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RESEARCH ARTICLE

DELINEATION OF ECOLOGICALLY SENSITIVE AREAS DIVERSIFICATION AGROPRODUCTIVE "IF STATE OF VERACRUZ CITY COATEPEC"

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ABSTRACT

In Latin America, the socioeconomic models of development are generally based on the exploitation of natural resources with a poorly planned vision, they promote the expansion of the extraction and processing of activities of natural resources. Providing a greater environmental fragility while attacking the biodiversity ecosystem. There is the important need to balance the dynamic energy in the agro ecosystems. In this proposal, the methodology consisted on two phases: the first contemplated the construction of criteria to define the ecologically sensitive areas; and the second, the realization of the space analysis. The remote sensing technologies and the geographic information systems are research tools that facilitate the analysis of the territory; in surface areas larger than 100 km2. Therefore, the objective was to show its applicability in the space delimitation of ecologically sensitive areas. The value of identifying and measure them in the agro productive territorial ordering context with ecological criteria and agro productive diversity, while being surfaces that contain elements of the landscape, of a physical nature, biological and cultural, significant features for the functioning of the ecosystem, provide crucial information for the correct planning in the agro productive and conservation diversification. Applied in the municipality of Coatepec, Veracruz. The results show a total of ecologically sensitive areas of 4255 has, meaning the 1.66 % of the total surface area of the Municipality, therefore, we've found that the critical areas associated with communication channels and urban areas are of 7851 has, with the highest impact percentage of 3.06 and the sustainably suitable areas for slopes and vegetation cover is 1.6 % of the total of the municipality of Coatepec.

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INTRODUCTION

The identification and delimitation of ecologically sensitive areas provides essential planning information aimed at enhancing the agro productive diversification of territorial units with ecological and sociocultural importance, can be identified and classified by their uniqueness, representativeness, risk, environmental value and functions within the total environmental system cycles (Schereier *et al*., 2012) are surfaces that contain of landscape elements, of a physical. Biological or cultural nature, therefore, they must be protected through ecological planning of the territory. Includes areas of riparean wetlands, dampening areas that were developed along the rivers and streams (Brandes *et al*., 2005) habitats for wildlife or areas of protection for endangered or threatened species, flood plans, land for primary agriculture or areas with traditional diversified crops. Are interrelated and may form natural areas, in networks or connections of landscape elements that provide ecological benefits, recreational and cultural communities (Ndubisi *et al*., 1995). In the planning process, you should consider six basic elements: 1) identification of the area type or geographical

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context; 2) Quantification size and number of patches; 3) determination of their significance; 4) priorities and policies to develop for their protection; 5) incorporate them into local operational plans; 6) monitoring of the development of the use of land. Planning should be the guide to develop strategies for the use of the soil or of regulation (Ndubisi *et al*., 1995). Remote perception provides a better approximation to identify geographical elements because it gives a broader vision than the one obtained on the ground surface, by which it is applied in regional areas, it provides sources of information on the implementation of processes of geographic information systems, to facilitate the analysis of a region as a bio-geographical unit to delineate the products registered in the algebra of maps of the areas of interest (Di Gregorio *et al*., 2000). Therefore, the objective of the present study was to delineate areas for the agro productive diversification, through both instruments of analysis and regional planning to identify ecologically sensitive areas, criticism and sustainably suitable in the municipality of Coatepec, Veracruz.

MATERIALS AND METHODS

Study area; The Municipality of Coatepec is located between the parallels 19° 21' and 19° 32' north latitude; the meridians 96° 47' and 97° 06' west longitude; altitude between 500 and 2 900 m. (Figure 1). It is bordered to the north by the municipalities of Perote, Acajete, Tlalnelhuayocan, Xalapa and Emiliano Zapata; to the east with the municipalities of Emiliano Zapata and Jalcomulco; to the south with the municipalities of Jalcomulco, Tlaltetela, Teocelo and Xico; to the west with the municipalities of Xico, Perote and Acajete. It occupies the 0.28% of the state's suface (INEGI 2010).

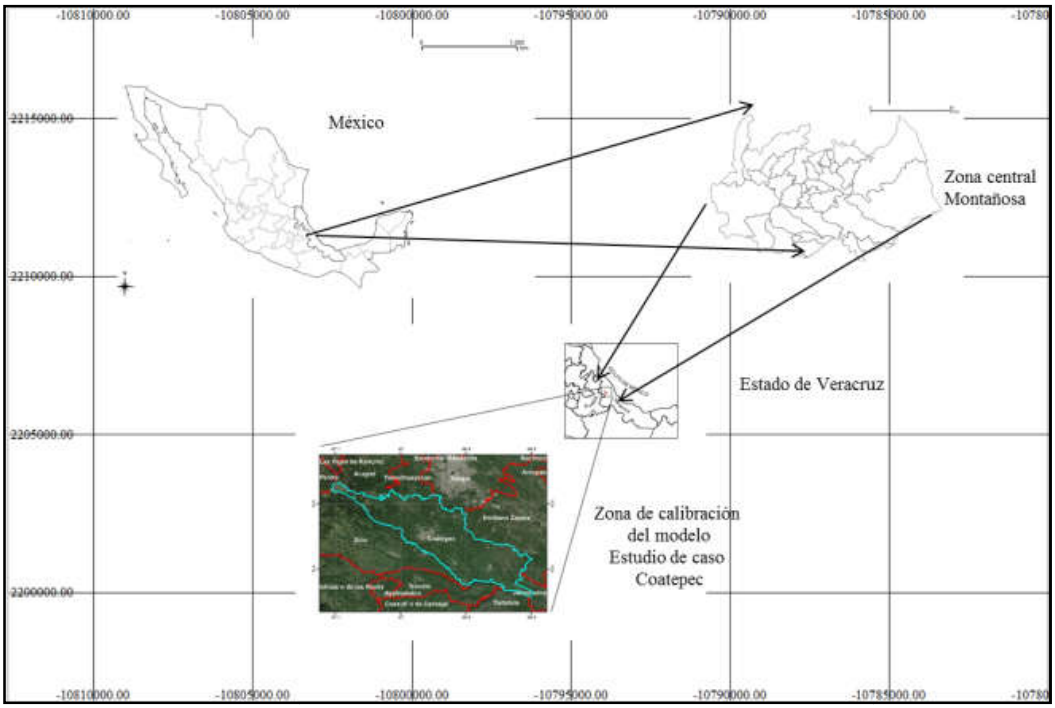
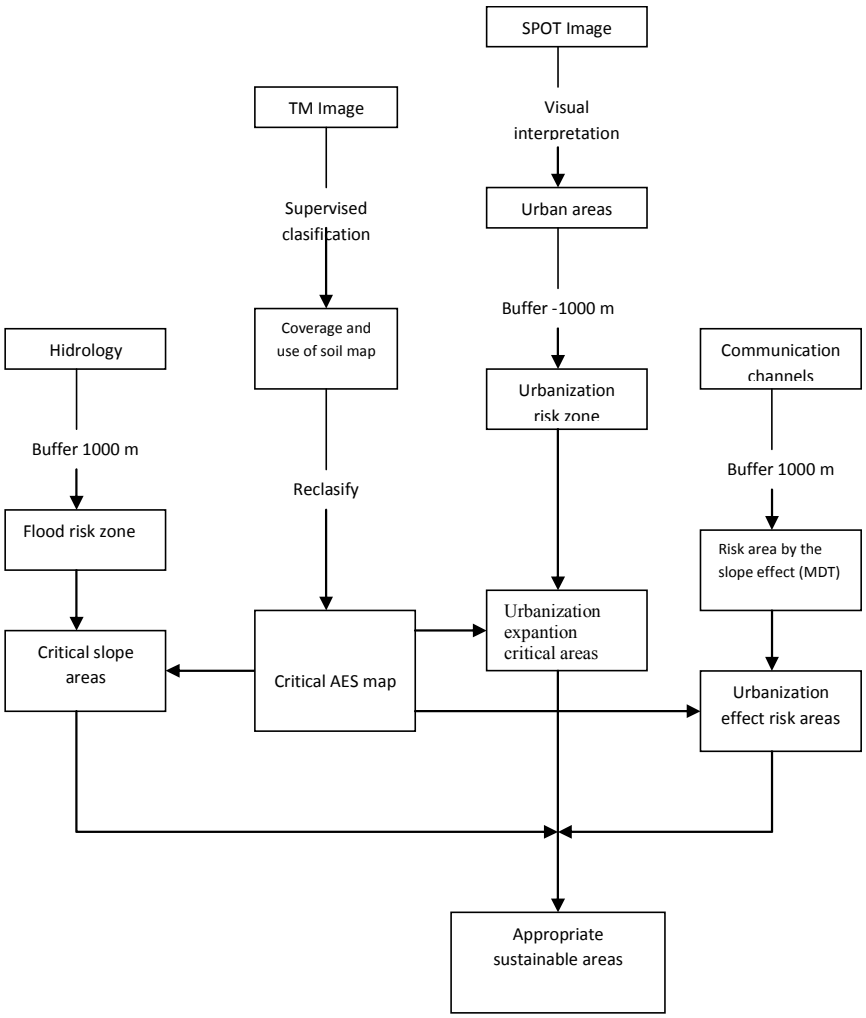


Figure 1. Municipality of Coatepec, Veracruz Localization

The methodology consisits of two phases: the first contemplated the criteria construction to define ecologically sensitive areas; and the second, the realization of the spatial analysis. To define ecologically sensitive areas (AES) critical associated areas (ACA) sustainably suitable areas (ASA). 1) determines the presence of traditional crops; selected by the importance of the areas that relate the identity perception of the inhabitants with the landscape (BMLFUW 2011); 2) presence of native vegetation, which is associated with the conservation degree and naturalness of the region. 3) susceptibility to erosion by slope that is the largest destabilizing force in the terrestrial ecosystems (Borman and likens, 1979); 4) susceptibility to flood, related to the previous criteria, since it enables to identify the areas affected by runoff in a permanent way, which conditions the development of natural vegetation or traditional crops; 5) proximity to communication channels; selected because the areas with native vegetation or with traditional crops close to the same, are more susceptible to changes in the most cost effective ways of the use of land; 6) proximity to urban areas, criteria that complements the earlier because the growth of urban areas is the greatest threat due to the high profitability of the urban use of ground (Schmitz, *et al*. 2003), for spatial analysis, the cartographic information sources were: 1) hydrology thematic map, 1: 25 000 scale; 2) Satellite Image SPOT 6 (Earth Observation Evidence System) dated on April 15th, 2015, 1.5 m multispectral resolution; 3) digital highway network, 1:25 000 scale. And 4) Digital Terrestrial Model. The method was aimed to define the spectral classes present in the SPOT 6 multispectral sensors. The control points, allowed to integrate the multispectral information with the regular topographical mapping, which corresponds to topographic charts at scales of 1:250,000 (INEGI; 1987-1996-2002-2010-2011 periods). Satellite images, handled with Q GIS Browser 2.6.1, GV SIG, IDRISI, ERDAS 8.2, ARC GIS 9.2.ERDAS, ENVI 3.6 software, were cut and charted the polygonal of the Municipality. The supervised classification was carried out with the 1 and 2 main components, (Yankelevich *et al*. 2007) (NDVI) (Virginia and Wall. 2001). Normalized Difference Vegetation Index to identify and delineate the current land use considering 4 categories: traditional crops, natural vegetation, soils without vegetation and slopes. The information was processed with Q GIS Lyon, it is summarized in the cartographic model (Scheme 1). To define the ecological sensitivity of a biogeographic region should be examined under scientifically existing connections



Spatial analysis cartographic model

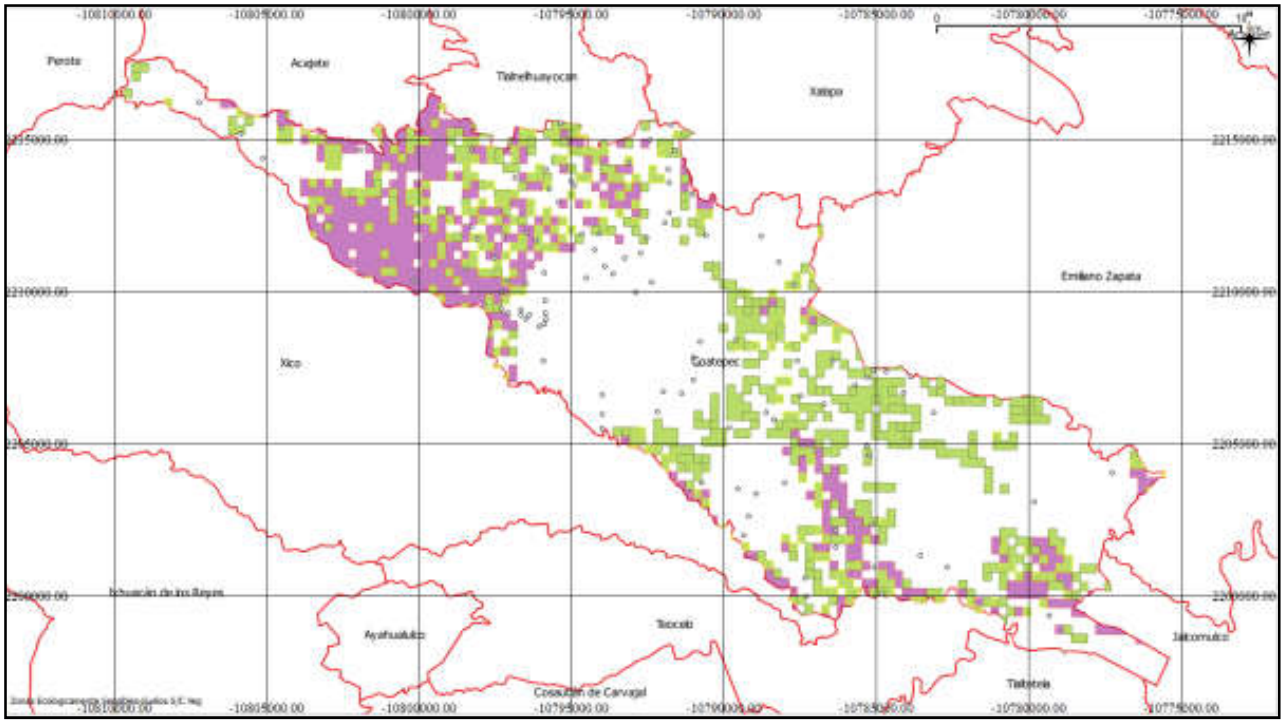


Figure 3. Ecologically sensitive areas

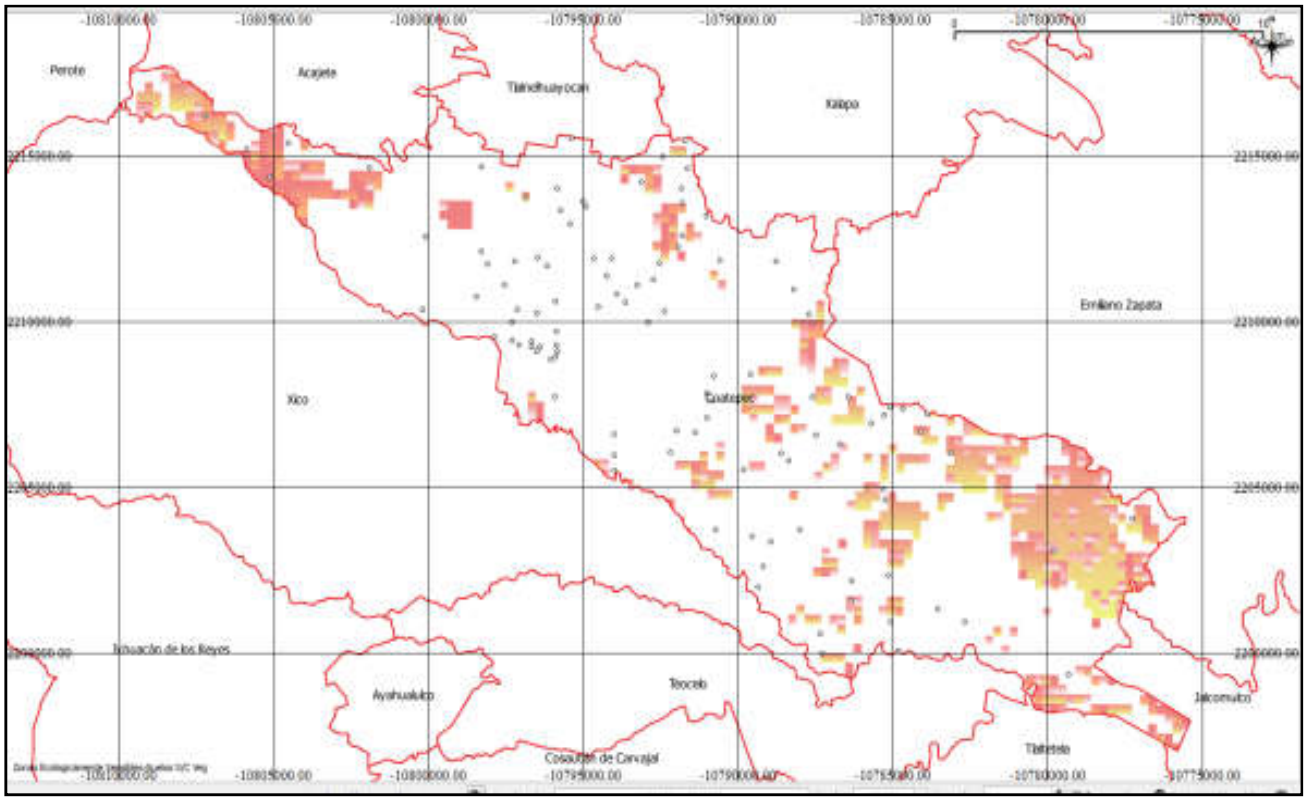


Figure 4. Associated critical areas

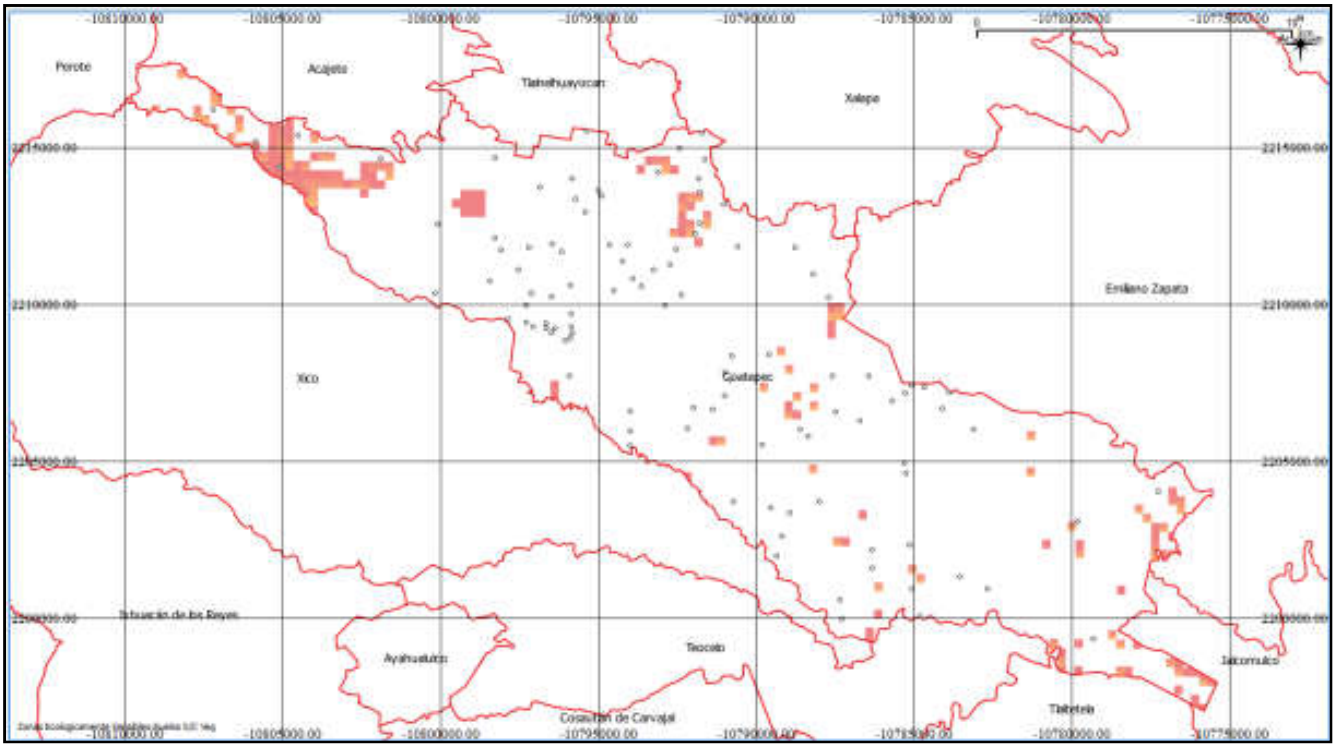


Figure 5. Sustainably suitable areas

(Transversatility) indicators for the physical and social environments sensitivity. (DOF 10-31-2014) For example, the purification of water and air: detoxification and decomposition of waste, production and renewal of soils. Soil fertility: the pollination of natural vegetation and crops, natural pest control. The spread of the seeds: the livelihood of biodiversity (genetic potential) moderating influence on the weather: temperature, wind, balance of rainfall, floods and droughts. (I.N.E. 2006).

Protection against avalanches, landslides and erosion. The supply of resources from economic activities and the supply of raw materials (Schmitz *et al*., 2003). Scheme 1. Elaboration of synthesis maps. The conducted procedures are summarized in three products: (1) A map which integrates the ecologically sensitive areas (Figure 3); (2) a map that shows the urban areas influence and the main communication routes, in a radius of 1000 meters which shows the critical areas as a result of the urban growth and the channels of communication

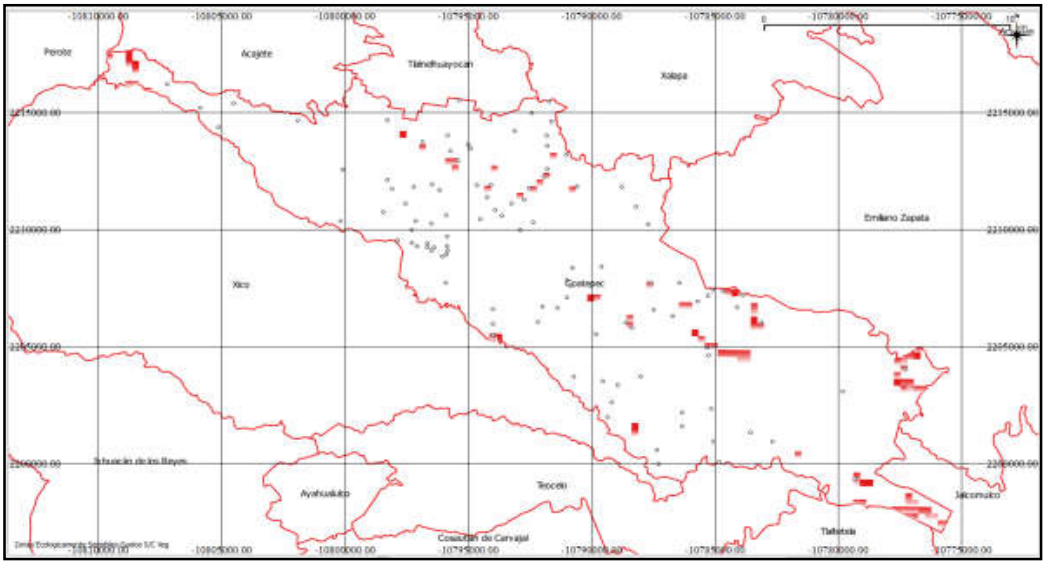


Figure 6. Sustainably suitable areas for paths

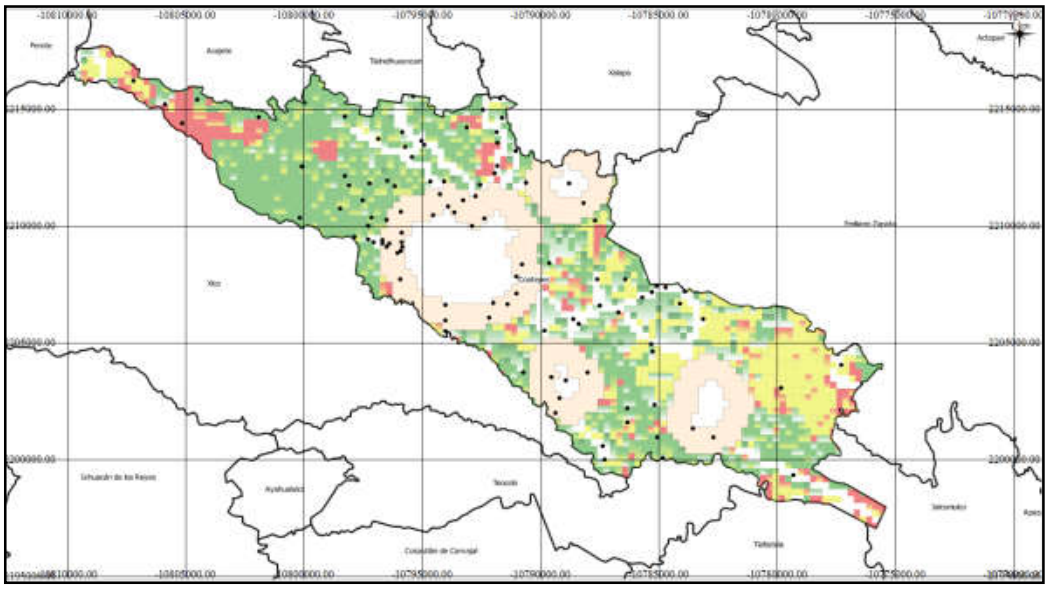


Figure 7. Ecologically sensitive areas

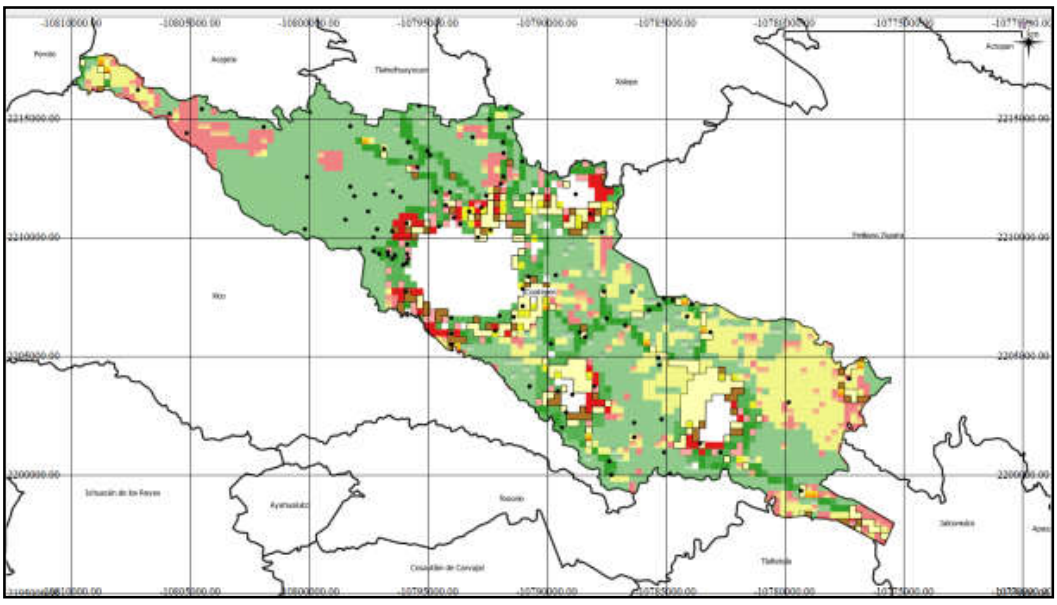


Figure 8. Critical areas associated with urban areas

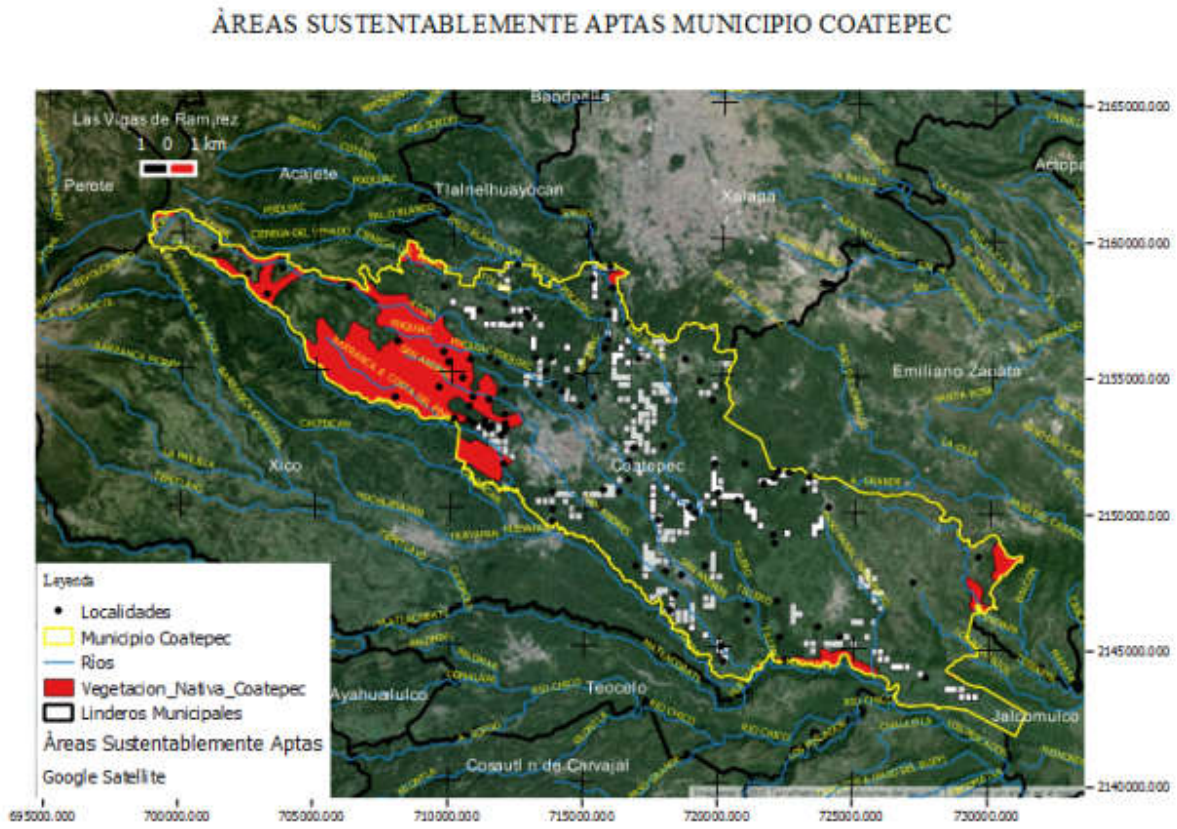


Figure 9. Sustainably suitable areas and V / N

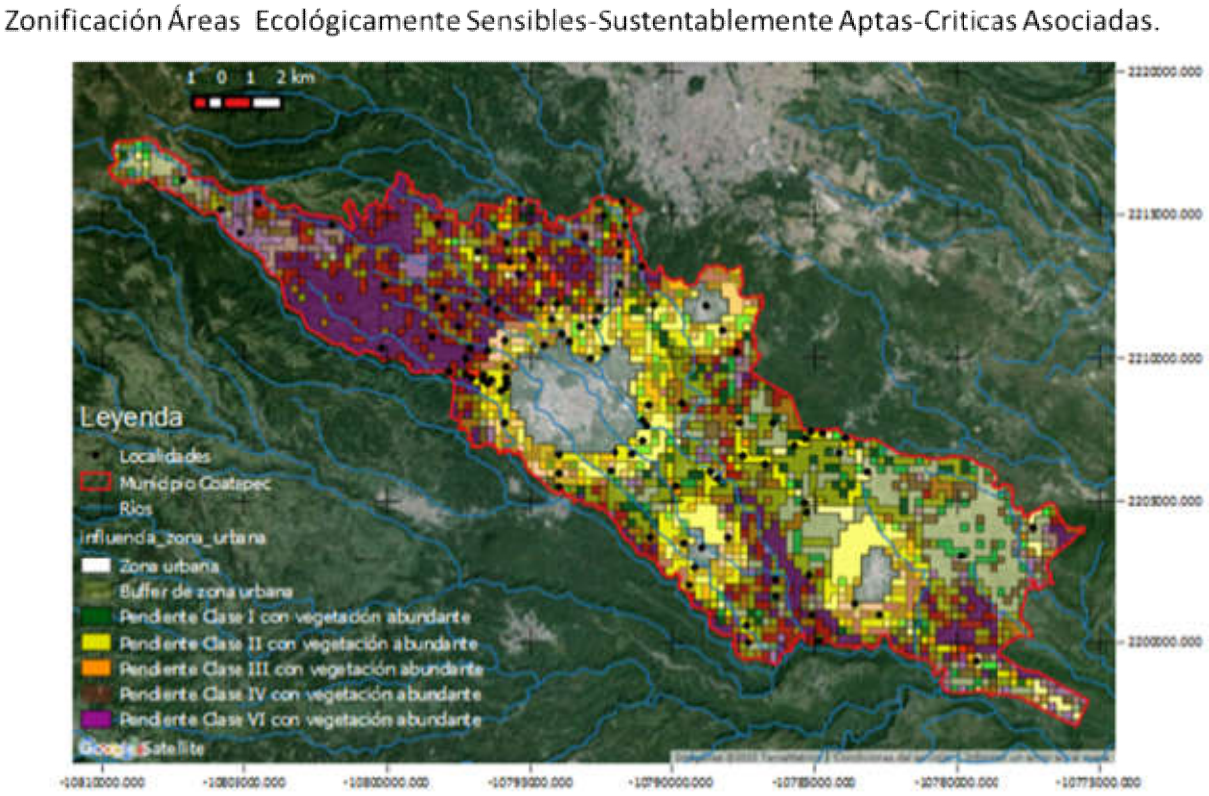


Figure 10. Total areas. AES-ACA-ASA

Table 1. Quantification of areas

Area Type	Hectares	Total Percentage %
Ecologically Sensible	4255	1.66
Associated Critique	7851	3.06
Sustainably Suitable	4116	1.6
Total	16222	6.32

Table 2. Policy decisions rules by type of ecologically sensitive areas and their level of information

POLICIES	TYPE OF ECOLOGICALLY SENSITIVE AREA	INFORMATION PLANS SATELLITE IMAGE SPOT 6
Utilization by its potential sustainable use	- Polyculture agricultural areas - Agroforestry livestock areas - Agro forestry areas with fruit trees and corn - Timber and non-timber areas	- Current land use V.S. Potential use - Supervised classification - Primary agro ecological zoning
Restoration by its value and protection	-Riparian areas -Natural vegetation relicts -Very eroded areas for restoration with native vegetation or mixed forest plantation for protection. -Soils and exploitation in a not so distant future.	-Delineation of Rivers -Bodies of water. -Delineation of zones of soils without vegetation.
Protection and preservation by their risk	-Forest of special plants and animals where the community is forbidden to take advantage of its flora and fauna. - In the protection area, are also found places recognized by the inhabitants and the national of international national or international.	-Native Vegetation -Headwaters
Conservation by its fragility	- Permanent forest area where wood is extracted and it is being developed a sustainable forestry program that has maintained the natural forest in the richness and biodiversity aspects.	-Current Use V.S Potential use

(Figure 4); and (3) a map of sustainably suitable areas, these maps are delineated where the use of soil is exclusively for agriculture and livestock, not where the native vegetation is located (Figure 5).

RESULTS AND SICUSSION

The ecologically sensitive areas are found in two slope gradients, the first in the range of 3% to 12% with a modest trend to water and wind erosion, effective depth less than that of an ideal soil to some impediment degree such as an unfavorable structure, it presents a moderate acidity, the second, where the areas with soils in a very steep range of slope between 12 and 25%, very strong stoniness restrictions, fertility and surface soils. To a lesser degree, there are vestiges of natural vegetation and areas susceptible to erosion (Figure 9).

The areas that were of natural vegetation (cloud forests) are now only patches in an area dominated by traditional crops (Figure 7) detecting a conservation relict with resilience vegetation. The critical areas associated with the infrastructure and roads, it is recognized that its dynamics is a function of the continuous evolution of the management impacts and the progressive expansion of the scale of the human influences. (Hammer and Söderqvist 2001) Claim that many of the problems referred to as critical are those that involve the interactions between man and the ecosystems, are of transdisciplinary nature and overlapping of scales. The total of ecologically sensitive areas is of 4255 has, meaning the 1.66% of the total surface area of the Municipality, it is that the critical areas associated with the communication channels and urban areas is of 7851 has, with the largest percentage of impact of 3.06, and the sustainably suitable areas for slope and vegetation cover is 1.6% of the total of the Municipality of Coatepec. Table 1.

The overlay of thematic maps obtained through the current land use analysis: total vegetable coverage, areas without vegetation coverage, native vegetation areas, urban areas. Priorities for the protection of ecologically sensitive areas. The criteria are designed to contribute to a culture of agriculture and clarify the social, political and administrative interests that have ecological foundations and cultural rights for a specific zone. For example: soil conservation, health and welfare. Natural resources must be used in an optimally possible manner the most part of the time, for example, forestry regulations (forests for the protection against avalanches) the conservation of water, quality of the air maintenance (Bosier, S. 2005).

Conclusion

The AES prove to be a very valuable bio space analysis tool to prevent and measure the magnitude of conflicts that occur between incompatible visions between not sustainable cultural activities and the sectors which cause negative impacts to the health of the ground, water and plant resources. Another application is that it also allows to model, in a specific way, abstract concepts, as the fragility, part of the location of biotic areas or types of vegetation, and natural habitats, in a short term to avoid changes to their structural properties. Likewise, it constitutes a perspective to guide the policies for territorial management aimed for the developing activities that contribute to the generation of employment and income. The design of the AES under the "potential" criteria, empowers the possibility to develop a sustainable use of natural resources, which results will help to pull down social lags, integrate and give social cohesion to the territory, and to identify investment opportunities. For example, for the agro productive biodiversity. It is therefore a secure tool for the agro productive ordering of the territory, due to the detection of sensitivity, it is closely related with the intrinsic and extrinsic characteristics of the agro ecosystems and, therefore, the potential of an area to be designated as an AES can be determined using a wide range of indicators that illustrate the particular ecological value, its potential for development and its risk. Also, these indicators have the advantage that they are based on simple methodologies and can be cartographically represented, allowing to define spatial and timely indexes from each specific area.

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