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# The *Altepetl*: Fractal Modeling of a Pre-Hispanic Human Agency

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Fernando López Aguilar

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## Abstract

The *altepetl* is a category that describes the organizational structure of the territory and the social hierarchy of pre-Hispanic societies in Mesoamerica. This category is used to understand the basic generator of territorial and political complexity in pre-Hispanic times. It is proposed that the repetition of itself, its iteration, increases social complexity until reaching structures comparable to big cities and great empires. These complex cultural developments are self-similar to the basic structure that generates them, the *altepetl*. The modeling of the pre-Hispanic *altepetl* is based on contributions made by ethnohistory to a spatial and social organization of territory and on the characteristics of alliances and segregations. These constitute the mechanisms that can explain linearization, increasing complexity or collapse of societies. The interactions between the *altepetl* and its agency capability are studied from the perspective of complexity theories to understand the relationships between neighboring entities. The study seeks to demonstrate the fractal properties of the structure and dynamics of Mesoamerican groups, based on the iteration principle of the generator component: the *altepetl*.

**Keywords:** *altepetl*, agency, complex systems, interaction

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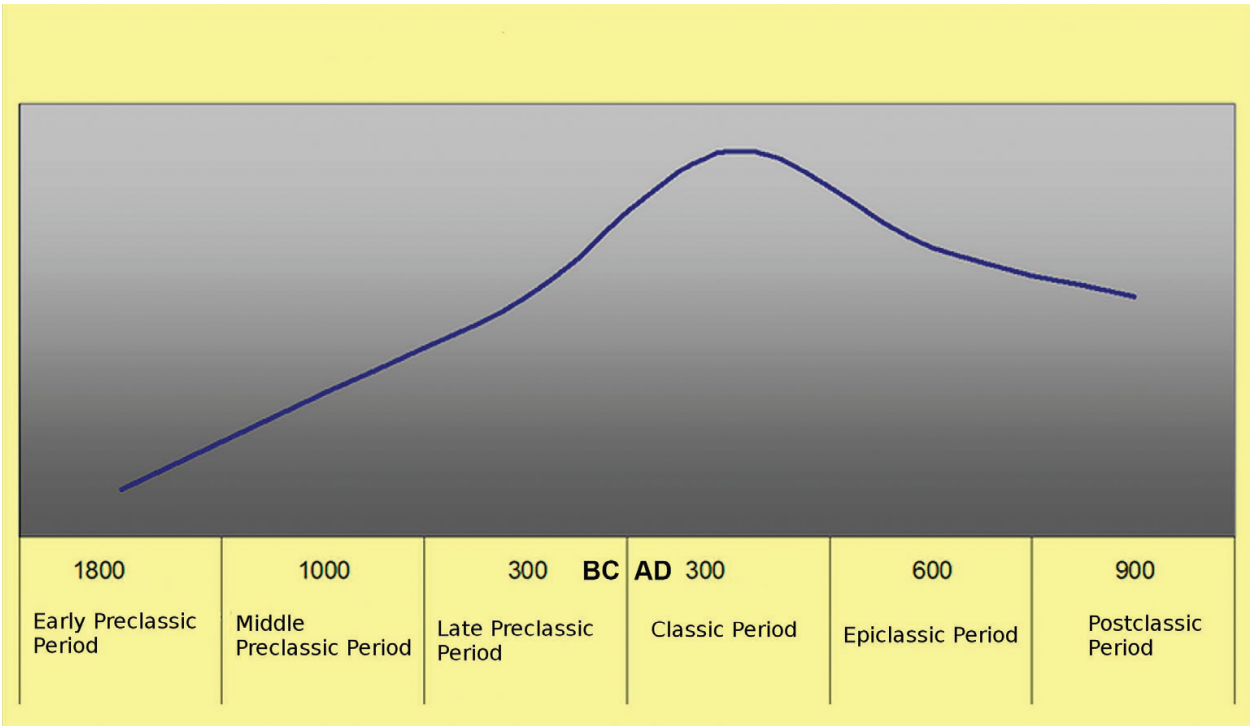
## 1. Introduction

The historical reconstruction of pre-Hispanic civilizations of Mexico has been undertaken from a traditional point of view, building on the western concept of “City.” Associated with this approach is a linear perspective of history that emphasizes the origin of civilization, its climax, and its collapse, forming a path that resembles a Gaussian function. Civilization and complex societies, the city that characterized them and their collapse have been considered as a unique historical event.

Pre-Hispanic history of Mesoamerica was characterized by the civilizing and cultural climax of the Classic Horizon, and its catastrophic collapse was an enigma that archaeology tried to solve. The terms “Maya collapse” or “end of the Classic Horizon” allude to the idea that for the whole of the cultural area, climax occurred between 400 and 800 AD and that the cultures that the Spanish conquerors observed 700 years later were the decadent remains of great civilizations (**Figure 1**).

The representation of this linear process does not allow to observe the fractal properties of the evolution of pre-Hispanic cultures; it is seen as having an integer dimension, and not a fractional one. However, for example, from an epigraphic and ethnohistorical exploration, Joyce Marcus has observed that this view was incorrect and that the pre-Hispanic history of the Mayas was characterized by permanent fluctuations; small and big collapses could be observed, some local and other of a regional scale. Her perspective was based on two processes: linearization and segregation, that is, the alliances and ruptures that characterized the social dynamics of the Maya [1].

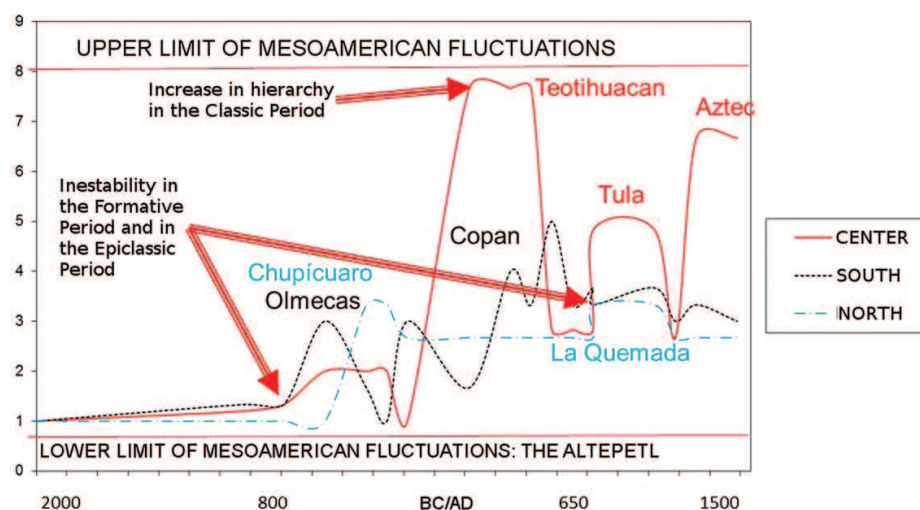
López Aguilar and Bali analyzed the fluctuations and instabilities inherent to the evolution of pre-Hispanic societies. They included in their study three variables obtained from available archaeological information: maximum extent of the territory of a system, the size of the capital, and the hierarchical levels of the subordinated settlements. The hierarchical levels considered what some scholars have called *altepetl*, the City-State, as a minimum unit of analysis that generates increasing complexity by the reiteration of the hierarchical structure of Mesoamerican societies. This study identified three divergent and intertwined trajectories: stable, unstable, and semi-stable [2].



**Figure 1.** Traditional evolutionary path of Mesoamerican civilizations.

Criss-cross oscillations of the three trajectories—between the lower limit defined by the structure of the *altepetl*, below which the Mesoamerican system would collapse, and the upper limit being the maximum structural complexity attained, over which the system would transform—characterize the fluctuating order of the Mesoamerican attractor with a history of 30 centuries, from its origin around 1500 BC to the sixteenth century AD. In **Figure 2**, the beginning of a “turbulence” lasting for 500 years can be observed. The turbulence was resolved by an increasing hierarchy (linearization) of the systems depicted in the Central and Southern trajectories.

The collapse of these two systems resulted in a small fluctuation that started around 650 AD and it gave place to a plateau-type stability phenomenon that collapsed with the expansion and linearization of the Central trajectory in the sixteenth century. The hypothesis that guided this research was that fluctuations of social systems of pre-Hispanic Mesoamerica had self-similar fractal properties based on the reiteration of a basic generating unit: the *altepetl*. The repetition of processes added or eliminated levels of hierarchical control in a non-linear manner.



**Figure 2.** Mesoamerican trajectories.

## 2. The *altepetl*

*Altepetl* was the term with which the pre-Hispanic Mesoamerican groups referred to the people, their government, their space, their territory, and their time. The nahuatl term *in atl in tepetl* has equivalents in all the indigenous languages and can be translated as “in the water in the hill”: the concept refers to a mountain located in a place where there is water, both with a sacred character. As a metaphor, the term includes territory, time, space, social organization, the form of government, the sacred, and the profane.

The discussion of the fruitfulness of this ethno-category for the comprehension of the Mesoamerican indigenous world is beyond the scope of this work. The intention here is to start a modeling process of Mesoamerican dynamics that builds on a symbiosis of the ethno-category with models, concepts, and metaphors taken from complexity sciences and fractals as families of models [3], inspired by auto-organized criticality research [4] and complex agents [5].

The *altepetl* has been studied by ethnohistorians for a number of years [6–9] and at present it is considered to have a greater explanatory potential than concepts developed elsewhere such as that of “City-State.”

To date, the exact configuration of the structure of the *altepetl* is unknown. Based on anthropological models, Paul Kirchhoff noted that it could be a recursive system of a structure of hierarchical lineages that had called the attention of anthropologists for some time: the conical clan. In it, social hierarchy was based on the proximity by kinship to the common ancestor or the founder of the lineage, and its growth was nurtured by marriage alliances. In classic anthropology, the clan system corresponds to social hierarchization that precedes state structures [10, 11]. This type of social organization could have existed around 2000 BC in the Mesoamerican farming communities that gave place to the first *altepeme*<sup>1</sup> around the sixth century BC.

With time, the pre-Hispanic interaction system started a long and irreversible fragmentation process, indicating that the Mesoamerican attractor no longer existed. In the sixteenth century AD, with Spanish conquest and the insertion of America in the capitalist world-system, the long history of fluctuations of the indigenous social organization was shattered, which gave place to an a synchronic pulverization of the *altepeme* subsequent to the segregation of its structural components: lineages and the seminal structure of the conical clan [12, 13].

Gradually, the mechanisms of linearization and segregation were lost, the scope of action and control of indigenous rulers was reduced as a consequence of territorial conflicts generated by the Spanish and mestizo invasion of the space of the *altepetl* and by the emergence of new organizations of the Indian peoples and communities between the eighteenth and twentieth centuries structured along the lines of the Spanish model of town council (Cabildo).

However, the segregation and fragmentation of the territory of the *altepetl* of Ixmiquilpan, for example, show self-similar, recursive, and fractal processes: the number of segregated towns, the extension of their territories, the size of their borders, and the fractal dimension of the latter are a function of time. The process is isomorphic with respect to the reduction of the fractal dimension of the Sierpinsky carpet [14, p. 154].

Bounded in the time and space of the Mesoamerican attractor, the dynamics of growth and collapse of pre-Hispanic cultures was based on a system of alliances and conquests, of segregations and independences. Alliances permitted the aggregation of similar structures to the body of the *altepetl* until it reached the form of a great confederation, like the insights Lewis

<sup>1</sup>*Altepeme* is the plural of *altepetl*.

H. Morgan had since the nineteenth century of the Iroquois and Aztec confederations [15]. Alliances allowed the system to increase complexity and hierarchy within a structure that has been proposed as self-similar to the fundamental entity.

The reiteration of the *altepetl* on itself reached a complexity comparable to that of the great cities and empires. In ancient Mesoamerica, these had the ambiguous appellation of *huey altepetl*, the great *altepetl*. Equally, independence and segregation of components could take place, producing significant changes in the organizational structure of the *altepetl*. Fragmentation could even reach the level of the rudimentary generating unit.

The basic structure of government entailed at least three discernible hierarchical posts: the *tlatoani*, the *tecuhitli*, and the mayor, which were associated with the same number of hierarchical levels of settlements: the capital, the subordinated village, and the neighborhood or extended family house (*calli*). This arrangement is not necessarily linear. Joyce Marcus proposes four levels for Maya settlements, from first level villages to hamlets [1, p. 314], but it seems that at the base of this hierarchical, rotating, and non-linear system, a structure like the conical clan could be found in the hamlets.

In the conical clan, social organization and economy were beyond the level of an equalitarian community. Even if production was based on domestic units, the population had to collaborate in the construction of extensive works, like temples or palaces, and products and services were exacted for the purposes of the clan, the deities or for the hierarchy of the rulers [11, pp. 45–46]. This system was repeated in the neighborhoods, the hamlets, the capital, in the *altepetl*, in the *huey altepetl*, increasing the number of participants and the structure of the organization.

This basic structure repeated itself by means of alliances of different types, especially through marriage bonds (a higher level *altepetl* or lineage offered a noble woman in marriage to a lower level *altepetl* or lineage, or vice versa), increasing hierarchies and territorial control until reaching the ambiguous maximum of the *huey altepetl*. Alliances and confederations allowed the evolution of systems of cumulative complexity.

In the opposite direction, one or several *altepeme* could segregate from the larger entity and forge their autonomy. The segregated units increased their hierarchy in circumscribed territorial domains, while the larger system reduced its size and territory. These dynamics, when present in an accelerated fashion in short periods, like an avalanche, is a collapse. The reiteration of these processes—the diffusion and propagation of decisions—resulted in *altepeme* of different levels of hierarchy and territorial extension or the pulverization and the return to the minimum unit of the system: the *altepetl* [16, pp. 40–41].

The *altepetl* is a complex autonomous agent, since the decisions it makes while acting on its environment can intensify unsuspected evolutionary capacities that can manifest as an increase in hierarchy and social complexity, as an indifferent response, or as a transit toward lower levels of organization or to collapse or extinction.



In the environment of each *altepetl*, there are other *altepetl* that react to the actions and decisions of their near and far neighbors, with which they compete or collaborate to obtain the maximum benefit. The result of the actions and interactions is unforeseeable but, as in an interrelated system, the *altepetl* co-evolve, they are co-dependent one from the other and, in the network of local relations and practices, at times they win, at times they lose.

The *altepetl* is an agent that has action capability: it has reasons; it strives to concur in what it can do and what it knows with its peers, other *altepetl*. The decisions can take the form of cooperation, competition or rivalry, that is, alliances, confederations, segregations, or warfare. The aggregate of interactions between the agents can produce greater social and political hierarchy or collapse, the possibility to acquire prestige goods or consumption restricted to local goods [16].

Minor autonomous or subordinate entities (lineages, *altepetl*) tend to show a layout like that of the major entity due to integration and greater social hierarchies, which, in turn, results in complex cohesive and durable units. The complex autonomous human agent *altepetl* is a reproducing system based on the structure of lineages of the conical clan.

As corporative systems, in the lineage, in the conical clan, and in the *altepetl*, the action capacity resides in the head of the hierarchies, in the rulers, who spoke for the people. Collectively or individually, the ruler's decision was reflected in the action of the *altepetl*. Consequently, the dynamics of the *altepetl* reflects circumstances, intentions, reasons, deliberation, voluntary or involuntary motions, passivity, coercion or expected results, conformed in an open network of inter-signification, where each action has significant repercussions on all the network [17].

The agent's action has a cultural horizon that establishes the limits and conditions of knowledge, of know-how, and of awareness of problems, dilemmas, solutions, and strategies to follow. What is not in the framework of their traditions, their knowledge, and of their historically determined cultural horizon cannot be done, thought, practiced, or even imagined [16, pp. 21–32].

Dynamics and fluctuations of Mesoamerican systems can be modeled by a space where  $N$  elementary agents (lineages) have  $K$  interactions with their peers. The dynamics of this  $NK$  space result in the emergence of an agent of a higher degree of complexity: the *altepetl*. The latter also interacts with peers in an  $NK1$  space originating an even higher degree of complexity, the *hueyaltepetl*. In turn, the interactions of this agent with the ensemble of its peers in an  $NK2$  space increase complexity until a limit in which the system collapses (**Figure 3**).

Collapses were a historical possibility in any moment of the evolution of the system in the  $NK$ -dimensional space of the Mesoamerican interactions. It could have a local and restricted character, or take the form of a global and generalized avalanche as is shown by the scheme elaborated by Joyce Marcus for the Maya area [1, pp. 322, Figure 11] (**Figure 4**). This was the stable form of Mesoamerican fluctuations that were present throughout their history.

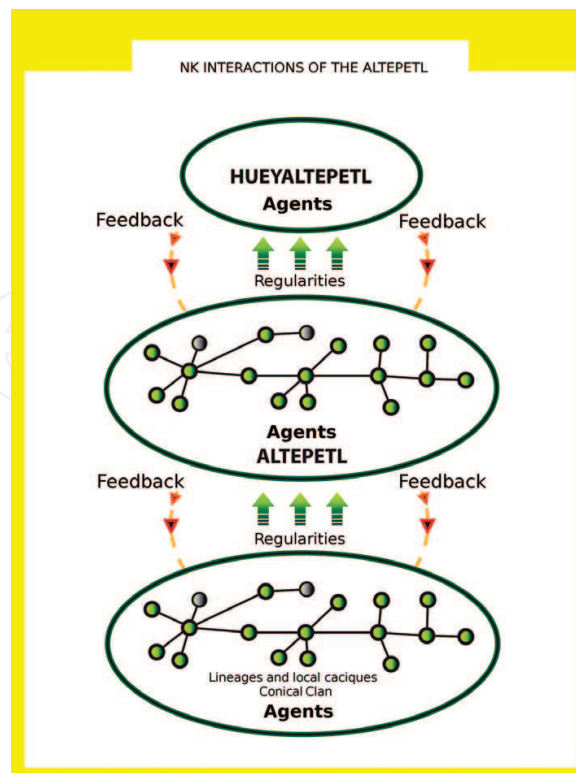


Figure 3. Space of interaction among agents and self-similar hierarchy.

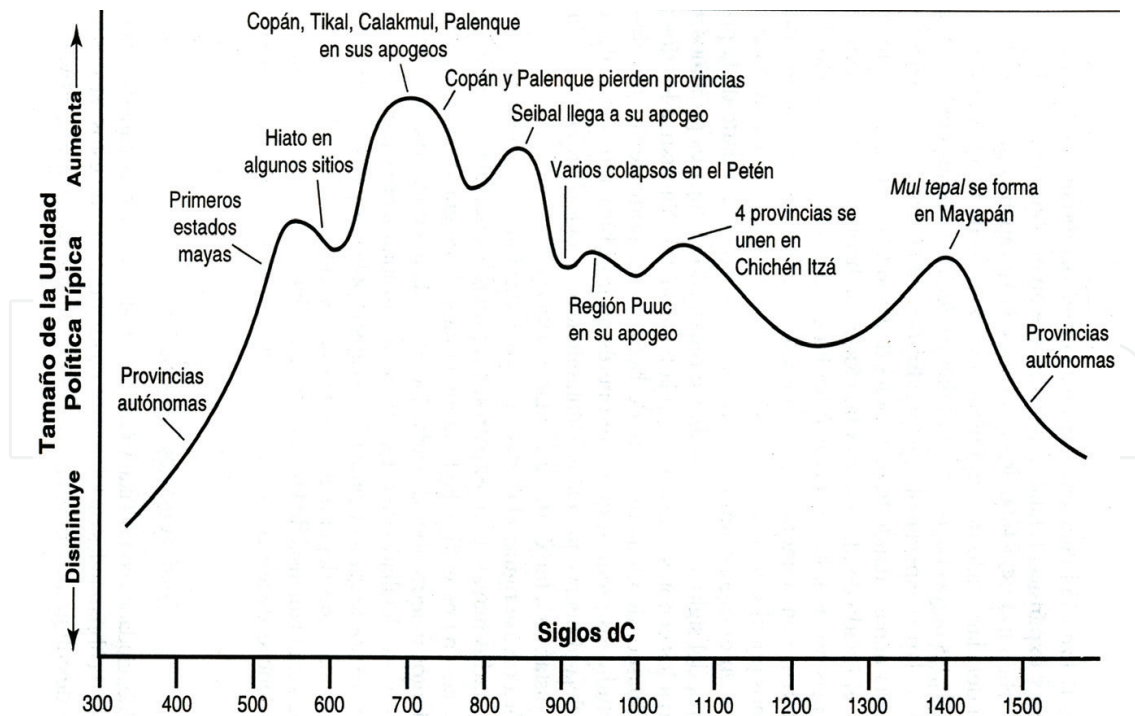


Figure 4. Oscillations of Maya collapses, taken from Ref. [1, p. 322, Figure 11].



### 3. Conclusions

One of the dilemmas faced by the fractal modeling of Mesoamerican pre-Hispanic societies is that the history and the evolutionary path of these cultures have been undertaken from a perspective that does not contemplate oscillations and fluctuations that characterize a dynamical complex system.

In this long-term research, we analyze the self-similar fractal properties that occur in systems that emerge from the NK space of interactions of the *altepetl* as a human agent.

The NK interactions of the *altepetl* can be considered as an example of what Kauffman called the NK landscapes that are based on the interconnections between agents: the actions of an agent are dependent on the actions of other agents.

Interconnections between agents are the basis of Kauffman's model, in which a network of  $N$  agents is constructed such that each is randomly connected to  $K$  others. The interactions between each agent and its  $K$  neighbors can be cooperative, competitive, or a mixture of both. Now, instead of all agents reacting to a few environmental variables, each agent reacts to the actions of the  $K$  other agents in its communication network. Each agent, therefore, has a unique set of conditions governing its behavior. Optimal strategies in the present moment may not be what they were before, because they depend on the previous actions of other agents. This result is a "Red Queen" effect, in that agents are forced to keep evolving (i.e., searching the fitness landscape) toward higher fitness peaks just to stay competitive [18, p. 13].

Kauffman's model [19] establishes that interactions among agents depend on the value of the interconnections among them and that they react differently when they have a moderate connection than when they are completely interconnected. In the first case, they can adapt easily and make small adjustments in their strategies to avoid greater risks, while in the other case, each agent has so many unfavorable interconnections that the favorable ones do not seem to exist, and the quest toward a decision is not better than chance [18, p. 13].

Kauffman's model was used by Kohler to analyze the Plaza people that occupied the Pajarito plateau in New Mexico toward the thirteenth century AD. Kohler focused principally on the interaction between households ( $N$ ) and observed that their number increased while their interconnections ( $K$ ) practically remained constant [20, p. 381].

When the NK interactions of the *altepetl* are considered in the long run, they result not only in the existence of closer interactions but also in closer organizational *altepeme*, and therefore a superior entity is formed—the *huey altepetl*— that maintains lower-level interconnections and reiterates them with neighboring *huey altepeme*, forming an NK space self-similar to that of the *altepetl*.

This characteristic was repeated until a configuration of higher hierarchy and control entities were established. In the case of Teotihuacan, up to seven hierarchical levels above the *altepetl* can be distinguished. In a self-similar fashion, they repeated the NK interactions with their close neighbors. We can put forth the hypothesis that when these interconnections reached a limit, a critical state was reached without the interference of external agents. Small local collapses ensued and, eventually, the massive cultural collapses.

The Mesoamerican attractor, characterized by three intertwined trajectories of stability, instability, and semi-stability, included the fractal self-similarity of the interaction among agents that formed its cultures, with independence of the scale of hierarchical complexity of the system.

## Author details

Fernando López Aguilar

Address all correspondence to: [flopez.enah@inah.com.mx](mailto:flopez.enah@inah.com.mx)

National School of Anthropology and History, Mexico City, Mexico

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