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**Conference Paper**

## Processes of Territorial Transformation: Autopoietic Systems in Planning and the Theory of Chaos

39th Congress of the European Regional Science Association: "Regional Cohesion and Competitiveness in 21st Century Europe", August 23 - 27, 1999, Dublin, Ireland

**Provided in Cooperation with:**

European Regional Science Association (ERSA)

*Suggested Citation:* Maciocco, Giovanni; Dessi, Barbara; Battista Masia, Giovanni; Steingut, Ilene; Venturi, Beatrice (1999) : Processes of Territorial Transformation: Autopoietic Systems in Planning and the Theory of Chaos, 39th Congress of the European Regional Science Association: "Regional Cohesion and Competitiveness in 21st Century Europe", August 23 - 27, 1999, Dublin, Ireland, European Regional Science Association (ERSA), Louvain-la-Neuve

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# PROCESSES OF TERRITORIAL TRANSFORMATION: AUTOPOIETIC SYSTEMS IN PLANNING AND THE THEORY OF CHAOS

*ERSA 39<sup>th</sup> European Congress - Session: Spatial Data Analysis And Space Time Processes  
Dublin, Friday 27<sup>th</sup> August*

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## **Introduction**

Phenomena involved in the environmental crisis today encroach upon various aspects and dimensions of the territory. Such phenomena are expressed in processes of de-localization<sup>1</sup> and de-contextualization<sup>2</sup> and can be referred to the urban crisis, which is linked, in turn, to the crisis in the city's hierarchic model. (Maciocco, 1998). In this light, it seems important to explore the auto-organizational capacities and the potential for transformation of "territorial systems."

A metaphoric and literal reading of autopoietic theory suggested an interpretation of auto-organization that could be useful for the understanding of these phenomena. At the same time, it seemed stimulating to associate research on models, alongside interpretative or analytic instruments, with purely theoretical approaches to the same issues. Thus, we identified a common ground for autopoietic theory and chaos theory, both of which are involved, from different standpoints, in phenomena of complexity.

Through a cross reading of both theories, and of territorial processes, in particular their reactions to exogenous stimuli (elements of disturbance or noise that affect the evolutionary state of a given system –defined in economics as externalities), we attempted to interpret, and represent, the behavior dynamics of highly structured territories in terms of dense relations and stratifications of population, activity and place (Geddes).

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<sup>1</sup> Indicating a sense of discomfort on the part of the community regarding their territories tied to a loss of relationship with place

<sup>2</sup> The influence of models of both endogenous and exogenous development that does not take into account the true and inherent potentials of a given territory.

## **1. Objectives of the study**

In order to understand issues relating to the auto-organizing processes in different territorial contexts, as well as to interpret and identify them, we will first seek to explore the importance of such processes. Auto-organizing phenomena will then be interpreted and analyzed utilizing a metaphoric reading of the theory of autopoiesis.

This analytic passage will offer an objective reading of auto-organizing processes acting within a territorial context. It will also seek to evidence its peculiarities, requisites and strong characterizations. In this context, we will seek to point out the relevance of external perturbations, or externalities, (phenomena or elements whose nature, in the first part, will be referred to any environmental, social and economic dimension) that are fundamental for the growth and dynamic evolution of any territorial context.

In section 5, based on the requisites of auto-organizational systems, deriving from the previous interpretation, we will create a valid occasion for the encounter of autopoietic and chaos theory.

This first theoretical exploration will clearly demonstrate the qualities, vitality, and capacity for innovation that are necessary for auto-organizing systems. From such an evaluation, we will demonstrate the need to find, and if necessary, modify, an instrument that can predict the auto-organizational capacity of a system in relation to external interventions, whether they are economic or political in nature or even projects and planning interventions.

In this sense, we will recognize certain elements of territorial systems in the perspective opened by chaos and autopoietic theory. These are due to the peculiarities of the systems themselves – complexity, non-linearity, casuality, dynamism, evolution in function of the perturbing action, internal structure and initial conditions. These are all ripe subjects for modeling that can be executed within our disciplinary field.

In the next phase, given the multiplicity of meanings and dimensions of a territorial system, we will narrow our field of observation, exploration and experimentation to that of economics. In this field, many modeling experiments have already been executed in reference to chaos theory.

We will explore the model of Lucas (Lucas 1988) and the potentialities that appear most congruent to our research. This model allows us to transcend the internal potentialities of a system by introducing a perturbing factor, an externality, into its growth process. The externality will be made to act upon physical capital interpreted as environmental capital in contrast to previous studies in which externalities act upon human capital.

This evolution, based on the analysis of auto-organizing systems and processes of territorial crisis, is due to the conviction that any territorial system rich in social figures who interpret the system and confer meaning to it, is potentially autopoietic. We believe, in any case, that it is possible and important to identify behaviors referring to other processes, situations and social dynamics to which we may attribute meanings and interpretations.

Using the results of the analytic model that we propose to produce and interpret, the objective here is to contribute to meaningful and conscious action upon territories while managing a large quantity of information.

## **2. A Response to the Environmental and Urban Crisis in Reference to Auto-organization**

Interest in “territorial systems,” and in their capacity to react in a self-managing way to external stimuli in economic, social and environmental terms, marks the need to verify if very specific territorial situations can survive today’s globalizing and destabilizing pressures. In particular, such a capacity appears relevant in response to environmental and urban crises.

The results of the former are manifested almost ubiquitously in social hostility towards a decayed context or in contexts that seem extraneous to their inhabitants (Maciocco 1998). These responses correspond to processes of de-localization and de-contextualization. In other words, we are witnessing “loss of territoriality due to the decline in the environmental quality of place, problems of contamination, pollution or congestion.....A place becomes extraneous because it is taken over physically by others, because it is treated with settlement patterns that are extraneous to the internal logic of that particular place, or because inhabitants are lost in a kind of indifference to physical context, taken in by the flux that represents the new gravitational force of the contemporary urban world”(Maciocco, 1998)

The urban crisis is, in reality, a territorial crisis with an underlying logic tending towards polarization regarding activities indifferent strategic sectors. It is linked to a crisis in urban form and organization as well as to a crisis in the hierarchical organizational model. These phenomena are manifested in forms of polarization, simplification of the city characterized by closure, absence of any external effect, and lack of any relational dimension (Maciocco 1998).

In this complex framework, in which crises of urban and territorial socialization are reflected (Maciocco 1998), it seems opportune to seek “clues of vitality” (Magnaghi 1994), which are those signs that reveal if and when an active and dynamic processes of constructing the territory are

occurring within a given context. At the same time, it is necessary to verify the existence of “nodes of vitality” (Giovannoni). These are territorial centralities that are not necessarily tied to the built environment but could be considered relevant fragments of both a territory’s history or of a series of places that stimulate community reactions even when interventions are not directly related to them. In this sense, clues of vitality are manifested by the production of services or by exceptional activities.

The search for such clues in this study seeks to include the modalities mentioned above but is rendered concrete in the identification of signs of auto- organization on the part of local communities. Such signs are evident in processes and transformations regarding the economic and social sectors and are manifested in diffuse forms of “socio-cultural auto-production, auto-consumption and auto-representation” (Magnaghi 1994). They are also revealed by innovations in the agricultural and service sectors and by a vast array of private initiatives based on cooperation and not directly linked to the market system or to the public assistance system. For example, the situation of ethnic differences could be considered a phenomenon that involves urban centers of even a reduced dimension where “an ambivalent interaction between foreigner and local creates a move towards transformation” (De la Pierre 1994). We could also examine completely contemporary design experiments by numerous artists and architects inspired by the specificity of place and by the discovery of a lost symbolism. In this case, we refer not to simple experiments of environmentally appropriate materials and technologies that seek to “preserve,” but to experiments which reinterpret a local context in present terms without distorting it, as in the case of the works of Herzog and DeMeuron (Brandli, Croset 1994).

The conjunction between the exploration of the territorial crisis and auto-organizational processes lies in the conviction that it is possible to refer to a correct comprehension and interpretation of phenomena acting within territorial systems. The capacity to predict and understand leads to interventions, at least in general terms, upon the nature and quality of processes, their changes, adaptations, stimulating pro-active and constructive attitudes towards the territorial context.

This affirmation is supported by the interpretation of the term ‘auto-organization,’ and of the dynamics generating it by means of a definition of autopoietic theory and the instruments deriving from the theory of chaos. In this sense, we chose to emphasize the destabilizing effects of externalities acting upon various dimensions of territorial systems and which solicit different reactions based upon the territory’s relational substrata with which the externalities enter into contact and with which they interact.

### **3. Metaphorical Considerations of Territorial Systems: Autopoiesis and Chaos Theory**

The concept of auto-organization and of the complexities tied to this concept stems from disciplines outside planning. The idea has its origins in the philosophic and scientific study of systems, non-linear processes and forms. In these disciplinary contexts, different attitudes and interpretative theories have emerged.

The terms “synergetics” (Stern, 1992; Haken and Portugali, 1994; Scandurra, 1996) refers to the set of theories inspired by and derived from Haken’s and Prigogine’s studies. The emphasis is placed on the complexities of auto-organization. This same paradigm addresses issues referring to often conflicting approaches, (on the one hand reductionist and, on the other holistic), regarding studies of auto-organization and that are relevant to scientific, technological and social ambits. From biological and social observations, the concept of interdependence between the parts of a whole is fundamental for synergetics. The observation that the behavior of the whole is distinguished from that of its parts is an inevitable one. In synergetics, “the interpretation of reality is through organisms for which one cannot presume simple cause-effect relations or simplified interconnections” (Scandurra, 1996); “the behavior of the system’s totality is not only more than the sum of the behavior of its components, but something that is completely new, at least in a qualitative sense.” (Stern).

Territory becomes relevant after applying a metaphorical transposition of the above concepts and when it is composed of different dimensions and elements or when its parts and evolution cannot be conducted to cause-effect linear dynamics. The results produced by actions upon it are not due to the sum of the objects that compose it. Each possesses its own internal organization and projects a strong external image stemming from the quality of its own organization.

This first interpretation of auto-organizational processes relating to territory is enriched by Stern’s considerations regarding territorial development and is articulated by a metaphoric reading of autopoietic theory.

Autopoiesis (Bateson G., 1984; Maturana, Varela, 1984) is offered as a “working metaphor.” The concept was born outside the planning disciplines or the study of urban phenomenon. Influencing many disciplines, it can be useful in an interdisciplinary approach as we turn our attention to the characteristics of a territory endowed with identity, structure and organization. These characteristics are able to activate auto-organizational processes. Some have transferred the basic

concepts and requirements for autopoietic systems to these characteristics. (Cavallaro V., 1994, 1997; Tagliagambe, 1994, 1996). Systems theory together with synergetics defines a point of view that, when applied to the study of territory, leads to the recognition of certain qualities (Cavallaro, 1994; 1997). The first conceptual passage is the one that addresses the “territorial system” or the territory as a “living subject.” It is conceived of explicitly as “a set of multiple structures interconnected by relations and endowed with spatial configuration” (Cavallaro, 1994). The structures (social, economic, environmental) composing it are made up of their own organizational and spatial dynamics defined by laws regulating their internal relations.

Such research takes into account functions, processes and relations between the elements of a place. For this reason, it is logical to consider the “territorial system” and to inquire into the reasons for its uniqueness. Similar interest is brought to territories made up of processes endowed with their own personalities, an existence that roots itself in the minds of the individuals who populate it (Maciocco, 1995a) and so condition its future (Stern, 1992).

Beginning here, a qualitative variation in the relations between population and place, or its modification, can be referred to auto-organizational processes. This phenomenon becomes explicit particularly in modifications involving perception, spatial and temporal interpretation, the needs of the local community, its “modus vivendi” and its “concept of inhabiting” (Maciocco, 1995a, 1995b, 1996, 1997). It also becomes explicit in a personalized and unique interpretation of external stimuli to which a territory is subject.

The guiding principles deriving from the metaphoric interpretation link autopoietic thinking to the concepts of *local* (Clemente F., Maciocco g., 1991a, 1991b, 1994, 1995a, 1995b, 1996; Magnaghi A., 1994; Gatti, 1984) when the settlement of a place, and the process of appropriating it, has its origins in the general laws of the socio-economic geography to which local populations refer. Individual decisions conditioned by topographical factors, relationships between individuals, and between individuals and place represent the reasons for the construction, in time and space, of anthropogenic areas that can grow and develop.

Autopoiesis stimulates a more careful exploration in other directions. Models of territorial creation and development, in autopoietic terms, are dynamic models and the structure of place, due to the qualities of relations, will influence future decisions regarding allocation, economic development and so on. A territory’s personality represents the information imparted to an environment related to it and which continuously solicits it through physical and social elements or the crises discussed above.

#### **4. The Concept of Externalities and Contributions from Chaos Theory**

In this context, the term *externality* refers to any action, effect, agent, project that can intervene from the exterior to produce a change in a territorial state. The externality is a kind of vital element for any structured system that is dynamic and able to construct itself in terms of vitality, relations, qualitative variations and innovations.

In light of autopoietic theory, a “territorial system” depends upon the stimuli, or noise caused by externalities. These can then be translated into internal characteristics of the system once they are recognized by its internal organizing structure, purified of extraneous elements and confronted with past errors. In this way, the system is comparable to an organism endowed with auto-organizational capability to provide differentiated responses to its environment.

The concept of externality, of external input, of energy that must be metabolized, is interesting for all territorial dimensions in all of which the matrix and nature of the externality is completely different. It is a fundamental stimulus for social processes. It is a kind of energy for the eventual autopoietic nature of the territorial component. It is a factor of disturbance, both positive and negative, in the economic sphere. For each of these dimensions, which intermingle within the unit of the territorial system, the nature, strength and energy intrinsic to the externality play a secondary role if they are compared to the internal structure and organization of the specific system that will need to assimilate and redefine it. It is not a coincidence that the same external stimuli can reemerge, after having been absorbed and reworked, in many aspects of the object’s “specificity.” Once again, the concepts, theoretical bases, elaboration and descriptions of the theme of the local and autopoietic theory must share the same observations and deductions relating to specificity, to the uniqueness of conditions, situations, internal organizations, sensibility, receptivity or permeability to the stimuli.

Through the process of internalizing externalities, the resulting characteristics, and thus dynamism, are points of interest for analysis and interpretation. In particular, dynamism allows the introduction of the complexity paradigm in order to apply it to the study of territory.

The paradigm of complexity allows the affirmation that any small variation in the original conditions of a physical dynamic can have large repercussions on the course of events. In many cases, the same causes can produce very different effects (Medio, 1996).

Any territory, taken as a complex system, utilizes behavior that cannot be understood in a simple way beginning with the behavior of its component elements. Its overall behavior presents properties that are derived from cooperation between elements (Lombardo, 1994). The properties of



a system are expressed in such a way that the system itself manifests behaviors that are not all predictable but are potentially so if the structure and internal organization of the system are known. Complexity means non –linearity, non-repeatability, and dependence upon initial conditions, structure and internal organization. Defining it means, in a certain way, to replicate a definition of auto-organization and to underline its importance. From a territorial and social point of view, it means to open dialogue with the future, seeking and soliciting development oriented towards specificity of place, culture and resources.

Undoubtedly, territory is linked to interrelations between the complex systems that give it life and specificity. As such, it can produce behavior and dynamics that are not predictable (chaotic). Abusive or illegal construction in an urban context, the chaotic behavior of traffic, the abandonment of certain areas and the revitalization of others (all manifesting crisis conditions in the city and the environment (Maciocco 1998), belong to a category of reactions that can be identified in the territory. They are often linked to auto-organizational capacities, or to their absence, in populations and, as such, are difficult to foresee and control (Scandura, 1991).

Complexity thus takes on a positive connotation for our study and, in general, for more recent and enlightened studies of the territory: “unpredictability and uniqueness are concepts relating to a dynamic of natural balances.” (Magnaghi, 1994); it emerges in a critical/dialectical relationship between population, activity and place. Complexity is often identified with conscious auto-regulation and is an intrinsic quality tied to specificity, integration of the natural and the artificial in the city and in the territory.

The concept of complexity becomes an expedient to overcome conceptual divergences relating to the various disciplines revolving around the study of territorial dynamics. Complexity confirms the idea that we cannot completely know the “territorial phenomenon” and the processes that animate it (Scandurra, 1997). The idea of complete knowledge thus becomes a recognized utopia, a past constraint on real knowledge.

Analysis taking into account complex phenomena does not necessarily permit us to obtain models that can be used in a predictive and normative way. It may lead to the observation that we really do not know the ways in which a system behaves; that which is verified is strongly tied to the conditions of the moment and will be different from expected results. Sustaining complexity is equivalent to safeguarding the territory’s “genetic” information so that values are transmitted over time.

Chaos, a complex and dynamic behavior that characterizes some systems, allows the use of other instruments in light of the territorial interpretations sought. The convergence of different

behavior dynamics towards chaos has been explored through different approaches. One of the most common consists in the identification, within the evolutionary dynamics of a system, of the appearance of strange or fractal attractors that function as generators of order. Other definitions include the sensitivity of chaotic systems to their initial conditions and mark a convergence towards chaos by means of the total loss of information relating to the system that can be registered after a brief period. (Russel, 1998).

For two reasons, the behavior of a chaotic system is not completely casual. The first is due to deterministic or probabilistic processes. Second, the dependent variables of a model that provides different solutions, including chaotic ones, do not take on random values but are concentrated on a particular range determining for example, the limits of a strange attractor.

The links between the apparently unrelated theories of synergetics and autopoiesis lay in the fact that a dissipative system (or an autopoietic one) behaves without apparent rules in a chaotic way. In any case, the philosophical treatment of synergetics and the biological treatment of autopoiesis are much more ample than the restrictions due to mathematical methods and considerations (Stern, 1992).

In practice, it is possible to treat diversity, complexity and chaos, and thus auto-organization, mathematically, although it might reduce the horizon of observation to simple research into the characteristics of behavioral trajectories.

## **II Session**

### **5. Autopoietic Systems In Planning And The Theory Of Chaos**

Theoretical treatment of autopoiesis and the mathematics of chaos intersect in a concrete way at this point through the analysis of the results of an economic model that can potentially comprehend the set of concepts outlined previously.

The economic dimension of the territory was chosen for the application of the theories of complexity and chaos. Such an approach allows us to consciously consider only one of the relational dimensions that can stimulate reactions and metabolization within a given territorial context. In any case, we sought to overcome this limit through an interpretation in a direction that transcends the merely economic sphere in an effort to integrate the economic system with others acting on the broader territorial scale.

The tool is analytic and seeks to broaden the knowledge base of a territorial system. The imperative of enlarging the knowledge base and its meaning is becoming ever more apparent in order

to calibrate, orient and evaluate planning or project interventions in the most pointed and cognizant way possible.

## 6. The Modification of the Model of Lucas

The possibilities offered by Lucas' model of endogenous growth (Lucas, 1988) appeared to be the most suitable for our research. This model seems to be able to investigate not only a system's internal potential but allows the introduction of external elements of disturbance into the system's growth. It is formally expressed as follows:

$$\max_{c(t), u(t)} \int_0^{\infty} \frac{c^{1-s}}{1-s} e^{-rt} dt \quad (1)$$

subject to

$$\dot{k} = Ak^b (uh)^{1-b} k_a^g - c \quad (2)$$

$$\dot{h} = dh(1-u) \quad (3)$$

$$k(0) = k_0 > 0 \quad (4)$$

$$h(0) = h_0 > 0 \quad (5)$$

Lucas' model can be studied both discretely and in the continuum and is based on the optimization of a utility function (1) undergoing a set of constraints (2), (3), (4), (5).

The introduction of externalities (the term  $\gamma$  that appears in the constraints of the model) regards both physical ( $k$ ) and human capital ( $h$ ). In this context, following an approach oriented prevalently towards phenomena referring to the environmental crisis, we chose to modify the model to let the externality act upon physical capital. The economic studies (Benhabib J., Perli R. 1994; Benhabib J., Nishimura K. 1996; Boldrin M., Rustichini A. 1994; Chamley C. 1993; Mulligan C. B., Sala-I-Martin X. 1993; Xie D. 1994) have so far explored the model with externalities acting only on human capital (with the exception of Mattana, Venturi 1997 who did not develop the model in that sense).

Use of the externality makes sense particularly in the economic context. It disturbs that dimension in a specific way. And, certainly, it implies reinterpretations and assimilations by the other

systems, such as the social and environmental ones. The positive and negative effects, chaotic or not, of its introduction are superimposed upon a myriad of other reactions that have their origins in other internal reinterpretations caused by other externalities with different origins and characteristics.

The introduction of an externality leads to indeterminate conditions or to the contemporaneous presence of various solutions, making possible the coexistence of different dynamics departing from an initial condition. This implies, even in mathematical terms, the possibility of a dialogue between autopoietic and chaos theories with the aim of offering a choral interpretation of territorial dynamics when analyzing various solutions.

The terms used in the model have the following meanings:

‘ $c$ ’ - per-capita consumption;

‘ $s$ ’ - the inverse of intertemporal elasticity of substitution;

‘ $k$ ’ - physical capital

‘ $h$ ’ - human capital;

‘ $u$ ’ - the fraction of labor allocated to the production of physical capital

‘ $r$ ’ - a positive discount factor;

‘ $A$ ’ and ‘ $d$ ’ - positive parameters of technology ;

‘ $b$ ’ - share of capital;

‘ $g$ ’ - a positive externality parameter in the production of human capital.

The problem is a standard one of dynamic optimization, whose limits are represented by equations (2) and (3).

## Conclusion

The interpretation that we have offered for the prospects opened by the model’s application is enriched when considering a local situation whose history, traditions, culture and economic conditions are known. In this case, in fact, it is possible to interpret the results in a conscious way, to integrate the information obtained by other techniques to confirm or confront ideas and expectations about particular conditions of an environmental context and to compare them to other territorial conditions. The model of Lucas, and, above all, the concept of externalities, has lead to an endogenous re-elaboration of complexity and dynamism; in other words, to the intersection between chaos and autopoietic theories. The horizon is potentially rich in new analytic and interpretative

elements for the study of territorial dynamics. It is particularly stimulating for the understanding of new directions, signs and orientations that can direct the transformations of and for the territory.

The territory's vitality is recognized in autopoietic signs, and thus in chaotic solutions, necessitating an experimental test that could be the follow-up of this research. It would suffice to contextualize the values of the model's parameters by means of econometrics and necessary calibrations of the economies considered.

By means of opportune considerations, the same model could be utilized to evaluate projects and interventions, assimilating externalities in order to simulate or forecast their effects on the project's context.

The model's application and thus the dialogue between chaos and autopoietic theory mark:

1. the possibility to explore the autopoietic potentialities of a territorial system on any scale and to analyze other behavior dynamics that can be referred to other solutions
2. the possibility to test the congruence of a project or other externalities with a territorial situation considering the project as an externality which intervenes upon a territorial situation
3. the possibility to integrate and enrich the quantity and quality of information relating to a territorial system.

Currently, the Dipartimento di Ingegneria del Territorio is testing the model using Sardinia as a case study. We chose to study Sardinia's local context as a specific system in which the different spatial forms assumed by human settlements, the variegated settlement tendencies and the specific interactions between man and environment are articulated. The basis is the information provided by the ITATEN project (Indagini Sulle Trasformazioni Degli Assetti Del Territorio Nazionale) and the study entitled "Design and planning of an informational systems of regional data for the evaluation of different configurations of the new regional ambits in Sardinia" (1997, both executed by the Dipartimento di Ingegneria del Territorio, Sezione Urbanistica di Cagliari). Both studies utilize the concepts of local identities, differences and specificity of place to identify, represent and interpret the phenomena acting upon Sardinian cities and territory. The analysis of the territory's subjectivity was an important conceptual reference insofar as, in Sardinia, the perceptual worlds of the collectivity were considered with attention and sensitivity as elements which characterize the present and future of the environmental contexts.

The two studies identified specific local units called *settlement environments* and defined as “communication space between population, its activities, meaningfully structured with regard to a set of places that are dense in nature and history” (ITATeN, 1996).

Sardinia was divided into units based upon a scenario of “concepts organized in a dimension of spatial content as well as in a field described by the relations set up between population, activity and place” (ITATeN, 1996).

The criteria for the identification and selection of places were founded upon suppositions deriving from various disciplines. “Large” natural and historical signs were identified as elements that constitute the infrastructural skeleton giving meaning to the territorial reality according to local or supra-local dimensions. Again, this research sought to understand the perceptive dimensions of the community interpreting it as an indication of the settlements’ vitality. Forty-five settlement ambits were identified evidencing the settlement differential of the island’s territory as well as its richness. Another classification, in micro settlement ambits associates the micro-environments in an urban communications space, characterized by the dynamics of the contemporary city that open to the territory.

The research projects is being utilized and expanded here in order to identify autopoietic and auto-organizational signs in local realities as unequivocal signs of vitality thus offering new perspectives to our understanding of the settlement environments. For example, in light of complexity, dynamism and diversity of the territorial systems, it seems interesting to ask how strongly characterized settlement environments receive outside information.

For example, in solid waste management practices, how do contiguous settlements deal with that disturbing factor as an agent acting upon social dynamics, and in particular upon capital and the environment as resource. Are the settlement environments able to transform such problems into an opportunity rather than an encumbrance? This is notoriously an area that necessitates organization and cooperation especially regarding localization, management and transportation.

Utilizing the instrument proposed here, we might verify how and if an environment reacts to such stimulus, solicited by political action, as has recently occurred in Italy after the Ronchi decree. Does the system act internally varying its own organizational structure to accommodate the problem in an autonomous way? Such a reading could allow us to understand if the internal premises of an ATO (area territoriale ottimale – optimal territorial area) are sufficient for the success of a waste management plan. Based on autopoietic considerations, an ATO must possess self-reproducing capacities. In other words, what is sufficient would most likely be a spontaneous attempt at auto-

organization and cooperation of the settlement ambits involved. Another kind of autopoietic behavior would be that of a community that decides to limit the quantity and quality of its waste.

If, instead, we refer to environments that address the economic resources of the sea , we could ask what happens if the tourism externality causes these environments to demonstrate autopoietic and auto-organizational capacities. We could look at particular situations that have most recently been stimulated by such a factor. In all of these situations, traditions, culture and attitudes are extremely different. Often contrasting conditions of inertia and dynamism<sup>3</sup> indicate recognition, acceptance or refusal of the tourism opportunity. The instrument studied here could identify the meaningful indications and possible interpretations that such different situations could furnish in relationship to the tourism externality. This would then provide further and more in-depth information upon which to base future planning strategies.

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– <sup>3</sup> Such information derives from a cluster analysis applied to the municipalities of Sardinia during the ITATeN research project aiding the identification of the settlement ambits (Aa. Vv , 1996).

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