7

Agriculture and Rurality as Constructor of Sustainable Cultural Landscape

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1. Introduction

Is the XXI century an age of changes or is it a change of age? We must assume that new and more complex challenges are as necessary as deep culture and paradigmatic modifications. Growing complexity and the present-day territorial degradation has made it necessary that we transform the dominant science paradigm to face the sustainability problems. A new science is essential to improve the understanding of ourselves and our environmental life [1-4].

The evolution of new technology, about ten thousand years ago, gave birth to the artificialization of nature and agriculture. The way said artificialization and management of the natural resources was determined basically by the factors and cultural tendencies. Culture can be defined as a learned system that produces an action and the way we relate with the world [5]. It is a set of subordinated suppositions and beliefs shared by a group or society, influencing their behavior [6].

The cultural landscape concept has emerged as a systemic transdisciplinary study object. To understand the present context it is basic to understand the cultural landscape concept, representing an expression of cultural activities in a territory, and as such, it is a key factor for the sustainability study [7]. Cultural landscape is a XXI century integrative concept.

Depredating conditions and trends of ecological-territorial systems and their effects on planetary life require an urgent change of the present dominant artificialization style and cultural landscape construction. We are part of the unique and interdepending web of life [8]. Complementary couplings of our construction cultural landscape style and nature organization result in healthy and sustainable cultural landscapes [9].

Starting from a historical ecological-territorial footprint and facing the relationship between agriculture, rurality and cultural landscape, the main objective of this work is to state the fundamentals to understand, develop, and construct a sustainable model adaptive of our age.

2. Agriculture from nature

2.1 Nature

Nature is the set of all entities and forces that constitute the territory. It is the natural world without mankind or civilization [10]. The natural world is the background matrix where humans have evolved during a long period of time, leading to rurality and urbanity as a complement to wildland [11, 12]. Since the presocratic time of Anaxagoras, it is stated that nothing is born or dies, but that everything emerges from preexisting entities and elements; just as it happens in Nature, which when artificialized, is transformed into a cultural landscape. Natural resources are the supply source of our civilization and act as the life support for our domain of existence [13]. This is the reason why the resources should be sustainably managed and maintained, turning the agricultural activities into a main component. Complementary, ecosystem is a concept that allows placing and integrating the various disciplines that transform the agronomic sciences into a transdisciplinary dialog. Recently, cultural landscape emerges as a strong concept. It develops from the territorial stakeholders in a certain cultural context integrating the various sustainability and development dimensions. All of this arises from a social-cultural coevolutionary process with nature, and from the stakeholders with their surroundings.

Territory may be conceived as a "land or aquatic volume or area belonging to a farm, county, province, region or nation" [14]. The territory is used by society, originating from the interaction of three main components: nature, society and technology. Nature comes before man, what grants it a different evolutionary meaning. Man develops culture as a way to establish a relationship with the world, gradually organizing growing and complex structures integrating ethnics, politics and labor, among others, generating as a result the social structure. From the resulting integration of nature with social structure emerges technology as an articulating component for both. This process gives birth to a territorial system which in time becomes an integral unit [14, 15].

Cataldi, an italian mathematician and designer during the XVI-XVII centuries, states that man modifies nature until finally transforming it into a cultural landscape. As a result, he generates a sustainable or unsustainable system depending on the behavior of the people, and ultimately, on the type of activities carried out by the stakeholders.

2.2 Agriculture: Definitions and formulation

Agriculture *sensu lato* can be defined in various ways. Lawes [16] and Prado [17], defined it as a process of artificialization and decision taking about nature, with some specific human purposes, such as producing food, fiber, leather, wood or landscape beauty. It is, therefore, a process of transformation with a given objective, involving nature, stakeholders and technology. In this context, agriculture *sensu lato* includes numerous activities related to multiple land use for production purposes (vegetable garden, forestry, aquaculture, livestock, etc.), protection (of soils, fauna, banks, landscapes, etc.) and recreation (agrotourism, camping, sports, entertainment, and so on).

During the seventies, when hard productivity technologies were being enforced, agriculture was defined as putting a harness to solar energy through plants for human purposes [18]. An earlier definition, 1814, describes it as science of managing farmland [19]. The latter

definition is consistent and complements, as well as, integrates the above ones; it combines Nature and its artificialization with land management, organized around rural properties. In all these definitions the ecosystem is essential and a priority.

On the other hand, agriculture can be defined as an economic activity related to the sustainable production of crops and its transformation into elements which can be consumed by man. Many people perform this activity as a way to live [20]. This definition expresses the policy approach of the farmers' associations and some of the Ministries of Agriculture, who tend to consider agriculture as a mere business, when it should be seen as a central component for integral rural development.

In recent decades, agriculture has been looked upon only as an agribusiness, which takes away much of its significance and meaning, leaving it only as a minor branch of the economy [21]. In Chile, in general this began mainly during the second half of last century and continues today. Agriculture has been restricted to crops, economy and enterprise, overlooking its farm dimension and in many cases causing the degradation of the natural resources of the country [11, 22, 23] Unlike this, the traditional large farm (hacienda) for the first 300 years after the conquest and colonization of America was the major territorial, social, economic, and management unit, later complemented with other styles of farm in all its forms [24, 25].

In the early Christian age, at the time of Columella [26, the original paper written during the 1st century aD], there was talk of *re-rustic*, referring mainly to the rurality, which is complemented by the urbanity that takes place in small towns and villages in the territories of Babylon, Greece and Rome [27, 12]. It was necessary to supply the cities with abundant food; thus, it was necessary to develop specialized farms with efficient production processes. The English word farming derives from here, differentiating it from cropping and husbandry (analogous to agriculture in Castilian). Farming can be defined as the arrangement, management and administration, of rural lands, which achievement center on the territory articulated by technological activities related to agriculture *sensu lato* [11, 28].

Ecology is incorporated formally and rigorously since the twenties, adding the ecosystem in the year 1935 [29], and becoming generally known between the sixties and seventies. It is difficult to argue that modern agriculture can develop sustainably without incorporating the ecology as a fundamental paradigm. This due to the agricultural matrix land generated from the artificialization of the natural ecosystem forming rural properties, and due to expansion of the agricultural frontier as generalized as a worldwide phenomenon [1, 2, 23, 30].

Symbolically, the artificialization (A) of nature, or agriculture, can be represented as [15]:

$$A = (\pi_a / \pi_a \,:\, \Sigma_0 \rightarrow \Sigma_1) \tag{1}$$

where:

π_a: Set of operators of artificialization for a state of artificialization "a"

Σ_n: State of the ecosystem to time n=0, previous to time n=1

$\Sigma_0 \rightarrow \Sigma_1$: Change of the state of the ecosystem from Σ_0 to Σ_1

From an operational point of view, the farm can be defined as "an organized unit of decision making, an area of renewable natural resources, connected internally and limited externally, which aim is to make agriculture" [31, 32]. Formally, the farm (P) consists of [15]:

$$P = f\ (S, \Sigma, \phi, \sigma_a) \quad (2)$$

where:

S: Space-time, L^3 x T (length^3 x time)
Σ: Spatio-temporal units of renewable natural resources
Φ: Inter or intra flow of matter, energy or information
σ_a: Answer or output as a function of artificialization

2.3 Ontology and epistemology

Ontology refers to the nature of the reality or phenomenon under study. In this case, it is the agriculture, rurality and cultural landscape in the context of integral and sustainable development based on local and global landscape design, situated in a systemic theory [33], ecological theory [29, 34], as well as the information theory [35, 36], the complex systems theory [8, 37, 38], and cognitive theory [3, 13, 39, 40]. The adaptive flexibility of the cultural landscape is related to the information content of the system [41]. Information and diversity, from the operational point of view, can be considered equal.

Despite the enormous technical advances modern agriculture has undergone, the late twentieth century lacked a unifying theory integrating all the above issues, as well as its thematic and conceptual context. A theoretical framework was needed to locate and frame the agricultural engineering in a holistic, systemic, integrated, and transdisciplinary context, in view of the advance of science and engineering paradigms by the end of the century [13, 42-44]. This theoretical framework arises for agriculture and for several other disciplines from general systems theory, holism, ecology, and new paradigms emerging in recent decades.

The final rationality of stakeholders, as cognitive agents, is to maintain the structural coupling with its domain of existence [13, 39, 40]. In this context, mutual determinations that keep this co evolutionary coupling between the stakeholders and their scenario are of an emotional nature [4]. The stakeholders experience an emotion when confronted with the phenomenon they perceive, determining the action which will generate the landscape, which in turn feeds their perception [8].

According to Röling [13], the cognitive support of collective decision making is sized into four components: value, theory, context and action (Figure 1). According to Lawes´ [16] definition of agriculture, value must be based on ecological rationality given by principles, laws and ecosystem structure, with any style of agriculture. In the theoretical model the value must be constructivist, so it must be generated within an epistemological framework for dialogue and collective subjectivity. Action should be deliberate and collective according to the culture of the stakeholders, associated with their perception and cognition. Finally, the context of agriculture should focus on man as the greatest driving force of the cultural landscape and determining their own future. However, the territorial problems as well as degradation of ecosystems and natural resources, show the lack of an instrument which lets us handle this force [2].

The four dimensions of cognitive support of collective decision making are considerably modified if instead of using the definition of Lawes, we use a definition that increases an agriculture focused on production. The prevailing definition of agriculture determines the paradigm that governs the actions on the cultural landscape and its sustainability.

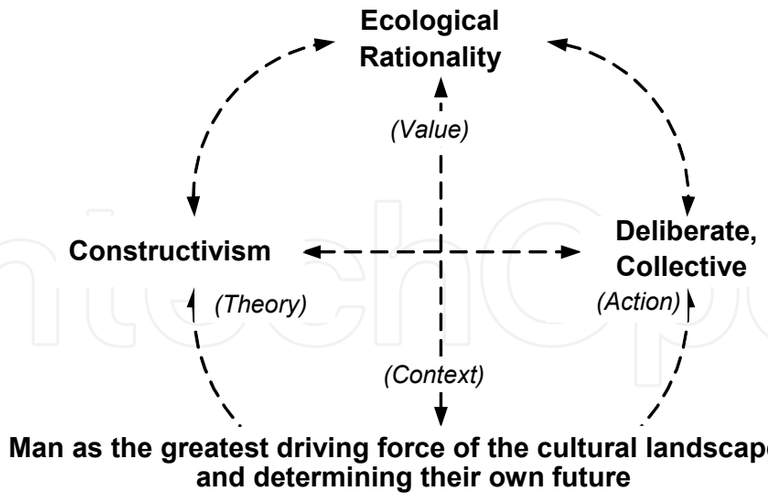

Fig. 1. Decision taking as a function of Lawes definition of agriculture as artificialization of nature [adapted from 13].

3. Rurality, territory and cultural landscape

3.1 Hominid frontier expansion and cultural landscape

Land cropping and the following appearance of the rural cultural open landscape[1], occurs only starting around 10.000 years ago. This is the starting point of the process of landscape hominization [45, 46] and the homind frontier expansion. Each society relates differently to nature and its surroundings, arranging the territory according to its culture, setting the bases of the different cultural landscapes.

The nature artificialization process, and the expansion of the hominid frontier is intended to conquer niches and improve anthropogenic canalization of goods and services, requiring the extraction and insertion of elements into the ecosystem.

As example of the hominid frontier expansion and creation of a cultural landscape, Gastó [47] reports what happened in the range lands of the North American west. After the arrival of settlers there was degradation of the soil and vegetable covering, and as a consequence of this, large stretches of land were abandoned due to low productivity. These settlers didn´t have the necessary knowledge to open up, order, manage and administer the territory. Faced with this, the Government, got involved and establishes the National Park Service (1873), National Forest (1890), Native American Reservations, Wild Life Shelters and the Land Grant College. At the same time, and in order to improve the public land management, the Government set up the Forest Service (1905), Bureau of Land management-BOM (1935), and the Soil Conservation Service (1905). Meanwhile settlers were converting private land into great ranches. The American Society of Range Land Management was created in the 1940´s, with the intention of developing a science based on principles differing from those of agronomy. Currently one of the most important aspects is

[1] Rural, etymologically means wasteland, opened by and for mankind. This is within the expansion of the hominid frontier, the place where man can live and generate rurality.

the publishing journal of range management for continuous renewal of concepts, technology, and guidelines, in order to be consistent with the demands of society and maintain the sustainability of the territory [28]. Because this, "rangeland" is an expression of the contemporary American cultural landscape.

Another interesting case of cultural landscape generation is *dehesa*[2], in Mediterranean Spain. Dehesa corresponds to a cultural landscape created and developed by the popular culture. By definition it is a typical natural dense sclerophyllous Mediterranean forest, with a simplified structure and diversity of species achieved by reducing the tree density by pruning and thinning, developing isolated fruit producing trees loaded with acorns and stimulating the formation of a natural prairie in the undergrowth [47, 48]. Two main livestock niches are generated: one of the acorn consuming pig and the other of the ruminant ovine and bovine grass consumers (Gastó 2008). The evolution of the *dehesa*, of its elements and landscapes is deeply related to the development of the transhumant livestock, which has been very important for the Iberian development. According to Gastó [47] the *dehesa* is a sustainable system by generating products of great value while maintaining landscapes of immense aesthetic value with a mixed wintry herbaceous cover and evergreen trees.

In both cases, the rangeland in the United States, as well as, the *dehesa* in the Iberian peninsula, the expansion of the hominid frontier and of the construction of the cultural landscape, created a stable cultural landscape, harmonizing the economic, social and ecological services with a remarkable identity [49].

Easter Island on the other hand has become an emblematic case [12, 50] of a very fast hominid frontier expansion, which extremely modified and depleted a fragile ecosystem (isolated area in the middle of the Pacific, 388 Km^2). There are various hypotheses, which explain this particular degradation process. Some of them suggest that the deforestation and severe depletion of the ecosystem was the result of the increased demand for logs used for the transportation of the Moais, and that the population of the Island got to be 7.000 [12]; other hypothesis sustain that the disease and slavery brought by the Europeans were the main reason that triggered the population crisis, aside from the introduction of the Polynesian rat that prevented the forest from regenerating and generalized harvest [50]. Nevertheless, the Eastern Island society colonized said territory but failed in its attempt to make it sustainable, producing the depletion of its own ecological support and thus, its own extermination.

In each one of these situations (rangeland, *dehesa* and Easter Island) man colonized a territory, expanded the hominid frontier, artificialized nature and transformed the ecosystem, creating a new cultural landscape to fit their needs, culture and technology, and attaining an improved or poorer system in terms of sustainability and life quality [28, 49].

3.2 Rural, urban and wildland. Territories typologies and components

Before mankind all that existed were natural scenarios based on systemogenic processes and ecological succession guiding the ecosystem to more complex and self-organized stages [49, 51]. People colonize habitats and develop niches; starting the process of nature artificialization and hominid frontier expansion, as well as, the clearing of the wildland and

[2] The *dehesa* is a *savannah* Spanish landscape type.

its transformation into rural (wasteland) and, afterwards into urban (built territory); *bann* (abandoned territory) and *agri deserti* (agonizing territory) [49, 52]. When man clears the *wildland*, there is a simultaneous hominid frontier expansion, simplification of the natural ecosystems and input-output of ecosystem elements, shaping the territory on the basis of society´s culture and technology. In this context, the cultural landscape appears gradually as an expression of the sociostructure over the biogeostructure, in a coevolutive context articulated by the tecnostructure [23, 52, 53].

The hominid frontier expansion is followed by a territorial specialization and the emergence of different territory typologies, such as: protected wildlands, rural and urban. These territorials typologies are differentiated by the various proportions of the three territorial components within: *saltus, ager* and *polis* (Figure 2). *Saltus* represents the territorial component which is not directly affected by the anthropic action; *ager* is a territorial component cleared with direct artificialization due to the anthropic action in a intermediate level, being land cropping the predominant artificialization style; *polis*, refers to a territorial component with a high level of artificialization, being its main style construction and infrastructure. The protected wildland territories are made up of in large proportion by *saltus* and in lower proportions by *ager and polis*. Urban territories are mainly made up of the *polis* component; and rural territories present a more balanced situation of these three elements: *saltus, ager and polis*.

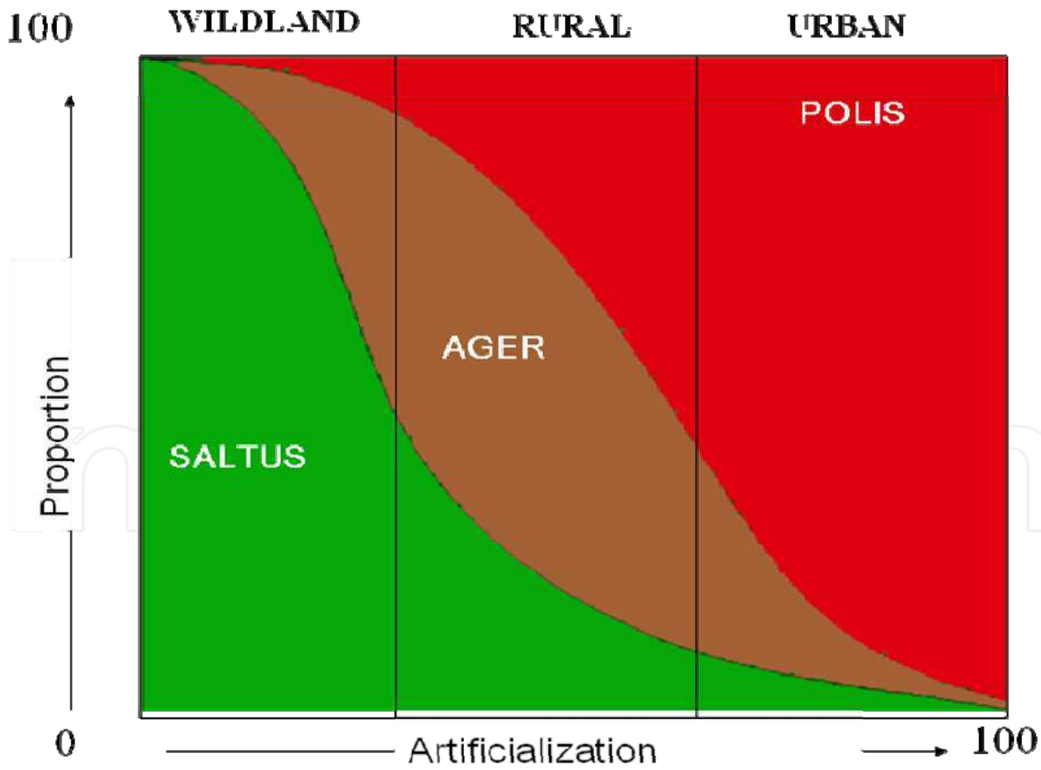

Fig. 2. Relative proportions of territorial components: *saltus*, *ager* and *polis*, belonging to the territorial typologies: protected wildland, rural and urban, depending on the level and style of artificialization [adapted from 54].

Various farms management typologies appear in these territories: in the urban territories, there are megacities, cities, towns, villages, among others; in rural territories, different kind of farms, vegetable gardens, urban parks, ranches, coexist; an finally, in the natural territories there are National Parks, Biosphere Reserves, Forest Reserves, Nature Sanctuaries, ethnic reserves, and the like.

4. Cultural landscape construction and governance

4.1 Spirit of age and place

Culture has become the main factor to determine the evolutionary dynamic of the ecological-territorial systems of our age, and consequently the construction and resulting cultural landscapes of the stakeholders. The spirit of age was first developed in Germany in the year 1769 by the poet and philosopher John Gottfried von Herder, giving it the name of *Zeitgeist* which means: spirit (*Geist*) and age (*Zeit*). The *Zietgeist* concept is mainly known in relation with the German historical philosophy of the philosopher George Wilhelm Friedrich Hegel. Zeitgeist refers to the predominant cultural tendency at a certain time in the history of mankind. There is a certain vision and behavior during each particular period of sociocultural evolution which is expressed in the ecological-territorial systems and resulting cultural landscapes. This vision and style corresponds to the profile of the age and the conception of the world [55], which would be equivalent to the concept of paradigm in the world of science. Zeitgeist defines in the Hegel approach a certain state of the dialectic evolution of a person, a group of people, society or the whole world. Also important, and complementary with the spirit of age concept, is the spirit of place (*Volkgeist*), which mainly refers to the cultural tendencies of groups or societies in different places. This is related with the Nature's conditions in each place.

A common characteristic of the beliefs from eras preceding the industrial revolution was that human acts were limited to our basic needs and that technology only developed according to them [56]. During the industrial age, development was understood as a rebellion in contradiction to the need governing all societies until the XVIII century, and that progress is the success of said rebellion [56]. This has happened in association with technocracy and economic rationality predominance and with the neoliberal economic model [57]. This world notion and, the related growth model have generated great impact on the ecosystems, natural resources and, have been associated with the unsustainability tendencies of the ecological-territorial systems.

During the last decades of the XX century there have been territorial tendencies damaging sustainability and life quality, motivated by the stakeholders. The predominant sociocultural, economic and territorial tendencies in our time make it necessary to integrate new regulatory and management parameters, as well as new methodological tools to explicit and integrate the ecologic and social approach, methodological frameworks and design tools in addition to ecological-territorial planning [51].

Such unsustainable territorial tendencies have been and are presently generated by issues, such as: the economic strategies and targets that seek principally short term maximization of financial profit; predominance of private short term interest above long term public interest; a sectorial organization and design incapable of integrating the various dimensions of

human society development; the non-inclusion of the social and environmental services in the regional o national accounting [58].

The predominant green agricultural industrial revolution known as conventional agriculture is associated with institution, policies and technologies administered form urban centers and markets, which interact with the present-day development model. The green agriculture revolution is based on a great use of capital and exhaustive transformation technology, as well as, laborer reduction, high energy, water and mechanization input, applied in high potential productive ecosystems. Industrial agriculture can be defined as a way of artificializing nature and natural resource management, in pose of agriculture productivity, giving great importance to the economic profit through marketing, and occasional technological processing of highly homogenous products, by means of exogenous inputs into the agro ecosystem, by its artificialization, simplification and destruction of the natural recycling energy and material process [59].

This kind of context and agriculture has generated an important territorial-ecological impact and footprint in rural areas. The main footprints have been: carbon, energy, water and information, which put together, can be considered the agricultural footprint of our era. The agricultural frontier expansion and domestication of nature, both associated to the rural and cultural landscape construction, have developed several ecosystem diseases and affected life quality; such as: soil erosion, desertification, biodiversity reduction, cultural landscape homogenization, loss of niches and habitat diversity, in other words eco-diversity, unstable ecosystems, loss of resilience and stability, etc.

Several studies show the consequences of the great economic importance given to the ecological-territorial management, generating ecosystem dysfunction in maintenance, use and regeneration of resources, as well as, degradation of the ecosystem services [60]. These authors indicate the importance of keeping the pressure on the landscape within the required limits for a stable ecosystem function, key for a sustainable management. Unfortunately these limits are frequently trespassed. This is the case of the Australian grazing system management. The innovation and production goals motivated by the wish for great short term profit in the ranching activities have produced many ways of degradation of the cultural landscape: Diminished natural grange and crop productivity; lower tolerance to drought, salinization, acidification, soil structure and erosion, water salinization, eutrophication of streams and lakes; loss of trees considering the cultural landscape scale; loss of important local and regional plant and animal species; invasion of native and exotic grasses; loss of future potential use of the land (tourism, research, etc.); besides the lower rural life quality [57, 60].

In Latin America there are also many cases. One is the Chilean forestry crop industry, broadly studied in academic and scientific literature and fully examined by Erlwein *et al.*, [61]. The tremendous growth of this industry, explained mainly by the forest plantation territorial expansion starting the mid 60's till the end of the 90´s, and due to the increase of plants and production of cellulose, has triggered effects, such as: the unsustainable rurality; increase of the surface intended for intensive production; extreme production which excludes other uses and activities; reduction of native forest patches and of bio and eco-diversity; separation from land multiple use; resource degradation and production

potential; capital concentration and socioeconomic inequity; inconsideration to cultural diversity contrary to social ethics; and cultural landscape uniformity, among many others. In conclusion it has been a sectorial growth which hasn´t incorporated any aspect other than the economic growth (such as the historic, social, ecologic, etc.) nor objectives different from the personal and private ones of the social actors, who have administered the process, and consequently have not stimulated and integral and sustainable territorial development [57].

This has all happened jointly with the emergence and development of the "industrial empires" pertaining to our industrial era. By the end of the XVIII century, with the industrial revolution there is a modification of products, transportation, technology and the demand for elements from nature which start becoming scarce or limited, generating the term natural resources in 1875. Modern industrial empires, such as: USA, United Kingdom, Japan, China, Germany, France, and others. Their natural resource requirement is so high that the commodities are extracted from the rest of the planet, generating the ecological footprint [62] of our industrial age. Said ecological footprint is grater in the countries producing the commodity to fulfill the demand of industrialized countries [53].

According to the ecophilosofer Sigmund Kvaloy two basics kinds of society can be distinguishes as a result of the industrial cultural tendencies and cultural landscape construction style: the Industrial Growth Society (IGS) and Life Necessity Society (LNS). The IGS are orientated towards industrial growth, whereas the LNS to fulfilling vital necessities.

IGS are developed through the interaction of four main dynamic factors [41]: oriented towards the linear or accelerated expansion to the production of industrial goods and services using industrial methods, as massive standardized production, the concentration of a few urban centers, and the specialization; the main force is the individual competition in every field of human effort, including leisure and art; the main resource for expansion and to eliminate competitors is not the mineral, energy, etc. resource control but the applied science control. The leading method to manage everything and perform diagnosis and prognosis is quantification. There is only one historic case of this kind of society: The present one which is becoming global. Most human societies have been of the LNS type. Among them there is a subvariety: the "Life Growth Societies" (LGS). These societies are focused on life improvement and promoting ecological complexity, cultural development and human creativity. This kind of society only can surface as a subspecies of the LNS type [41].

At present, progress is focused on the full understanding of territorial development. In which the territory is not a circumstantial factor of the economic analysis, but a descriptive element of the development processes. For a society to approach sustainability there must be cultural and paradigmatic changes to favor and direct, the integral construction of sustainable cultural landscapes, suitable for a good quality of life. For such paradigmatic changes to take place, there must be a considerable reorientation in the approximations that study these issues. Within the following paragraphs we present the theoretic and conceptual basis for the integral construction of the cultural landscape in the context of our era.

4.2 Change of paradigm

During the last thirty or forty years there has been a paradigm shift due to the postmodern scientific revolution, mainly with the emergence of so called complex sciences, which change the object of study from the parts to the whole [30]. This has meant no longer centering the study in linear and determinant processes, but in non-linear processes organized in hierarchical interrelated networks, in order to identify the main interactions among variables and the processes involved in the study´s objective; this way the processes and tendencies that emerge from these interactions, turn the concepts of complexity, network and hierarchy into fundamental issues [57].

This means changing the fragmentation for integration and complementation of the parts. The intention is to trespass the limits of the traditional scientific knowledge which proposes the objectivity and certainty of scientific truths, recognizing the need for an integral and contextual vision, as well as, and the need to deal with uncertainties [13, 30, 63, 64]. The key of the epistemological property of this paradigm shift is the development of an inter- and trans-disciplinary approach that requires variation in the current scientific reasoning. Röling [13] proposes the evolution of the science paradigm, starting with the simple dynamic structures and mechanical models, passing by the self-regulated models and homeostatic feedback models, towards the complex adapting auto-organizing systems, as well as, the autopoietic cognitive models (Figure 3).

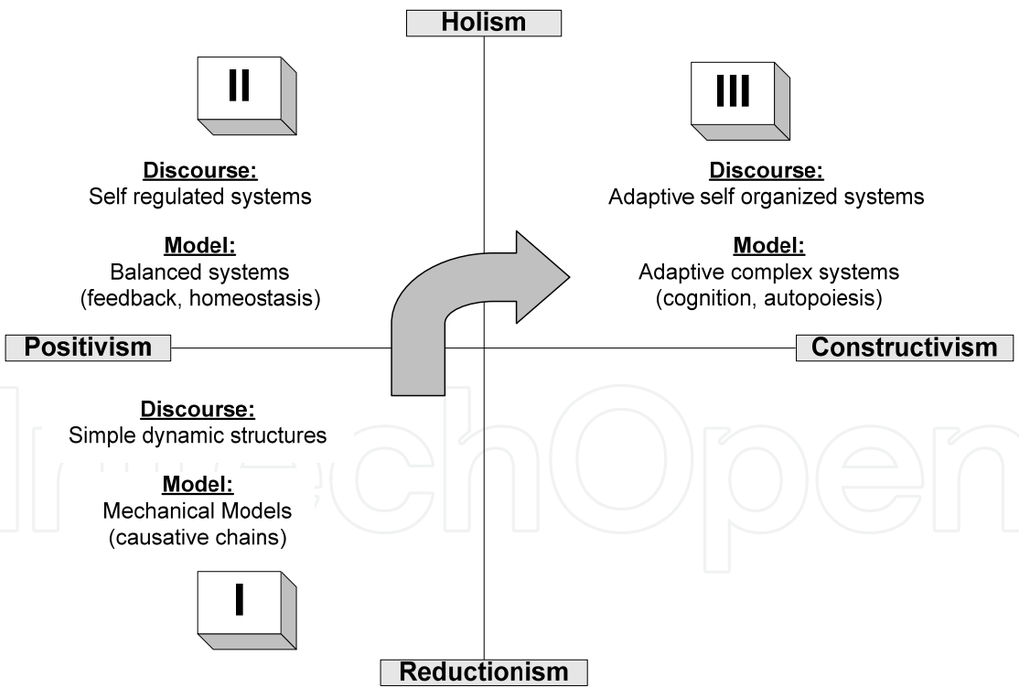

Fig. 3. New scientific paradigm evolution [adapted from 13].

The main difference between positivism and constructivism lies in how you consider epistemologically, the relationship between the observer and the object and phenomena observed. Positivism considers the independent phenomena of the particular observer. Constructivism, on the other hand, incorporates an interaction between the observer and the

phenomenon observed, and recognizes that our perception of the world is only an individual and partial one [63]. From the perspective of constructivism, there should be a permanent dialog between the various observers, in order to piece together a group vision of reality, turning this into a collective cognition process. This effective dialogue, resulting from the collective construction is the foundation for the study of the phenomenon from the constructivism perspective.

In the XVII century, the French mathematician Rene Descartes formalized the reductionism perception. According to him, it is necessary to dissect and analyze separately and make precise measurements of the complex phenomena to fully understand it. This approach is synthetized in D*iscours de la méthode* (1637). As a consequence, it has created a utilitarian criteria of the truth and a reduction of the phenomenon studied to an instrumental notion [30]. During the same century, the English physicist, Isaac Newton, complemented this approach with mechanical vision of the universe. In this approach the wish to set rules and laws, and even some regularities could be sensed [65].

The holistic approach is based on the system theory, and thus, on the approach which established that the universe is an interrelated system, originating in the aristotelic consideration that the whole is greater than the sum of its parts. All the data is more than the sum of the fragments of information, having to know it all to understand the collective behavior of the parts [30], namely, its combinations, and functional interactions in the construction of the systemic totality. The holistic approach considers that the problems must be tackled from the totalities and considering the contexts, as well as from the qualitative approach which gives meaning and sense to the quantitative.

The first quadrant of Figure 3, shows the reductionist - positivist approach, where each phenomena is perceived and treated independently from every discipline; the second quadrant is still based on positivism, but has evolved from a reductionist to a holistic perspective. There is a partial integration of the positivist – reductionist disciplines, but not enough to develop an integral and operational approach toward transdisciplinary and multidimensional problems.

The third quadrant presents an holistic and constructivist approach. Here the Adaptative Complex System (ACS) is located [*sensu* 64], the cognitive theory [39, 40, 8], the social knowledge based on and intentional and adaptive collective cognition in the design and management of our own destiny [1, 2, 13].

One of the outstanding values of the systemic approach, which is based on second order cybernetics, is that it may overcame epistemological barriers between science and humanity, as well as, between the techno-economical-political areas, where the decision process regarding the management of territories and natural resources take place [13, 30].

The homeostatic systems are related to the model equilibrium paradigm [35, 63], that is to say, they are connected to nature and to the perception of ecosystem as a balanced system. A central issue of this paradigm is the system´s tendency to reach a unique state of stability. In the evolving complex system study emerges a non-equilibrium paradigm [66]. Key aspects of the non-equilibrium paradigm are: the system can reach numerous constant states and keep the organizational pattern; the system has an open relation with its surroundings; it is capable of focusing on the continuous process co-evolutionary coupling [66].

The Adaptive Complex System (ACS) is a concept and model that correspondence a turning point for the study systems of traditional sciences. The main feature of ACS, according to Gell-Mann [64], could be its use for landscape study. Each landscape is an iterative information processing system interacting with its environment; it continuously processes new information from its surrounding environment, generating new adaptive tendencies, coupling and stability. Since, the historical evolving process doesn't couple under the new circumstances and information, it can`t adapt to the system not connect with its surrounding environment, and thus, collapses.

In systems far from equilibrium, such as the ACS's, order and disorder (chaos) are continuously interacting. In the chaotic stage, these systems tend to dissipate energy and generate entropy, creating conditions with new, continuous and iterative, order patterns, and occasionally developing a new organizational pattern and type of system [8, 13, 30]. This perspective is necessary to understand the adaptive evolution of cultural landscapes [13, 30, 67, 68].

The goal of the ACS's is to adapt to variable and changing environments, through different schemes stored in the historic system memory. The self-oriented capacity to adjust is explained by the ACS model. Highlighting human behavior as the main determining factor in the cultural landscapes dynamic and evolution.

4.3 Development approach and models

At this moment in time, the processes of human society development are dominated by the sectorial approach. Each sector pursues optimization according to their own requirements, such as: economic, urbanistic; agricultural, rural, real state, forestry, mining sectors. This approach triggers territorial degradation tendencies as is doesn't considerer territorial integrity. It is a merological approach, reducing the problem to specific problems and interests.

On the other hand, the territorial approach centers the main objective on the landscape planning units and its surroundings, focusing on the integral system development. It is based on the holistic system paradigm, emphasizing a transdisciplinary approach as a key epistemological attribute for human development processes.

The XX century traditional paradigm focuses on three main interacting components: sectors, people and economic efficiency (Figure 4). With this approach, activities and development processes are evaluated as successes or failures, considering mainly the economic parameters, such as IRR (internal return rate) and NAV (real net value) [53].

In the XXI century a new paradigm emerges. The model integrates three dimensions: territory in instead of sectors; stakeholders instead of people; global quality instead of economic efficiency (Figure 4). The global indicator parameter for the sustainable cultural landscape construction and evaluation is related to each specific condition, and is a function of the following variables: ecological, social and economic. It is a determinant based on the interaction of three main axes: economic productivity, social equity and ecological sustainability [66, 69]. This approach and paradigm focus on the sustainable development and life's quality.

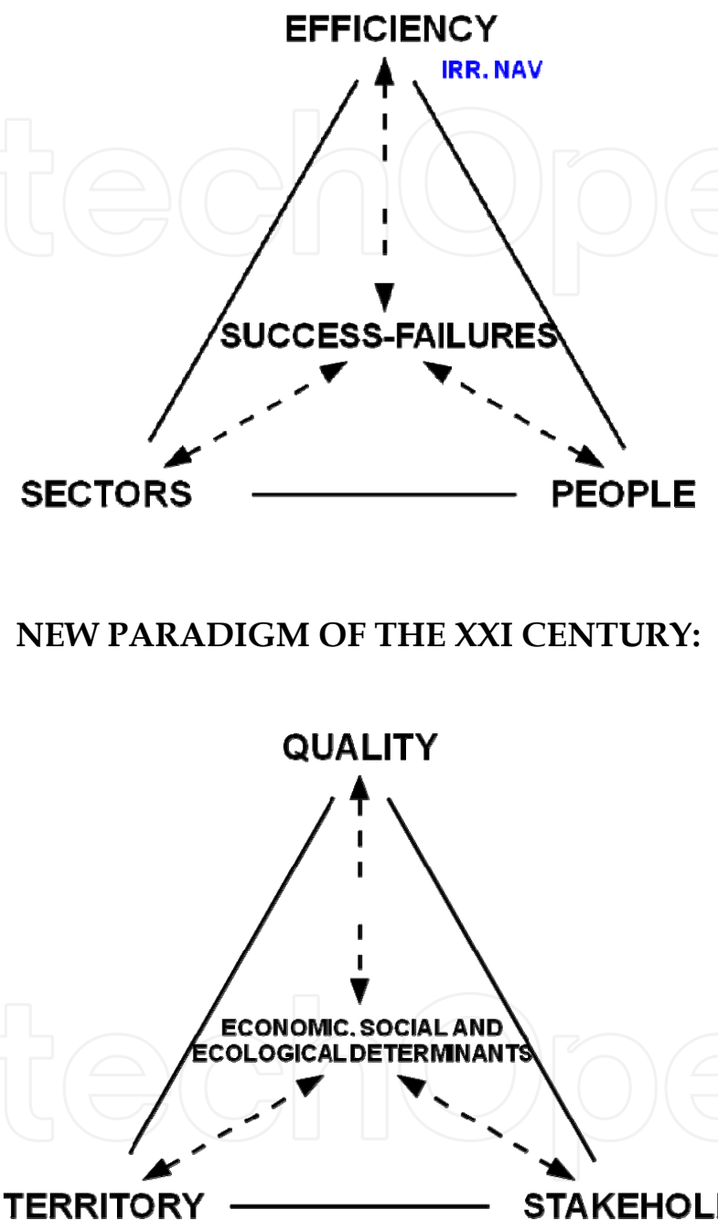

Fig. 4. Evolution of the development paradigm. The new paradigm focuses on cultural landscape, integrating sustainable development and life's quality [53].

4.4 Territorial arrangement and cultural landscape design

Territorial arrangement and planning is not only a technological, ecological and political subject, there are also related with the spirits of age and place (*Zeitgeist* and *Volksgeist*). The Territorial arrangements of a country and places are always related with culture [15].

The European Cart of Territory Arragement, emphasized regional territorial balance. They pursued a territorial arrangement with the best distribution of spatial and human activities, to achieve the best combination, as a function of societies´ requirements given its culture, ecological limitations and potential, as well as, life quality optimization and sustainable development. The multiple use principle is a main argument referring to the purpose and management of territorial resources, in order to provide a better use for human requirements without causing ecosystem degradation, as well as, setting up areas for human life and integral development. Thus, multiple use of the territory focuses on different objectives from many sectors and subjects [70].

Watershed is the basic unit for territorial arrangement and where biocenosis (phytocenosis and zoocenosis) interact with the ecotop. Social, economic, institutional and cultural dimensions of the stakeholders administration, resource management and arrangement at the watershed level, are related with α, β, γ diversity.

The design of the cultural landscape is an essential element and operator to reach the goal of balance, the stakeholders need in the landscape context [71]. Presently it is necessary in order to increase territorial services and sustainability, not only to preserve but also to design and construct [13], with an integrative, dynamic, intentional and collective approach. The fundamental dimensions in the cultural landscape design are: ecological, anthropic functionality, life and leisure, and aesthetics.

The ecological dimension refers to system sustainability as a result of cultural landscape nature conservation, ecological connectivity and ecodiversity. It optimizes the positive and negative ecosystem effects, designs the structural cycles (recycling) and ecosystem efficiency, in addition to stability (energy, matter and information). Another key concept is technological receptivity, defined as the amount of technology that could be applied in each particular site to produce a desired sustainable output. Technological receptivity allowed discriminating differences to select the right operator [14].

The functionality dimension is reared towards human actions aspiring to accomplish the activities associated with stakeholders' objectives. The aesthetic dimension deals with symmetry, beauty and landscape perception, which deals with elements such as forms, colors, textures, borders, observations points, etc. Life and leisure dimension are related with resting places for the social actors amusement. Leisure is something highly valuated associated with the creative potential of people and human development [72]. All of this is related with the concept of biophylia, which can be defined as the inherent tendency of humankind to get closer to different kinds of life and natural processes, desirable for a better life quality in step with human evolution during a long period of time.

The landscape design methodology is presented in Figure 5. The first stage is the polithemathic analysis of the landscape's limits, including: zoning, technology, hydrology and the natural matrix in a topological arrangement. The second stage established the threshold of the landscape: functionality, aesthetics, ecology, as well as life and leisure. Then, in the third stage, the territorial components: *saltus*, *ager* and *polis,* and their relative proportions in cultural landscape types: wildland, rural and urban. The last part is directly related with the construction of cultural landscapes by the action of the stakeholders and stockholders.

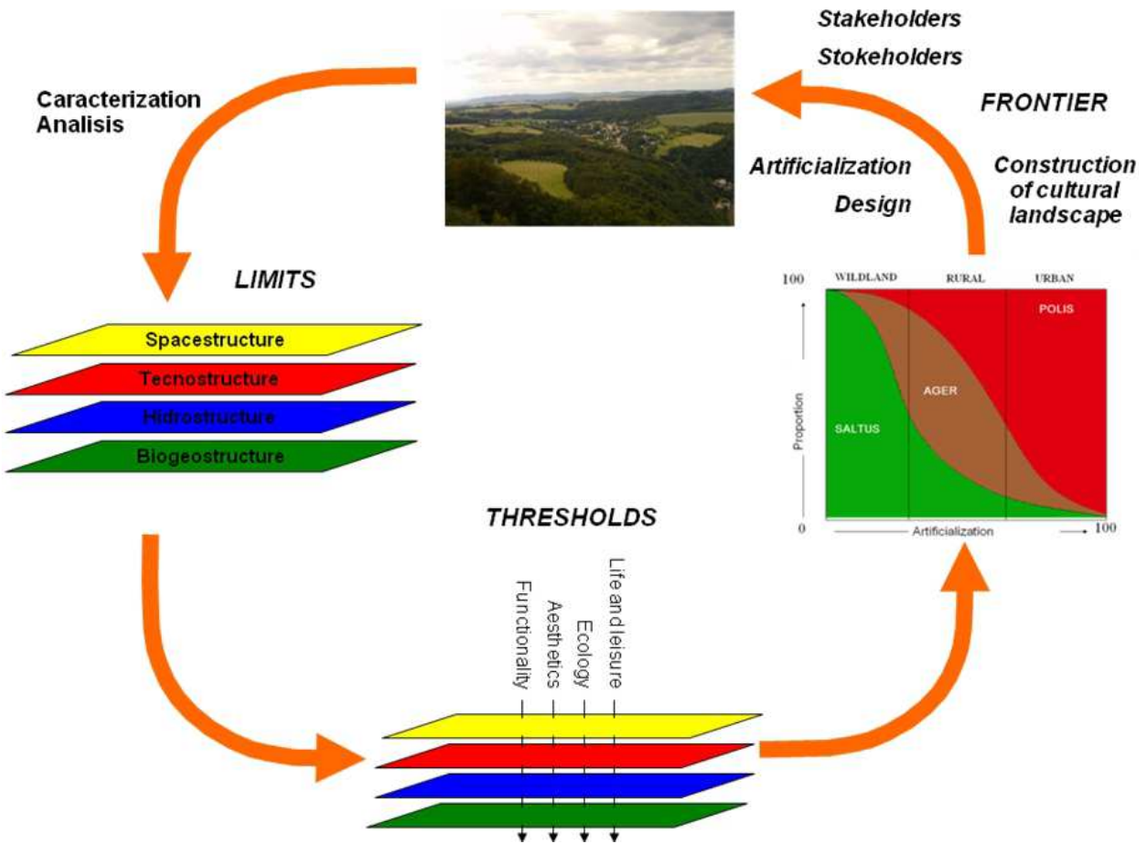

Fig. 5. General methodological model for the cultural landscape design and construction of a sustainable development.

The design and construction of sustainable cultural landscapes include:

- Diversity. Refers in a broad sense to biodiversity (α, β and γ), ecodiversity (niches and habitats) and territorial diversity, the last one related with territorial multiple use.
- Connectivity. Refers to the generation of ecosystemic and territorial networks, including: technological (resource management styles), social, cultural and institutional dimensions. It is a complement of the ecosystem interaction network considering the stakeholder and technology.
- Coupling. The ecological connections aren´t enough, they also require energy, matter and information exchange by coupling between system's components. System functionality requires the complementation and integration of their components.
- Location. Technological receptivity and ecosystem resilience is a function of the location of the watershed and biocenosis type [70].
- Recurrence. Design and management of ecological and territorial systems should not be lineal but recurrent. This is equivalent to recycling in natural ecosystems. The recurrent input management is related to achieve adaptation [73]. Agriculture ecosystem design and management is related with connectivity and grater autonomy of agroecosystems.

4.5 Cultural landscape governance

Governance refers to the art and the way of carrying out government, as well as, the executive action. Governance emerges based on the general request for the administration of: natural resources, world ecosystems and territory development. It should be allowed an antrophic control of the phenomena. Governance improves public policies and collective actions to solve problems and take care of the integral development. Nevertheless, it is not possible to predict the future cultural landscape but to simulate and evaluate further scenarios [30]. Some handling capacity can be developed in order to shift to a more specific and desirable situation for a particular culture and stakeholder.

Jentoft [44] states that territorial governance is basically a relationship between two systems: the government system and the governed system. The first is a structure of institutions and control mechanisms. The second is partially social and partially natural: it consists in one ecosystem coupled with its resources, as well as stakeholders, all of them developing institutions and political conditions. Territorial government is related to the connections of both subsystems, by integrating them into only one. In order to make operative governance, both systems should be mutually sensible, combined and coevolving [40].

Jentoft [44] has developed a governance model, where both systems (government and governed) should be efficient (Figure 6).

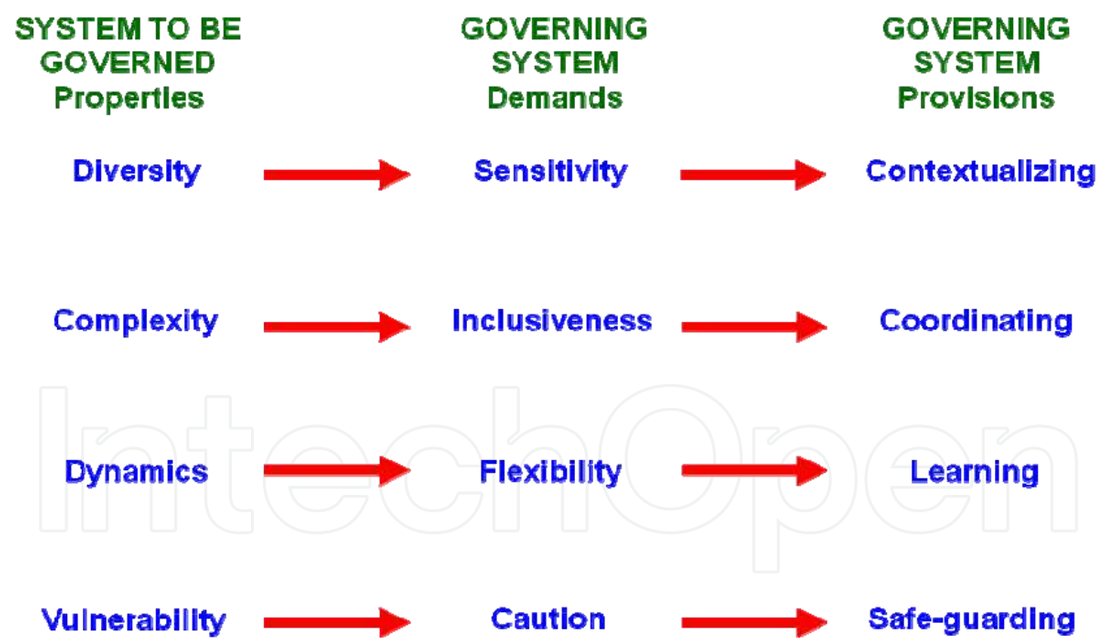

Fig. 6. Territorial governance model. The governed system attributes and the requirements the government system must have [44].

An ecosystem service is a basic element for the territorial sustainable governance that supports life on earth and takes care of the diversity of those services within a varied cultural landscape [74, 75]. These services are necessary for human survivorship and social development [1, 2, 13, 76]. Since ecological services are not tradable in financial markets,

there is a shortage of regulatory mechanisms to detect the supply and ecosystem damage [2, 74, 75, 77-79]. Human economy can´t operate without ecosystem services, and thus, the financial value is infinite. Constanza *et al*. [74] present seventeen categories of ecosystem services: gas regulation, climatic regulation, disruption regulation, hydric regulation, water supply, erosion control, soil formation, nutrient cycle, waste treatment, pollination, biological control, shelter, food production, raw materials, genetic resources, recreation, and culture.

It is amazing to notice that conventional productive agriculture only generates two of those seventeen categories: food and raw materials. What is more, the green revolution of industrial agriculture has a negative effect on the other fifteen. However, it´s important to mention that rurality is concerned about all seventeen ecological services.

5. Cultural landscape sustainability

5.1 Universal legality

All human activities linked with artificialization and management of natural resources should be set up on a hierarchical system (Figure 7). The degrees of freedom on each hierarchical level change according to the hierarchical context and wheater the direction is downwards or upwards, in line with the hierarchical theory [30, 43].

Decision making at any level depends on the stages above and below. Political decisions should be subordinate to economic, technologic, social and ecological levels. A right decision should be valid on all the levels of the universal legality.

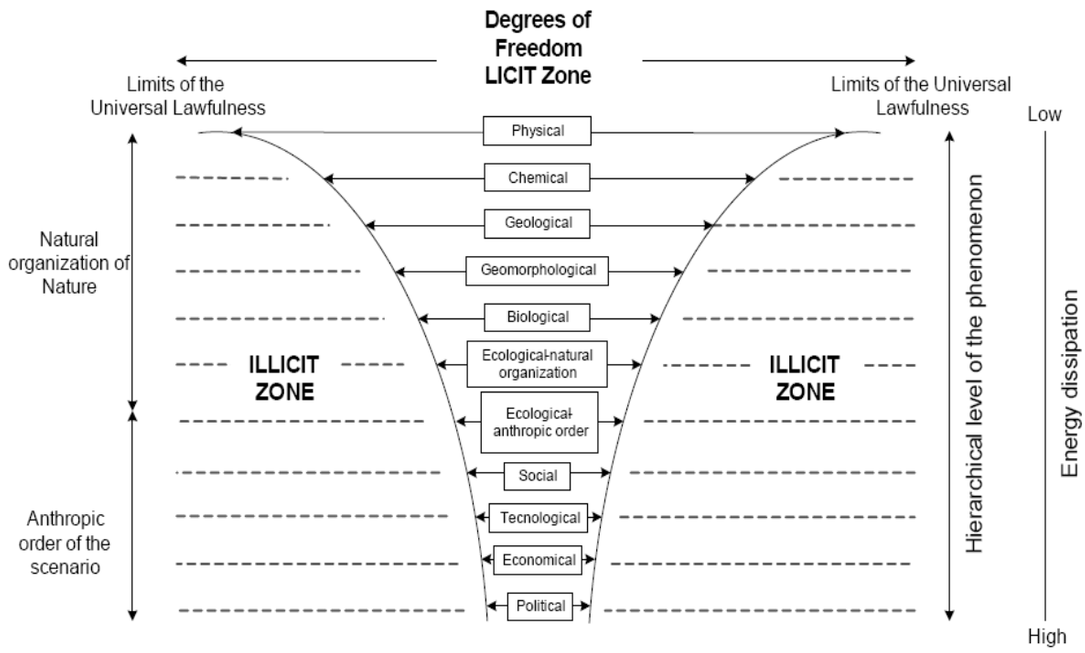

Fig. 7. Hierarchical scheme for landscape decision making and the relative degree of freedom of each level [28].

5.2 Planning and design of sustainable cultural landscape model

One of the main principles for landscape planning is to minimize negative effects, give equal opportunities and maximize the aptitude, all of this in interaction. In order to plan, design and govern the cultural landscape, it is essential to follow the value based model, defined by the particular culture (Figure 8).

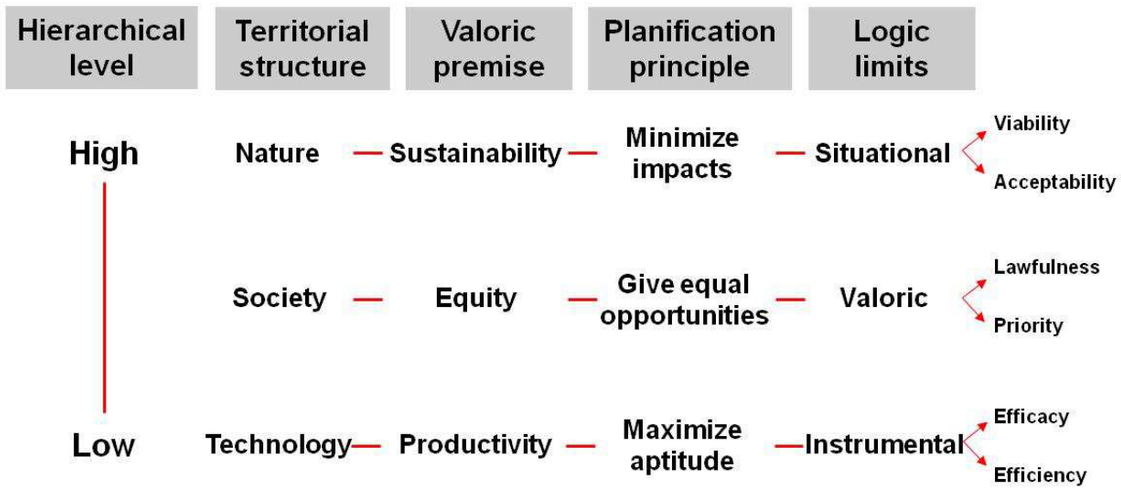

Fig. 8. Model for planning and designing a cultural landscape in order to provide a sustainable governance [51].

5.3 Ecosystem artificialization and sustainability

Artificialization is defined as a way to apply a certain amount and kind of technology to transform the ecosystem. The resulting ecosystem transformation is a function of the technical inputs. Thus, the end result could express the main functions. One of them is the anthropic benefits brought about as a consequence of this transformation. Still, there is a cost associated with the work inputs applied to the ecosystem.

In general, and consistent with the degree of artificialization the cost increases significantly in vulnerable ecosystems. In contrast, the benefits of marginal ecosystems usually increase very little compared with the degree of artificialization. If this case were to happen, both functions would never intersect. As a consequence this extreme vulnerable ecosystem should not be artificialized at all, being necessary to preserve them in a natural state.

Then again, there are highly stables ecosystems where the additional costs to keep them sustainable are insignificant, but the output benefits of artificialization are high. In this case the degree of sustainable artificialization could be immense.

Under usual condition, namely ecosystems which are not extremely vulnerable nor highly stable, there is an intermediate degree of potential sustainable artificialization (Figure 9). At the right side of the figure, the artificialization costs are greater than the benefits, and thus, the degree of transformation should be no higher than this magnitude. In contrast, at the left side, the cost is lower than the benefits, so it is fine to transform the landscape up to this magnitude. This defines the artificialization for the sustainable cultural landscape construction.

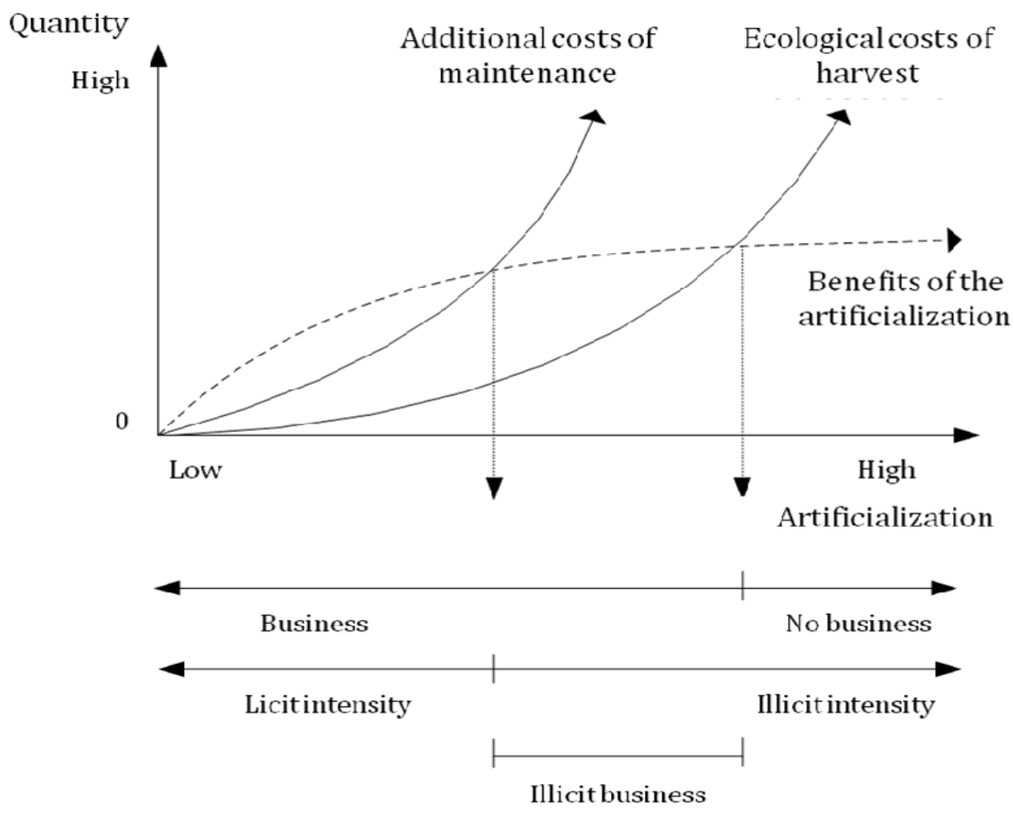

Fig. 9. Cost-benefit relation from artificialization in landscape transformation, for an ecosystem of intermediate vulnerability [23].

5.4 Adaptability and panarchy

The adaptive capacity to environmental changes is key for stability and sustainability of open systems. The adaptability of anthropic ecosystems and cultural landscapes is mainly determined by the stakeholders behavior and management.

Recently the concept of panarchy has been proposed to develop the ACS sustainability theory. Panarchy stems as an antithesis of hierarchy, representing the framework of "nature rules", suggested by the Greek nature god *Pan*. This state is reinforced supported by two main issues. The first one is a four face heuristic model change: exploitation, conservation, creative destruction and renovation, which brings about an adaptive cycle. This is a fundamental model to understand ACS, such as cells, ecosystems, human societies and culture landscapes as a whole.

Three proprieties define the adaptive cycle: potential, which provides and determines the limits of changing capacity; connectivity, which provides the variable internal control and consistency; resilience, which determines the vulnerability of each system's shifting. The adaptive cycle model provides the conceptual bases for understanding hierarchy not as fixed structures but as dynamic entities [80], which is basic for cultural landscape sustainability.

6. Concluding remarks

To come closer to sustainability it is necessary understand the ontology and epistemology of the relation and interaction between Nature and human society, which implies deal with the artificialization of the first one for the stakeholders. This is a central part of agriculture and cultural landscape construction.

The evolution of perception, as well as the interest, stimulus, and priorities of the social actors involved in the construction of agricultural and rural territories is constantly changing. It's related to the spirit of age (*Zeitgeist*), the spirit of place (*Volkgeist*), and certainly, to their culture and the characteristics of their territory.

The main concern associated to agricultural sustainability is discovering the problems affecting the stakeholders and their activities. In this context, technology, nature, society, economy, and ecology are related in different ways and intensities to rurality and agriculture *sensu lato*, in line with the meaning given, as well as where the problem is located and framed.

Landscape is a set of countless ways to characterize, and differentiate a specific area of land. It's a natural and cultural association of society with the components of the land. The cultural landscape is the consequence from the technological activities carried out by the stakeholders in a territory, and its transformation into sustainable or non sustainable agriculture. The cultural landscape concept emphasizes culture as the main dynamic determinant of the territorial evolution, aiming and associating it with the stakeholders' behavior.

Modern agriculture deals with extreme capital use, high technology, reduction of manual labor, high energy and water inputs, as well as, great mechanical labor, all things taking place in high input and high output ecosystems. It's associated with policies, development strategies, institutions, resources and technologies regulated from urban centers and markets. All of this generates, in rural areas, a significant ecological and agricultural footprint. The main ones are: carbon, water, energy, information, and all of this generate a substantial biodiversity loss, as well as, niches, ecodiversity and adaptability reduction. This process, has taken place in combination with a divergence and dissociation of agriculture and the integral rural development.

Rural landscape plays other roles beside those of agriculture, such as: gas regulation, climate stability, water regulation, erosion control, nutrient cycles, biological regulation, recreation, culture conservation, soil formation, as well as, the generation of genetic resources. Agricultural sustainability is a component of the rural landscape and actors. As such, it should also be analyzed in a complementary context, take into account its interaction with the urban areas and the protected wild areas.

Currently, the social and territorial development focuses on the relationship of sustainability with life quality for the collective construction of the territory, associated to the paradigmatic change of science and culture. Several well known schools of thought and intellectual scientific, and philosophical currents approach to this quandary is in a holistic and systemic transdisciplinary way.

The unifying agricultural and rural areas sustainable concept is linked to the territorial governance, limits, regulations, in addition to the development of the rural cultural landscapes.

Only if stakeholders operate with prudence in the artificialización of ecosystems and in the construction of the cultural landscape, according to the universal legality, a sustainable future will be possible. For this we must assume the challenge of design ecological-territorial systems appropriately adaptatives for our age context.

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Landscape architecture is the design of outdoor and public spaces to achieve environmental, socio-behavioral, and/or aesthetic outcomes. It involves the systematic investigation of existing social, ecological, and geological conditions and processes in the landscape, and the design of interventions that will produce the desired outcome. The scope of the profession includes: urban design; site planning; town or urban planning; environmental restoration; parks and recreation planning; visual resource management; green infrastructure planning and provision; and private estate and residence landscape master planning and design - all at varying scales of design, planning and management. This book contains chapters on recent developments in studies of landscape architecture. For this reason I believe the book would be useful to the relevant professional disciplines.

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