. Their research agenda gathers the contributions from notable researchers like Holland, Gell-Mann, Andrade, Kauffman, and Lara, among others. In the adaptable complex systems (CAS), Holland has centered on the aspect of the complexity focused on adaptation.

In these, it is conceived that adaptation originates the emergence of a type of complexity that considerably hinders the attempts of solving the most important problems the world currently faces. The system changes or adapts (from the Latin *adaptare*) but preserves an impressive coherence, which permits demonstrating identity in scientific manner. In several instances a CAS can be a network with an aggregate of emergent identity, which learns quickly and with great ease, and its behavior depend on much more on the interactions than on the actions. The numerous interactions, modified by the changes learnt, produces the whole system's unique ability to anticipate the consequences of its actions through modeling (the capacity to make a mental model) of their worlds, or internal models, based on experience (Holland, 2004).

The agent in the complex adaptable systems is an active element of nature. The behavior of the agents is determined
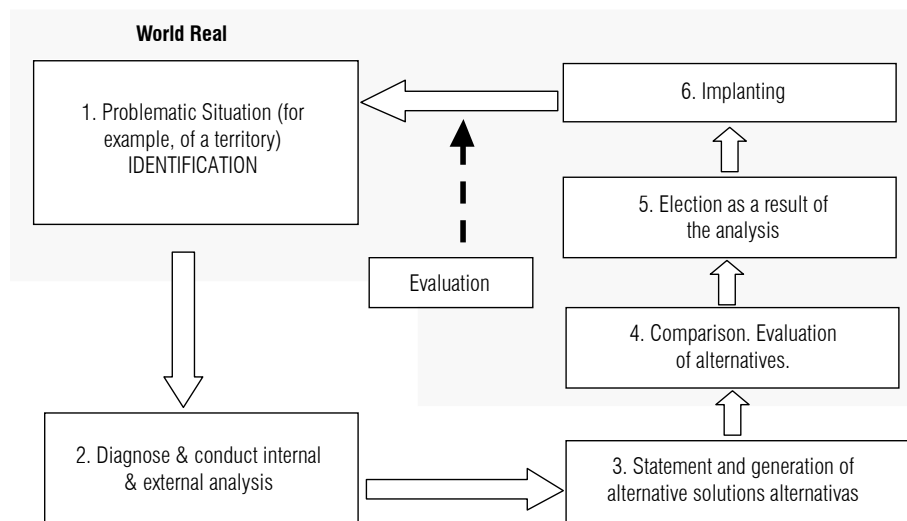

FIGURE 5. The stages of the SSM. Source: Checkland and Scholes (1990).

by a set of rules or norms. The stimulus-response rules are typical and simple: If a stimulus *s* occurs, then give a response *r*. Even when the stimulus-response guidelines have a limited scope, its scope can be broadened; it can be broadened sufficiently so that a multitude of guidelines can generate any behavior susceptible of being described. The greatest part of the modeling effort for any CAS is centered on selecting and representing stimuli and responses.

Guidelines can represent both diachronic relationships (e.g., present and future) and synchronous relationships. There are structures of higher-order knowledge, which correspond to clusters of guidelines, while these clusters are comprised of blocks of condition-action guidelines. On the other hand, the guidelines operate under a principle of limited parallelism (serial processing), and compete to represent the problem and guide action and thought. The central attribute will be the existence of internal models, of which a population can be available, are processed in parallel and the models in this population compete and cooperate (Holland *et al.*, 1989; Holland, 2004).

Holland (2004) proposes adopting seven basic concepts, four properties, and three mechanisms. The properties are the following:

- Aggregation: its main characteristic is the emergence of complex behaviors from the interactions of the individual agents aggregated, which can act as meta-agents within a higher degree of hierarchy.

- Non-linearity: The behavior of the system is not similar to the sum of the behaviors of its components.

- Flows: the CAS will interact in flow form through networks formed by nodes and connectors. The nodes are agents that relate through interactions that are symbolized by multiple connectors.

- Diversity: which appears where there is an interaction by several agents and also depends upon the context where said interactions develop. Diversity is a dynamic pattern that determines a tendency toward the system's self evolution and regeneration.

As mechanisms, the author mentions the following (Holland, 2004):

- Labeling or label: permits the agents to identify within the system the other agents with whom they exchange resources. The labels work as a survival mechanism, and via specialization, lead to the construction of hierarchical structures that contribute to the survival of the agents (Holland, 2004). It permits observing and acting upon properties that were previously hidden by symmetry. It favors selective interaction and permits the agents to select other agents or objects that would otherwise be indistinguishable, given that it permits discrimination, specialization, and cooperation with these agents.

- Internal models: CAS have as a distinctive mark, their ability to anticipate. To understand the mechanism of anticipation, we must understand that it is a complex mechanism denominated internal model. The use of internal models for anticipation and prediction is a theme that encompasses many of the sciences. The basic maneuver to construct models starts with the aggregation: eliminating details, so that the selected patterns are weighed. Because the models of interest are those prior to the agent, said agent should select the patterns from the stream of information received, and after converting these patterns into changes in his internal structure. Finally, the structural changes – the model – must allow the agent to anticipate the consequences generated when said pattern or another similar one is found again. There are two types of internal models: tacit and manifest. A tacit internal model simply describes a current action motivated by the implicit prediction of some desired future. A manifest internal model is carried out as a basis for explicit, but internal, explorations of alternatives. This process is denominated "look ahead" (Holland, 2004). In essence, they are anticipation mechanisms of the consequences and help improve the chances for survival, through *ex ante* learning.

- Construction blocks: An internal model should be based on limited samples of an ever-changing environment (Holland, 2004). However, the model can only be advantageous whenever there is repetition of the modeled situations. The answer to this question appears when we can see the capacity to break down a complex scene into parts. Upon doing this, it is possible to regroup the component parts into a great variety of combinations. Holland (2004) states that experience is gained through the repeated use of the construction blocks. The search for these blocks becomes the best technique to prosper in the elaboration of models, given that although a situation has not occurred in the past (from the interaction between the agent and the environment), and a list of solutions is not readily available for all the possible situations the agent may be in, as alluded by the agent-programmed model, what happens is that the situation is broken down, extracting

from the agent's repertoire of construction blocks the guidelines that can be related to the problematic of the specific adaptation (Holland, 2004). When there is a totally new situation, the most relevant and tested blocks are combined to represent the situation so that it suggests suitable actions and their possible consequences. Construction blocks, permit building possible scenarios to anticipate reality (Holland, 2004).

With these mechanisms and properties, it is possible to describe the adaptation process of an agent within a complex system.

Territories through the use of CAS

The main distinction of CAS is the possibility agents and agent aggregates (meta-agents) have of facing uncertainty when constructing internal models, coinciding with their internal models, and conducting *ex ante* learning, due to its possibility of solving problems through the interaction and emergence of internal simulation skills of action sequences, originated by the competition and cooperation of these models.

Also, the possibility of forming aggregates, which with established adaptation mechanisms, can set complex agents with internal organizational hierarchies.

Conclusions

The framework in soft systems methodologies (Reynolds and Holwell, 2010) and adaptable complex systems permits addressing the identification of the territory with the following advantages:

- Methodology is more or less defined

- Study of complex problems where adaptation phenomena participate

- Possibility of emergencies

- The researcher's view of the world is evidenced alluding explicitly to the intentionality in the study

- Permits limited rationality and the conception of territory as coordinator of expectations

- Modeling of *ex ante* and *ex post* learning

Literature cited

Anderson, P. 1999. Complexity theory and organization science. Organ. Sci. 10(3), 216-232.

Aoki, M. 1986. Horizontal vs. vertical information structure of the firm. Amer. Econ. Rev. 76(5), 971-983.

Aoki, M. 2010. Corporations in evolving diversity, cognition, governance, and institutions. Oxford University Press, Oxford, UK.

Arrow, K.J. 1974. The limits of organization. Norton, New York, NY.

Becker, M. 2004. The concept of routines twenty years after Nelson and Winter (1982): a review of the literature. Ind. Corp. Change 4, 643-677.

Becker, M., N. Lazaric, R. Nelson, and S. Winter. 2005. Applying organizational routines in understanding organizational change. Ind. Corp. Change 14(5), 775-791.

Brian, G. 2001. How the Leopard Changed its spots: the evolution of complexity. Princeton University Press, Princeton, NJ.

Castañeda, G. 2009. Sociomática. El estudio de los sistemas adaptables complejos en el entorno socioeconómico. El Trimestre Económico 76(1), 5-64

Ceña D., F., R. Gallardo, and P. Garrido G. 2007. An approach on integrated territorial competitiveness to ensure long term viability in rural areas of Andalusia (Spain). pp. 1-17. In: 1st Mediterranean Conference of Agro-Food Social Scientists. European Association of Agricultural Economists - EAA, Barcelona, Spain.

Checkland, P. and J. Scholes. 1990. Soft systems methodology in action. John Wiley & Sons., Chichester, UK.

Checkland, P. 2001. Soft systems methodology. pp. 61-90. In: Rosenhead, J. and J. Mingers (eds.). Rational analysis for a problematic world revisited: problem structuring methods for complexity, uncertainty and conflict. John Wiley and Sons., Chichester, UK.

Cyert, R. and J.G. March. 1963. A behavioral theory of the firm. Prentice-Hall, Englewood Cliffs, NJ.

Dooley, K.J. and A.H. Van de Ven. 1999. Explaining complex organizational dynamics. Organ. Sci. 10(3), 358-372.

Dosi, G. and L. Marengo. 1994. Some elements of an evolutionary theory of organizational competence. pp. 211-235. In: England, W. (ed.). Evolutionary concepts in contemporary economics. The University of Michigan, Ann Arbor, MI.

Dosi, G., R. Nelson, and S. Winter. 2002. Introduction: the nature and dynamics of organizational capabilities. pp. 1-22. In: Dosi, G., R. Nelson, and S. Winter (eds.). The nature and dynamics of organizational capabilities. Oxford University Press, Oxford, UK.

Gavetti, G. 2005. Cognition and hierarchy: rethinking the microfoundations of capabilities development. Organ. Sci. 16(6), 599-617.

Gavetti, G., D. Levinthal, and W. Ocasio. 2007. Perspective—neocarnegie: the carnegie school's past, present, and reconstructing for the future. Organ. Sci. 18(3), 523-536.

Gell-Mann, M. 2002. The quark and the Jaguar: adventures in the simple and the complex. Henry Holt & Co., New York, NY.

Gigerenzer, G. and R. Selten. 2001. The adaptive tool box. MIT Press, Cambridge, MA.

Holland, J.H. 2004. El orden oculto, de cómo la adaptación crea la complejidad. Fondo de Cultura Económica-FCE, México DF.

Holland, J.H. 2005. Language acquisition as a complex adaptive system. pp. 411-435. In: Minett, J.W. and W.S.-Y. Wang (eds.). Language acquisition, change and emergence: essays in evolutionary linguistics. City University of Hong Kong Press, Hong Kong, China.

Holland, J., R. Holyoak, P. Nisbett, and P. Thagard. 1989. Induction: processes of inference, learning, and discovery. The Mit Press, Cambridge, MA.

Jackson, M. 1994. Más allá de las modas administrativas: el pensamiento sistémico para los administradores. Innovar 4, 6-21.

Kauffman, S.A. 2003. Investigaciones. Metatemas, Barcelona, España.

Lara, A. 2008. Sistemas complejos adaptables y teoría de la empresa: el programa de investigación. Economía Informa 352, 65-92.

Lara, A. 2009. Agente adaptable, aprendizaje y estructura del ambiente: un enfoque alternativo. pp. 1-33 In: Memories 1st Seminario Nacional de Economía Institucional: Fronteras del Análisis Económico de las Instituciones. Universidad Autónoma de México - UAM, Mexico DF.

Macadam, R.D. and R.G. Packham. 1989. A case study in the use of soft systems methodology: Restructuring an academic organisation to facilitate the education of systems agriculturalists. Agric. Syst. 30(4), 351-367.

March, J. 1988. Decisions and organizations. Blackwell, New York.

March, J. and H.A. Simon. 1958. Organizations. John Wiley & Sons., New York, NY.

Maya, R., A. Rattrout, and S. Hassas. 2008. The web from a complex adaptive systems perspective. J. Comput. Syst. Sci. 74(2), 133-145.

Montoya, I. 1999. Global management siglo XXI. Universidad Nacional de Colombia, Bogota.

Montresor, E. 2002. Rural development: an analytical approach at different territorial levels. pp. 1-10 In: European Association of Agricultural Economists, International Congress, Zaragoza, Spain.

Mora-Alfaro, J. 2006. Territorial rural development in Latin America and the Caribbean: discourses and realities. MPRA Paper 8468, University Library of Munich, Munich, Germany.

Nelson, R.R. and S.G. Winter. 1982. An evolutionary theory of economic change. Harvard University Press, Cambridge, MA.

Nidumolu, U.B., C.A.J.M. de Bie, H. Van Keulen, A.K. Skidmore, and K. Harmsen. 2006. Review of a land use planning programme through the soft systems methodology. Land Use Policy 23(2), 187-203.

Ocasio, W. 1997. Towards an attention-based view of the firm. Strat. Mgmt. J. 18, 187-206.

Pérez, E. 2001. Hacia una nueva visión de lo rural. pp. 17-29. In: Giarracca, N. (Comp.).Una nueva ruralidad en América Latina? Consejo Latinoamericano de Ciencias Sociales- CLACSO, Buenos Aires.

Petkov, D., O. Petkova, T. Andrew, and T. Nepal. 2007. Mixing multiple criteria decision making with soft systems thinking techniques for decision support in complex situations. Decision Support Systems 43(4), 1615-1629.

Revéiz, E. 2007. El Estado regulador de riesgos. Academia Colombiana de Ciencias Económicas; Centro Colombiano de Responsabilidad Empresarial, Pontificia Universidad Javeriana, Bogota.

Reynolds, M. and S. Holwell. 2010. Systems approaches to managing change: a practical guide. Springer Publishing Company, New York, NY

Ribero, M. del P. and R. Echeverri. 1998. Towards a new meaning of development: a view from the rural. pp. 45-67 In: Rural Mission: Transition, Coexistence and Sustainability. National Planning Department, Ministry of Agriculture and Rural Development, Bogota.

Rubiano N., M.A. 2005. Local partnerships as an innovative strategy to enhance collective learning in an area. Facultad de Agronomía, Universidad Nacional de Colombia, Bogota.

Schumpeter, J.A. 1934. The theory of economic development. Harvard University Press, Cambridge, MA.

Simon, H.A. 1957. Models of man: social and rational. John Wiley and Sons., New York, NY.

Solarte L., G. 2003. Cooperación local. In: Cooperación Latinoamericana Misión Rural, http://www.misionrural.net/publicaciones/cooperacion/cooperacion_local.pdf; consulted: December, 2010.

Stacey, R.D. 1995. The science of complexity: an alternative perspective for strategic change processes. Strat. Mgmt. J. 16, 477-495.

Teece, D., G. Pisano, and A. Shuen. Dynamic capabilities and strategic management. Strat. Mgmt. J. 18(7), 509-533.

Tripsas, M. and G. Gavetti. 2000. Capabilities, cognition, and inertia: evidence from digital imaging. Strat. Mgmt. J. 21(10-11), Special Issue 1147-1161.

Tsoukas, H. and C. Knudsen. 2002. The conduct of strategy research. In: Pettigrew, A., H. Thomas, and R. Whittington. (eds.). Handbook of management & strategy. Sage Publications, London.

Varela, F.J., E. Thompson, and E. Rosch. 1991. The embodied mind: cognitive science and human experience. The Mit Press, Cambridge, MA.

Williamson, O.E. 1989. Transaction cost economics. pp. 135-182. In: Schmalensee, R.L. and R.D. Willig (eds.). Handbook of industrial organization. Vol. 1. Elsevier, Amsterdam.

Witt, U. 2008. What is specific about evolutionary economics? J. Evol. Econ. 18(5), 547-576.