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RESEARCH ARTICLE

MODEL FOR THE AGROPRODUCTIVE DIVERSIFICATION WITH SOCIAL FEASIBILITY FOR HELP IN THE INTEGRAL MANAGEMENT OF THE MICRO-WATERSHED IN TOLAPAN, COATEPEC, VERACRUZ. MEXICO

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ABSTRACT

In Latin America, the socioeconomic development models are based, generally, on the exploitation of natural resources with a poorly planned vision. Promote the environmental fragility. The producer typology, in Mexico, is composed of the ejidatarios, comuneros and the intermediate or in transition individuals, and the agro industrials. The changes of agro cultural habits cannot be achieved by decree, without losing sight of the fact that public policies favor the globalized agricultural market, not the interim. The ability to call for the participative planning with a comprehensive management approach of watersheds, presents difficulty for its instrumentation, requiring planning instruments more aimed for the different degrees of environmental sensitivity in specific areas of the whole of the river basin. The inclusion of the social sector in the decision-making. For that purpose, it is raised the research question, What crops can be selected for the agro productive diversification in the Tolapan Coatepec State of Veracruz micro-watershed, on the basis of the particular conditions that are agro-ecological, climatic, soils and physiographic with technical, economic and social feasibilities, which can be integrated to a territorial model for the decision-making, the objective was to develop a support system, for decision-making in the production diversification for crops with technical, economic and social potentials to transit towards a more sustainable benefit. The subsystems are integrated by properties in the individual and in its articulation, (approach, analysis, diagnosis, prognosis, understanding). Operated through a territorial information system with free software and hardware. The statistical design combines quantitative and qualitative researches. We identified 27 crops with productive, technical and economic feasibility potential. This model is complementary with other methodologies, also flexible, and it can be adapted to different scales and different conditions of information availability, therefore, it is suitable for the Local, Regional and National managements.

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INTRODUCTION

In the State of Veracruz, more than 40 per cent of its population lives in the rural areas; and are engaged in the agricultural sector, providing only 12% of the state's gross domestic production (Inegi, 2013). Approximately, 1 million 325 thousand hectares are dedicated to agriculture, and from these, 652 thousand are programed with cyclical crops (highlighted: corn, with 87.4%, and beans, with 4.8%), while 673 thousand hectares are being established with perennial crops, among them, the sugar cane, with a coverage of 36.8% of the surface; oranges, with 22.1%, and coffee, with 21.2% (Inegi, 2013). The annual agricultural production value is higher than 14 billion pesos, which represents a daily gross income of 30.45 pesos per hectare. In Veracruz, the production value is less than a daily minimum wage. Of the little more than 551 thousand hectares destined annually for the cultivation of corn in the entity, it is obtained a crop whose value is of 1 billion, 930 million pesos, which translates into 9 pesos with 58 cents per day. This landscape shows why the primary sector of the state is maintained in the neglection and poverty. It is worth mentioning that the public policies and planning should be analyzed, as well as the

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making of decisions regarding the self-determination of food in the fields of Veracruz.

Within the sector, stands out the livestock activity, which occupies an area of approximately 3.3 million hectares, equivalent to about 50% of the total area from the state of 7 million, 281 thousand, 500 hectares (INEGI, 2013). Livestock has been characterized for being extensive and for being developed with a low technological level. The use of irrational practices of land use and the management of remnants led to environmental damage and, as a collateral consequence, to the decline in the economic efficiency of the production systems. (CEPAL, 2004). Such agriculture model depends on the incorporation of exogenous energy, as the oil derivatives (fertilizers), which attents against the biodiversity; while the sustainable agriculture requires an autonous energy; in other words, of an efficient and effective biodiversity, in order to transit towards a food autonomy with a positive impact in the human health and the welfare. (Altieri, 2010). These changes in the use of land have resulted in environmental imbalances that threaten communities, which demand more goods and services; however, the loss of quality and quantity of natural resources, ecosystems and agricultural activities is an accelerated trend that favors a large social gap, seen from the perspective of the rural life, where marginalization and unemployment are the incubation of chaos and the governance loss (Figure 1) (Altieri 2011).

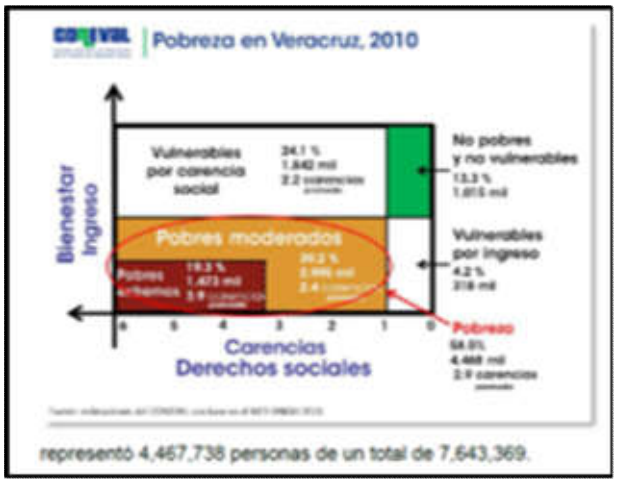


Figure 1. Poverty in Veracruz. CONEVAL

The fundamental inequality is cumulative and it spreads from generation to generation, which relates to the differentiated property of goods and resources for the production or for the obtaining of revenues, such as land, natural resources, capital (buildings, equipment and machinery) and therefore with liquidity of financial resources available for only a few.

Objective

Develop a support system, for the decision making in the agro-productive diversification for crops with technical, economic and social potential, in order to transit into a sustainable productivity in the Municipality of Coatepec Veracruz.

Development (Methodology)

The general framework that wraps this methodology is; Applying landscape ecological concepts and metrics in sustainable landscape planning, Landscape and Urban Planning proposed by Botequilha and Ahern (2002). It incorporates into a contribution of operational procedures for each phase, the first of them with the stable and dynamic qualities and of territorial information feedback, the second is a selection and identification process of productive potential indices, exclusion areas, areas of interest, among others of qualitative nature, following a process of consultation and coordination with the actors, producers and users through their personal opinions as to the possibility of changing cultural habits with potentially productive crops in the interests of a greater agro productive diversification. The primary information is collected and checked in libraries, research cartography centers and institutes (topographical soils, vegetation, basins. 1:50 000 and 1:250 000 scales from INEGI, prioritizing 1:25 000 the digitized scale). The secondary information was held in field with a first tour of the study area, allowing to raise a record of training points (georeferencing) to identify components of the landscape (Annex list of GPS points). This database was taking shape in the extent to which it incorporates the Satellite Image and Remote Perception. With the support of the Q GIS, ERDAS ARW GIS and ENVI Software, It identifies the problem and purpose of the intervention, contemplating the elements with their factors that are related as are determined and correlated, in such a way as to draw the target image that it intends to build through the systemic planning with agro eco systemic scientific criteria and of landscape, with a territorial model for the agro production diversification with technical-economic and social feasibility to transit to an agro production diversification with social feasibility in the territory the micro watershed occupies in Tolapan, in the municipality of Coatepec.

The sustainable land-use planning phases. The research was conducted in five phases

1) Approach Phase. It defines and determines the goals and objectives of the production sustainable diversification. It identifies the problem and purpose through the design of the target image that is intended to be achieved, proposing a territorial organization model focused on the agro productive diversity to transit to sustainability in the management of natural resources (water, soil, vegetation) were defined the criteria to perform a diagnostic on the potential use of the site, the selection criteria are traced that define areas ecologically sensitive as the criteria for the territorial ordering, more in line with the comprehensive management, as a mechanism to not degrade the natural resources contemplating, the trends in the growth of the populated areas and its urban services. However, the process of dynamic sustainable planning, interactive and incremental.
2) The Analysis phase. Describes the study area and its context in multiple dimensions and scales, economic, social and environmental. It identifies the processes of interest that determine the functionality of the landscape and its interaction with the various elements that make up the physical landscape (biotic and abiotic). Answers the questions: What is there, How much is there, Where is it? Describes the aspects of the composition and the array configuration, the construction and validation of tools for the collection and application of information, and research tools for

the obtaining of data, through the analysis of the Lansadt 7 TM and SPOT 6 Satellite Image with the integration of a database which served to support the diagnosis.

3) Diagnosis phase. Reviewing the signs and symptoms (quality-quantity-functionality) of natural resources.

This, applying the balance in the equilibrium of the flow of energy in the ecosystems of the same (Brandes, 2005). For this, one should endeavor to answer the following questions: Does the landscape works good or bad? What If it does not work properly with regard to the sustainability premises, where the problem is located, and why there is no functionality? This is analogous with the evaluation phase of Steinitz, 2010, where are identified in the landscape the dysfunctional components of a system. 4) Prognosis phase. Implies to sort and develop possible future visions or scenarios, both positive and negative, and the construct of the discourse and the scaffolding structure of ethically correct relations and their systematic logic and dynamic sequences of each stage of the Plan, Program, Project, Actions (Incorporating to the players and owners in the Toloapan micro watershed, in the decision-making for the change of land use, habits and customs in the management of natural resources, the following generating questions are addressed on how it is applied and what attitudes, actions and partnerships build and make possible the governance. We consider the answers to the four levels of the generating questions: I) What is required for the establishment of mechanisms and rules for the multilevel cooperation. What actors should be involved in the design and implementation of the rural development policies in each territorial scale? How to ensure consistency between rural policies of the various municipal levels and the overall national policy objectives? What mechanisms are required to achieve this? What are the advantages of contemplating responsibilities in a local level? II) What are the suggestive cooperation frameworks, how to encourage the united cooperation between the different public and private levels? What is the inter-municipal or interstate cooperation, more efficient than the maintenance of the competition between neighboring authorities? What role should be played by the private actors (small and large) the financial sector and the civil society in the local, regional, state and national governing levels? III) Which are the spaces and mechanisms for consultation and coordination? How to generate spaces for consultation and participation, effective? IV) The integral operability in the hydro agricultural micro-watersheds. How to encourage consistency in the application of environmental management instruments, to strengthen sustainable development in hydrological systems? The spaces of conclusion of the basin must coincide with the Councils? On the other hand, with the purpose of establishing the identification of territorial units for their study, we will use the zoning rules that will apply the indicators that identify the cause-effect relationships between disturbance actions and environmental conditions. To do this, contemplated indicators were used for the identification of ecologically sensitive areas, associated criticism and sustainably suitable. 5) Understanding phase. Specific actions are defined to prevent the future negative impacts on natural resources, ensuring their transit for the sustainable operation. The territorial organization plan is designed, with focus on the diversification of potential production. Includes the supervision of the processes and the changes in progress, the evaluation of the processes that are running and occur in the new configurations of the proposed plan, allowing the reorientation of processes that were conceived in the planning. The importance of the monitoring system is to achieve consistency and effectiveness in the defined participative actions and goals.

Criteria that define an ecologically sensitive area (AES) and its measurement attributes

1.- Ecologically Sensitive Areas 2.- Sustainably Suitable Areas- 3.- Critical Associated Areas. The value criteria is an indicator that allows the attribution of validation to an object or space, which achieves the modification of the behavior and attitudes of an individual or social group toward the object or space in question, so that this criterion acquires a great importance in the AES characterization. This criteria serves to describe landscapes and rare habitats, important habitats for wildlife and that are necessary for the survival of significant, threatened or endemic species; are high biodiversity areas or areas of exceptional geological or botanical interest, virgin areas, areas with important ecological functions as the control of flows, purification of water and air, decoding and decomposition of waste; pollination of the natural vegetation and planting; natural pest control; seed dispersion; biodiversity maintenance (e.g. the genetic potential); influences the climate, temperature and wind moderation; supply of resources for economic activities, etc. (BMLFUW, circa 2011). The AES delimitation beginning from the fragility criteria, part of locating the biotic or types of vegetation areas, natural habitats, that because their low resistance, are less able to tolerate negative environmental impacts, and modify in the short term their structural properties. In this sense, the fragile AES are an important reference for identifying priority areas for the diversification of production, protection or restoration, or regulate or induce the use of the soil and the productive activities to be establish, since these can exceed the load capacity. On the other hand, the same AES approach constitutes a perspective to guide the policies of territorial management aimed for the development of activities that contribute for the generation of employment and income.

The very conception of the AES under the "potential" criteria, enables the possibility to develop initiatives for the sustainable use of natural resources, whose results will help get rid of social lags, integrate and give social cohesion to the territory, and to identify opportunities for investments and for the promotion of any economic sector. In the context of defining a territorial unit, a strong characteristic of the AES approach is the multiple and flexible perspective with which it is conceived the "territory value" because as relevant are the biotic areas, as the historical or cultural sites, or the micro-regions with high productive value. In this regard, counting with a more integral and complementary vision about the valuable territory areas, allows to identify all those areas that must be managed under scientific and integral premises, to be preserved, rehabilitated, transformed, applying the General Law for the Protection of the Environment, independently that those belong to different dimensions (ecological, cultural, economic). The ecosystems are not uniform nor static environments, but diverse and dynamic. What is seen as homogeneous and static is a scale, which becomes very heterogeneous and changing to another configuration and structure. A central aspect in the search for transit and reach of sustainability, due to the identification of areas in conflict

or at risk, so as to be able to redirect the uses and management (exploitation, conservation and restoration). These areas will be, for this study, the ecologically sensitive areas (AES). These can be identified and classified by their uniqueness, representativeness, risk, environmental value and functions within the cycles of the total environmental system (Schereier *et al*., 2001). When the AES are interconnected, they may form natural areas that consist in networks or connections of landscape elements that can provide ecological, recreational and cultural benefits for the communities (Ndubisi, *et al*., 1995). The ecologically sensitive areas. AES are surfaces that contain elements of the landscape of a physical, biological or cultural nature, significant for the operation of the environmental system in its entirety; and therefore must be protected by preventive actions through the ecological planning of the territory.

RESULTS AND DISCUSSION

The Tolapa microwatershed has a surface of 493.374 km^2, and is located in the northwest of the municipalities of Coatepec and southern Tlanehuayocan, Veracruz. It is located between the UTMcoordinates. Upper Left Corner 19.51164, 2158658.080, top right corner 19.51282, 2158843.521, lower left corner 19.49463, 2156274.384 and lower right corner 19.49307, 2156657.263 (Figure 2). Its position on the Veracruz' hillside in Cofre de Perote makes this basin to be exposed to the trade winds, which laden with moisture, collide with the volcanic structure and the ascend up to condense. One of the relevant characteristics, from an ecological point of view, is that it presents various climatic, topographic and biological conditions which confers very particular ecotonic conditions: The height variation is 330 m with minimum and maximum heights of 1,370 m and 1700 m.

Figure 2. Location of the Microwatershed from Tolapa, Municipality of Coatepec, Veracruz, Mexico

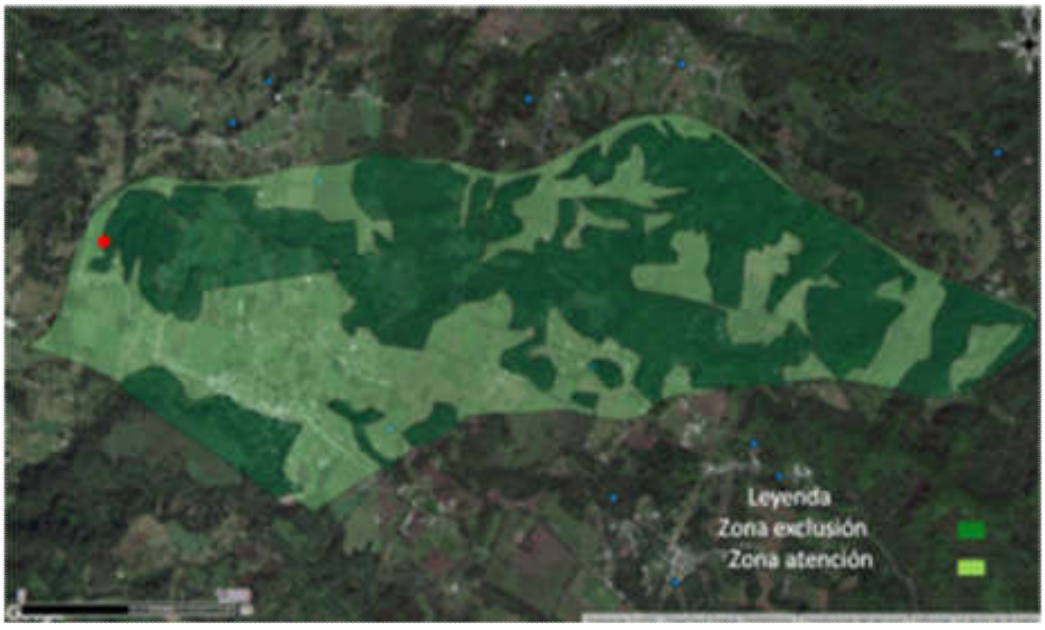
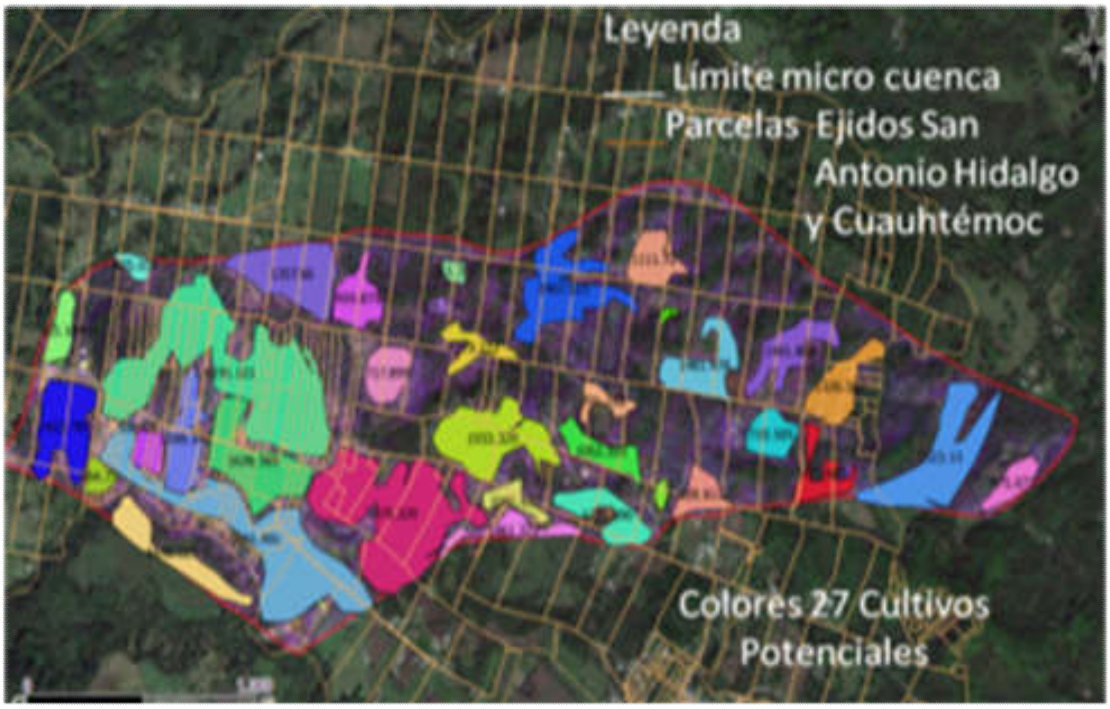


Figure 3. Exclusion areas 244 hectares and attention areas 249 hectares



Fuente, Maqueo 2016.

Figure 4. Ecologically Sensitive Areas by their Agro Productive diversification

Table 1. List of Potential crops Source, Maqueo 2016

Cultivos a Clasificar \ Variable	Nombre científico
Piñon Mexicano	*Jatropha curcas*
Café	*Coffea Arabiga*
Maiz	*Zea mays L*
Trigo	*Triticum aestivum L.*
Tomate verde de cascara	*Physalis ixocarpa*
Chile	*Capsicum annuum*
Ajo	*Allium sativum*
Lechuga	*Lactuca sativa*
Arandano	*Vaccinium myrtillus*
Brocoli	*Brassica oleracea var. Italica*
Amaranto	*Amaranthus*
Anis	*Pimpinella anisum*
Jitomate	*Solanum lycopersicum*
Berenjena	*Solanum melongena*
Canela	*Cinnamomum verum*
Chico Zapote	*Manilkara zapota*
Frijol	*Phaseolus vulgaris*
Sorgo	*Sorghum*
Jamaica	*Hibiscus sabdariffa*
Mangostan	*Garcinia mangostana*
Pimienta	*Piper nigrum*
Soya	*Glycine max*
Stevia	*Stevia rebaudiana*
P_Orchard	*Dactylis glomerata*
P_Elefante	*Pennisetum purpureum*
P_Estrella de Africa	*Cynodon plectostachyus*

There are three climatic types: temperate, humid temperate and humid semi cold. It is a high basin, characterized by a dense network of drainage in which prevail the temporary and ephemeral runoffs of first and second order. The remnants of forests are pine-oak, oak and mesophilic mountain forest. The monsoon influence, altitude, and particularly the forest and soil types, favor the processes of water storage and precipitation, including the horizontal precipitation or gathering of water from fog. On the other hand, the socio-economic marginalization conditions that predominate in the area have led to incompatible use of the land with the conservation of forests and water resources, so, at present, the microwatershed has seen reduced its total forest area dramatically due the clearing of forests for the sale of timber and the increase in cattle and agricultural production of low performance in areas unsuitable for these activities. The hasty decrease of the forest masses in the basin has led to a considerable loss of biodiversity, as well as the increase in the erosive susceptibility of the landscape, the alteration of the processes of soil formation and the decline of the atmospheric humidity. The tenure of the land in the watershed is covered by two ejidos, San Antonio Hidalgo with 45 ejiditarios, and Cuauhtémoc with 90 ejiditarios from which 60 exhibit a tendency for the fragmentation of their land (Figure 3). The exclusion areas are 249 hectares, the total of ecologically sensitive or of attention areas are 249 hectares, meaning the 50.50% of the total surface area of the microwatershed of Tolapa (Figure 3), also it is understood the critical areas associated with channels of communication and urban areas is of 40 hectares. (Figure 4) With the implementation of the territorial Model for the agro productive diversification with technical, economic and social

feasibility, it was possible to locate 27 crops with productive potential for their agro diversification (Table 1).

Conclusion

This model is flexible and can be adapted to different scales and different conditions of availability of information, therefore, it is suitable for both the Local, Regional and National Management. The model offers the best way to incorporate the producer to optimize the existing natural resources in the mountain areas in the state of Veracruz and to diversify their productive potential to move to a sustainable agriculture.

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