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IV. DESCRIPTION OF ENVIRONMENTAL SYSTEM AND POINTING OF ENVIRONMENTAL PROBLEMS DETECTED IN THE AREA OF INFLUENCE OF THE PROJECT

IV.1 DELIMITATION OF AREA OF STUDY

The Environmental System (SA) is the geographical area where the development of a project or activity may have effects on various environmental components that comprise it (air, water, soil, geomorphology, vegetation, fauna, etc.). either directly or indirectly, in the short, medium and long term.

For the establishment of the SA where the project will be developed, we considered the characteristics of the project (size, distribution of types of works on the project), and abiotic factors such as geomorphoedaphological and hydrographic features were also used, biotic factors such as types of vegetation and social factors such as communities that will support the construction and operation of the Project. Next, an analysis of the factors considered is presented.

- The Project consists of the construction and operation of a wind generation farm, which is intended to be develop in the region of “Tres Mesas”: Mesa La Paz, Mesa Las Chinas and Mesa La Sandía, in the town of Llera de Canales and a small portion in the Municipality of Casas in the state of Tamaulipas.

  In all, it is foreseen that from 152 to 436 wind turbines of 1.6 to 3.3. MW will be installed. Once the five stages have been completed it is expected to generate 500 to 700 MW of total electric energy. The wind turbines will be installed only in Mesas La Paz and La Sandía.

- For the delimitation of the Environmental System, criteria on the sub-basin where the project will be developed was used. Watersheds and their subunits (sub-basin, watershed) are an appropriate geographical context because they constitute functional units, as the area of land that forms the basin is linked by the hydrological dynamics that occurs in it. The impact of a management action will tend to be contained within the watershed and what takes place in the upper part will impact the bottom part.

  The SA was delimited based on the boundaries of two sub-basins: Alto Gallinas belonging to Soto La Marina basin which in turn is included in the RH 25 Soto La Marina-San Fernando and the sub-basin called Río del Miembre-La Cañada located within the Tamesis River Basin RH 26 Panuco .

- The Area where the project is to be developed is an important step for migratory birds flying from the north of the continent towards tropical areas further south for the winter. It is also known that the main confluence of migratory birds has been recorded along the coastline of the Gulf of Mexico up to the Isthmus of Tehuantepec. This is because it has been found that migratory birds make use of certain features of the landscape or geological formations for orientation during their long migratory journeys such as mountain ranges and coastlines.

  The SA is located approximately 81 kilometers from the coast so it is unlikely that the intensity of migration registered in the Veracruz coastal areas be present within the SA and, therefore, it is expected that the project influence does not reach the coast; so technically speaking, it is not feasible to extend the SA to those parts of the Tamaulipas territory.

- Moreover, it is noteworthy that the SA proposed encompasses landscape elements that are important for the retention of the regional diversity of bats, primarily the areas of hills and ridges which usually are less affected by human activities, in part because of their inaccessibility. It is likely that these areas provide shelter and breeding sites for bats and that they use these disturbed areas to find food.

The Environmental System is located in the State of Tamaulipas encompassing two municipalities Casas and Llera and has a total area of 2,603.82 km^2; in the following figure, location and limits are shown, while the Project Area encompasses Mesa La Paz, Mesa La Sandía, and Mesa Las Chinas, covering an area of about 29,000 hectares.

It is noteworthy that for the preparation of this chapter the following activities were carried out:

- Review of the maps produced by INEGI
    - Shp Geológico. INEGI.
    - Shp Edafológico INEGI
    - Land Use and Vegetation Types Shp. Series III. INEGI, 2007.
    - Basins and Sub-basins Shp, INEGI, 2002.
    - State Political Division, INEGI.
    - Municipal Political Division, INEGI.
- Review of the National Forest and Land Inventory conglomerates (INFyS) carried out in the Municipality of Llera de Canales and Casas during the period 2004-2007, 2009, 2010 and 2011.
- Field sampling to determine vegetation types and species present on the site
- Review of the collection records deposited in the World Biodiversity Information Network (REMIB).
- Review of the collection records of monarch butterfly *D. plexippus* obtained from the Global Biodiversity Information Facility (GBIF, http://www.gbif.org/) and the National Biodiversity Information System (SNIB)
- Development of simulations to determine the potential distribution of monarch butterfly in the State of Tamaulipas
- Sampling and monitoring of birds and bats, for which services of Ecology Institute were contracted, under the responsibility of Dr. Rafael Villegas

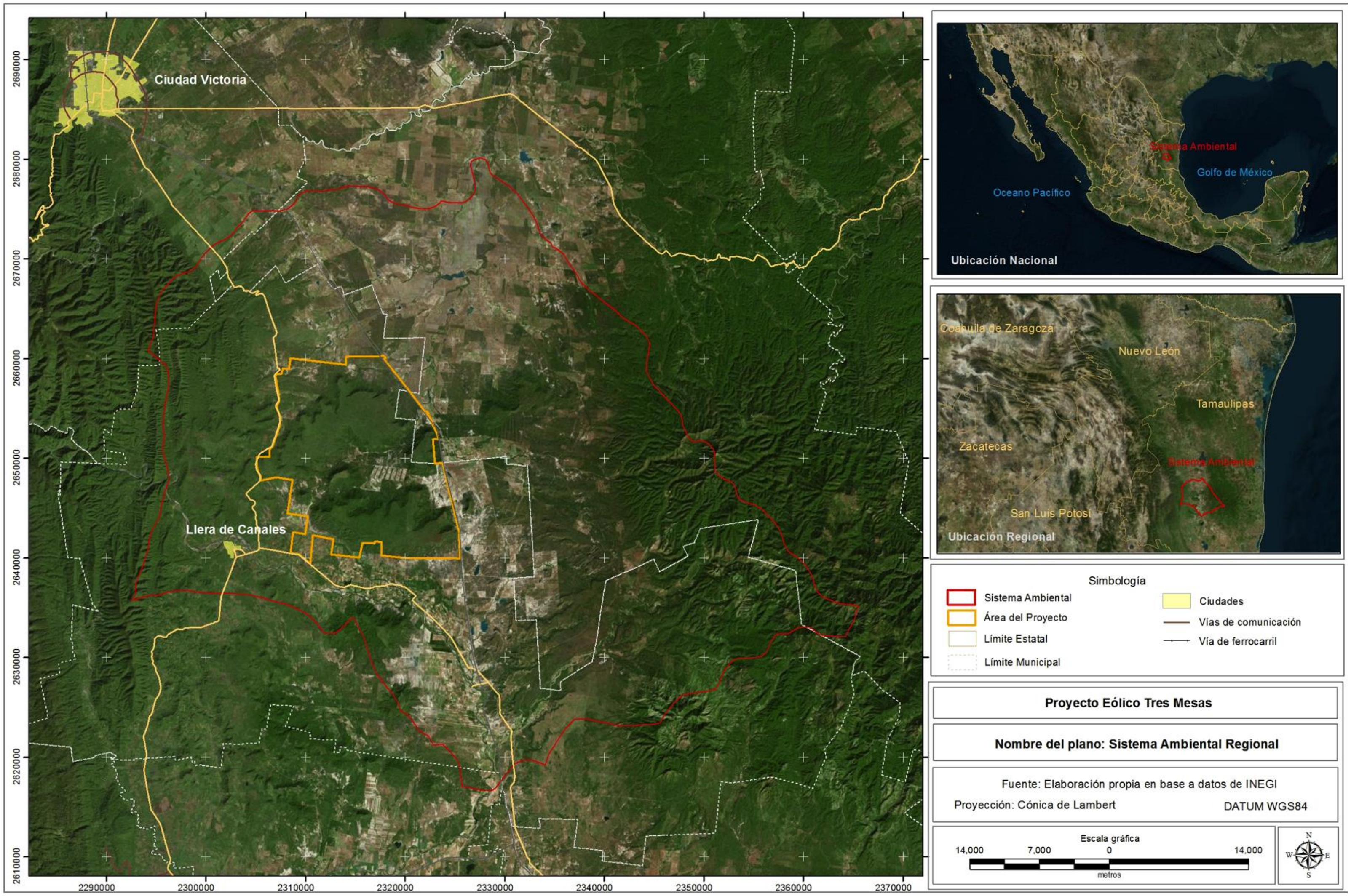


Figure IV.1 Environmental System Map and the Project Area Location

IV.2 ENVIRONMENTAL CHARACTERIZATION AND ANALYSIS SYSTEM

The characterization of the physical environment was made through the documentary and cartographic analysis by the INEGI and other government agencies; aspects of the biotic environment were performed through an exhaustive literature review, supplemented by field work especially in the Project Area.

The aspects of the Environmental System socio-economic environment were characterized at the municipal level with the information from the last census in 2010 and marginalization studies prepared by CONAPO.

IV.2.1 Abiotic aspects

IV.2.1.1. Climate

According to the Köppen climatic classification system modified by García, two types of climates in the Environmental System were detected, sub-humid warm and humid warm with variations which are described in the following table.

Table IV.1 Types of climate in the Environmental System

Climatic formula	Description
(A)C(w0)	Semi-warm sub-humid of group C, mean annual temperature over 18ºC, the coldest month temperature below 18ºC, temperature of the hottest month over 22ºC Summer Rains with a P / T rate below 43.2
(A)C(w1)	Semi-warm sub-humid of group C, mean annual temperature over 18ºC, the coldest month temperature below 18ºC, temperature of the hottest month over 22ºC Summer Rains with a P / T rate between 43.2 and 55
(A)C(w2)	Semi-warm sub-humid of group C, mean annual temperature over 18ºC, the coldest month temperature below 18ºC, hottest month temperature over 22ºC Summer Rains with a P / T rate higher than 55.
Aw1	Warm sub-humid, mean annual temperature over 22ºC and coldest month temperature over 18ºC.
Aw2	Warm sub-humid, mean annual temperature over 22ºC and coldest month temperature over 18ºC.

The Project Area has a semi-warm sub-humid climate; its formula is (A)C(wo) and it records an annual average temperature higher than 18°C; the temperature of the coldest month is below 18°C; temperature of the hottest month is over 22°C. The rain of the driest month is less than 40 mm, with summer rainfall index P / T below 43.2 and percentage of winter rain from 5% to 10.2% of the annual total.

The stations used for characterizing temperature and precipitation in the SA are located at the following coordinates:

Table IV.2 Location of the meteorological stations within the SAR

Station	Coordinates		Altitude (m ASL)	Municipality
	Latitude	Length		
Angostura	23°22'00"	99°00'40"	500	Llera
San Francisco	23°23'18"	98°18'40"	260	Casas
Emilio Carranza	23°15'18"	98°50'00"	210	Llera

Source: National Weather Service.

- **<u>Monthly average temperatures</u>**

The average annual temperature in the SA is 28 °C being April and May the hottest months with an average temperature of 31.5 and 32.2 °C, respectively, the lowest temperature is recorded in January with 25.4 °C.

Table IV.3 Average annual temperature of the stations located in the SA (ºC)
1971-2000 period

Month	Angostura	San Francisco	Emilio Carranza
January	14.6	18.1	18.1
February	16.6	20.0	19.6
March	19.6	22.9	23.5
April	21.6	25.6	26.3
May	25.0	27.6	27.6
June	25.1	28.3	27.8

Month	Angostura	San Francisco	Emilio Carranza
July	25.4	27.5	27.8
August	25.4	27.6	27.4
September	23.2	26.0	26.2
October	21.1	23.9	24.2
November	17.8	21.4	21.6
December	15.1	19.1	19.0

Source: National Weather Service.

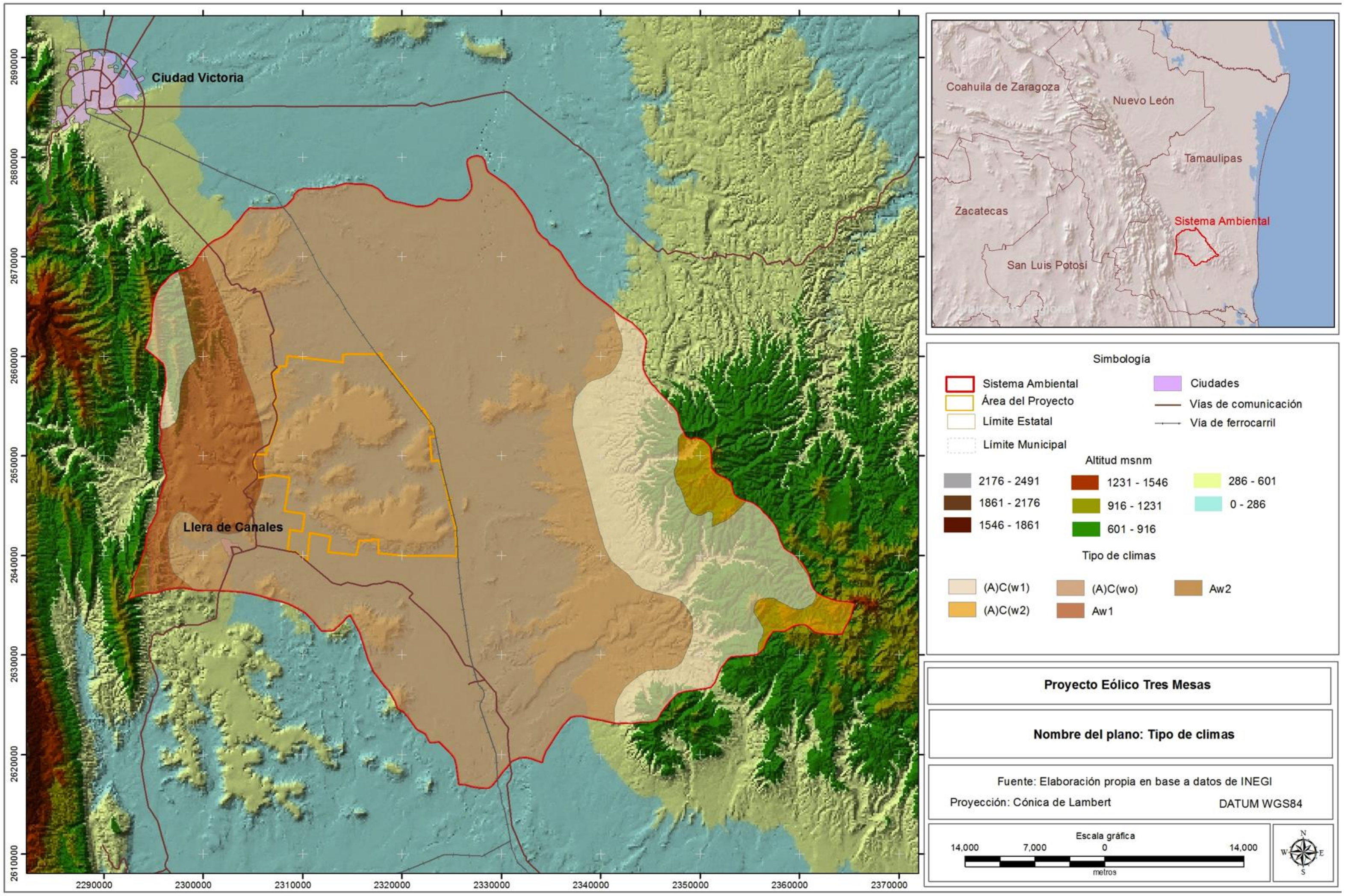


Figure IV.2 Climate types present in the Environmental System and the Project Area

- ***Average annual and monthly precipitation***

The average annual precipitation ranges from 637 mm, the driest months are February and December with ranges from 6.8 to 26 mm and the wettest is September with 208.2 mm.

Table IV.4 Average annual precipitation of the stations located in the SA (mm) 1971-2000 period

Month	Angostura	San Francisco	Emilio Carranza
January	25.2	23.3	18.1
February	6.8	7.0	19.6
March	12.8	13.4	23.5
April	31.9	33.7	26.3
May	66.7	57.4	27.6
June	107.9	85.7	27.8

Month	Angostura	San Francisco	Emilio Carranza
July	73.4	85.4	27.8
August	85.6	84.6	27.4
September	137.6	108.8	26.2
October	53.4	37.0	24.2
November	10.3	12.3	21.6
December	26.0	11.0	19.0

Source: National Weather Service.

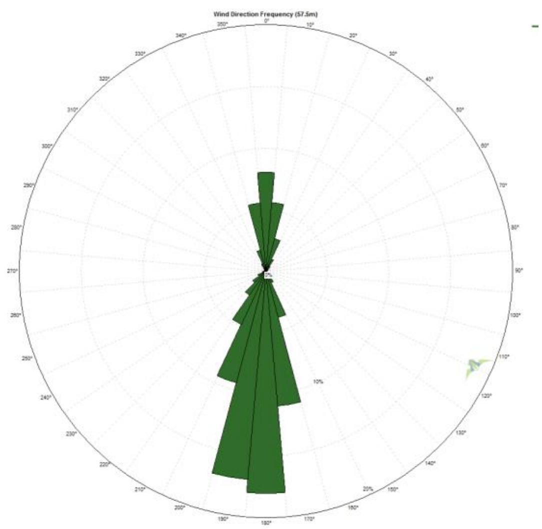
- ***Winds.***

To generate information about the direction and wind speed, three meteorological towers were installed at the site (one in Mesa La Sandía and two in Mesa La Paz. Wind speed records at heights of 40, 50 and 60 meters were obtained, as well as wind direction at heights of 47 and 57 meters. Specifically, in the towers of the Mesa La Paz, there are records from January 2008 to date, while in the tower of Mesa La Sandía, there are records from August 2009 to date.

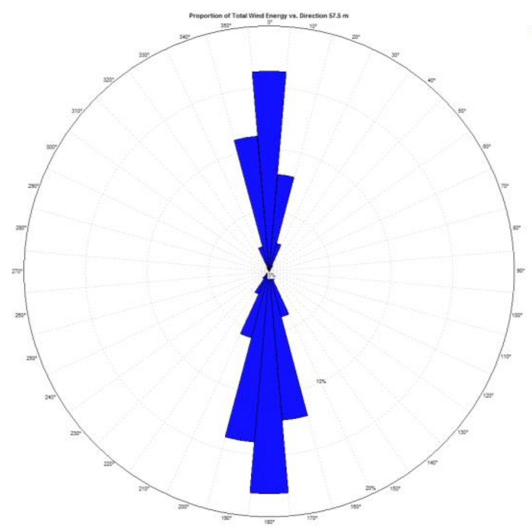
The wind rose (A) shown in the following figure was generated from the records obtained and shows that the wind pattern is bi-directional with an angle of 180 degrees apart, the prevailing wind comes predominantly from the south approximately 67% of the time. This wind pattern facilitates the orientation of the east-west rows of turbines with small spaces between the turbines. Besides, the east-west orientation of the plateaus allows maximizing the number of wind turbines on the site and reducing construction costs with relatively short distances between the turbines.

The wind rose (B) represents the energy generated by the wind direction. Although the prevailing wind comes from the south most of the time, the energy contained in the northerly winds is greater, therefore, the energy generated in the two predominant wind directions is similar as shown in the following figure.

Figure IV.3 Wind Roses



(A) Wind rose showing wind direction



(B) Wind rose showing the energy generated by the wind direction.

- ***Extreme meteorological events***

In the municipalities of Llera and Casas where the Environmental System is located, 34 Tropical Cyclones have been identified that have influenced directly (crossed municipalities) and indirectly (passed at a distance of less than 100 km) between 1854 and 2009. (Government of the State of Tamaulipas and Mexican Geological Service, 2009).

Table IV.5 Historical Record of Tropical Cyclones in the Municipalities of Casas and Llera that have directly influenced them

Name	Tropical cyclone type	Maximum sustained wind (km/s)	Date	Direction
No name	Tropical storm	64.36	September 19, 1863	East of Llera
No name	Tropical storm	56.32	August 10, 1909	Southeast to Northeast of Llera
No name	Tropical storm	88.49	August 28, 1909	North of Casas
No name	Tropical storm	96.54	September 07, 1921	South-North
No name	Hurricane category 1	112.63	July 7, 1933	Southeast of Casas
No name	Tropical storm	56.32	June 22, 1936	North of Casas
No name	Hurricane category 1	104.58	September 12, 1970	North of Casas
Anita	Hurricane category 4	193.08	September 2, 1977	Northeast-Southeast
Keith	Hurricane category 1	128.72	October 5, 2000	South of Llera

Source: Government of the State of Tamaulipas and Mexican Geological Service 2009. Risk Atlas of the Municipalities of Casas and Llera, State of Tamaulipas.

The period between the months of June and October represents the period of greatest recurrence of Tropical Cyclones. Meanwhile, Tropical Storm recurrence is higher with an average of 7.38 years and an interval of years between each logged event of 1 and 2 years minimum, and a maximum of 24. Hurricane Category 1 is the second event with higher recurrence with an average of 10.81 years. Tropical Depression has occurred three times 1950, 1970 and 2005, whereas Hurricane Category 3 only two (1966 and 1975). Finally, the Hurricane Category 4 occurred only once: 1977, whereas the Hurricane Category 2 and 5 showed no records. (Government of the State of Tamaulipas and Mexican Geological Service, 2009).

Cyclones and hurricanes affect in two ways: the first is the wind factor, which depends on the quality of construction of damaged homes and secondly, not least, is the moisture concentration involved, for their range of disturbance is usually regionally extensive and cause heavy rains which in turn cause floods. The strongest winds usually occur around the eye of the storm and usually affect smaller areas. (Government of the State of Tamaulipas and Mexican Geological Service, 2009). The only event that directly crossed the Environmental System was the Tropical Storm registered on September 7, 1921 with top wind speed of 96.54 km / s. (Government of the State of Tamaulipas and Mexican Geological Service, 2009).

IV.2.1.2. Geology and geomorphology

The Environmental System is located in the Coastal Plain Physiographic Province of the Gulf; it covers most of the state and is characterized by the presence of two sedimentary basins where Paleogene-Neogene rocks composed mainly of shales and sandstones were deposited, which lithology varies according to the environment in which they were deposited ranging from continental (deltas and bars) to shallow marine. The altitude range of the province ranges from 10 to 500 m, the outcropping materials are for the most marine unconsolidated sediments (clays, sands and conglomerates) presenting a direct age relationship which increases with the distance from the coast . (CONAGUA, 2008).

The plain extends transversely to the base of Sierra Madre Oriental and is intersected by hillocks, plateaus and planes slightly inclined to the east. The less resistant rocks such as marl and shale, widely exposed in the area are dissected rapidly generating moderately deep canyons with vertical and stable slopes (CONAGUA, 2008).

The Project Area is comprised of Mesas La Sandía and La Paz, which are characterized for being formed by QptB unit consisting of basalt olivine, vesicular structure and amygdaloid filled with calcite, they may be found from unchanged to very weathered. Spills are located in the valley of Ciudad Victoria, resting on the conglomerates. (CONAGUA, 2008).

The plain surrounding Mesas La Sandía and La Paz consists of a series of inter-bedded calcareous shale gray bluish and coffee color with nodular fracture, alternated with marl layers ranging from 5 cm to over 2 m thick, which sometimes alternate with thin layers of bentonite. (CONAGUA, 2008). The area lies within the Sierra Madre Oriental Province, a mountain range with elevations above 3,000 meters ASL, which runs NW-SE direction.

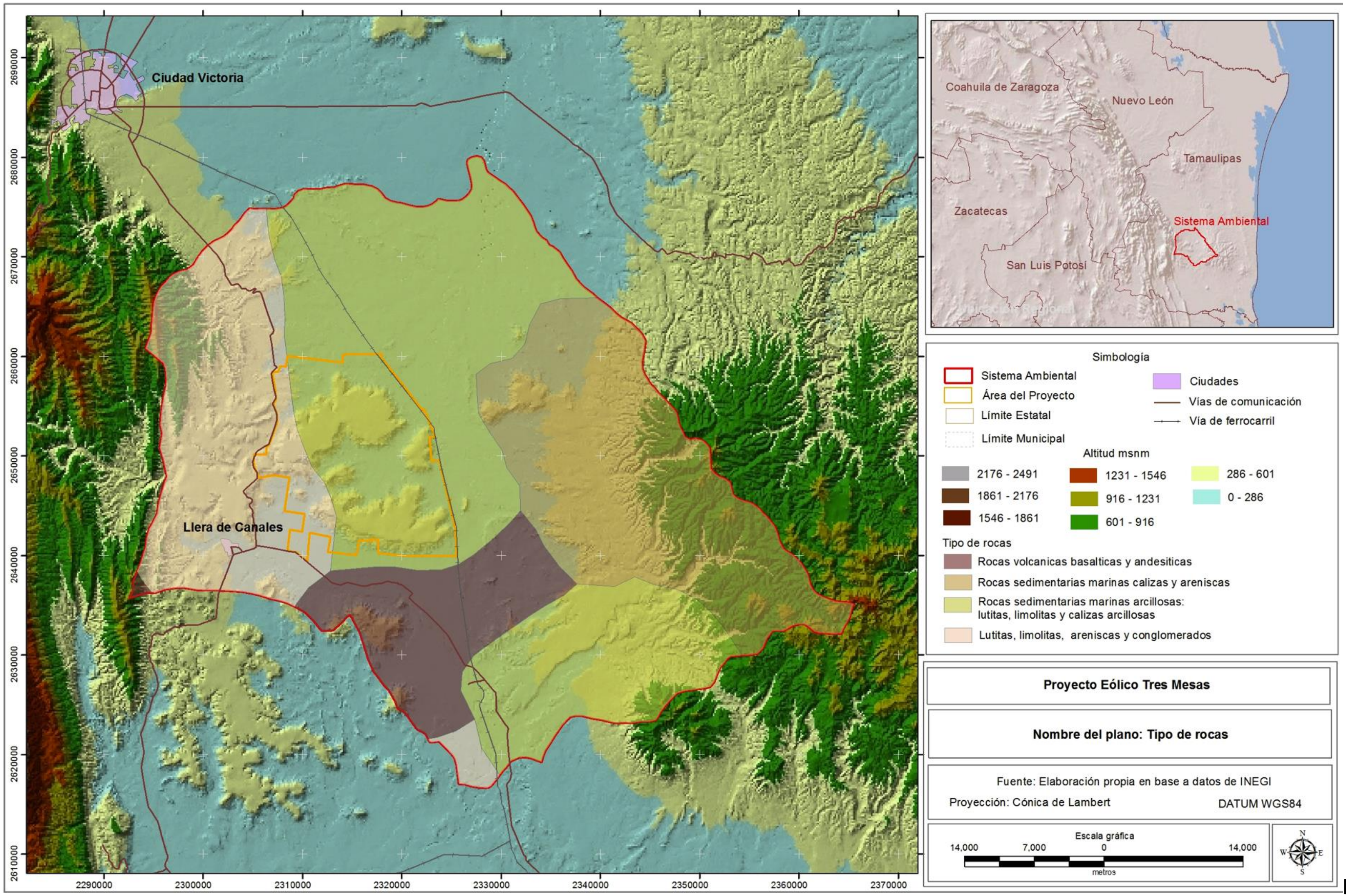


Figure IV.4 Rock types present in the Environmental System

- ***Relief Features***

The relief features of SA are determined by the foothills of Sierra Madre Oriental to the west where above 1500 m elevations are reached and Sierra de Tamaulipas to the east with maximum elevations of 800 m. Both sierras are in essence Mesozoic folded rocks, cut by deep drainage that originate large scarps; among the most notable features of the relief are karst forms and sinkholes that exist on the surface associated with caves of vertical development, controlled by regional fractures systems. (CONAGUA, 2008)

The central part of SA presents a varied morphology, with elevations ranging from 200 to 300 m, with a relief of flat surfaces, sloping eastward, caused by fluvial and marine accumulation, as well as corrugated surfaces formed by differential erosion in the Neogene layers. The plain extends transversely to the base of Sierra Madre Oriental and is intersected by hillocks, plateaus and planes slightly inclined to the east. Less resistant rocks such as marl and shale exposed widely in the area are dissected rapidly, generating moderately deep canyons with vertical slopes, the layer of conglomerates where appropriate, has been intensively dismembered on the surface, remaining by way of patches defined by river valleys. (CONAGUA, 2008).

The Project Area is located on two plateaus in the central part of the SA and reaching altitudes of approximately 400 m ASL and 200 meters above the plain surrounding them.

Figure IV.5 Relief Overview in the Project Area

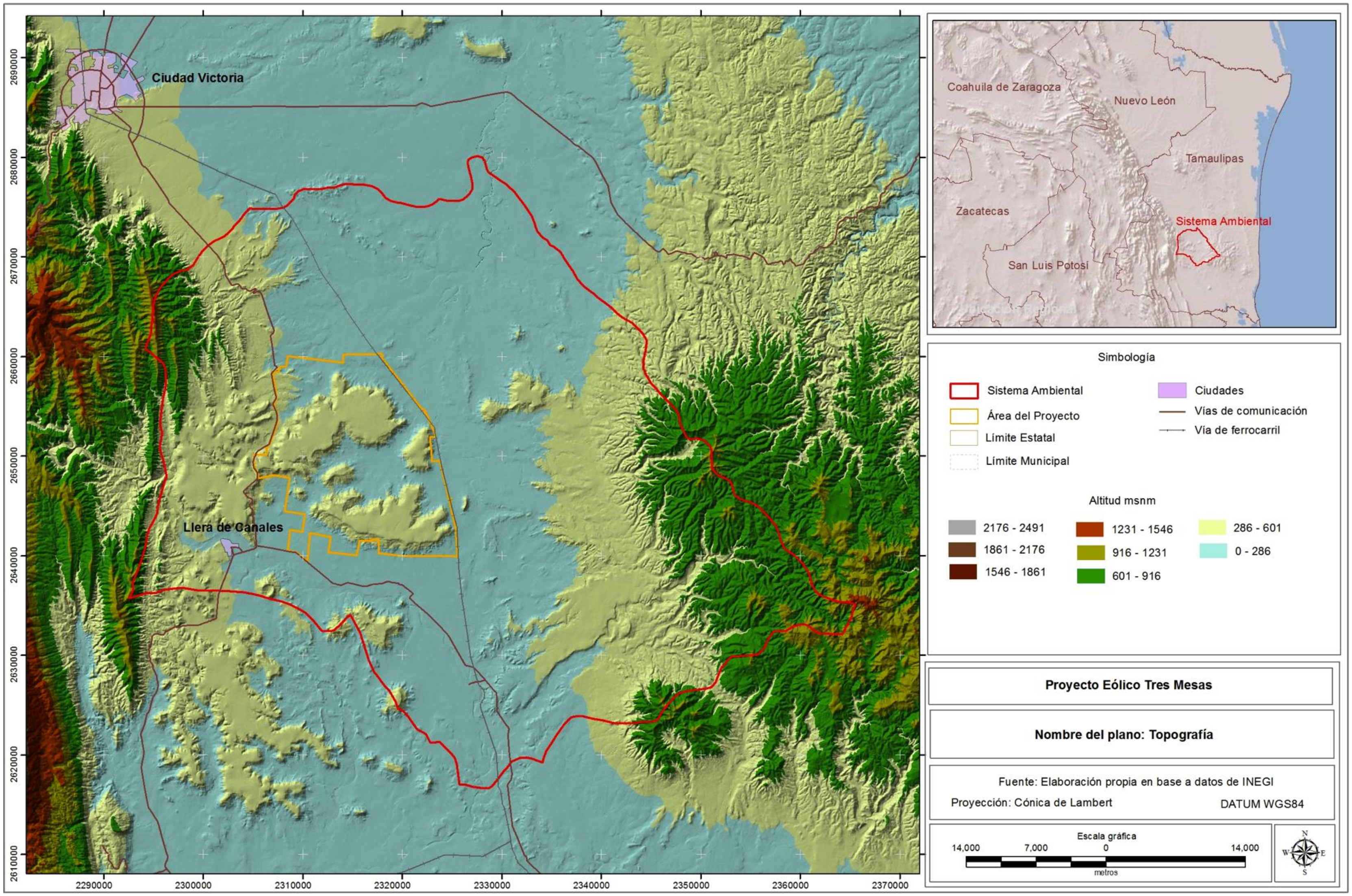


Figure IV.6 Altimetry of the Environmental System

- ***Faulting and fracturing***

The faults and fractures are planes of rupture within a lithologic unit. Despite being considered as inactive, they create separate blocks susceptible to be in motion by changes in their environment, such as overlapping or extraction of stone materials, urban settlements, construction of roads and / or infrastructure, among others. If it were to make a move or reactivation, it is capable of causing severe damage depending on its intensity, direction and surface or affected infrastructure. (SEGOB, et al 2009).

The SA presents faults and fractures systems with preferential orientations NE-SW and NW-SE, some notable NS. In the portion corresponding to the Sierra Madre Oriental higher density is concentrated as it was the result of tectonic stress, which subsequently gave rise to discontinuities systems, causing fractures or movement of rocks. The structures are distributed evenly across the region within which the María and Camilo Faults can be found to the Southeast of Casas, the El Progreso, Gómez Farías and Las Fortunas Faults distributed to Southwest of Llera. Likewise, to the Northwest and to the south of the same town we observe the El Platanillo and El Cautivo faults, presenting a preferential orientation from NW to SE and some others, North to South. (SEGOB, et al 2009).

- ***Seismicity Susceptibility***

Seismic vulnerability could be considered an expression that relates the likely consequences of a movement of earth on a construction, an engineering work or a set of goods or systems exposed to the intensity of the quake which could generate them. For purposes of seismic design, Mexico is divided into four seismic zones; this was done according to the catalogs of earthquakes occurred since early last century.

Table IV.6 Seismic zones of Mexico

Zone	Name
A	Area where there are no historical records of earthquakes in the last 80 years and no ground accelerations are expected above 10% of the acceleration due to earthquakes.
B and C	Intermediate zones, where not as frequent or high accelerations affected by earthquakes are reported, but do not exceed 70% of the ground acceleration
D	Areas where there have been large historical earthquakes, where the occurrence of earthquakes is very common and the ground accelerations may exceed 70% of the gravity acceleration.

Figure IV.7 Seismic zones of Mexico

Source: CENAPRED. 2000. Ranking in Mexico according to the seismic regionalization.

IV.2.1.3. Soils

- ***Soil types in the study area, according to the classification of FAO / UNESCO and INEGI***

The soil is the result of the interaction of several forming factors. As a result of this interaction different simple or complex processes are generated, that can be observed in their morphology and in their physico-chemical characteristics. It consists of layers or horizons that indicate the different processes and soil types, so it is considered a dynamic element, open to the surrounding environment, and constantly changing (INEGI, 1981).

According to the soil classification system of INEGI in the Environmental System eight types of soils were identified: Cambisol, Chernozem, Feozem, Fluvisol, Litosol, Regosol, Rendzina and Vertisol.

In the SA, Litosol soil type are predominant, which is recorded on the slopes corresponding to the Sierra Madre Oriental and Sierra de Tamaulipas, Pelic Vertisol and Cromic regosol occur mainly on the plateaus.

Table IV.7 Surface for each soil type present in the SA and Project Area

Soil type	Environmental System		Project Area	
	Km^2	(%)	Km^2	(%)
Calcium Cambisol	37.08	1.42	--	--
Calcium Chernozem	7.02	0.27	--	--
Luvic Chernozem	2.84	0.11	--	--
Calcaric Feozem	81.95	3.15	--	--
Haplic Feozem	137.78	5.29	1.46	0.48
Calcaric Fluvisol	24.24	0.93	--	--
Litosol	653.74	25.11	--	--
Calcaric Regosol	563.12	21.63	121.76	40.43
Eutric Regosol	0.23	0.01	--	--
Rendzina	259.80	9.98	10.58	3.51
Chromic Vertisol	266.47	10.23	32.85	10.91
Pelic Vertisol	564.49	21.68	134.47	44.66
Other (including urban areas and water storage	5.05	0.19	0.01	0.00

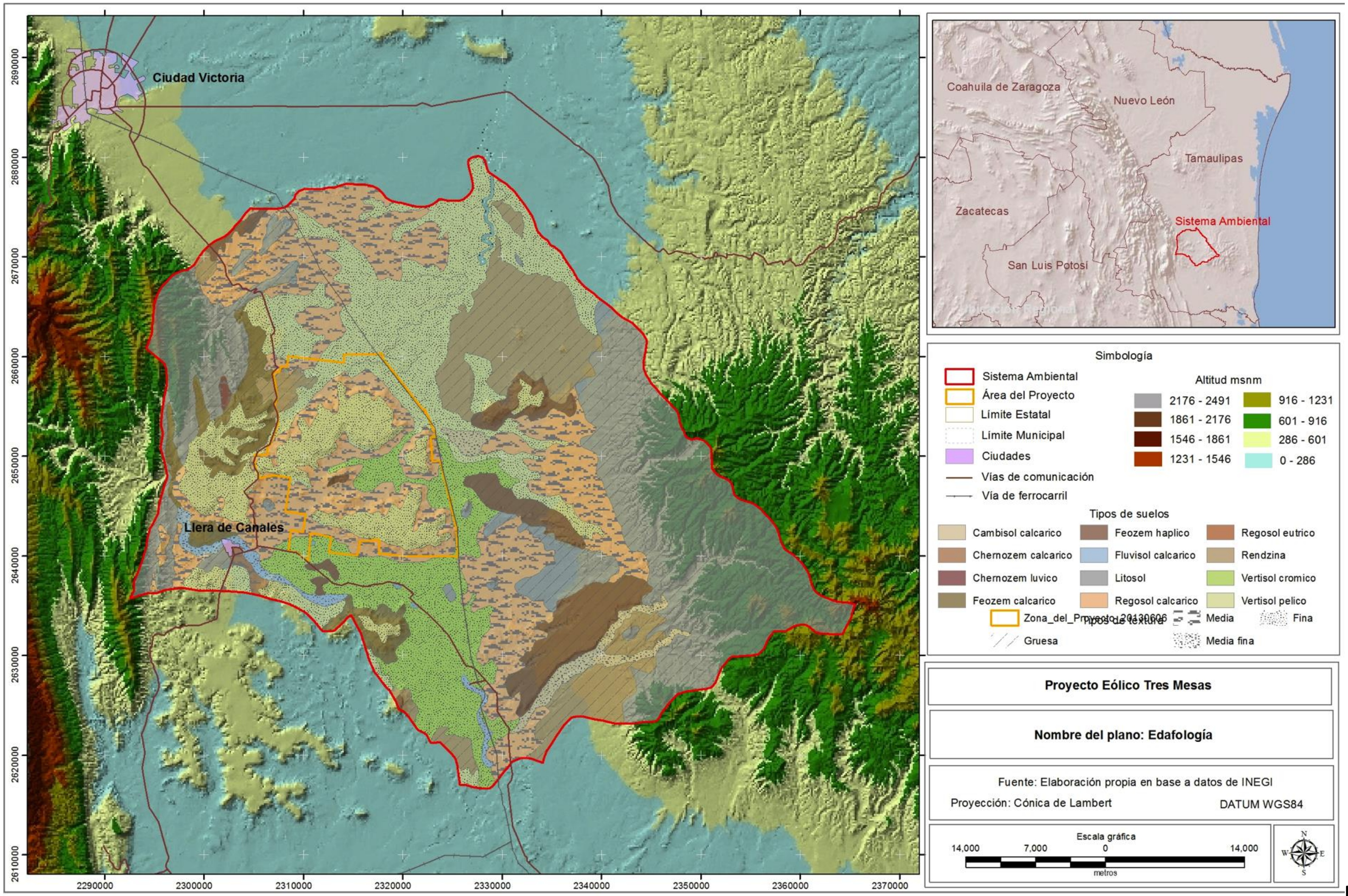


Figure IV.8 Soil types present in the Environmental System

- ***Physicochemical properties: structure, texture, phases, pH, porosity, water retention capacity, salinity and saturation capacity.***

The characteristics of the major soil units present in the Environmental System are described in the following table.

Table IV.8 Main characteristics of the soil types present in the SAR

Main Unit	Main characteristics
Cambisol (B)	They are developed on material of alteration from a wide range of rocks, among them wind deposits of alluvial or colluvial character. The profile is ABC type. The B horizon is characterized by a weak to moderate alteration of the original material, due to the absence of appreciable amounts of clay, organic matter and iron and aluminum compounds, of alluvial origin. They allow a wide range of possible agricultural uses. Its main limitations are associated with topography, low thickness, stoniness or low content in bases as well as their non-chemical phase feature. The degree of current water erosion of this soil type is considered moderate.
Chernozem (C)	Black soil, rich in organic matter and nutrients, permeable present in two Calcium Chernozem subunits with a layer of more than 15 cm thick rich in lime or gypsum and Luvic Chernozem, they have considerable accumulation of clay in the subsoil and are very permeable.
Feozem (H)	It is characterized by a dark, smooth surface layer rich in organic matter and nutrients. It has a clay-loam texture, slightly alkaline pH, organic matter content media profile, optimal levels of nitrogen and deficient levels of phosphorus and potassium; it is considered a type of soil that does not present salinity problems and soils that are sensitive to erosion.
Fluvisol (J)	Soil that is characterized by being formed of materials carried by water and poorly developed which structure is weak or loose, having alternating layers with stones or rounded gravel, due to the effect of current and flood water in rivers; they are "beaches" forming rivers. The calcaric fluvisol with calcareous material in the soil matrix, hauling product like limestone, very common in the area and its code is Jc
Litosol (I)	They are characterized by lower depth of 10 inches, limited by the presence of rock, hardpan or hardened caliche. Its natural fertility and susceptibility to erosion is highly variable depending on other environmental factors.
Regosol (Re)	They are soils with little development so do not present differentiated layers. They are generally light or poor in organic matter. They are often shallow. As subunits, the regosols presented are: calcaric regosol symbolized as Rc, which is characterized by calcareous material in the soil matrix; the other subunit present is eutric regosol; it does not have any extra feature but it has a high percentage of bases saturation (> 50%), its symbol is Re.
Rendzina (E)	Shallow soils which main characteristic is a surface layer with plenty of organic matter accumulation resting on limestone.
Vertisol (V)	They are clay soils at least within the first 50 cm depth, cracks as a general characteristic are presented from the surface down in the dry season; in the rainy season they are sticky so that the transit through this type of soil is complicated over uncoated gaps. In the SA, there is a Chromic Vertisol (Vc) subunit that is characterized since it is formed from

Main Unit	Main characteristics
	limestone and have a brown or reddish color and the Pelic Vertisol (Vp)

- ***Soil Texture***

Different types of soils are also characterized by the texture indicating the overall size of the particles that forming the soil and the physical phase indicating the presence of fragments of rock and material.

The Project Area is covered by fine textures that occur on the plateaus. On the plain that surrounds there medium textures while coarse textures occur primarily in the Sierra Madre Oriental and the Sierra de Tamaulipas.

Table IV.9 Features of types of textures

Texture types	
Fine (1)	The fine-textured soils have more than 35% of clays and these soils retain water.
Medium (2)	It refers to medium textured soils, commonly called franks, generally balanced in the sand, clay and silt content.
Thick (3)	The coarse-textured sandy soils (with more than 65% sand), with lower water retention capacity and plant nutrients.

IV.2.1.4. Surface and groundwater hydrology

The SA is located in two hydrological regions RH25 Soto La Marina-San Fernando and RH 26 Panuco, two watersheds called Rio Soto La Marina and Tamesis River.

In the SA, the presence of the Guayalejo River is highlighted, which is originated in the mountains forming Valle de Palmillas, to then enter the Municipality of Llera through the Santa Rosa Canyon, where it has an approximate length of 85 Km, crossing the Head Municipality of Llera from West to East. It is a perennial river and it crosses the SA from west to east; it is enriched by run-off from streams of Santa Clara, Las Adjuntas and Lucio Blanco; this river is the engine of agriculture in this area.

- ***Reservoirs and water bodies nearby***

In the Environmental System, there are no reservoirs or water bodies, only small water berms built by farmers and ranchers and some intermittent water flows are recorded. The most important water reservoir but that is outside the limits of the SA is Vicente Guerrero Dam that is located to the north.

- ***Underground hydrology***

The SA includes three aquifers: Llera Xicotencatl, Casas-Victoria and a small part of the aquifer Palmillas Jaumave, according to CONAGUA data, the three aquifers have groundwater availability as shown in the following table.

Table IV.10 Water balance from aquifers in the SA in millions of m^3/year

Concept (million cubic meters per year)	Casas Victoria[1]	Llera Xicoténcatl	Palmillas-Jaumave
Average annual recharge	31.3	39.3	293
Committed natural discharge	2.5	14.4	18
Licensed volume of groundwater	14.049946	16.968509	2.335403
Annual average groundwater availability	14.750054	7.931491	8.964597
Deficit	0.0	0.0	0.0

Source: [1] CONAGUA. 2008. Determination of water availability in the Victoria-Casas aquifer (2808).
[2] CONAGUA. 2009 Determination of water availability in the Llera-Xicotencatl aquifer (2811).

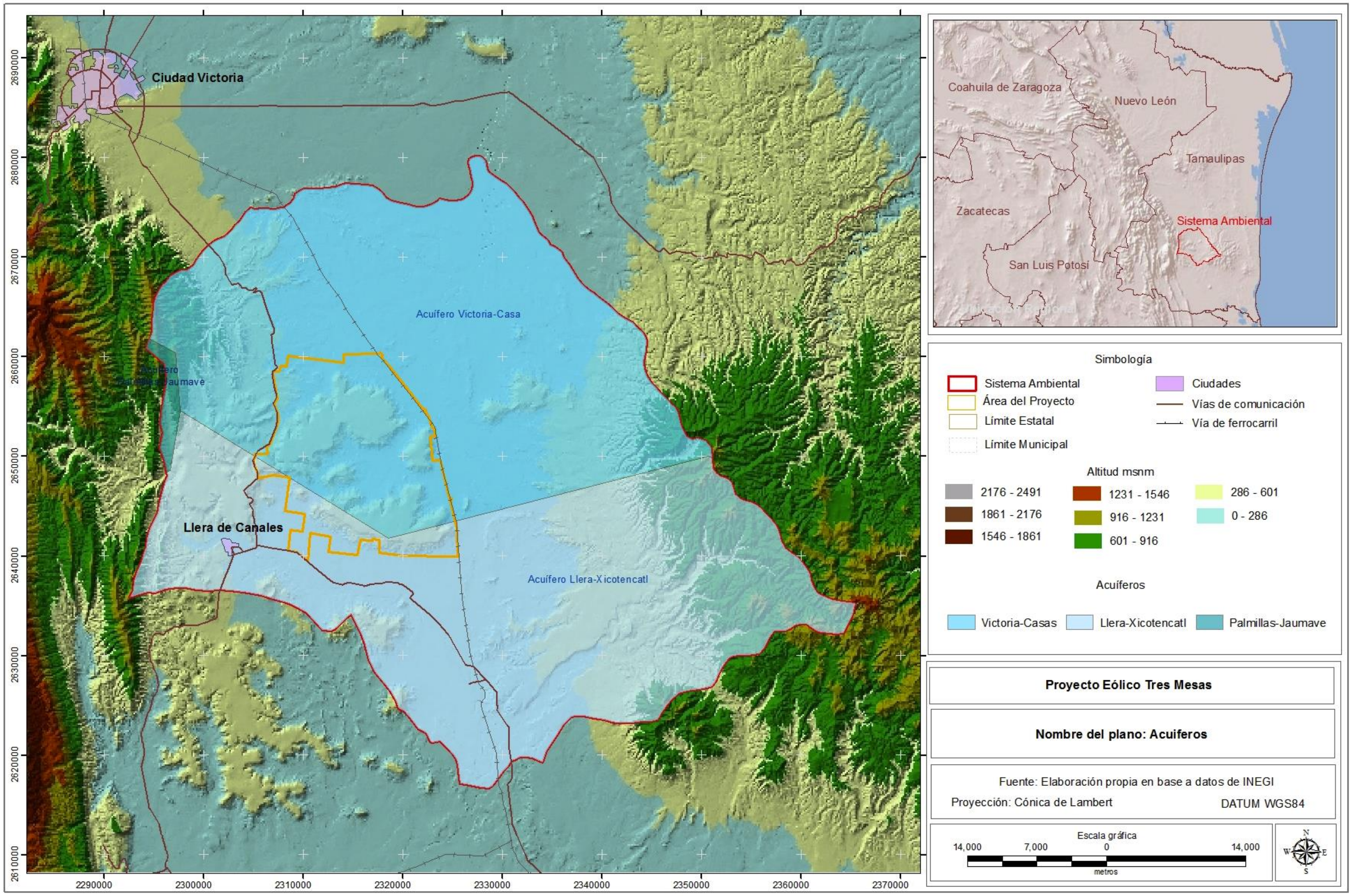
The characteristics of the three aquifers covering the environmental system are described in the following table.

Table IV.11 Main characteristics of the aquifers covering the SAR

Aquifer	Main characteristics
Casas-Victoria	The aquifer is free to semi-confined type, which is exploited by a large number of uses. Water is found at an average depth of less than 25 m, decreasing towards the center and north of the aquifer up to a few meters. However, discrepant values are evident due to topographic changes. (CONAGUA, 2008) There is a preferred direction of groundwater flow to the NW, with lateral recharge from the surrounding mountains. In the western portion of the

Aquifer	Main characteristics
	aquifer settings of the equipotential show a direction of groundwater flow from west to east, where the mountain acts as recharge zone. (CONAGUA, 2008).
Llera-Xicotencátl	It is free to confinement type depending on the deposition of the sediments constituting it. Due to existing geological formations the area is considered a low potential aquifer, however, there are areas where good flows can be extracted. (CONAGUA. 2009). The flow direction is generally from west to east and from north to south, unless the conditions are met in a particular way in some places by the topographical and geological conditions. (CONAGUA. 2009).
Palmillas Jaumave	It is a heterogeneous unconfined aquifer type, depth of the static water level ranging from 1 to 47 m, gradually increasing along the course of rivers and streams, as one moves topographically. (CONAGUA, 2008).

Figure IV.9 Aquifers included in the Environmental System



IV.2.2 Biotic aspects (Flora)

IV.2.2.1. Land use and vegetation

In the SA, eleven land uses and vegetation were identified according to the charter of land use and vegetation of INEGI series IV, which shows that the submontane scrub predominates, followed by rainfed agriculture; the same situation is repeated for the Project Area as shown in the following table.

Table IV.12 Land use and vegetation surface

Ecosystem Type	Vegetation Type	Environmental System		Project Area	
		(Km^2)	(%)	(Km^2)	(%)
Natural	Submontane scrub	821.54	31.55	207.56	68.93
	Tropical Mezquital	171.36	6.58	13.57	4.51
	Deciduous lowland forest	421.86	16.20	23.51	7.81
	Low thorny deciduous forest	91.34	3.51	10.10	3.35
	Pine-oak forest	1.19	0.05	--	--
	Oak forest	68.65	2.64	--	--
	Water body	4.15	0.16	--	--
Modified	Pastureland	336.20	12.91	--	--
	Irrigation agriculture	145.55	5.59	9.65	3.20
	Rainfed agriculture	537.29	20.63	36.72	12.19
Artificial	Urban zones	4.68	0.18	0.02	0.01

A brief description of the main types of vegetation present in both the Project Area and the SAR is presented below.

- ***Submontane scrub***

It is developed in semiarid conditions with 450-900 mm of rainfall per year, on shallow soils with stem sedimentary rock between 500 and 1000 m ASL. It is characterized as a community of short stature, 3-5 meters and very dense. It is dominated by spineless shrubs with small leaves, without being microphyllous, among the most common taxa are huizache (*glandulosa Prosopis*), the anacahuita (*Cordia boissieri*), (*Leucaena leucocephala*), *Helietta parvifolia*, claw (*Pithecellobium brevifolia*), *Quercus fusiformis*.

The Asteraceae family is often the most important. Other important families are Fabaceae, Agavaceae, Cactaceae. (CONANP et al. 2006).

View of submontane scrub on the plateau of La Sandía.

The submontane scrub has three layers: upper, middle and bottom, some of the species present in the upper layer are: tenaza (*Pithecellobium brevifolium*), barreta (*Helietta parvifolia*), anacahuita (*Cordia boissieri*), gavia (*Acacia amentacea*), corvagallina (*Neopringlea integrifolia*), chapote (*Diospyros texana*); in the middle layer there is anacahuita (*Cordia boissieri*), gavia, panalero (*Forestiera angustifolia*), crucero (*Randia laetevirens*). In the lowest layer, there is: coyotillo (*Karwinskia humboldtiana*), several species of the type of *Croton sp*, *Lantana sp* and *Opuntia sp*; the most predominant is *Yucca filifera*. (CONANP et al. 2006).

In the lower parts, especially slopes there are submontane scrub intermingling with lowland forest and are part of its composition. In this type of vegetation, we can find chaparro prieto (*Acacia rigidula*), el huizache *(Acacia farnesiana*) Anacahuita (*Cordia boissieri*) and several species of Opuntia. (CONANP et al. 2006).

- ***Deciduous lowland forest***

In Tamaulipas it is found to the south, almost always on soils derived from marine sedimentary rocks between 50 and 800 m. In general, trees are characterized because their lose their leaves in the dry season during a period which generally ranges around six months, having low branching with greater than or equal to the height of the shaft width, having from 5-15 meters in height with a normal range of 8-12 m high (CONAP, 2005).

The canopy is dominated by one or a few species; diameter (DBH) is 50 cm (CONANP, 2005). Puig (1970) describes two types of forest in this region, one dominated *Bursera simaruba and Lysiloma divaricata* and the other *Phoebe tampicensis and Phitecellobium flexicaule*. It is found in rocky areas characterized by the presence of *Pseudobombax ellipticum, Neobuxmaumia euphorbioides and Bursera simaruba*, with canopies not exceeding 10 m. Among the shrubby elements, there is *Agave lophantha and Hecthia sp*, and herbs like *Syngonium podophyllum* and *Pilea serpylliflolia* , which are the most notorious in the undergrowth (Valiente-Banuet et al., 1995).

For the SA, the representative species are: *Phoebe tampicensis, Mariosousa coulteri, Pithecellobium flexicaule, Tecoma stans, Mimosa monancistra, Sapindus saponaria, Erythrina herbacea, Ipomoea nil, Ipomoea alba, Cephalocereus palmeri, Cnidoscolus aconitifolius, Croton ciliatoglandulifer, Brosimum alicastrum, Ebenopsis ebano, Havardia pallens, Ehretia anacua, Parkinsonia aculeata, Leucophyllum frutescens, Caesalpinia mexicana, Acacia farnesiana, Capraria biflora, Croton reflexifolius, Citharexylum berlandieri and Capparis incana.*

- ***Low thorny deciduous forest***

This vegetation type includes a number of somewhat heterogeneous plant communities that share the characteristic of being low and which components at least in large proportion, are thorny trees, are also characteristic of flat or slightly inclined terrains. (Rzedowski, 2006).

This vegetation type has typically 4 to 15 m in height and is often seen as dense formation at the tree level. The stems are often branched from near the base, abundant and often thorny cacti and there are also related cactus candelabriform. (Rzedowski, 2006).

- ***Mezquital***

The mesquital is formed by species of *Prosopis*, together with other elements; this vegetation type has three main strata, at the top there is *Prosopis glandulosa* and *Pithecellobium flexicaule*; the middle strata has *Condalia lycioides, Randia sp*, tenaza (*Pithecellobium brevifolium*) and mesquite (*Prosopis glandulosa*); and the lowest strata has a variety of species.

View of a mesquital near Mesa La Sandía

- ***Oak forest***

They are plant communities characteristic of the mountainous areas of Mexico, and along with the pine forests make up the majority of vegetable coverage of temperate and semi-humid climate areas, although they enter in warm, humid and semi-arid regions; the latter form thickets. They are found from sea level to 3100 m ASL, although more than 95% of its length is at altitudes between 1200 and 2800 m asl. In southwestern Tamaulipas, it is developed between 900 and 2 100 m, and consists of a mid-open forest 5-20 m tall, with a round top and deciduous or perennial leaves.

In the Northeast Coastal Plain there are extensive oak, as in the higher parts of the Sierra de San Carlos and Tamaulipas (Rzedowski, 2006). This community is represented by *Quercus affinis, Quercus polymorpha, Quercus sartorii , Quercus rysophylla, Quercus canbyi, Quercus pungens, Quercus sebifera, Quercus laceyi, Sophora secundiflora , Xylosma flexuosum , Clematis pitcheri, Havardia pallens, Rhus virens, Amyris madrensis, Smilax bona-nox, Colubrina greggii. Because of its relationship with the MET, there are species such as Neopringlea integrifolia, Helietta parvifolia y Diospyros texana* (García-Hernández, 2008).

- ***Pine-oak forest***

Community of widely distributed forest that occupies most of the forest area of the upper portions of the mountain system of the country. The different species of *Pinus spp*, frequently form the higher strata while the species of *Quercus spp* represent a second lower strata.

The species listed in the SA for this type of vegetation are: *Pinus teocote, Quercus rysophylla, Juniperus fláccida, Wimmeria concolor, Scutellaria seleriana, Litsea glaucescens, Paspalum mutabile, Solanum americanum.* Within the species commonly found, we can mention *Quercus polymorpha, Q. fusiformis, Q. lacey, Q. affinis, Pinus montezumae, P. arizonica, P. teocote and P. ayacahuite*.

In general, the species of this community reach heights higher than 4 meters and its elements typically have sclerophyllous or needle leaves. It is set on the eastern slopes of the Sierra Madre and is a mixture of elements from neighboring forests of oak and pine trees (García-Hernández, 2008).

- ***Pastureland***

They are found on hillsides and bottom of valleys with moderately deep, fertile and moderately rich soil in organic matter. The species that often can be found are: *Tridens texanus, Tridens muticus, Digitaria hitchcockii, Aristida purpurea, Eragrostis palmeri, Setaria macrostachya, Pappophorum bicolor, Hilaria belangeri, Sorghum bicolor, Agave lecheguilla, Acacia schaffneri, Aristida adscensionis, Bouvardia ternifolia, Buddleja sessiliflora, Salvia polystachia, and Zinnia peruviana.*

- ***Agriculture***

In the SA there are significant areas devoted to rainfed agriculture where the main crops are grain corn and sorghum.

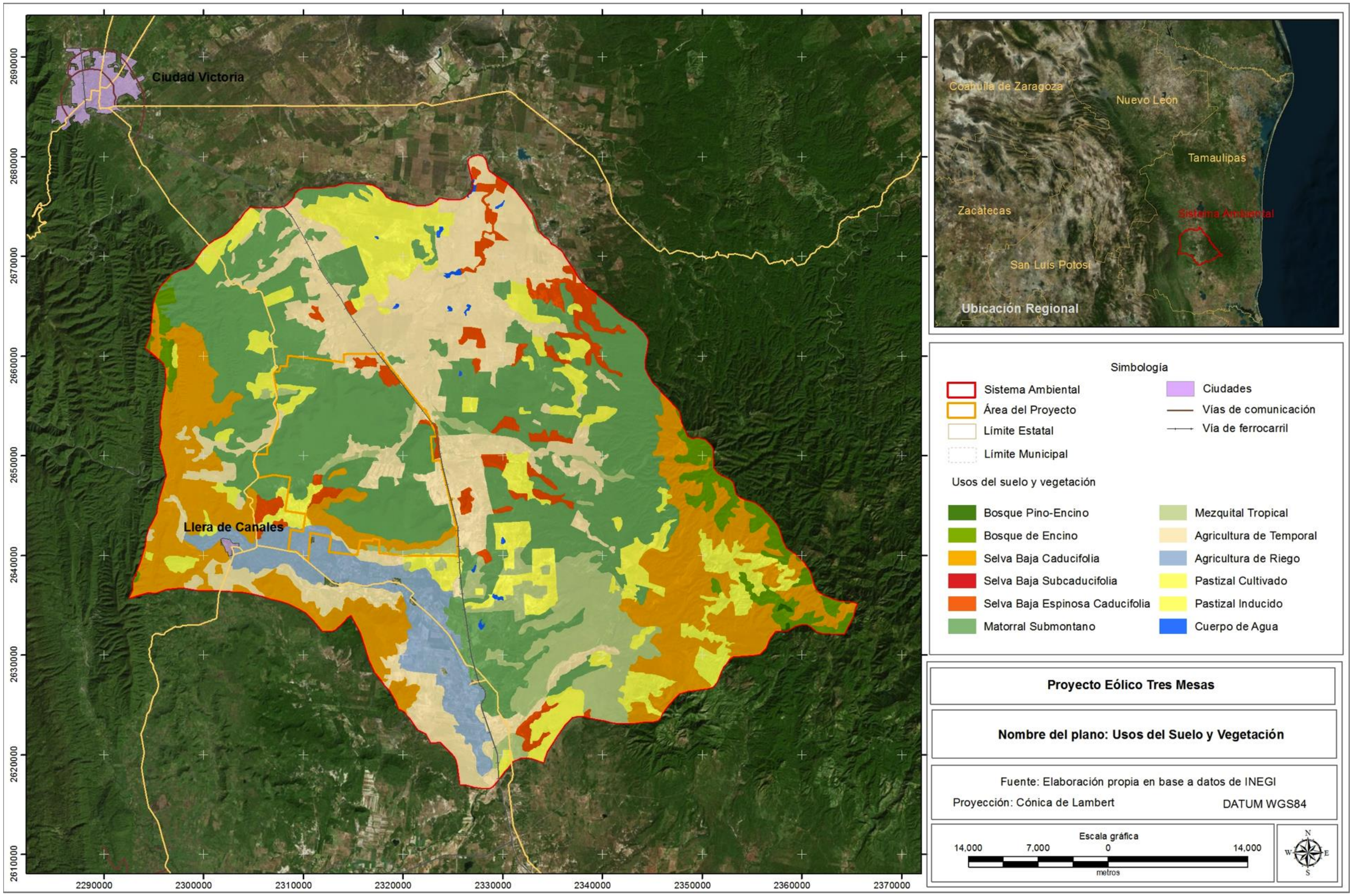


Figure IV.10 Land use and vegetation present in the Environmental System

IV.2.2.2. Vegetation sampling

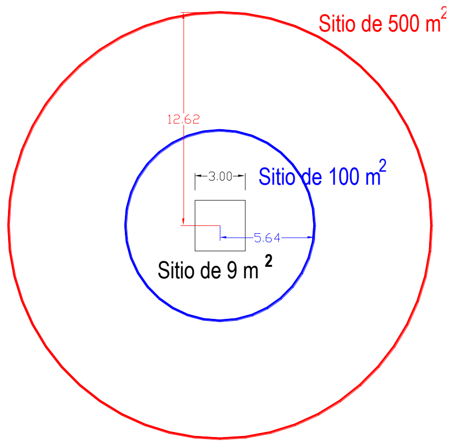
To determine the floristic composition, vegetation structure and diversity of the Project Area, a sampling campaign was conducted. A total of 50 sampling sites were taken which location coordinates are presented in the following table.

Table IV.13 Location coordinates of the samples taken to characterize vegetation in the Project Area

Site	Vegetation Type	UTM Coordinates		Site	Vegetation Type	UTM Coordinates	
		X	Y			X	Y
0-A	Submontane scrub	501000	2586500	3-7	Low thorny deciduous forest	505927	2583006
0-B		501500	2586500	3-8		506513	2583285
0-C		513601	2593027	3-9		506913	2583882
1-3		502940	2586912	3-10		507835	2583997
1-4		503354	2586946	3-11		508912	2584134
1-5		503745	2587350	3-12		509538	2584290
1-6		504488	2587358	3-13		510034	2584391
1-7		504651	2587856	3-14		511115	2583463
1-8	Submontane scrub	504803	2588261	4-1	Submontane scrub	517890	2582822
1-9		505831	2588699	4-2		517575	2581855
2-1		504757	2591787	4-3		517501	2581184
2-2		505088	2591829	4-4		517348	2580976
2-3		505399	2591681	4-5		517810	2580913
2-4		505663	2590942	4-6		518131	2579481
2-5		506025	2591027	4-8		518449	2578927
2-6		508872	2591059	4-9		518107	2578839
2-7		509225	2591129	4-10		517761	2578913
2-8		509556	2591039	4-11		516389	2578824
2-9		509811	2590774	4-12		516055	2578824
2-10		500175	2590677	4-13		515674	2578739
3-1	Deciduous lowland forest	506804	2580326	4-14		515363	2578749
3-2		506382	2580762	4-15		515094	2578970
3-3		506013	2581133	4-16		516439	2580312
3-4		505635	2581417				
3-5		505377	2581757	4-17		516758	2580453
3-6		505575	2582430				

Sampling points were circular with different diameters depending on the layer to be evaluated as shown in the following table.

Table IV.14 Type of sampling conducted to characterize vegetation in Project Area

Diagram of sampling types	Sampling Type
	For the evaluation of individuals with normal diameter, sites of 500 m^2 were used, with radius of 12.62 m.
	For the evaluation of individuals with normal diameter < 5 cm, sites of 100 m^2 were used; that is, evaluation of the tree stratus which radius is of 5.64 m.
	Finally for evaluating herbs and pasture grasses, sites of 9 m^2, which dimensions are 3x3 m were used.

The following figure shows the location of the sampling sites.

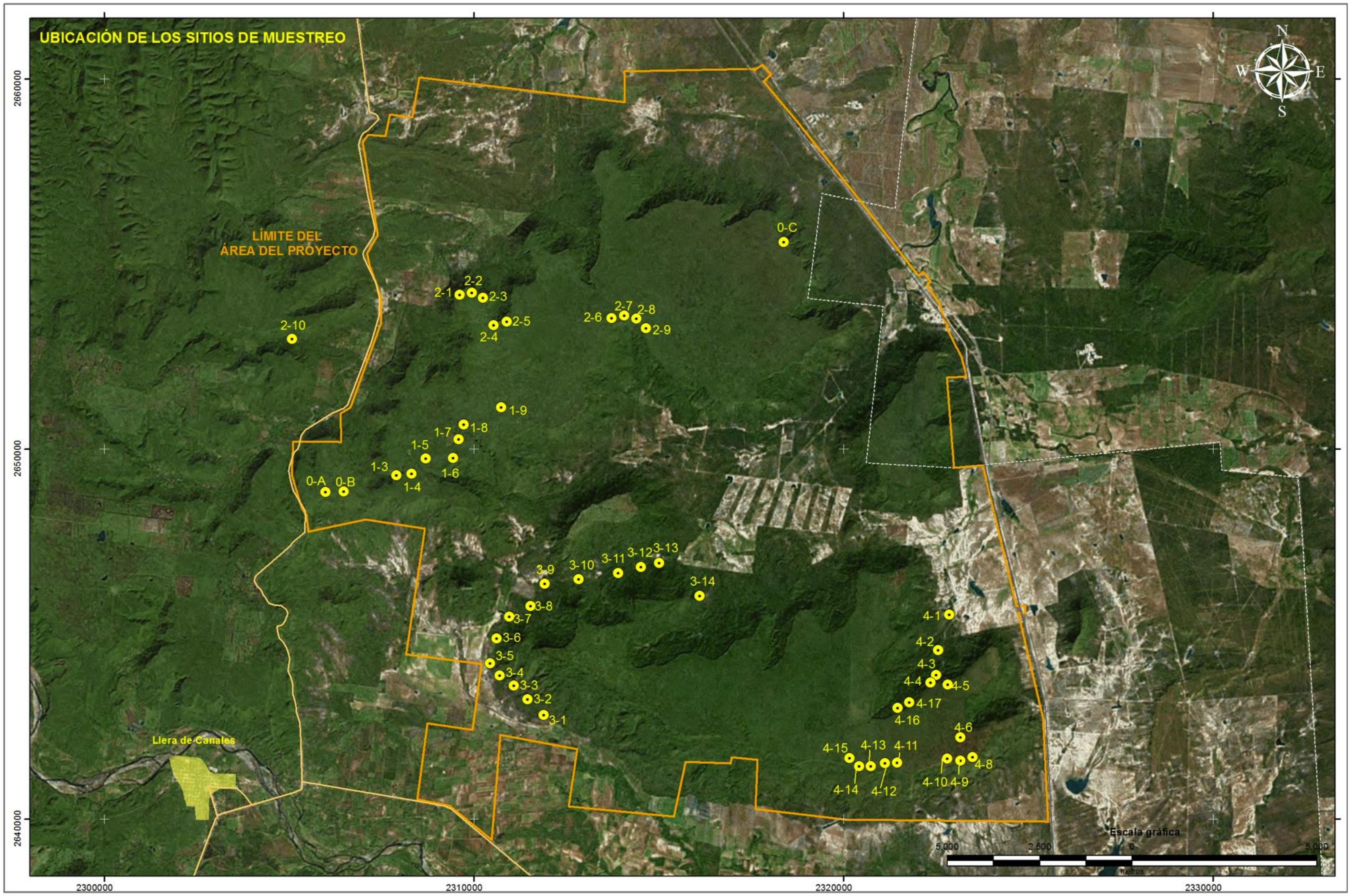


Figure IV.11 Vegetation sampling sites

- ***Sampling Results***

Specifically, the vegetation types within the polygon of the project are:

- Submontane scrub
- Low thorny deciduous forest
- Deciduous lowland forest

Appendix IV.1. presents the list of species registered at each sampling point.

IV.2.2.3. Vegetation structure

To identify species called dominant, the Relevance Value (IV) was used, which was obtained with the following:

VI = Relative density + Relative dominance + Relative frequency

The value of each of the characteristics (density, dominance and frequency) is a percentage ranging from 0 to 100, so the scale ranges from 0 to 300. Thus, if a species has a VI = 300, it means that only that species is found in the community and that it channels all available resources.

The species with the highest VI will be that with the highest combination of density, dominance and frequency, so they take advantage of most of the resources available and largely determine the functioning of the plant community.

- ***Submontane scrub***

In the Mesa La Sandía, a presence of 20 tree species (S = 20) for a total of 16 sites of 500 m^2 each were recorded. Records obtained defined as *Cordia boissieri* and *Phithecellobium flexicaule* have a similar IVI and higher than the other species, due to their Relative Frequency (RF) for the first and the Basal Area (ABR) for the second. This result confirms that *C. ut2 boissieri* is a conspicuous element in the community (Relative Abundance, AR = 23.82%) and P. *flexicaule* reaches much higher sized than the rest of the species. It is noteworthy that *Neopringlea integrifolia* also presented a high VI and, therefore, along with the other two species would receive most of the submontane scrub community resources in Mesa La Sandía.

Table IV.14 Relevance Value Index of tree species in Mesa La Sandía

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Acacia farnesiana	3.226	5.378	18.75	27.354
Acacia polyphylla	0.496	1.188	6.25	7.934
Acacia rigidula	5.211	2.940	18.75	26.901
Bursera simaruba	0.496	0.193	6.25	6.939
Celtis pallida	0.248	0.216	6.25	6.714
Cordia boissieri	23.821	15.745	62.5	102.07
Diospyros texana	2.233	1.558	6.25	10.041
Erythrina americana	0.248	0.054	6.25	6.552
Gutierrezia microcephala	2.730	3.425	12.5	18.654
Harpalyce robusta	1.489	0.495	12.5	14.484
Heilietta parvifolia	11.414	8.039	31.25	50.704
Karwinskia humboldtiana	0.248	0.054	6.25	6.552
Neopringlea integrifolia	13.896	6.107	43.75	63.753
Phithecellobium flexicaule	10.670	32.469	37.5	80.64
Pithecellobium pallens	4.467	3.663	12.5	20.629
Prosopis glandulosa	5.211	9.740	12.5	27.451
Randia laetevirens	6.203	2.966	18.75	27.920
Sargentia greggii	1.241	1.984	6.25	9.475
Yucca sp	1.241	1.848	6.25	9.338
Zanthoxilum fagana	5.211	1.938	12.5	19.649

Regarding the shrub layer of Mesa La Sandía, 16 samples of 100 m^2 were made in this plateau, where a total of 15 species of *Zanthoxilum fagara* presented the highest relevance value (132.48%) which is distinguished by its high Relative Basal Area (ABR), so much of the biomass in this layer is stored by this species. It was determined that the relevance values were similar for *Hapalyce robust, Neopringlea integrifolia and Randia laetevirens* which were defined by their high values of Relative Frequency (RF).

Table IV.16 Relevance Value Index of bushy species in Mesa La Sandía

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Acacia farnesiana	0.735	0.308	6.250	7.294
Celtis pallida	2.206	0.700	18.750	21.656
Cordia boissieri	2.696	0.477	12.500	15.673
Eysenharditia polystachya	4.167	0.685	18.750	23.602
Forestiera angustifolia	7.598	1.972	37.500	47.070
Harpalyce robusta	18.137	2.711	43.750	64.598
Heilietta parvifolia	8.578	1.450	31.250	41.279
Karwinskia humboldtiana	3.922	0.139	18.750	22.810
Leucophyllum frutescens	0.245	0.018	6.250	6.513
Lysoloma divaricata	1.225	0.208	6.250	7.683
Neopringlea integrifolia	10.784	1.196	50.000	61.981
Pithecellobium pallens	1.225	0.094	6.250	7.569
Randia aculeata	12.990	3.070	31.250	47.311
Randia laetevirens	13.971	3.513	43.750	61.233
Zanthoxilum fagara	11.520	83.459	37.500	132.48

Meanwhile, in the submontane scrub of plateau La Paz, a total of 39 species was recorded in 13 samples of 500 m^2. The results show that *Pithecellobium pallens* is the species with the highest IVI (91.89%). The Species *Diospyros texana* and *Esenbeckia berlandieri* presented similar IVI, resulting from their high values of FR. In general, the dominant species *P. pallens* represents an abundant and common element in submontane scrub of Mesa La Paz, and therefore, the dominant species within this plant community.

Table IV.17 Relevance Value Index of tree species in Mesa La Paz

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Acacia farnesiana	0.097	0.291	7.692	8.080
Acacia rigidula	1.435	1.747	15.385	18.566
Amyris madrensis	0.049	2.038	7.692	9.780
Bumelia celastrina	0.919	1.892	7.692	10.504
Caesaria nitida	0.099	0.146	7.692	7.937
Cordia boissieri	4.464	8.297	53.846	66.607
Cupania dentada	0.036	0.146	7.692	7.873
Diospyros sp	4.828	2.038	15.385	22.250
Diospyros texana	4.594	6.114	69.231	79.938
Drypetes lateriflora	0.063	0.146	7.692	7.901
Ehretia anacua	0.025	0.146	7.692	7.863
Esenbeckia berlandieri	17.119	11.354	46.154	74.627
Euphorbia antisyphilitica	4.888	1.601	7.692	14.181
Eysenharditia polystachya	0.099	0.146	7.692	7.937
Forestiera angustifolia	4.438	2.911	23.077	30.426
Fraxinus greggii	0.025	0.146	7.692	7.863
Guazuma ulmifolia	0.049	0.291	7.692	8.033
Haematoxylum brasiletto	0.063	0.146	7.692	7.901
Harpalyce robusta	0.626	2.329	23.077	26.032
Heilietta parvifolia	1.112	0.873	15.385	17.370
Heliocarpus donnell-smithii	0.396	0.146	7.692	8.234
Hippocratea celastroides	0.025	0.146	7.692	7.863
Karwinskia humboldtiana	2.308	3.493	23.077	28.879
Karwinskia mollis	0.127	0.291	7.692	8.110
Leucophyllum frutescens	0.233	1.456	7.692	9.380
Liquidambar macrophylla	0.080	0.146	7.692	7.918
Lysoloma divaricata	5.568	1.747	15.385	22.699
Neopringlea integrifolia	0.968	3.493	15.385	19.846
Ocotea tampicensis	0.048	0.146	7.692	7.886
Persea liebmannii	0.444	0.291	7.692	8.428
Phithecellobium brevifolium	1.452	0.728	15.385	17.564
Phithecellobium flexicaule	0.099	0.146	7.692	7.937
Pithecellobium pallens	22.905	15.138	53.846	91.889
Prosopis glandulosa	5.670	4.512	30.769	40.951
Randia aculeata	1.872	9.461	38.462	49.795
Randia laetevirens	11.325	11.790	38.462	61.577
Senna reticulata	0.025	0.146	7.692	7.863
Wimmeria concolor	0.396	0.146	7.692	8.234
Zanthoxilum fagana	1.032	3.785	15.385	20.201

The relevance value for the shrub layer in the Mesa La Paz, obtained for 15 sampling sites of 100 m^2 was characterized for showing for the 19 species recorded that Randia laetevirens, Forestiera angustifolia and Harpalyce robusta, are distinguished by their high values of Relative Frequency (RF) which is denoted for its highest IVI. As corroborated, what is observed in the field concerning species are common elements in the submontane scrub shrub layer of that plateau mentioned above.

Table IV.18 Relevance Value Index of bushy species in Mesa La Paz

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Acacia rigidula	0.976	0.543	6.667	8.186
Bursera sp	0.976	0.054	6.667	7.696
Celtis pallida	1.463	0.535	13.333	15.332
Cordia boissieri	2.439	1.049	20.000	23.488
Diospyros sp	0.244	0.270	6.667	7.180
Diospyros texana	3.659	6.742	6.667	17.067
Esenbeckia berlandieri	4.390	3.656	13.333	21.379
Eysenharditia polystachya	2.195	1.383	20.000	23.578
Forestiera angustifolia	11.951	18.270	46.667	76.888
Gutierrezia microcephala	1.707	1.066	13.333	16.107
Harpalyce robusta	15.366	9.776	46.667	71.809
Heilietta parvifolia	1.707	0.392	6.667	8.766
Heliocarpus donnell-smithii	0.244	0.037	6.667	6.948
Karwinskia humboldtiana	1.707	0.815	13.333	15.856
Neopringlea integrifolia	0.488	0.075	6.667	7.229
Pithecellobium pallens	9.268	12.339	13.333	34.940
Randia aculeata	14.146	13.501	20.000	47.648
Randia laetevirens	20.732	25.102	46.667	92.501
Zanthoxilum fagana	6.341	4.395	26.667	37.403

The herbaceous layer was characterized by a total of nine annual or ephemeral species that increase their densities in the rainy season, so as the season in which the samples were taken, it was found that the density of herbaceous is low in most sites, but there are species that maintain high coverage ratios (CBR) and are quite common at the study sites (FR). In the submontane shrub, the species that showed the highest relevance value indexes corresponded to *Lantana sp., Guterrezia microcephala and Gramma sp,* due to their high relative frequency, recorded in most of the samples taken in this vegetation type.

Table IV.19 Relevance Value Index of herbaceous species in submontane scrub

Species	Coverage	Relative Frequency (%)	Relevance Value Index (IVI)
Castella texana	0.34	4.76	5.1
Forestiera angustifolia	2.81	4.76	7.57
Gramma sp.	15.8	42.9	58.7
Gutierrezia microcephala	18.3	47.6	65.9
Harpalyce robusta	27	23.8	50.8
Lantana sp	22.2	57.1	79.4
Randia aculeata	8.99	4.76	13.8
Randia laetevirens	1.69	4.76	6.45
Zanthoxilum fagana	2.81	4.76	7.57
Castella texana	0.34	4.76	5.1

- ***Deciduous lowland forest***

A total of 10 species were recorded in the six samples of 500 m^2 made, from which *Neopringlea integrifolia* recorded the highest IVI, followed by *Phitecellobium flexicaule* and *Prosopis glandulosa*. Their IVI in the case of the first two species are determined by their Relative Frequencies and in the case of the third species its IVI is defined by its Relative Abundance.

Table IV.20 Relevance Value Index of tree species from the Deciduous lowland forest

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Acacia polyphylla	1.759	4.094	16.667	22.520
Bursera sp.	4.807	6.433	16.667	27.906
Cercidium floridum	0.149	0.585	16.667	17.401
Esenbeckia berlandieri	0.596	2.339	16.667	19.602
Forestiera angustifolia	6.107	7.018	33.333	46.458
Heilietta parvifolia	2.374	2.924	16.667	21.964
Neopringlea integrifolia	15.513	39.181	83.333	138.03
Phithecellobium flexicaule	23.952	21.637	66.667	112.26
Prosopis glandulosa	40.550	5.263	33.333	79.146
Randia laetevirens	4.193	10.526	33.333	48.052

For the shrub layer, the area sampled was 600 m^2 counting in a total of 61 individuals, from which 31% corresponded to *Forestiera angustifolia*. The shrub layer of deciduous lowland forest was represented by seven species of which the most abundant was *Randia laetevirens*, and the one presenting the highest relevance value was *Forestiera angustifolia*.

Table IV.21 Relevance Value Index of shrub species in the deciduous lowland forest

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Celtis pallida	8.197	6.278	16.667	31.141
Esenbeckia berlandieri	4.918	3.872	16.667	25.456
Forestiera angustifolia	31.148	33.379	33.333	97.860
Harpalyce robusta	14.754	23.175	16.667	54.596
Heilietta parvifolia	8.197	14.989	16.667	39.852
Neopringlea integrifolia	4.918	2.323	33.333	40.574
Randia laetevirens	27.869	15.985	33.333	77.187

The herbaceous layer is distinguished by the presence of *Harpalyce Robusta* and *Lantana sp*. The low number of species in this layer is explained by the season in which the samples were taken. Meanwhile, the Lantana is a common element in the dry tropical area in the northeast of the country.

Table IV.22 Relevance Value Index of herbaceous species in the Deciduous lowland forest

Species	Coverage	Relative Frequency (%)	Relevance Value Index (IVI)
Harpalyce robusta	33.3	50	83.3
Lantana sp	66.7	100	167

- ***Low thorny deciduous forest***

The total number of species recorded in the low thorny deciduous forest was 11 for eight samples of 500 m^2 distributed among 204 individuals. This vegetation type was characterized for presenting dominant species such as *Heilietta parvifolia, Phitecelllobium flexicuale, and Prosopis glandulosa*, which presented the highest values of Relative Frequency. The community of low thorny deciduous forest presents an average height of 4.23 m, with individuals of up to 12 m tall, belonging to *Heilietta parvifolia*.

Table IV.23 Relevance Value Index of tree species of Low thorny deciduous forest.

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Cercidium floridum	5.622	9.804	37.500	52.926
Bumelia celastrina	0.246	0.980	12.500	13.727
Cordia boissieri	8.318	4.412	25.000	37.729
Diospyros sp	1.016	2.451	12.500	15.967
Diospyros texana	6.922	3.922	12.500	23.344
Drypetes lateriflora	1.363	0.490	12.500	14.353
Heilietta parvifolia	20.934	29.902	62.500	113.34
Neopringlea integrifolia	3.550	6.373	12.500	22.423
Phithecellobium brevifolium	3.627	6.373	12.500	22.499
Phithecellobium flexicaule	18.537	16.176	50.000	84.714
Prosopis glandulosa	29.864	19.118	50.000	98.982

The shrub layer of low thorny deciduous forest presented a total of seven species in a sampled area of 800 m ^{2} from which *Randia aculeata* and *R. laetevirens* were the species with the highest IVI; the first had a high Relative Frequency and the second a larger Relative Basal Area. The sites show high heterogeneity. No extensions in which a single species dominated were found, as it occurs when *A. farnesiana* dominates almost the complete area, which forms monospecific thickets in certain regions, and correspond to a particular stage in the community succession.

Table IV.24 Relevance Value Index of shrub species of low thorny deciduous forest

Species	Relative Abundance (%)	Relative Basal Area (%)	Relative Frequency (%)	Relevance Value Index (IVI)
Acacia farnesiana	1.310	0.702	12.500	14.512
Arpalyce robusta	5.677	2.463	12.500	20.640
Castella texana	5.240	1.689	12.500	19.429
Euphorbia antisyphilitica	17.904	17.387	12.500	47.791
Forestiera angustifolia	2.620	2.074	12.500	17.194
Harpalyce robusta	13.537	1.692	25.000	40.229
Heilietta parvifolia	8.297	3.996	25.000	37.293
Karwinskia humboldtiana	0.437	0.156	12.500	13.093
Neopringlea integrifolia	10.917	2.540	37.500	50.957
Randia aculeata	18.341	6.904	62.500	87.745
Randia laetevirens	15.721	60.398	25.000	101.12

The herbaceous layer in low thorny deciduous forest community was characterized by the dominance of *Echinocereus pectinatus* and by the presence of species of *Lantara sp and Gramma sp*; this layer will be determined by the seasonality of the place, being in the rainy season when the maximum values of biomass are reached.

Table IV.25 Relevance Value Index of herbaceous species of low thorny deciduous forest

Species	Coverage	Relative Frequency (%)	Relevance Value Index (IVI)
Echinocereus pectinatus	66.1	100	166
Gramma sp.	24.8	100	125
Lantana sp	9.09	100	109

IV.2.2.4. Diversity

The description of the plant communities in terms of species composition and distribution of all plants of each species found, described in the preceding paragraphs allowed defining which community is more diverse, by using the following indexes:

Table IV.26 Indexes used to determine diversity

Index	Description	Formula
Specific richness (S)	It is the easiest way to measure biodiversity, since it is based solely on the number of species present, regardless of the relevance value of the same.	S= number of species
Shannon Index-(H´):	It expresses the uniformity of relevance values across all species in the sample. It measures the average degree of uncertainty in predicting to which species belongs an individual randomly chosen from a collection. It assumes that individuals are selected randomly and that all species are represented in the sample. It takes values between zero, when there is one single species and the logarithm of S, when all species are represented by the same number of individuals.	$H' = -\Sigma p_i \log_2 p_i$ pi = proportional abundance of species i, i.e. the number of individuals of species i divided by the total number of individuals in the sample.
Simpson Dominance Index λ	Low λ values indicate greater diversity, while high values (close to 1) represent low diversity.	$\lambda = \Sigma p_i^2$ λ = Simpson Dominance pi = proportional abundance of species i, i.e. the number of individuals of species i divided by the total number of individuals in the sample.
Shannon Equity Index	It measures the proportion of the diversity observed in relation to the expected maximum diversity. Its value ranges from 0 to 1, so that 1 corresponds to situations where all species are equally abundant so there not one species that dominates in the community.	$J' = \frac{H'}{H'_{max}}$ (J') = Shannon value of equity Where H'max is obtained as the log2(S).

The Shannon diversity index takes values between zero, when there is a single species and the logarithm of S, when all the species are represented by the same number of individuals. The maximum values of the index are reported close to six (the latter is extremely rare), therefore, the higher the index value, the greater the diversity of an area.

The Shannon index is independent of the sample size, this means that it works well with few count data. According to the Shannon index, all sites that presented high values are more balanced compared to the number of species and their abundance. While low dominance values (λ) indicate that the site has more diversity, ie, species have a similar frequency in the sample and have the same probability of being found in consecutive samples, however, at sites with high values (λ = 1) a low diversity is present, because only a portion of the species presents high frequencies.

The following table shows the diversity indexes per type of vegetation distributed in the Project Area.

Table IV.27 Diversity index for the tree layer and for each type of vegetation

Vegetation Type	S	λ	1-D	H'	H'max	J
Submontane scrub (Mesa La Sandía)	20	0.1173	0.8827	2.438	2.995	0.814
Submontane scrub (Mesa La Paz)	39	0.079	0.921	2.855	3.66	0.7794
Deciduous lowland forest	10	0.2264	0.7736	1.805	2.30	0.784
Low thorny deciduous forest	11	0.1741	0.8259	1.978	2.39	0.8247

Next, the rates recorded by vegetation type diversity are presented.

- ***Submontane scrub***

Diversity indexes indicate that the plateau La Paz and La Sandía have similar diversity according to Shannon and Simpson indexes. Equity (J) was greater in the scrub community of La Sandía, which shows us a greater uniformity between the relevance values of all species of the samples, which contrasts with the low dominance obtained (D = 0.1173).

The Simpson index indicates that the two plateaus are fairly homogeneous in terms of abundances of species, since the values obtained indicate different sites (1-D), for there is little species dominance (D), so the species distribution is equitable. Similarly, the above is confirmed by the values obtained from Shannon, which are close to the maximum diversity expected for each community.

- ***Deciduous lowland forest***

The indexes calculated indicate a moderate diversity (1-D = 0.7736 and H = 1.8) for a total of 171 individuals distributed across the 10 species. The equity obtained is also moderate (J = 0.784) showing the dominance of *N. integrifolia and of P. flexicaule*. The deciduous lowland forest presented an average height of 3.45 m, registering trees of up to 9 m tall. This plant community is preferably set on the slopes that are exposed to winds from the northeast, on stony soils and steep slope terrains.

- ***Low thorny deciduous forest***

Dominance calculated was low and consistent with the moderate diversity values of Simpson and Shannon. Overall, diversity calculated for the low thorny deciduous forest regarding submontane scrub and deciduous lowland forest was lower due to the high frequency and abundance of *H. glandulosa and P. parvifolia*.

IV.2.2.5. Species of terrestrial vegetation in conservation status

The sampling was done seeking of representativeness of the vegetation types disturbed by the project, emphasizing the submontane scrub for being the vegetation type with the highest concentration of infrastructures of the same. In the 50 sampling sites, no plant species were recorded in conservation status according to NOM-059-SEMARNAT-2010.

However, it is important to note that during the field visits, the presence of the species *Beucarnea recurvada* (Elephant' Foot) was detected, which is in the endangered category. This species was observed in the slopes of the plateaus in the deciduous lowland forest and low thorny deciduous forest mainly and very sparsely in the submontane scrub. Particularly, it was observed in the northeastern and southeastern parts of the polygon, so there is very low probability of finding it in the areas affected by the project. With no representation of this species in the sample taken, we proceeded to make a visual estimation of its frequency in areas where it was present, having as a result that it occupies between 7 and 10% of the total frequency of species in the environment. However, in the unlikely event of finding it within the project area, we will proceed to implement a rescue program as established in Chapter VI of this impact statement.

View of the species *Beucarnea recurvata* known as elephant's foot and under the threatened category

IV.2.3. Biotic Environment (Fauna)

To characterize the fauna and identify species with potential distribution in the SAR distribution, collecting records were requested from national and international zoological collections (CONABIO, GBIF) for the state of Tamaulipas. Subsequently, these records were geo-referenced and grouped in a database with the following taxonomic fields: class, order, family and species, these fields were validated according to current literature.

Establishing the type of habitat was solved by placing the geographic references of records obtained in a free use GIS which was added vectorial data on types of vegetation available online by INEGI (1:1,000,000 vector arrays). Subsequently, verification and Sherman trap placement tours were carried out for amphibians, reptiles and terrestrial mammals in the Project Area.

For the specific case of birds and bats, a sampling campaign that lasted approximately three week was carried out in the Project Area. The monitoring of these group continues given the potential importance of the impact of the project during the operation stage.

As a result of the field work, collections and literature reviews, a potential list of 565 species was obtained, the greatest richness presents is presented by the bird group including 62% of the species followed by terrestrial mammals with more than 13%.

Table IV.28 Number of fauna species with potential distribution in the SAR

Vertebrate Group	Species with potential distribution in the SAR	
	Number	(%)
Amphibians	28	4.96
Reptiles	65	11.52
Birds	350	62.06
Terrestrial mammals	76	13.48
Chiroptera	45	7.98

Appendix IV.2 presents complete lists of species with potential distribution in the SAR

IV.2.3.1. Amphibians

Records of amphibians and reptiles of the collections obtained were validated according to current literature (amphibian Frost, 2012; reptiles Flores-Villela y Canseco-Márquez, 2005; Liner y Casas-Andreu, 2008).

In all, a total of 1,113 records with richness (S) of 28 species of amphibians were obtained, representing 50% of the total known for the state of Tamaulipas. The families of amphibians better represented, in terms of species richness are Plethodontidae (S = 5) and Leptodactylidae (S = 6).

The following table presents the amphibian species with records within the Project Area.

Table IV.29 Amphibian species with records in the Project Area

Family	Species	Common Name	Records	Relative Abundance*
Bufonidae	*Rhinella marina*	cane toad	3	M
Hylidae	*Smilisca baudini*	common Mexican tree frog	3	M
Leptodactylidae	*Eleutherodactylus cystignathoides*	Frog	1	R
Pelobatidae	*Scaphiopus couchii*	couch's spadefoot toad	4	M
Bufonidae	*Incilius sp.*	toad	10	A
Ranidae	*Lithobates berlandieri*	Rio Grande leopard frog	10	A
	Lithobates sp	frog	2	R

*Note: A: abundant, M medium, R: rare

IV.2.3.2. Reptiles

From research made of collections, 1,924 records were obtained, distributed in 65 species corresponding to a 44.52% of species richness for the state of Tamaulipas. Families that have the largest number of species are Colubridae (S = 31) and Phrynosomatidae (S = 10). From most species, 71% were found to be nearctic and trophic guilds, carnivores were the best represented with 56% and insectivores with approximately 32%.

There are records for ten species in the Project Area, the most abundant group is the group of lizards.

Table IV.30 Reptile species with records in the Project Area

Family	Species	Common Name	Records	Relative Abundance#
Testudinidae	*Gopherus berlandieri*	Texas tortoise	1	R
Iguanidae	*Ctenosaura acanthura*	spinytail iguana	1	R
Phrynosomatidae	*Sceloporus variabilis*	rosebelly lizard	3	M
Teiidae	*Ameiva undulata*	rainbow lizard	4	M
	Aspidocelis gularis	lizard	7	A
Colubridae	*Thamnophis marcianus*	checkered garter snake	1	R
	Senticolis triaspis	green rat snake	2	R
	Lampropeltis triangulum	milksnake	1	R
	Nerodia rhombifer	diamondback water snake	1	R
	Gyalopion canum	snake	1	R

*Note: A: abundant, M medium, R: rare

Verification visits were made to the Project Area and as a result the records of six species of reptiles were obtained. It is worth mentioning that for two species there were no records in the databases of collections consulted collections: *Terrapene carolina* (common box turtle) and *Drymarchon corais* (indigo snake).

Table IV.31 Reptile species recorded during field trips

Order	Family	Species	Common Name	Coordinates X	Coordinates Y	Altitude (m ASL)
Testudines	Emydidae	*Terrapene carolina*	common box turtle	510771	2592309	438
	Testudinidae	*Gopherus berlandieri*	Texas tortoise	509457	2591632	459
				508386	2591803	451
				508386	2591803	451
				509537	2591641	462
Squamata	Colubridae	*Drymarchon corais*	indigo snake	506081	2593772	268
		Coluber constrictor	southern black racer	509185	2591597	458
	Phrynosomatidae	*Sceloporus variabilis*	rosebelly lizard	506758	2593998	209
	Teiidae	*Aspidocelis gularis*	Huico	506366	2593998	256
				506366	2593998	256
				506366	2593998	256
				506366	2593998	256
				506366	2593998	256
				506366	2593998	256
				518209	2579286	404
				518268	2579118	398
				518268	2579118	398
				518268	2579118	398

Drymarchon corais **(indigo snake)**
X: 506081 Y: 2593772; 268 m asl

Coluber constrictor **(constrictor runner snake)**
X: 509185 Y: 2591597; 458 m asl

Sceloporus sp **(lizard)**
X:506758 Y: 2593998; 209 m asl

Aspidocelis gularis **(huico)**
X: 0506366 Y: 2593998; 256 m asl

Terrapene carolina **(common box turtle)**
X: 0510771 Y: 2592309; 438 m asl

Gopherus berlandieri **(Texas tortoise)**
X: 0509457 Y: 2591632; 459 m asl

IV.2.3.3. Birds

The high richness of bird species in Tamaulipas due to its location in a transition zone between temperate and tropical climate regions containing both species (Brush 2009) has been recognized and 615 species have been recorded for the state. The vegetation of the Tres Mesas area consists of submontane scrub, second largest habitat in the state for the maintenance of migratory birds. Short-term studies have reported about 170 species of birds (Wauer 1998 and Ramirez-Albores et al. 2007, respectively) in this habitat, but the potential list generated for this report registers 350 species.

Rutas Central and Rutas del Mississippi exceed the territory consisting of the state of Tamaulipas and some important migratory species as the Golden Eagle (Aquila chrysaetos) (Garza-Torres et al. 2003), Canadian Grulla (Grus cadensis - Roderick et al. 1996) and Pilgrim hawk (Falco peregrinus, McGrady et al. 2002, Garza 2001) have been reported in some of the studies carried out in the state.

It has been reported that spring migration in Texas, USA, can start mid-March and continue until mid-May (Gauthreaux and Belser 1999, Shackelford et al. 2005), so it is possible that migration occurs in Tamaulipas on similar dates. Considering that the implementation of wind farms has been recognized as high risk for some migratory species (Ledec et al. 2011) and the impact of the transformation of habitats around the migratory routes and flight on these groups; it is necessary to describe the migration behavior for the spring season at Tres Mesas, Tamaulipas, where the Tres Mesas wind project is intended to be built.

In order to generate more information about the birds distributed in the Project Area, the services of Instituto de Ecología A.C. leaded by Dr. Rafael Vollegas Patrarca, Unit Coordinator of Highly Specialized Professional Services were hired. The full report is presented in Appendix IV.3., however, the most relevant information is presented below. It is noteworthy that the results correspond to the monitoring conducted in the spring season during the months of March and April. With the information that was generated, it was possible to determine the richness, abundance and behavior of resident and migratory birds in the SA and the Project Area.

For the spring monitoring during the pre-construction stage, the following methods were applied in field: point count, monitoring station, use of ornithological radar plus the review of literature used to develop the list of potential species.

- ***List of potential species***

The list of potential bird species was prepared according to the distribution and seasonality suggested by Howell and Webb, 1995 and Birdlife International. Four categories in relation to seasonality of species were distinguished: resident, summer resident, wintering, transitional, and with breeding colonies.

- ***Point count***

Four point counts, six tours were carried out in total, three for each mesa, an tour for the month of March and two for April. Point counts constitute the main method for monitoring land birds in many countries due to its effectiveness in all types of land, habitats and mainly the utility of data from which to analyze changes over time. This method involves monitoring at fixed points for a certain period when the observer remains at the point and takes note of all the birds seen and heard in an area and a defined time period (Ralph et al., 1996).

This method allows the study of annual changes in populations, diversity of compositions according to the type of habitat and abundance patterns of each species. The radius of observation for points was 25 meters. The observers who conducted point counts, have the skills and training necessary for visual and acoustic identification of bird species.

For each mesa, the exact location of each point was performed with a GPS; said location was maintained and kept constant for all samples. In order to have independence between each point; the distance considered for location was 150 meters. For mesa la Sandía, 12 points were located with their corresponding replicates (24 in total), along a pre-existing path. For mesa La Paz, we have the support of the ejidatarios from the ejido Las Compuertas to clean a previously existing road and be able to make the journey. In this case, 12 points were located also with corresponding replicates (24 in total).

The duration of the census at each point was five minutes and from these data, a record of the individuals identified in and out of fixed radius, ie, more or less than 25 m was developed. The birds that flew in and out of the area were also considered. With the data obtained, seasonality and habits were defined.

Over a period of five minutes, all birds identified both visually and hearing in an area of 50 m in overall diameter are recorded.

- ***Monitoring Station***

A monitoring station for the area of the mesas was operated and located outside the wind farm polygon in the Ejido La Angostura, because the site provided a view of the two mesas.

The counting method is useful to monitor predatory birds and waterfowl during migration periods; this method consists of direct observations to the areas where the turbines will be installed. The birds detected flying above the areas of the mesas were observed with the aid of Vortex binoculars and telescope. The identification was made with the help of a guide to bird identification. For the spring season, the monitoring station served daily from 8.30 am to 4 pm, for a period of two weeks.

Observation, identification and counting of species flying over the study area. As well as a description of their migration routes and flight heights

- ***Ornithological radar***

A marine X-band radar (model FR-1525 Mark 3 Furuno, Nishinomiya, Japan) mounted on a truck adapted as a mobile unit was used, which was transferred daily to the monitoring station, for the description of similar equipment, consult Cooper (1991) and Harmata et al. (1999). The radar transmitted with a frequency of 9410Mhz + / - 30Mhz through a two meter-long antenna with a maximum power output of 25kW and was operated with a pulse length of 0.07µs time (microseconds). The monitor screen has resolution of 35 meters, and the antenna emits a beam with a width of 1.23 ° (horizontal) x 20 ° (vertical) with lateral lobes ± 10 ° (Furuno 2002). The unit was powered by a low-noise electric generator.

The mobile radar unit was moved daily to the observation site, about 500 meters inside Mesa La Sandía entering the access located on Federal Highway 85. The monitoring station was established on the same service road, in an area where the surrounding vegetation was high enough to block the radar signal that would be reflected in the soil (4-5 m), thus avoiding contamination due to ground clutter and allowing good visibility of the surrounding airspace. We used the horizontal and vertical operation mode of the radar for seven days between March 29 and April 7, 2013, coinciding with the period of early spring migration on the region (Gauthreaux and Belser 1999, Shackelford et al. 2005).

The use of ornithological radar allowed monitoring diurnal migration of predatory and large soaring birds.

In horizontal mode, a radius of 3 kilometers detection was used because it is suitable for the detection of predatory birds (Cooper et al, 1991), main group of visitors near Ciudad Victoria (Gehlbach 1976); following Mabee et al. (2006) a 1.5-kilometer radio was used for vertical mode. Due to the study design, the dates and times of the observations, as well as the implemented method, we assume that the vast majority of targets detected were birds.

The observations were made during six sessions of one hour each, from 8:15 until 14:15, although some days it was delayed due to weather conditions which did not allow the use of the radar. Each one-hour session was subdivided into:

- a period of 10 minutes to set the antenna for horizontal mode,
- a period of 20 minutes in horizontal mode to measure flight directions and record polar coordinates of the trajectories of detected targets,
- a period of 10 minutes to change the antenna to vertical mode, and
- a period of 20 minutes in vertical mode to measure the heights of flight of the detected targets; for the case of groups, the maximum, minimum and average heights were recorded.

Before starting the horizontal mode operation, the orientation of the radar to the north was adjusted to allow precise direction of flight collection, which were measured using a card and an integrated radar screen compass. Polar coordinates represent three points along the trajectories of the targets: the starting point, a middle point and the end point. All data were captured on a laptop manually.

- ***<u>Results</u>***

A total of 803 individuals of 70 different species, the ten most abundant species were *Vireo griseus* with 11.71%, Asian Zenaida with 11.71%, *Cathartes aura* with a 9.34% Polioptila caerulea with 7.10%, *Buteo swansoni* with 5.98%, *Toxostoma longirostre and Arremonops rufivirgatus* both with 3.36%, *Baelophus atricristatus* with 3.24%, and finally, *Coragyps astratus* with 2.74%.

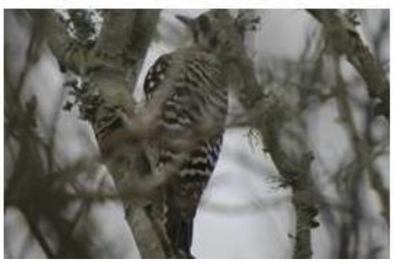
In relation to the habits of the species recorded, 80.0% (56 species) correspond to species with terrestrial habits, 18.57% (13 species) to predatory birds and finally 1.43% (one species) to waterfowl.

On the other hand, the highest percentage of species corresponded to resident species with 71.43% (50 species), followed by wintering with 21.43% (15 species) and transient with 10.0% (seven species).

Ortalis vetula

Archilochus colubris

Cynanthus latirostris



Picoides scalaris

Camptostoma imberbe

Tyrannus melancholicus

Vireo griseus

Psilorhinus morio

Baeolophus atricristatus

Polioptila caerulea

Regulus calendula

Toxostoma longirostre

Mniotilta varia

Setophaga coronata

Arremonops rufivirgatus

Aimophila ruficeps

Spizella passerina

Chondestes grammacus

Piranga rubra

Piranga bidentata

Cardinalis cardinalis

Icterus gularis

Euphonia affinis

Spinus psaltria

- ***Point counts***

The richness and abundance of species registered at point counts were higher for resident birds of terrestrial habits, finding low percentages of birds that fly above the canopy and also being mostly resident species. On the other hand, richness, abundance, and densities of birds recorded at point counts varied among the mesas. Although the vegetation in las mesas is similar and is considered submontane scrub, it was found that species richness and abundance is higher for mesa La Paz than mesa La Sandía.

- ***Monitoring Station***

The data collected from the monitoring station are used to determine migration patterns and predict the risk of collision of migratory and resident species that fly over the mesas during migration times, in this case spring. For this case, the highest proportion of individuals was found flying outside the Mesas areas. For the analysis, the species considered with the highest risk of collision include two migratory species, one is Swainson's hawk (*Buteo swainsoni*), the only considered protected by NOM-059-SEMARNAT-2010 species.

The abundance of birds recorded for the monitoring station during the sampling period is low compared to the abundance recorded for this season in other parts of the country such as the Isthmus of Tehuantepec in Oaxaca where species can be counted daily for up to thousands of migratory birds. However, it is important to note that the main limitations of visual monitoring is its inefficiency under conditions of fog and low visibility as registered on the site over the monitoring period, and the inability to register individuals flying at high altitudes. Next, the results obtained using this technique are described.

Table IV.32 Results obtained in the Monitoring Station

Concept	Results
Birds abundance	At the monitoring station, a total of 252 individuals, corresponding to 40 species, was recorded. 56.57% of individuals: 142, were seen flying in the area of the polygon corresponding to the Mesas and 43.42% (109) were found outside the Project Area. The aura vulture, Cathartes aura, was the most abundant with 26.69% (67 individuals) of the total registered, followed by Swainson's haws (Buteo swainsoni) with 19.12% (48 individuals) flying inside the park, the common buzzard (coragyps atratus) corresponded to 6.37% (16 individuals) and finally, the Psilorhinus morio and Euphonia affinis species with 4.87% (12 individuals) and 2.79% (seven individuals) registered. Of the species recorded flying within the Project Area, the five most abundant species were: Swainson's hawk (Buteo swainsoni) with 44.04% (48 individuals), the aura vulture (Cathartes aura), with 28.44% (31 individuals),Coragyps atratus with 10.09% (11 individuals), and finally the Buteo brachyurus with 3.67% (four individuals).
Collision risk	Collision risk was calculated for species flying within the polygon of the Mesas, to the above, data from individuals that flew between 26 and 75 meters high were considered. Individuals with high collision risk were those with p> 0.5. The species with the highest probability of collision include the Common Buzzard (*Cathartes aura*) with a probability of 0.64, Swainson's hawk (*Buteo, swainsoni*) with a

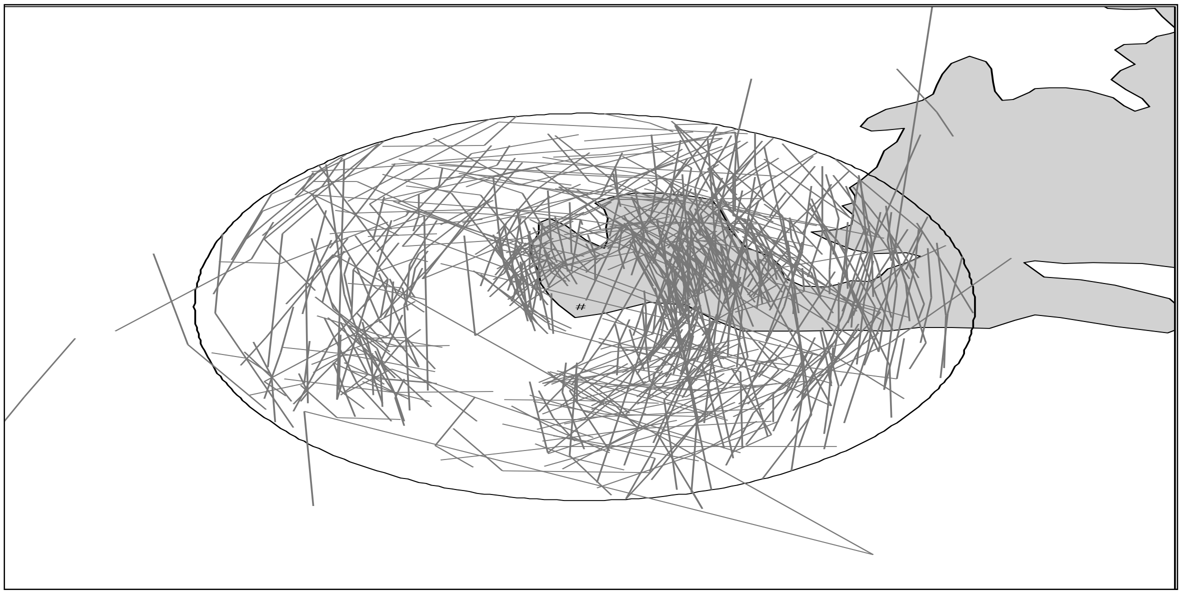
Concept	Results
	probability of 0.58, and short-tailed hawk (*Buteo brachyurus*) with probability of 0.5. The first two also correspond to the most abundant species.
Seasonality	Sixty-five percent of the species registered at the monitoring station corresponded to resident species, and the remaining 35% are species considered migratory species: wintering species 25% and transient species 10%. Finally, from the 40 species registered at the monitoring station, 65% (26 species) corresponded to terrestrial birds, 32.5% (13 species) to predatory birds and 2.5% (one species) to waterfowl.

- ***Radar***

By the method of radar, information about flight trajectories of the targets recorded in mesa La Sandía was obtained. As a result, we found that 4.5% of the 493 registered targets flew at altitudes from 0 to 100 m; there were higher records of targets flying at heights of over 125 meters. Furthermore, from the 493 targets, 30 were small groups, four big groups and two vortex, the remainder (n = 457) were individuals.

The following figure shows the trajectories of all targets within the detection radius of 3 km from the monitoring with radar, located to the extreme west of Mesa La Sandía. The gray polygon is representing the two Mesas and each line represents the trajectory of an individual.

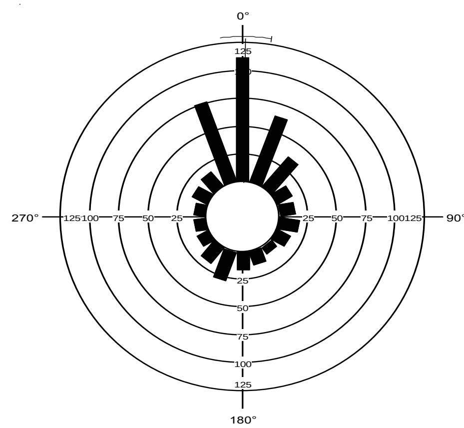
Figure IV.12 Flight paths within the detection radius of 3 kilometers detected by the monitoring station with radar,



- ***Flight directions***

The vortex are groups of birds (in this case with an unspecified number of members) flying in circles drawing hot air updrafts, so they do not show a particular direction of flight. However, the rest of the detected targets showed an average flight direction according to expected with the spring season, when Nearctic - Neotropical migratory birds return to their breeding grounds in North America (μ = 0.8 °, r = 0.4, n = 491.

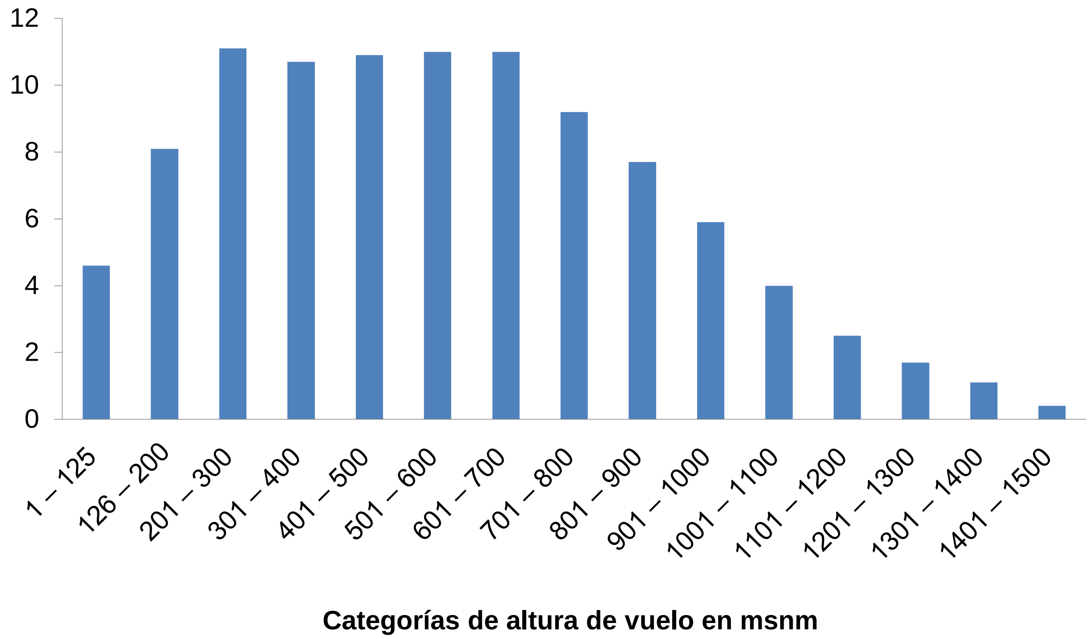
Figure IV.13 Average direction of all targets detected in mesa La Sandía, municipality of Llera, Tamaulipas during monitoring with marine radar. Spring 2013.



- ***Flight Heights***

During the seven days of monitoring, the flight height was recorded at 2,530 individuals and 34 small groups, perhaps less than ten individuals. From the individuals identified, 4.6% flew at risky altitudes (<100 meters above ground level), while more than ~ 55% did so between 200 and 700 m agl.

Figure IV.14 Chart of flight height in categories of 100 meters above ground level (mAGL)



The diversity and most abundant species include residents and terrestrial species not flying above the canopy and migratory species that flew off the mesas or at heights higher than 125 meters.

Table IV.33 Flight height in categories of 100 m ALG of targets detected during monitoring with marine radar in mesa La Sandía, Spring 2013

Height Category (m AGL)	Number of targets by category	Percentage of targets by category
1 – 100	116	4.6
101 – 200	206	8.1
201 – 300	282	11.1
301 – 400	271	10.7
401 – 500	275	10.9
501 – 600	278	11.0
601 – 700	278	11.0
701 – 800	234	9.2
801 – 900	196	7.7
901 – 1000	150	5.9
1001 – 1100	101	4.0
1101 – 1200	62	2.5

Height Category (m AGL)	Number of targets by category	Percentage of targets by category
1201 – 1300	44	1.7
1301 – 1400	28	1.1
1401 – 1500	9	0.4

The full report of bird monitoring including results is presented in Appendix IV.3. It is possible that the effect of the wind farm on the resident birds is probably related to habitat fragmentation related to the opening of roads.

IV.2.3.4. Mammals

Tamaulipas is Mexico's northern state with the highest diversity of mammals and third nationally, housing 148 species of the 525 reported in the country (Ceballos and Oliva, 2005). Since it is located in a transition zone between the Nearctic and Neotropical regions, in the state about 32 tropical species reach their northern limit, while six boreal species reach their southern limit. (Moreno-Valdez and Vásquez-Farías, 2005).

From a review of the collections a total of 1,116 records in 77 species was obtained, distributed in the following orders: Didelphimorphia (S=4), Xenarthra (S=1), Insectivora (S=6), Carnivora (S=20), Artiodactyla (S=5), Rodentia (S=38), and Lagomorpha (S=4). The 77 species registered represent 48.73% of total richness reported for the state of Tamaulipas. The families best represented in terms of species richness were: Muridae (S=9), Felidae (S=7), Leporidae and Mephitidae (both with S=4).

On the other side, there are five endemic species to Mexico (*Cryptotis obscura* (yellow earlobes shrew), *Notiosorex villai* (shrew) *Geomys tropicalis* (gopher), *Neotoma angustapalata* (white-throat rat), *Peromyscus levipes* (mouse).

Regarding zoogeography distribution, the species that are both neartic and neotropic resulted dominant with 68.83% (S = 53), followed by neartic with 20.77% (S = 16), and finally neotropical with 2.59% (S = 2).

Four trophic guilds for total of mammal species (S = 77) were recorded in the collections consulted; herbivores are the most representative with 58.44% (S = 45), followed by omnivores (14.28% S = 11), carnivores (18.18%, S = 15) and insectivores (9.09%, S = 7).

For the Project Area in the collections consulted, eight records of seven species which are listed in the following table were obtained.

Table IV.34 Mammal species with potential distribution in the Project Area

Family	Species	Common Name	Records	Relative Abundance*
Soricidae	*Cryptotis parva*	least shrew	1	R
Canidae	*Urocyon cinereoargenteus*	gray fox	1	R
Sciuridae	*Sciurus aureogaster*	Mexican gray squirrel	1	R
Sciuridae	*Sciurus deppei*	Deppe's squirrel	1	R
Heteromyidae	*Liomys irroratus*	Mexican spiny pocket mouse	2	R
Leporidae	*Sylvilagus floridanus*	Eastern cottontail	1	R
Soricidae	*Cryptotis parva*	least shrew	1	R

*Note: A: abundant, M medium, R: rare

A field check for verification of small mammal species was performed in the Project Area for which two transects were made, each with twenty Sherman traps, placed every twenty feet; the location is presented in the following table.

Table IV.35 Location coordinates of Sherman traps

Transect	Initial coordinates of transects		Altitude (m ASL)
	X	Y	
1	508808	2591571	463
2	510771	2592263	462

View of the location of Sherman traps and captured body

Traps remained for two nights and as a result of this effort two organisms of the same species were captured; a juvenile and an adult in two different days but in the same trap.

Sigmodon hyspidus **juvenile (pygmy mouse)**
X:510771 Y:2592257; 462 m asl

Sigmodon hyspidus **juvenile (pygmy mouse)**
X:510771 Y:2592257; 462 m asl

Additionally, tours were made in the Project Area in which organisms, trails and tracks of mammals were recorded.

Table IV.36 Mammal species recorded during field trips

Species	Common Name	Coordinates		Record type
		X	Y	
Sigmodon hyspidus	hispic cotton rat	510771	2592257	Trap
Sylvilagus sp	Rabbit	506535	2591640	sighting
Sylvilagus floridianus	Rabbit	509537	2591641	Skull
Odocoileus virginianus	*White-tail Deer*	509185:	*2591597*	*Pelvic girdle*
		506082	2599032	*Footprint*
Pecari tajacu	Collared peccary	506329	2594006	Skull
Coloured Puma	Puma	509185	2591597	Skull
		509185	2591597	Waist
		509190	259362	Excretas
Leopardus pardalis	*Oncilla*	507347:	2593881	Oncilla
Lynx rufus	*Stump-tailed cat*	509190	2593625	Stump-tailed cat

***Sylvilagus floridianus* (rabbit)**

Sylvilagus sp
X: 506535 Y: 2591640; Altitude 450 m asl

Footprints of *coloured puma* X: 506082 Y: 2599032 Altitude 268 m asl

Skull and pelvic waist of *Coloured Puma*
X: 509185 Y: 2591597 Altitude: 439 m asl

Skull of *Pecari tajacu* (collared peccary) X: 506329 Y: 2594006; Altitude: 252 m asl

***Odocoileus virginianus* (White-tail deer)**
Pelvic waist X: 0509185 Y:2591597

Footprint of*Odocoileus virginianus* (white-tail deer) X:506082, Y: 2599032

***Leopardus pardalis (*Oncilla)**
X: 0507347, Y:2593881

During the tours excreta which were identified were also recorded and are presented below

Lynx rufus **(bobcat)**
X: 509190 Y: 2593625

Coloured Puma **(puma)**
X: 509190 Y: 2593625

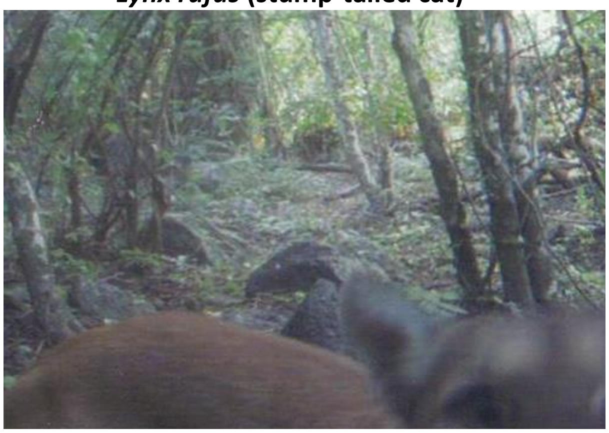
In addition to placing Sherman traps and tours, interviews about fauna with local people from the area were made. Based on this and the images taken through phototraps at the SA near or at the Project Area, the verification of some species registered in the collections was concluded. Next, the images provided by local people are presented.

Panthera onca **(Jaguar)**

Herpailurus yaguarondi **(snow leopard or lion)**

***Lynx rufus* (stump-tailed cat)**

***Leopardus pardalis* (Ocelot)**



***Coloured Puma* (Puma)**

***Urocyon cinereoargenteus* (Fox)**

***Taxidea taxus* (Tlalcoyote)**

***Didelphis virginiana* (Tlacuache)**

Bassariscus astutus **(Cacomixtle)**

Tayassu tajacu **(Collared peccary)**

Sylvilagus sp **(Rabbit)**

Odocoileus virginianus **(white-tail deer)**

IV.2.3.5. Bats

As for bats, the services of the Instituto de Ecología A.C. leaded by Dr. Rafael Vollegas Patrarca, Unit Coordinator of Highly Specialized Professional Services were hired. The full report is presented in Appendix IV.3., but the most relevant information is presented below.

To describe the community of bats, a research of information was made in the literature about the species with potential distribution in the premises of PE Tres Mesas, Tamaulipas. The list of bat species was obtained from Villa (1966), Hall (1981), Medellín et al. (1997), and Ceballos y Oliva (2005). The nomenclature used was the Simmons (2005). The conservation state of the species was obtained from the Official Mexican Standard NOM-059-SEMARNAT-2010 (SEMARNAT, 2010), CITES (2011) and IUCN (2012). Additionally, information on the natural history of the species collected. Such information includes food guild, reproductive patterns, population sizes, colony formation, habitats in which there is greater chance of finding them and flight heights.

Due to the complex situation of insecurity in the region and secondly, to the fact that monitor activities for bats take place mostly at night, for this particular case it was decided to use only the sampling method by detecting ultrasound (Griffin, 1958; Fenton, 1995). The ultrasonic detection method is mainly used to detect species of insectivorous bats, which vocalizations occur in high frequency (well above the audible range for humans> 20 kHz). Bats-caller detectors have been effective to describe the species of bats flying above the canopy at heights of over 3 m and therefore do not usually fall in mist nets.

The recordings are being carried out by the systems of ultrasonic detection of time expansion, which allows the accurate sampling of short sequences by a high-speed digital / analog converter (Fenton et al., 2001). Although this system does not allow continuous real-time recording, it does allow recording the original signal more accurately, providing higher level of resolution in the subsequent analysis (Parsons et al., 2000).

For recording of ultrasound, SM2BAT (Wildlife Acoustics) detectors are used, equipped with an SMX-US broadband ultrasonic microphone. With a card with sampling rate of 384,000 it records the recording in digital format on SD cards.

Recordings of the so called echolocation of bats were obtained passively, ie two SM2BAT detectors were installed at two different heights (40 and 80 m) on a meteorological tower inside the premises, in the Mesa La Sandia. The monitoring was performed continuously from sunset. The main purpose of the passive method is to monitor bat activity in the two height categories.

The recordings obtained will be analyzed with BatSound Pro v.3.3 (Pettersson Elektronik AB) program to identify the signals in terms of species using determination criteria existing in books.

With the recordings obtained, the way bats use the airspace of the Project Area could be estimated, as well as the foraging activity of each species. For this, each pulse detected is classified into two forms: search and capture. The proportion of capture sequences regarding the total number of recorded sequences give an estimate of how often the species are using the premises as a foraging area.

Currently, there is only information obtained through review of literature. The results of the analysis of the calls of bats will be included later.

Based on the work of Villa (1966), Hall (1981), Medellín et al. (1997) and Ceballos y Oliva (2005), a list of 45 species of bats with potential distribution within the property was obtained. The 45 species represent 32.85% of the total species recorded for Mexico (Medellín et al, 1997;. Ramírez-Pulido et al, 2005;. Ceballos y Oliva, 2005). The species belong to five families and 33 genera. The family with the largest number of species is the Vespertilionidae (17 species), followed by Phyllostomidae with only one species less (16 species).

The majority of species (29) belong to the for guild of insectivorous. This clearly shows that the bat community is dominated by members of this food guild.

Table IV.37. Chiroptera species with potential distribution in the SAR

Family	Species	Guild
Mormoopidae	*Pteronotus davyi*	Insectivore
	Pteronotus parnellii	Insectivore
	Pteronotus personatus	Insectivore
	Mormoops megalophylla	Insectivore
Phyllostomidae	*Macrotus waterhousii*	Insectivore
	Micronycteris microtis	Frugivorous
	Diphylla ecaudata	Blood-sucking
	Desmodus rotundus	Blood-sucking
	Diaemus youngi	Blood-sucking
	Glossophaga soricina	Frugivorous
	Leptonycteris curasoae	Nectarivore
	Leptonycteris nivalis	Nectarivore
	Anoura geoffroyi	Nectarivore
	Choeronycteris mexicana	Nectarivore
	Carollia sowelli	Frugivorous
	Sturnira lilium	Frugivorous
	Sturnira ludovici	Frugivorous
	Enchisthenes hartii	Frugivorous
	Artibeus jamaicensis	Frugivorous
	Artibeus liturarus	Frugivorous
	Centurio senex	Frugivorous
Molossidae	*Tadarida brasiliensis*	Insectivore
	Nyctinomops aurispinosus	Insectivore
	Nyctinomops laticaudatus	Insectivore
	Nyctinomops macrotis	Insectivore
	Molossus aztecus	Insectivore
	Molossus molossus	Insectivore

Family	Species	Guild
	Molossus rufus	Insectivore
Vespertilionidae	*Perimyotis subflavus*	Insectivore
	Antrozous pallidus	Insectivore
	Rhogeessa tumida	Insectivore
	Lasiurus blossevillii	Insectivore
	Lasiurus cinereus	Insectivore
	Lasiurus ega	Insectivore
	Lasiurus intermedius	Insectivore
	Corynorhinus mexicanus	Insectivore
	Nycticeius humeralis	Insectivore
	Eptesius furinalis	Insectivore
	Eptesicus fuscus	Insectivore
	Myotis auriculus	Insectivore
	Myotis elegans	Insectivore
	Myotis keaysi	Insectivore
	Myotis nigricans	Insectivore
	Myotis velifer	Insectivore
Natalidae	*Natalus stramineus*	Insectivore

From the point of view of wind projects, insectivorous species are relevant because this guild includes species that forage at heights ranging between 10 and 30 m, making them more likely to interact with the blades of wind turbines. This group of bats can be divided into two groups. Aerial insectivores, which are characterized by narrow wings and small body that allows them to develop an acrobatic flight, and insectivorous with foliage that usually fly at lower altitudes (2-5 m) and are characterized by wider wings and greater body mass (Neuweiler 2000). Species that could be recorded within the project area belong to the group of aerial insectivores, except for the pale bat (*Antrozous pallidus*) which forages in the undergrowth.

Some members of the Vespertilionidae family are the ones that have collisioned more frequently in wind farms in North America, whereas members of the second family Molossidae have been reported in collisions at the La Venta II WF, in the state of Oaxaca (CFE -INECOL 2008 and 2009). As for collisions, three species *Lasiurus cinereus, L. blossevillii and Tadarida brasiliensis* that could be recorded within the Project Area have been reported in collisions in other farms in the United States (Erickson, et al, 2003; Johnson, 2003, Johnson et al. 2003; Fiedler 2004; Johnson, et al. 2004; Koford, 2004; Arnett, 2005; Brown and Hamilton, 2006; Piorkowski, 2006; Arnett, et al. 2008). The first two belong to the Vespertilionidae family and the last to Molossidae family.

Undoubtedly, the grizzled bushy tailed bat (*Lasiurus cinereus*) is the species that has reported more collisions. It has been estimated that about 50% of collisions registered in the United States against wind turbines belong to this species (Arnett et al., 2008). This indicates that this species should be taken as a focal species for monitoring interactions of bats with wind turbines to be installed at the Project Area.

IV.2.3.6. Terrestrial fauna species in conservation status

A total of 101 species of fauna were detected in total, under conservation status as per the NOM-059-SEMARNAT-2010, of which 8 are endangered species, 29 are threatened and 63 under special protection. The group with the highest number of species is birds, followed by reptiles, terrestrial mammals, amphibians and bats (chiroptera).

Table IV.38 Number of fauna species with potential distribution in the SA in conservation status distribution according to NOM-059-SEMARNAT-2010

Group	Total species	Endangered	Threatened	Special protection
Amphibians	12	1	2	10
Reptiles	26	--	10	16
Birds	45	2	8	35
Terrestrial mammals	13	5	6	1
Chiroptera	5	--	3	1

It is noteworthy that the 101 species listed above are species with potential distribution in the area. During the field visits and surveys, only some traces of them were observed, as mentioned below:

- ***Amphibians***

Found in some conservation status according to NOM-059-SEMARNAT-2010, one of which is endangered, two threatened and nine are under special protection.

Notably, during the fieldwork no species of amphibians was recorded so in the following table only species recorded in collections with potential distribution are presented.

Table IV.39 Amphibian species with potential in the SA on conservation status

Family	Species	Common Name	NOM-059-SEMARNAT-2010
Bufonidae	*Anaxyrus debilis*	green frog, mountain toad	Pr
Craugastoridae	*Craugastor decoratus*	Ornate thief frog	Pr
Microhylidae	*Gastrophryne olivacea*	narrow mouthed olivaceous toad	Pr
Ranidae	*Lithobates berlandieri*	Rio Grande leopard frog	Pr
Rhinophrynidae	*Rhinophrynus dorsalis*	Mexican burrowing toad	Pr
Plethodontidae	*Pseudoeurycea cephalica*	chunky salamander	A
	Pseudoeurycea scandens	tlaconete tamaulipeco	Pr
	Chiropterotriton chondrostega	gristle-headed splayfoot salamander	Pr
	Pseudoeurycea bellii	Bell's false brook salamander	A
	Chiropterotriton multidentatus	toothy splayfoot salamander	Pr
Salamandridae	*Notophthalmus meridionalis*	black-spotted newt	P
Eleutherodactylidae	*Eleutherodactylus dennisi*	Dennis chirriadora frog	Pr

Symbols: P = Endangered, A=Threatened Pr = Under special protection

- ***Reptiles***

From all the species with potential distribution in the SAR distribution, 26 species were recorded under special protection status according to NOM-059-SEMARNAT-2010, of which 10 are endangered and 16 under special protection.

During the field visits, two turtle species were recorded: *Terrapene carolina* (common box turtle) and *Gopherus berlandieri (*Texas turtoise), which are in conservation status according to NOM-059-SEMARNAT-2010

Table IV. 40 species of reptiles in conservation status with potential distribution in SAR

Family	Genus	Common Name	NOM-059-SEMARNAT-2010
Testudinidae	*Gopherus berlandieri*	Texas tortoise	A
Gopherus berlandieri	*Kinosternon scorpioides*	scorpion mud turtle	Pr

Family	Genus	Common Name	NOM-059-SEMARNAT-2010
Emydidae	*Terrapene carolina*	common box turtle	Pr
Xenosauridae	*Xenosaurus platyceps*	flathead knob-scaled lizard	Pr
Xenosaurus platyceps	*Lepidophyma sylvaticum*	tropical night lizards	Pr
Viperidae	*Crotalus atrox*	western diamondback rattlesnake	Pr
	Crotalus lepidus	green rock rattlesnake	Pr
	Crotalus molossus	black-tailed rattlesnake	Pr
Scincidae	*Plestiodon lynxe*	oak forest skink	Pr
Phrynosomatidae	*Cophosaurus texanus*	greater earless lizard	A
	Sceloporus grammicus	mesquite lizard	Pr
Iguanidae	*Ctenosaura acanthura*	spinytail iguana	Pr
Elapidae	*Micrurus fulvius*	eastern coral snake	Pr
Colubridae	*Thamnophis marcianus*	checkered garter snake	A
	Thamnophis proximus	western ribbon snake	A
	Imantodes cenchoa	blunthead tree snake	Pr
	Tantilla rubra	Veracruz centipede snake	Pr
	Thamnophis mendax	Tamaulipan montane garter snake	A
	Leptophis mexicanus	Mexican parrot snake	A
	Lampropeltis triangulum	milksnake	A
	Thamnophis cyrtopsis	black-neck garter snake	A
	Coluber constrictor	southern black racer	A
	Rhadinaea montana	brown snake from Nuevo León	Pr
	Hypsiglena torquata	night snake	Pr
Boidae	*Boa constrictor*	boa constrictor, boa	A
Anguidae	*Abronia taeniata*	bromeliad arboreal alligator lizard	Pr

Symbols P = Endangered, A= Threatened Pr = Under special protection

- ***Birds***

From the total of birds with potential distribution in the SAR, 45 species are found in conservation status according to NOM-059-SEMARNAT-2010, two of which are endangered, eight are threatened and 35 under special protection.

From the 70 species recorded of birds so far only Swainson's Hawk (*Buteo swainsoni*) and white-tailed Hawk (*Buteo albicaudatus*) are under some special protection category by the NOM-059-SEMARNAT-2010.

Table IV.41 Bird species with potential distribution in the SA in conservation status

Species	Common Name	Status under NOM-059-SEMARNAT-2010
Ara militaris	military macaw	P
Amazona oratrix	Yellow-headed parrot	
Falco femoralis	aplomado falco	A
Aratinga holochlora	green parakeet	A
Rallus limicola	Virginia rail	A
Accipiter bicolor	bicolored hawk	A
Geranospiza caerulescens	crane hawk	A
Botaurus lentiginosus	American bittern	A
Nomonyx dominicus	masked duck	A
Crax rubra	great curassow	A
Crypturellus cinnamomeus	Thicket Tinamou	Pr
Cairina moschata	Muscovy Duck	Pr
Cyrtonyx montezumae	Montezuma quail	Pr
Tachybaptus dominicus	Least Grebe	Pr
Mycteria americana	Wood Stork	Pr
Ixobrychus exilis	Least bittern	Pr
Tigrisoma mexicanum	bare-throated tiger heron	Pr
Chondrohierax uncinatus	Hook-billed kite	Pr
Elanoides forficatus	swallow-tailed kite	Pr
Ictinia mississippiensis	Mississippi Kite	Pr
Ictinia plumbea	Plumbeous Kite	Pr
Accipiter striatus	sharp-shinned hawk	Pr
Accipiter cooperii	Cooper's hawk	Pr
Buteogallus anthracinus	Common Black Hawk	Pr
Buteogallus urubitinga	Great Black Hawk	Pr
Parabuteo unicinctus	Harri's Hawk	Pr
Buteo lineatus	Red-shouldered hawk	Pr
Buteo platypterus	Broad-winged hawk	Pr
Buteo swainsoni	Swainson's Hawk	Pr
Buteo albicaudatus	white-tail hawk	Pr
Buteo albonotatus	Zone-tailed hawk	Pr
Buteo jamaicensis	Red-tailed hawk	Pr
Heliornis fulica	Sungrebe	Pr
Megascops asio	Eastern screech owl	Pr

Species	Common Name	Status under NOM-059-SEMARNAT-2010
Glaucidium sanchezi	Tamaulipas pygmy owl	Pr
*Athene cunicularia (hypugaea) ** *	Burrowing owl	Pr
Asio flammeus	Short-eared Owl	Pr
Campephilus guatemalensis	Pale-billed woodpecker	Pr
Micrastur semitorquatus	Collared Forest falcon	Pr
Falco peregrinus	peregrine falcon	Pr
Aratinga nana	Olive-throated parakeet	Pr
Myadestes occidentalis	Brown-backed solitaire	Pr
Catharus mexicanus	Black-headed nightingale-thrush	Pr
Limnothlypis swainsonii	Swainson's warbler	Pr
Geothlypis flavovelata	Altamira yellowthroat	Pr

Symbols: P = Endangered, A=Threatened Pr = Under special protection

- ***Mammals***

From all mammals with potential distribution in SA, thirteen species are recorded in conservation status according to NOM-059-SEMARNAT-2010, of which five are endangered, six threatened and one under special protection. It is noteworthy that in the field work, trails, tracks or reports from the inhabitants of the area of tlacoyote and the four felines listed in the table below were found

Table IV.42 Terrestrial mammal species with potential distribution in conservation status

Family	Species	Common Name	Record type	NOM-059-SEMARNAT-2010
Soricidae	*Cryptotis obscura*	grizzled Mexican small-eared shrew	RC	Pr
	Notiosorex crawfordi	Crawford's gray shrew	RC	A
	Notiosorex villai	shrew	RC	A
Felidae	*Herpailurus yagouaroundi*	jaguarundi	RC, RS	A
	Leopardus pardalis	ocelot	RC, RS	P
	Leopardus wiedii	Oncilla	RC, RS	P
	Panthera onca	jaguar	RC, RS	P
Mustelidae	*Taxidea taxus*	American badger	RC, RS	A
Antilocapridae	*Antilocapra americana*	pronghorn	RC	P
Sciuridae	*Glaucomys volans*	Southern flying squirrel	RC	A
Castoridae	*Castor canadensis*	beaver	RC	P
Geomyidae	*Geomys tropicalis*	Tropical pocket gopher	RC	A

Symbols: P = Endangered, A=Threatened Pr = Under special protection
Note: RC: records in collections, RS: records on site due to trail, footprints or report by inhabitants.

- ***Chiroptera***

Of the bat species with potential distribution in the Project Area, two are in special protection, three are in the threatened category according to NOM-059-SEMARNAT-2010, the species are listed in the following table.

Tabla IV.43 Bat species with potential distribution on conservation status according to NOM-059-SEMARNAT-2010

Scientific Name	Common Name	NOM-059-SEMARNAT-2010
Diaemus youngi	White-winged vampire bat	Special protection
Enchisthenes hartii	Velvety fruit-eating bat	
Leptonycteris curasoae	Southern long-nosed bat	Threatened
Leptonycteris nivalis	Great long-nosed bat	
Choeronycteris mexicana	Mexican long-tongued bat	

Leptonycteris curasoae is in the VU (vulnerable) category, *Leptonycteris nivalis*in the EN (endangered) category, and *Choeronycteris mexicana* in NT (almost threatened) category in the IUCN red List (2012). Other species are not found within any category of risk in the NOM-059-SEMARNAT-2010, CITES (2011) and IUCN (2011).

The species mentioned fly at altitudes lower than five meters, so it is likely that the risk of collision with wind turbines to be installed is low.

IV.2.3.7. Monarch butterfly

- ***Background***

Monarch butterflies (Danaus plexippus) are the only butterflies capable of traveling such long distances back and forth when migrating. The flying capacity of the monarch butterfly is amazing. Butterflies have been observed in different places of North America flying between 600 and 1200 meters, rising into thermal currents and even entering clouds (GIBO, 1981).

Autumn migration begins end August and beginning of September in the north of the USA and south of Canada. Monarch butterflies are not adapted to low temperatures and lack of humidity. Instead of mating and laying eggs the use their entire energy to migrate to a climate that may help them survive until the following spring to begin their reproduction cycle again.

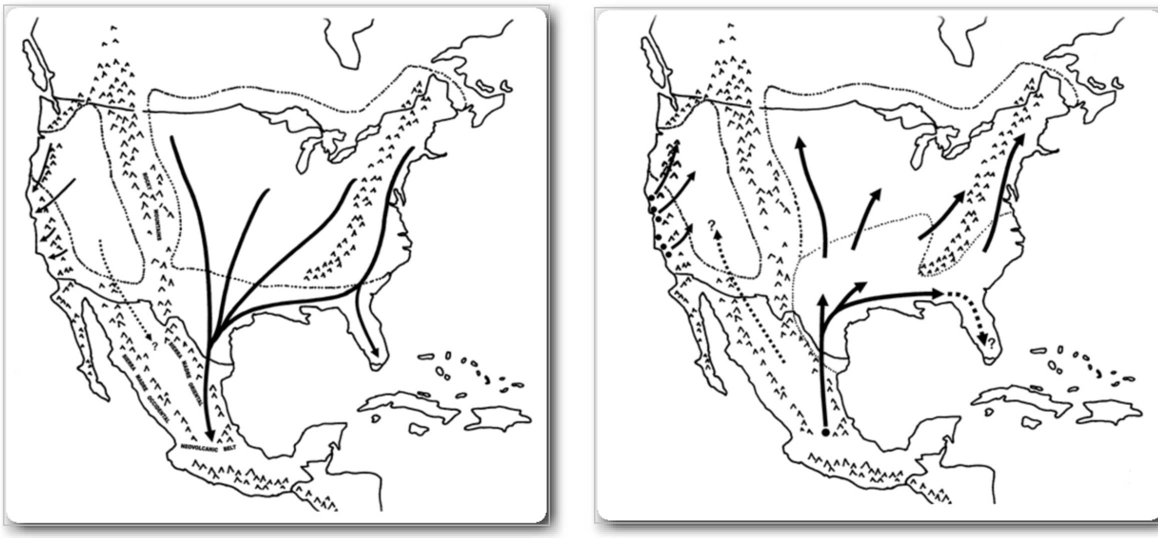
They travel for up to 2,000 km to the volcanic mountain range in the center of Mexico. Monarch butterflies drink nectar and use hot air currents to soar instead of flying, which requires high energetic consumption as they move. They do between 80 and 160 km per day. During the journey they join other individuals to reach the south of the US by the end of September-October.

They stay in Mexico from the beginning of November to March. Monarch butterflies are found on hillsides oriented to the south of the mountains and group over the branches of oyamel trees. Temperature and humidity allows them to turn lethargic (very similar to hibernation, but not as deep as a "dream"). Thus, they may preserve their energy until the warmer weather of Spring is back.

Spring migration occurs from the beginning of March. With warm temperatures monarch butterflies become more active and some of them interrupt the diapause to start mating and lay eggs. Soon the colonies disappear as butterflies start their trip back to their reproductive habitats. Offsprings become the new summer generation and conclude their trips spreading throughout the eastern region of North America as they have availability of *Asclepias sp*. Monarch butterflies reach the septentrional part of their habitat in beginning or mid June.

The following figures show the general trace of migratory routes both in autumn and spring, and it can be observed that both routes go through the State of Tamaulipas. However, there are no sufficient data to determine exactly the location of the same.

Figure IV.15 Migratory routes in autumn and spring



Autumn migratory routes | Spring migratory routes

Source: Oberhauser, S.K. North American monitoring program for monarch butterfly in http://www2.ine.gob.mx/publicaciones/libros/507/cap2.html

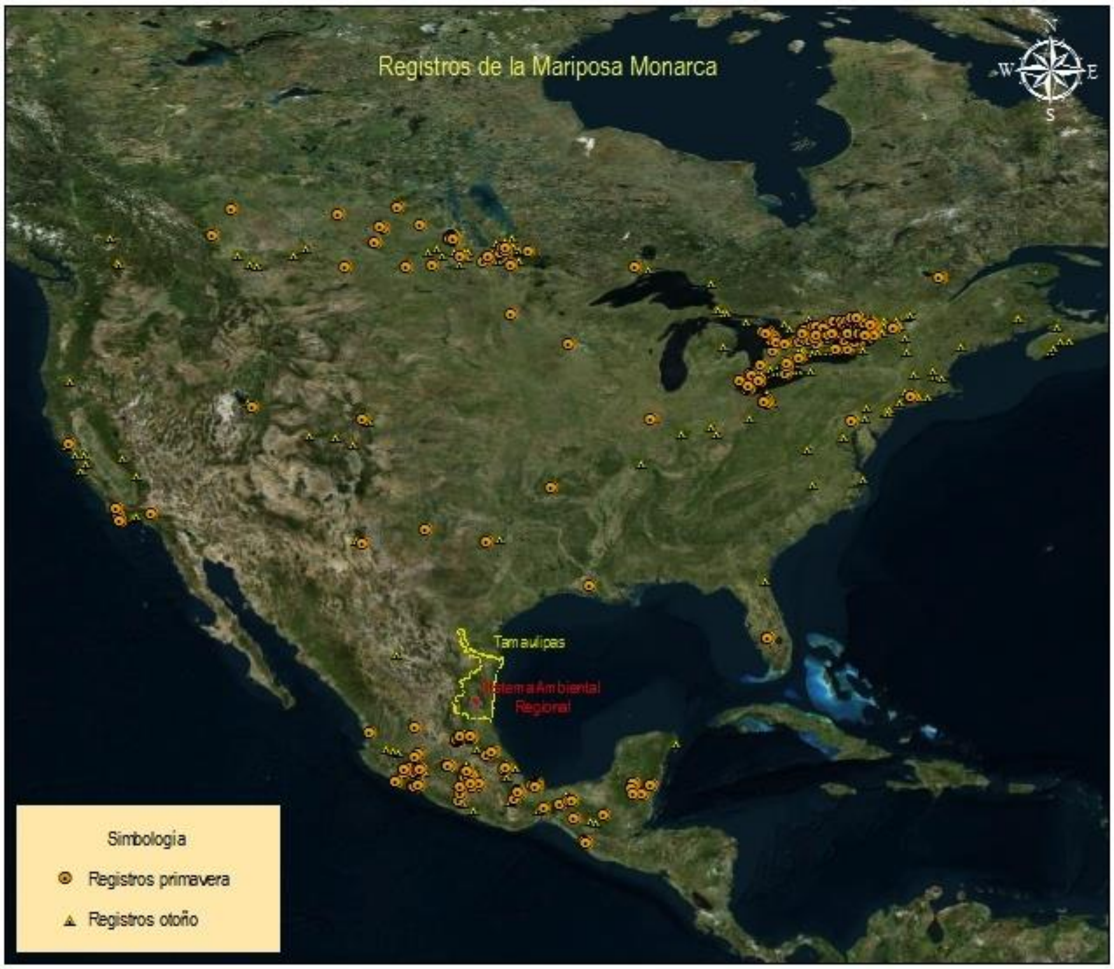
- ***Potential distribution model of monarch butterflies***

Considering that the Project is located in the state of Tamaulipas, two potential distribution models were applied to determine if the Project Area is located in the migratory route of monarch butterflies, for there are currently no sufficient data available to determine so. The methodology applied is presented in Appendix IV. 4.

The *D. plexippus* collecting records used for generating geographic distribution models were obtained from Global Biodiversity Information Facility (GBIF, http://www.gbif.org/) and the National System on Biodiversity Information (SNIB, http://www.conabio.gob.mx/remib/doctos/snib.html). Information obtained was filtered and organized in a database according to migration periods reported in books.

The number of collecting records obtained for *D. plexippus* was 1094 unpublished data, from a database of 3,095 observations, provided by the National Commission for Knowledge and Use of Biodiversity (CONABIO) and available online by the Global Biodiversity Information Facility (GBIF). The largest amount of records was observed in the central region of Mexico, northeast US and southeast Canada. The following figure shows the distribution of records obtained.

Figure IV.16. Monarch butterfly records



In order to determine the geographic distribution pattern of *D. plexippus* it was decided to use continuous variables of climatic character. Another option was with the distribution of *Asclepia sp* plants which host monarch butterflies. However, this was too complex because the exact number asclepia species in Mexico is unknown. The US reports 53 species of asclepias for North America that host the larva of *D. plexippus.*

The exploratory analysis of the collecting records of monarch butterflies with respect to nineteen bio-climatic variables indicate that he environments where they are found show an average annual temperature of 8.11°C and total average annual rain of 920 mm, which represents temperate and rainy climates. The spectrum of the value of bio-climatic variables shows rainy-temperate and tropical-rainy environments.

Two models were applied to determine the potential distribution of monarch butterflies, described in the following table.

Table IV.44 Description of models applied to determine the potential distribution of monarch butterflies.

Model	Description
MaxEnt	MaxEnt predicts very accurately species distribution between sampling points but has very low predicting capacity for zones with few collecting records.
Bioclim	Identifies minimum and maximum variables of each environmental variable, to define a "multidimensional environmental hub" which allows estimating the climatic affinity of species. The use of BIOCLIM helped obtain an explanatory model in terms of minimum and maximum limits of variables related to rain and temperature.

For the generation of distribution models for monarch butterflies we used the DIVA-GIS program (http://www.diva-gis.org/), a geographic information system used for the analysis of databases from gene, herbal and zoology collection banks designed to determine genetic, ecologic and geographic patterns for the distribution of wild and domesticated species.

In both models the SA was located in unsuitable (gray areas) areas of low climatic affinity. The areas of greater climatic affinity are located to the east and west of the SA on the Sierra de Tamaulipas and the Sierra Madre Oriental, with high, very high and excellent climatic affinity categories. This agrees with sites of very low variation of temperature and moderate rain.

The model obtained through MaxEnt showed a distribution pattern indicating that the areas of higher adaptation are located in the center of Mexico, southeast and northeast of the United States and southeast of Canada. The environmental adaptation level according to the MaxEnt model for the Environmental System was less than 5%.

As previously mentioned, MaxEnt predicts very accurately between sampling points but has very low predicting capacity for zones with few collecting records. This fact was confirmed in the model obtained, which predicts that the areas with high adaptation values are the center of Mexico and southeast Canada. And this agrees with the areas presenting a higher number of collecting records. MaxEnt did not distinguish intermediate areas of high adaptation between the records from north US and center of Mexico.

Figure IV.17 Model obtained with MaxEnt (AUC 0.909), Potential Distribution in North America

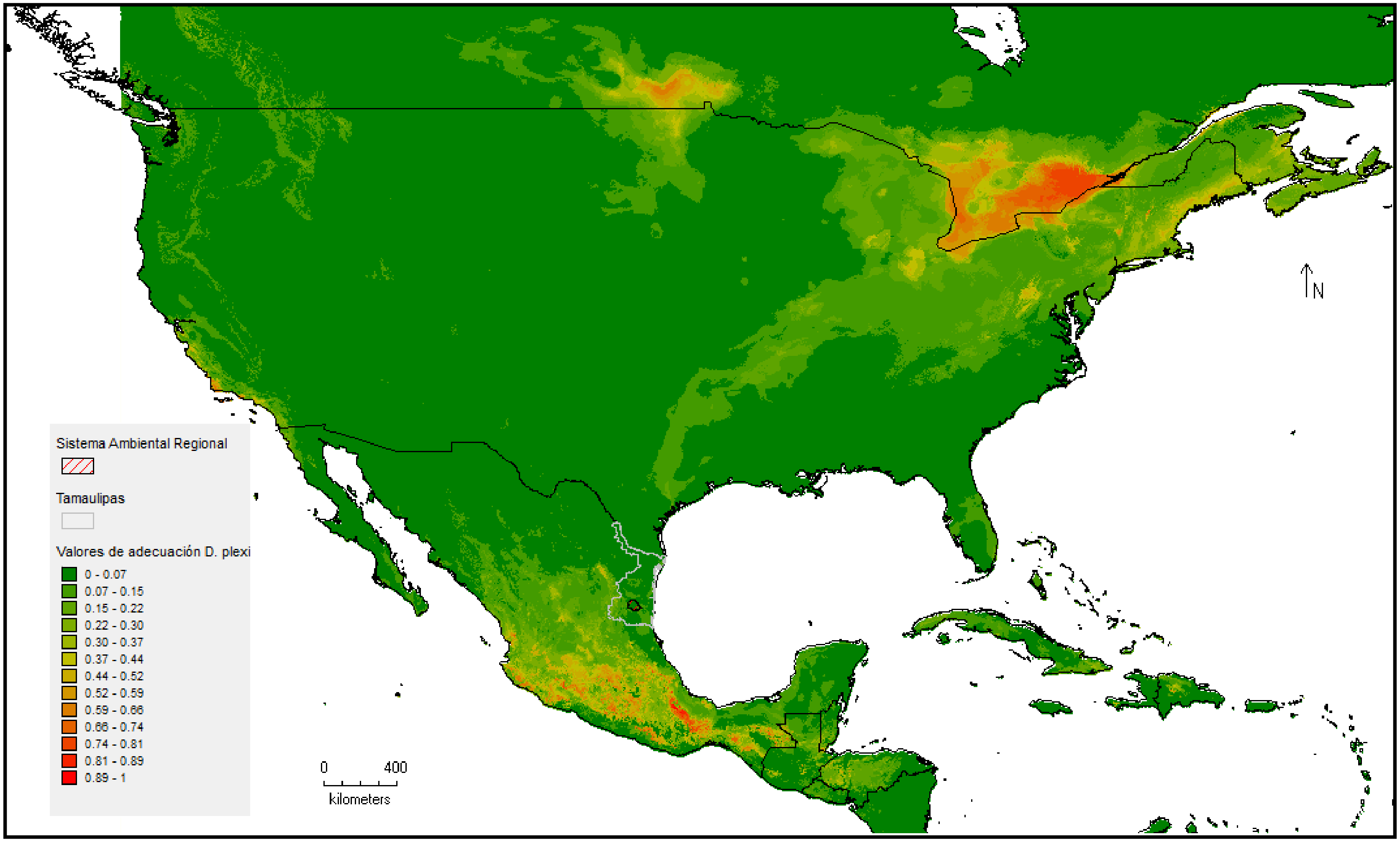
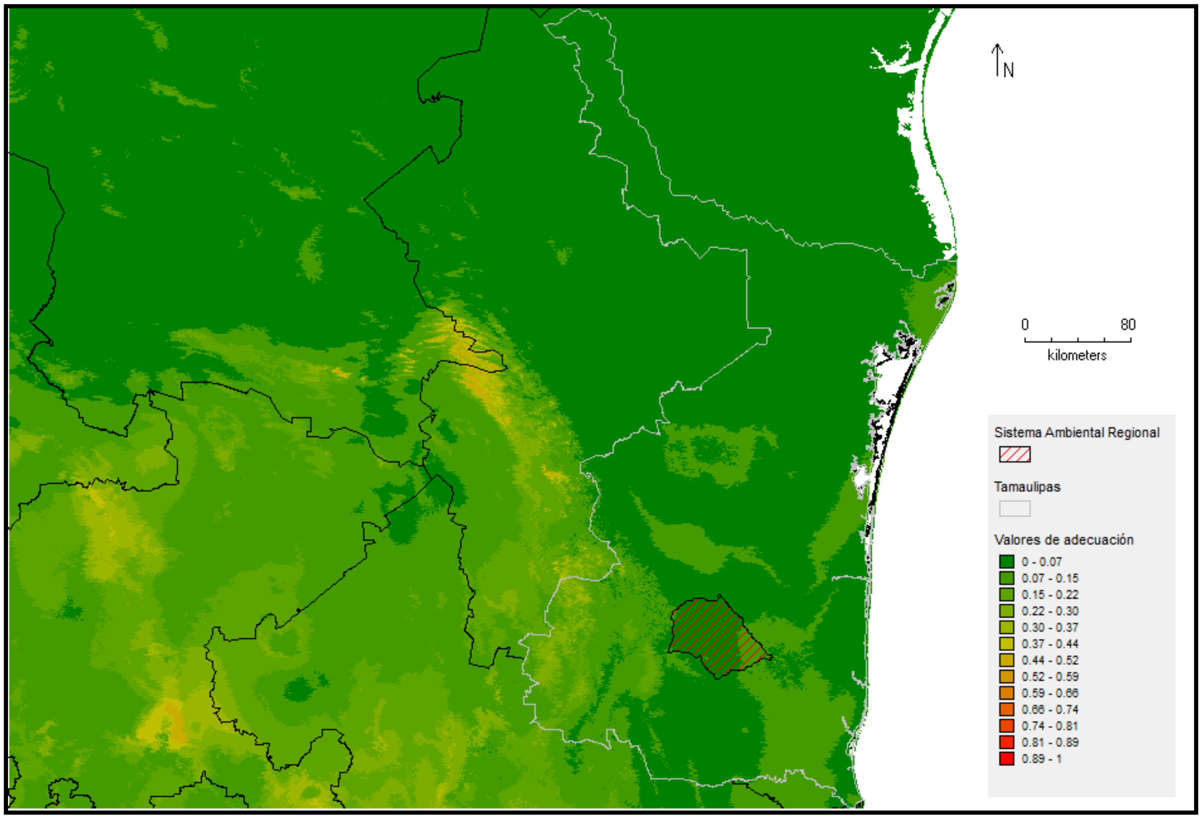


Figure IV.18 Model obtained with MaxEnt (AUC 0.909), details of distribution for northeast Mexico.



The Bioclim model results indicated that for 1094 non-duplicated records, the distribution pattern shows a wide area of climatic affinity (class: medium, high, very high and excellent) at the central east and northeast of the United States, as well as the center and east of Mexico, over the Faja Volcánica Mexicana and the Sierra Madre Oriental respectively, as observed in the following figure. As for the Environmental System (SAR) it was determined that it is located in an area of low climatic affinity for the records related to autumn and spring migration.

Figure IV.19 Climatic affinity model obtained with Bioclim

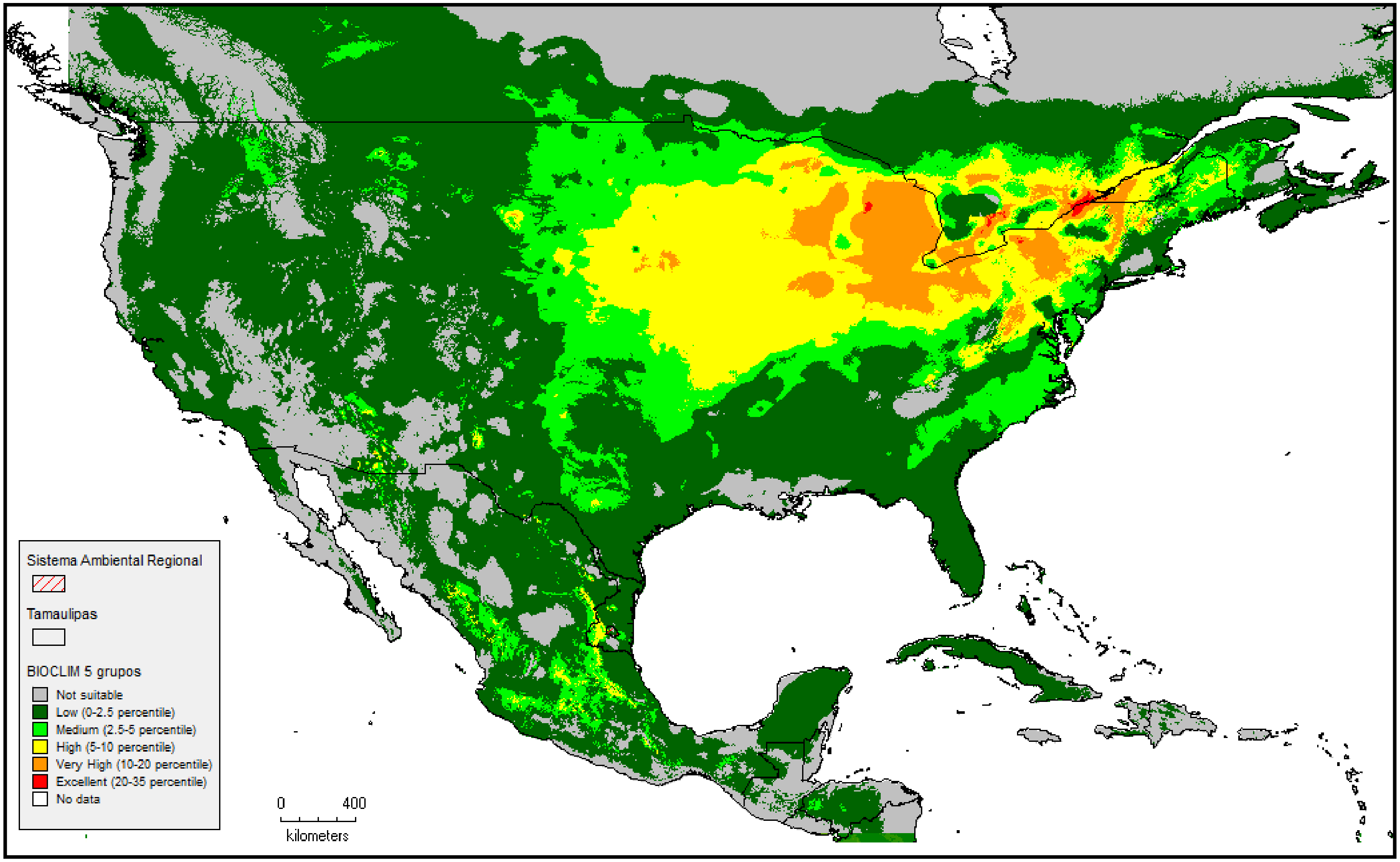
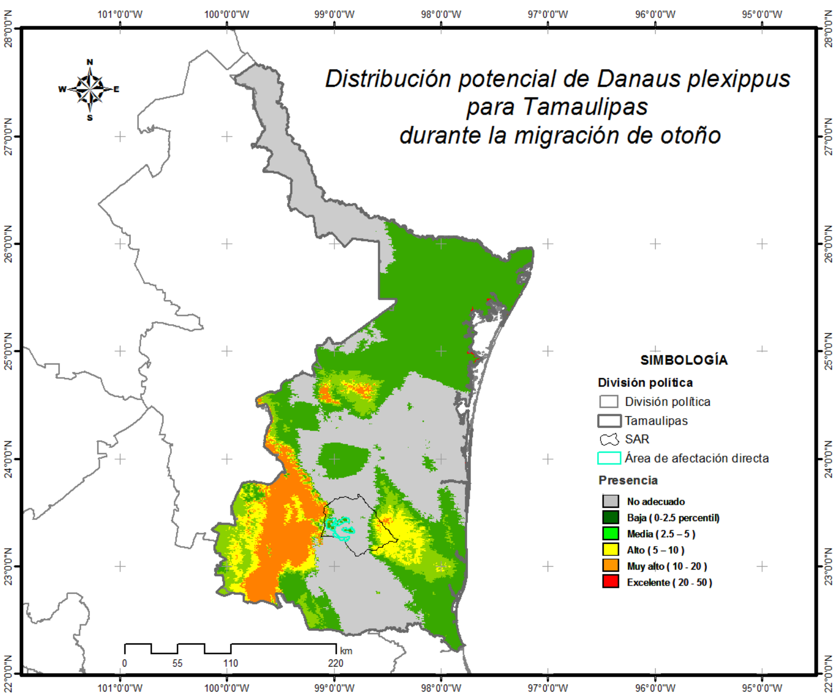
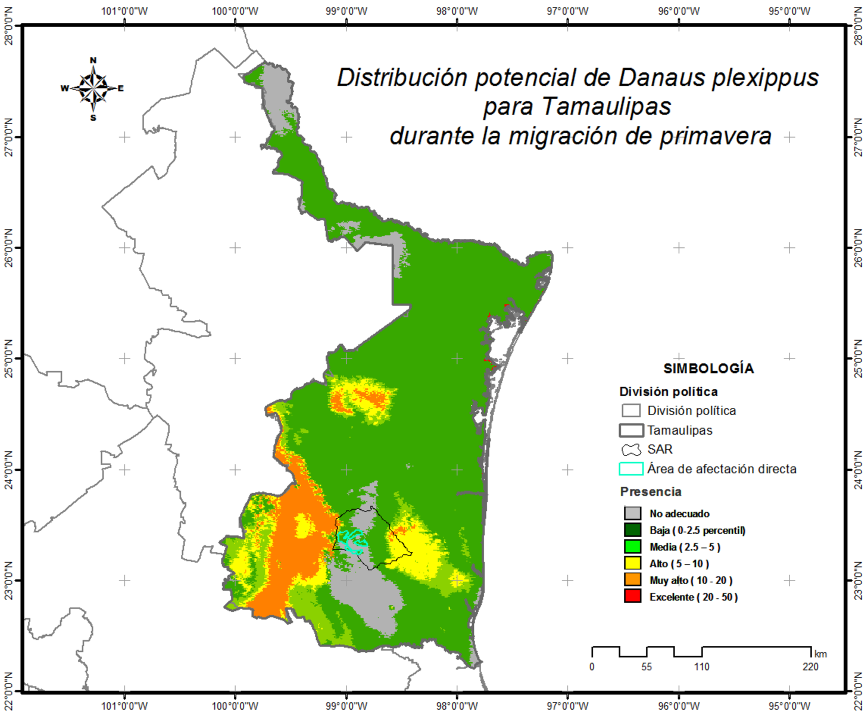


Figure IV.20 Potential distribution of *Danaus plexippus* during autumn and spring migration obtained through Bioclim





According to the results obtained from the models applied, MaxEnt and BIOCLIM, it is considered that within the Project Area it would be expected that the incidence of monarch butterflies during both migrations (spring and autumn) be minimum due to low levels of climatic affinity. Although precipitations agree with the general pattern of the species, this is not the case for the dominant condition of warm temperatures. However, it should be mentioned that the areas adjacent to the SA presenting a certain degree of affinity and adaptation were the Sierra Madre Oriental and Sierra de Tamaulipas representing a series of climatic conditions favorable for potential distribution during migrations of *D. Plexippus*.

The latter seems to be confirmed at least with the actions the SEDUMA undertook for the conservation of this species, the technical staff of the Deputy Department of Environment carried out 45 trips (from October 28 through November 8, 2012), in order to geographically locate the colonies of this species circulating through the State of Tamaulipas, as well as their migration dynamics in terms of population and their relation to environmental events. As a result of this campaign, 18 communities from 5 municipalities (Jaumave, Ocampo, Tula, Bustamante and Miquihuana) were detected in the southeast region towards the slope of the Sierra Madre Oriental and comprising part of the Altiplano Tamaulipeco, where food supply, water supply and overnight areas for their journey are located. (http://seduma.tamaulipas.gob.mx/wp-content/uploads/2012/12/boletin.pdf).

IV.2.4. Landscape

The concept of landscape has several ways to be conceived and also to be analyzed. In general, it may be stated that the landscape study may have two approaches: total landscape and visual landscape.

For the first one, with respect to total landscape, the interest is focused on the study of the landscape as an indicator or source of synthetic information on the land, where the landscape is a group of natural and cultural phenomena related to a territory. Said group has an organized structure which may not be reducible to the addition of its parts, but constitutes a system of relationships linking the different processes.

The second approach refers to the visual landscape and is focused on what the observer may perceive on said territory, the landscape as a spacial and visual expression of the environment. It contemplates and analyzes what men see; the visible aspects of reality.1

In order to asses the landscape quality, there is a difficulty of being a basically subjective component, but three basic criteria arise: visibility, landscape quality and visual fragility, defined as follows:

- Visibility: the space of the territory which may be appreciated from a certain spot or area.
- Landscape quality: includes three perception elements: intrinsic characteristics of the site, visual quality of the immediate environment and quality of the scenic background.
- Landscape fragility: the capacity of the landscape to absorb changes produced in it. Fragility is conceptually linked to the aforementioned attributes. The factors integrating it may be classified into biophysical (soil, structure and diversity of vegetation, chromatic contrast) and morphological (size and shape of visual basin, relative height, particular spots and areas).

Moreover, two other criteria are considered:

- Frequency of human presence: a landscape practically without observers is not the same as one frequently visited, for the population disturbed is higher in the second case.
- Landscape singularities: or elements outstanding in a natural or artificial character.

The assessment of each criterion listed for the SA is shown in the following Table.

[1] Martínez Vega, J., Martín Isabel M. P. y Romero Calcerrada, R. (2003): “Valoración del paisaje en la zona de especial protección de aves carrizales y sotos de Aranjuez (Comunidad de Madrid)”, GeoFocus (Artículos), nº 3, p. 1-21. ISSN: 1578-5157

Table IV.45 Landscape assessment criteria

Criteria	Score	Support
Visibility	High	The SA is located at three plateaus at an average height of 400 meters ASL. So these plateaus may be observed from the highest parts which are in turn surrounded by the Sierra Madre Oriental and the Sierra de Tamaulipas.
Landscape quality	High	The SA has natural vegetation on most of its surface and hence it has a high landscape quality. There are only some paths which do not disturb their quality, in addition to cleared areas for agricultural and farming activities.
Fragility	High	The landscape of the SA has low capacity to absorb changes by the introduction of artificial elements, mainly in the Project Area for the plateaus stand above the plain surrounding them for more than 200 m.
Frequency of human presence	Low	In the SA there are no relevant communities or agricultural areas so, in general terms, the presence of people is not frequent.
Landscape singularities	High	The plateaus located between the Sierra Madre Oriental and the Sierra de Tamaulipas and standing above the plain surrounding them for more than 200 m are the main singularity of the landscape.

IV.2.5. Socio-economic aspects

The SA is located in the middle part of the state of Tamaulipas in the municipalities of Casas and Llera. Both municipalities partially encompass the Sierra Madre Oriental and the Sierra de Tamaulipas.

The municipality of Llera is located in the middle portion of the state territory, at the foothills of the Sierra Madre Oriental and the Sierra de Tamaulipas, with a territorial extension of 2,307.40 km^2 representing 2.86% of the total surface of the State. It is divided into 220 communities and the most important are: Villa de Llera (Head municipality), Ignacio Zaragoza, El Encino, Emiliano Zapata, Compuertas and La Alberca.

The municipality of Casas has a territorial extension of 2,874.33 Km^2 and is integrated by 164 communities, of which the most important are: Villa de Casas, Ej. Estación San Francisco, La Lajilla, El Amparo, Nuevo centro de Población 5 de Febrero and 19 de Abril while the municipality of Llera covers 2,307.40 Km^2 with a total of 220 communities, where the most important are: Villa de Llera, Ignacio Zaragoza, El Encino, Emiliano Zapata, Compuertas and La Alberca.

Table IV.46 Main characteristics of the municipality

Municipality	Surface		Total population	Number of communities	Municipality classification
	Km^2	% with respect to the state			
Casas	2,874.33	5.11	4,423	164	Rural
Llera	2,307.40	2.86	17,333	242	Rural

Source: INEGI. 2010. Population and Housing Census.

IV.2.5.1. Demography

According to the population and housing census from 2010 the municipality registered a population of 4,423 inhabitants while the population of the municipality of Llera amounted to 17,333 inhabitants. When performing the historical growth analysis of the population it can be observed that both municipalities present a positive general trend. Only for the period of 2000-2005 a decrease was registered as it may be observed in the following table.

Table IV.47 Population in the municipalities integrating the SAR

Municipality	1990	1995	2000	2005	2010
Casas	4,830	4,959	4,537	4,123	4,423
Llera	19,083	19,274	17,620	17,317	17,333

Source: INEGI. 2010. Population and Housing Census.

The total population of the municipality of Llera is of 17,333 inhabitants distributed in 242 communities. The urban population represents 24% while the rural population amounts to 76%.

Table IV.48 Population in the municipalities integrating the SAR

Municipality	Total population	Urban population (%)	Rural population (%)	Number of communities
Casas	4,423			
Llera	17,333	24	76	242

Source: INEGI. 2010. Population and Housing Census.

There are eight communities located within the Project Area which totally belong to the municipality of Llera and together have a total population of 106 inhabitants according to the 2010 Population and Housing Census.

Table IV.49 Population of communities located in the Project Area

Community	Total population	Community	Number of communities
El Indio	1	Los Laureles	3
Rancho Nuevo del Norte (Guadalupe Cedillo Guerrero)	8	Los Manantiales	1
Rancho Nuevo del Norte	83	San Rafael	2
Las Cruces	2	Trópico de Cáncer	6

Source: INEGI. 2010. Population and Housing Census.

IV.2.5.2. Population structure

With respect to sex structure, it is known that both municipalities present a higher percentage of men than of women.

Table IV.50 Structure based on sex of municipalities integrating the SAR

Municipality	Total population	Men	(%)	Women	(%)
Casas	4,423	2,326	52.6	2,097	47.4
Llera	17,333	8,783	50.7	8,550	49.3

Source: INEGI. 2010. Population and Housing Census.

In the municipality of Casas, approximately 37% of the population is less than 18 years of age, 49% is between 18 and 59, approximately 13% is 60 and above. For the municipality of Llera records show that 32.5% is less than 18 years of age, 49.4% is between 18 and 59 and 18% is 60 and above.

Table IV.51 Structure based on sex of municipalities integrating the SAR

Range of age in years	Casas			Llera		
	Total	Men (%)	Women (%)	Total	Men (%)	Women (%)
0 to 2	287	49.83	50.17	791	50.57	49.43
3 to 5	332	52.11	47.89	960	50.0	50.0
6 to 14	766	51.44	48.56	2,877	50.19	49.81
15 to 17	253	50.99	49.01	991	49.45	50.55
18 to 24	501	52.50	47.50	1,802	51.22	48.78
25 to 59	1,670	52.81	47.19	6742	49.85	50.15
60 and above	601	56.24	43.76	3,131	53.24	46.76

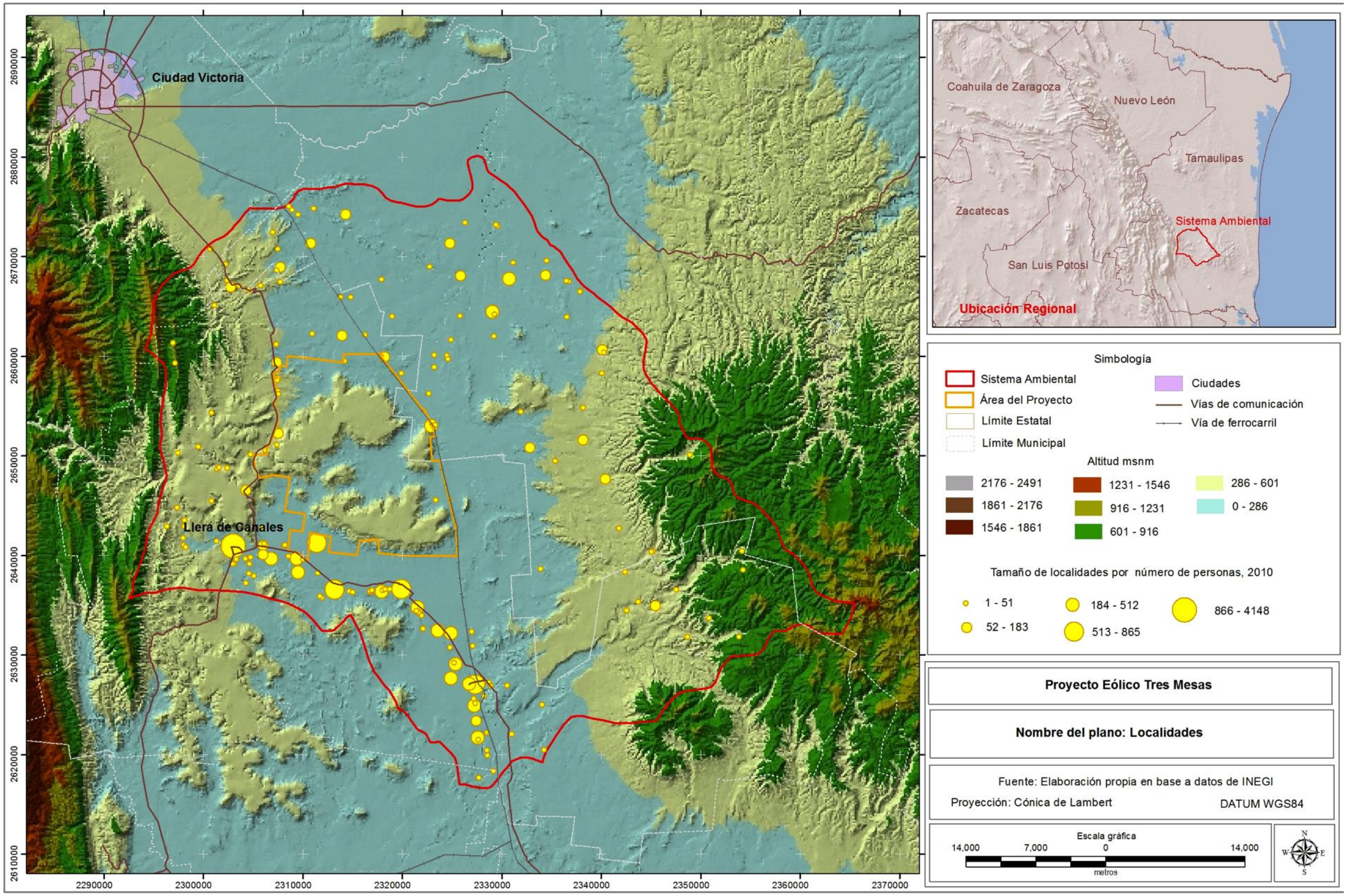


Figure IV.21 Distribution of communities within the Environmental System

IV.2.5.3. Education

The illiteracy level in both municipalities considered is a little more than 9% of the population of 15 years of age and above. The average level of education is 5.93 for Casas and 6.76 for Llera.

Table IV.52 Illiterate population in the municipalities integrating the SAR

Municipality	Population of 15 years of age and above					Average education level
	Total	Illiterate		Primary education completed		
		No.	(%)	No.	(%)	
Casas	3,025	286	9.45	701	23.17	5.93
Llera	12,666	1,222	9.65	1,796	22.82	6.76

Source: INEGI. 2010. Population and Housing Census.

The educational infrastructure of Llera is constituted by 48 kindergarten schools, 52 primary schools, 14 secondary schools and 3 high schools.

IV.2.5.4. Health and social security

81% and 87% of the population of Casas and Llera, respectively, have rights to health services. Most of them are entitled to services in Pemex, National Defense, Marine and IMSS.

Table IV.53 Population entitled to health services in the municipalities integrating the SAR

Municipality	Total population	Population not entitled to health services	Population entitled				
			IMSS	ISSSTE	State ISSSTE	Seguro Popular	Pemex Defense or Marine
Casas	4,423	836	200	103	6	4	2,767
Llera	17,333	2,126	3166	1138	39	20	10,917

Source: INEGI. 2010. Population and Housing Census.

IV.2.5.5. Housing

The municipality of Casas registered for the 2010 Census, 1,170 inhabited houses, presenting deficiencies in terms of utility coverage, mainly with regards to drainage covering only 15% of the houses and 63% have piped water service from the public network.

As for the municipality of Llera, 5,064 houses were registered and although they have better coverage in terms of utilities, drainage is deficient for it only covers a little more than 48% of houses with this service.

Table IV.54 Houses with services in the municipalities integrating the SAR

Municipality	Inhabited houses			
	Total (No.)	Electricity (%)	Piped water from the public network (%)	Drainage (%)
Casas	1,170	87.82	63.04	15.35
Llera	5,064	93.53	89.12	48.30

Source: INEGI. 2010. Population and Housing Census.

IV.2.5.6. Communications infrastructure

Casas has a 79 km-long Victoria-Soto La Marina Road as main road axis, working as the main line to the different communities composing the municipality; however, there is no rural road network in good conditions, which makes transportation of inhabitants and products inappropriate. (SEGOB, et al, s/f)

In Llera, the main roads are national roads No. 80 and 85 going from Ciudad Victoria to Tampico and from Victoria to Mante, respectively. Road No. 81, starting from the Head Municipality of Llera, enables communication with communities to the Southeast of the State. Likewise, it has railroad infrastructure crossing the middle portion of the municipality and a rail station called Zaragoza Station. (SEGOB, et al, s/f)

Figure IV.22. View of the railway crossing the middle portion of the municipality of Llera

IV.2.5.7. Economic activities

In Llera and Casas the main activity is agriculture and the main crop is grain sorghum, followed by white grain corn. As for fruit crops there is mango, orange, lime, plum, papaya, sugar cane and vegetables such as nopal verdulero, onion, tomato, watermelon, melon and serrano chili pepper. Currently, there are alternative crops such as agave tequilero and aloe. (Municipal Council for Sustainable Rural Development of Llera Tamaulipas. s/f).

Table IV.55 Production of main crops, 2011

Crops	Surface (hectares)		Production value thousands of pesos
	Sowed	Harvested	
Municipality of Casas			
Grain sorghum	37,211.00	30,961.00	116,494.20
Green grass and meadow	1,770.00	1,770.00	11,580.00
Safflower	340.00	340.00	850.00
White grain corn	120.00	120.00	504.00
Italian lime	105.00	105.00	5,250.00
Municipality of Llera			
Grain sorghum	8,750.00	6,100.00	38,545.00
Valencia orange	2,919.67	2,919.67	100,529.32
White grain corn	3,550.00	2,830.00	14,553.0
Green grass and meadow	1,238.92	1,238.92	4,088.44
Mexican lime	692.30	675.00	14,701.50

Source: Agricultural, Farming and Fishing Information Service (SIAP).

- ***Livestock farming***

In both municipalities the livestock farming activity is developed, mainly bovine and porcine. Honey production is also relevant.

Table IV.56 Production in tons of live cattle, 2011

Species/ Product	Production in tons		Production value (thousands of pesos)	
	Casas	Llera	Casas	Llera
Bovine	4,012	3,062	58,235	41,961
Porcine	115	1,040	1,840	16,540
Ovine	39	170	732	3,159
Goats	61	119	1,214	2,383
Birds	35	4	471	61
Egg	1	3	13	38
Honey	13.341	111.036	555	4,591
Milk	74	60	452	359

Source: Agricultural, Farming and Fishing Information Service (SIAP).

The following table presents a synthesis of the main economic activities developed in the two municipalities.

Table IV.57 Main economic activities developed in the municipalities integrating the SAR

Municipality	Economic activities
Llera	Agriculture: harvesting basically corn, beans, sorghum, citrus fruits, mango, avocado and sugar cane. Also honey from hives is produced. Livestock farming: the main production is bovine cattle (mainly creole, brahman and holstein), followed by goat, equine, ovine and porcine cattle. Mining: the following minerals are exploited: gold, silver, zinc, lead, copper, antimony and mercury, at a low scale. Tourism: among the main attractions we find the El Módulo dam where bass can be fished. The old Hacienda del Forlón, its temple and plaza also offer tourist attractions. Among the architectural monuments we may find Nuestra Señora del Rosario, which construction began late XVIII Century; Ex-Hacienda La Clementina, built on the late XIX Century. At the La Angostura ejido property one can observe some bases used by Janambre Indians for the construction of their houses within the region. Industry: the industrializing plant of vegetable products, processing thousands of tons of citrus fruits is the main feature. Likewise, the juice of cane is extracted to prepare powdered brown sugar (piloncillo) sweet. Trade: the trade of products is mainly domestic and stores of the public, private and cooperative sector.

Municipality	Economic activities
	Services: there are restaurants, hotels, gas stations, tire repair shops, repair shops and clinics.
Casas	Agriculture: the most important activity in the municipality. Its main crops are: sorghum and grass and Italian lime, in addition to agave, safflower, beans, grain corn, orange and grapefruit. Livestock farming: it is developed on pasture and the most important species is bovine, followed by porcine and ovine. Industry: the industrial equipment of the municipality is concentrated in small transformation industries. Tourism: on the banks of the Vicente Guerrero dam we can find the tourist fields Croix, Escamilla, El Cristalino and El Dorado. Sport hunting takes place in August and October with west Peruvian dove; in December and January with white-tailed deer and in smaller proportion the turkey in April and anatidae (goose and duck) in November and February. Trade: the commercial hub is located mainly in the Head Municipality where products managed are basic products sold in convenience stores, corner shops and candy shops.

Source: www.oeidrus-tamaulipas.gob.mx

IV.2.5.8. Marginalization Rate

Social marginalization is defined as the situation of a human population that has been left out of services to which the society in general is entitled. Said services are basic services such as availability of water at home, access to drainage and availability of electric energy. For the appropriate development of every person educational services must provide the necessary educational level which, if not provided with enough coverage, foster illiteracy, one of the main indicators of social marginalization. It is also important to consider economic income and other aspects arising from the dispersion of human settlements, which hinders the establishment of basic infrastructure works for communities. (CONAPO, 1995).

The marginalization rate is a measure-summary that enables to differentiate municipalities and communities according to the global impact of needs suffered by the village and measures its spatial intensity as percentage of population not enjoying the benefits of goods and services essential for developing their basic skills. The integration of the rate per municipality takes into account four structural dimensions of marginalization: lack of access to education, insufficient perception of monetary income and residing in small communities. It also identifies nine forms of exclusion.

According to the 2010 Marginalization Rate, both the municipality of Casas and de Llera suffer medium marginalization.

Table IV.58 2010 Marginalization rate

Municipality	Marginalization rate	Place in State context
Casas	Medium	9
Llera	Medium	4

Source: CONAPO. 2010. Marginalization Rate.

When doing a more detailed analysis on indicators it can be observed that the main deficiencies appear on the educational level where more than 35% of the population did not complete primary education. With regards to the house services, the deficiency in coverage of water is emphasized mainly in Casas, where 37% of houses do not have piped water; this is especially serious given the climatological conditions of the area.

Table IV.59 2010 Marginalization indicators

Municipality	Population		Occupants		
	Illiterate of 15 years of age and above (%)	Without complete primary studies of 15 years of age and above (%)	In houses without drainage or sanitary services (%)	In houses without electric energy (%)	In houses without piped water (%)
Casas	9.50	38.36	3.47	8.68	37.33
Llera	9.70	36.53	2.06	5.31	10.19

Source: CONAPO. 2010. Marginalization Rate.

The overcrowding level in houses is also high, for 47% of houses in the municipality of Casas and 39% in Llera show some level of overcrowding. As for the income level, more than 65% of employed population regarding income level in both municipalities more than 60% of employed population receives only up to two minimum wages.

Table IV.60 2010 Marginalization indicators (continues)

Concept	Houses with some level of overcrowding (%)	Occupants in houses with dirt floors (%)	Population in communities with less than 5,000 inhabitants (%)	Employed population with income of up to 2 MW (%)
Casas	47.64	7.19	100.00	68.22
Llera	39.08	8.22	100.00	63.93

Source: CONAPO. 2010. Marginalization Rate.

IV.2.6. ENVIRONMENTAL DIAGNOSIS

IV.2.6.1. Physical environment

The SA is located in the middle part of the state of Tamaulipas partially encompassing the Sierra Madre Oriental and the Sierra de Tamaulipas, to the west and east, respectively, and in the central part it is composed by an area of plateaus of which La Mesa La Sandía, La Paz and Las Chinas stand out for their approximate height of more than 400 m ASL.

According to the Köppen climatic classification system modified by García, two types of climates in the Environmental System, warm sub-humid and warm humid with variations which are described in the following table are logged. The Project Area shows a semi-warm sub-humid climate.

The wind rose shows that the wind pattern is bi-directional with an angle of 180 degrees apart, the prevailing wind is from the south approximately 67% of the time. Although the prevailing wind is from the south most of the time, the energy contained in the northern winds is greater, therefore, the energy generated in the two predominant wind directions is similar.

The only meteorological event that directly crossed the Environmental System was the Tropical Storm registered on September 7, 1921 with top wind speed of 96.54 km/s.

The Environmental System is located in the Coastal Plain Physiographic Province of the Gulf; it covers most of the state and is characterized by the presence of two sedimentary basins where Paleogene-Neogene rocks composed mainly of shales and sandstones were deposited. The portion corresponding to the Sierra Madre Oriental concentrates the higher density of faults and fractures with preferential orientations NE-SW and NW-SE, some of them noticeably N-S.

The relief features of SA are determined by the foothills of Sierra Madre Oriental to the west where above 1500 m elevations are reached and Sierra de Tamaulipas to the east with maximum elevations of 800 m.

According to the soil classification system of INEGI in the Environmental System eight types of soils were identified: Cambisol, Chernozem, Feozem, Fluvisol, Litosol, Regosol, Rendzina and Vertisol. Calcaric regosol and Pelic vertisol are predominant in the Project area.

The SA is located in two hydrological regions RH25 Soto La Marina-San Fernando and RH 26 Panuco, two water basins called Rio Soto La Marina and Tamesis River. The presence of the Guayalejo River stands out in the SA, which is continual while the rest of the rivers and streams are intermittent.

The three aquifers encompassing the SA do not present over-exploitation and/or pollution issues according to data published by CONAGUA.

IV.2.6.2. Biotic environment

- ***Vegetation***

In the SA, eleven land uses and vegetation were identified according to the charter of land uses and vegetation of INEGI series IV, which shows that the submontane scrub predominates, followed by rainfed agriculture; the same situation is repeated for the Project Area.

In the Project Area three types of vegetation were found. The submontane scrub which is predominant, and deciduous lowland forest and low thorny deciduous forest.

Table IV.61 Main characteristics of the types of vegetation found in the Project Area

Vegetation Type	Predominant species	Diversity
Submontane scrub	At Mesa La Sandía 20 tree species were found, and the predominant were *Cordia boissieri and Phithecellobium flexicaule and Neopringlea integrifolia*. At Mesa La Pas a total of 39 species was registered and predominant species are *Pithecellobium pallens, Diospyros texana and Esenbeckia berlandieri*.	The mesas La Paz and La Sandía show similar diversities and are very homogenous in terms of species abundance.
Deciduous lowland forest	This vegetable community is preferably set on the slopes that are exposed to winds from the northeast, on stony soils and steep terrain. A total of 10 species were recorded, from which *Neopringlea integrifolia, Phitecellobium flexicaule and Prosopis glandulosa* are predominant.	The diversity index calculated indicates that this community shows a moderate diversity.
Low thorny deciduous forest	A total of eleven predominant species were registered, including *Heilietta parvifolia, Phitecelllobium flexicuale and Prosopis glandulosa*	In general, diversity calculated for the low thorny deciduous forest regarding submontane scrub and deciduous lowland forest was lower due to the high frequency and abundance of *H. parvifolia* and *P. glandulosa*.

<u>Species of vegetation in conservation status</u>

In the 50 sampling sites, no plant species were recorded in conservation status according to NOM-059-SEMARNAT-2010. However, it is important to note that during the field visits, the presence of the species Beucarnea recurvada *(Elephant's Foot) was detected, which is in the endangered category. This species was observed on the slopes of the plateaus, in the deciduous lowland forest and the low thorny deciduous forest in the northeastern and southeastern parts of the polygon, so the probability of finding it in the areas affected by the project is very low.*

- ***Fauna***

As a result of the field work and literature reviews, a potential list of 565 species was obtained. The greatest richness is presented by the birds group, including 62% of the species followed by land mammals with more than 13%.

Table IV.62 Number of fauna species with potential distribution in the SAR

Vertebrate Group	Species with potential distribution in the SAR	
	Number	(%)
Amphibians	28	5.0
Reptiles	65	11.5
Birds	350	61.9
Terrestrial mammals	76	13.48
Chiroptera	45	8.0

Species of terrestrial fauna in conservation status

101 species of fauna were detected in total in the environmental system under conservation status as per the NOM-059-SEMARNAT-2010, of which 9 are endangered species, 29 are threatened and 63 under special protection. The group with the highest number of species is birds, followed by reptiles, terrestrial mammals, amphibians and bats (chiroptera). It is noteworthy that these species are species with potential distribution within the area, but this does not mean that there are records of said species within the polygon of study. During the staff's trips, only traces were detected for some of them.

Table IV.63 Number of fauna species with potential distribution in the SA under conservation status according to NOM-059-SEMARNAT-2010.

Group	Total species	Endangered	Threatened	Special protection
Amphibians	12	1	2	9
Reptiles	26	--	10	16
Birds	45	2	8	35
Terrestrial mammals	13	6	5	1
Chiroptera	5	--	3	2

The most relevant are endangered land mammal species for they include four felines such as the jaguar which has been registered both in the SA and the Project Area.

- ***Monarch butterfly***

Considering that the Project is located in the state of Tamaulipas, two potential distribution models were applied to determine if the Project Area is located in the migratory route of monarch butterflies, for there are currently no sufficient data available to determine so.

According to the results obtained from the models applied, it would be expected that the incidence of monarch butterflies during both migrations (spring and autumn) in the Project Area be minimum due to low levels of climatic affinity. Although precipitations agree with the general pattern of the species, this is not the case for the dominant condition of warm temperatures. However, it should be mentioned that the areas adjacent to the SA presenting a certain degree of affinity and adaptation were the Sierra Madre Oriental and Sierra de Tamaulipas representing a series of climatic conditions favorable for potential distribution during migrations of *D. Plexippus*.

IV.2.6.3. Socio-economic environment

The SA is located in the municipality of Tamaulipas and encompasses the municipalities of Llera and Casas. According to the 2010 population and housing census the municipality registered a population of 4,423 persons while the population of the municipality of Llera amounted to 17,333 inhabitants. When performing the historical growth analysis of the population it can be observed that both municipalities show a positive general trend. Only for the period of 2000-2005 a decrease was registered.

According to the 2010 Marginalization Rate, both municipalities, Casas and Llera, have medium marginalization. The main deficiencies appear on the educational level where more than 35% of the population did not complete primary education. With regards to utilities, the deficiency in coverage of water is emphasized mainly in Casas, where 37% of houses do not have piped water; this is especially serious given the climatological conditions of the area. The overcrowding level in houses is also high, for 47% of houses in the municipality of Casas and 39% in Llera show some level of overcrowding. As for the income level, more than 65% of employed population regarding income level in both municipalities more than 60% of employed population receives only up to two minimum wages.

In Llera and Casas the main activity is agriculture and the main crop is grain sorghum, followed by white grain corn. As for fruit crops there is mango, orange, lime, plum, papaya, sugar cane and vegetables such as nopal verdulero, onion, tomato, watermelon, melon and serrano chili pepper. Currently, there are alternative crops such as agave tequilero and aloe.

The SA has high quality landscape because it presents good vegetable coverage constituted mainly by submontane scrub and deciduous and thorny forests, especially the highest parts composed by the Sierra Madre Oriental, the Sierra de Tamaulipas and the Tres Mesas which also add a singularity aspect to the landscape.

In the lowest parts, the landscape has been modified by the establishment of communities, communications infrastructure and agricultural and farming areas which have eliminated the vegetable coverage.

IV.2.6.4. Integrated diagnosis

According to the OECD, an environmental indicator is a parameter or value resulting from parameters providing information to describe the state of a phenomenon, environment or area with a meaning that goes beyond the meaning related to the value of the parameter itself. (SEMARNAT. 2005. Basic Indicators of Environmental Performance in Mexico). Impact indicators must meet at least the following requirements:

- Relevant: information given is significant on the magnitude and relevance of the impact
- Reliable: representative of the impact to be measured
- Exclusive: that is, that its value involves mainly the impact to be measured and no other factors
- Feasible: identifiable and quantifiable (even if we must not be obsessed by the fact of quantifying everything, for one can always resort to semi-quantitative categories or qualitative measures).

The following table shows a description of the current state of each environmental component for the physical, biotic and socio-economic environment.

Table IV.64Environmental System Diagnosis

Environmental component	Indicator	Current state of environmental component
Physical environment		
Climate	Microclimate modification	The microclimate has been modified in the areas cleared of vegetation for the development of agricultural and livestock activities.
Air quality	Presence or absence of atmospheric emissions sources.	There are no relevant sources of emissions of pollutants into the atmosphere; probably the only relevant emission is the emission of dust from cleared areas, mainly agricultural areas.
Noise and vibrations	Presence or absence of noise emissions sources.	No important sources of noise were detected, except for those produced by vehicles on the road and the railroad.
Surface hydrology	Presence or absence of pollution in rivers and water bodies.	Rivers and streams existent at the ES and Project Area are intermittent and no pollution was detected; probably Guayalejo River presents pollution issues because irrigation agriculture is developed on its riverbeds.
Underground hydrology	Current state of aquifers (over-exploited and under-exploited)	The three aquifers encompassing the SA do not present over exploitation and/or pollution issues according to data published by CONAGUA.
Geomorphology	Relief modification	The relief of the SA does not show relevant modifications, only in the areas where roads have been built in areas with steep slopes.
Land	Presence or absence of erosion and/or pollution	Areas featuring erosion were detected in a very precise way and sometimes landfalls during rain season, especially due to construction of roads in areas with steep slopes.
Biotic environment		
Vegetation	Conservation state	Predominant vegetation in the SA is submontane scrub presenting good coverage

Environmental component	Indicator	Current state of environmental component
		and degree of conservation. Main disturbances to vegetation in the SA have appeared on the plain due to clearing and grubbing for development of agricultural and livestock activities.
	Species under conservation status according to NOM-059-SEMARNAT-2010	We found *Beucarnea recurvata* species known as elephant's foot which is in the threatened category.
Fauna	Number of species	101 species of fauna were identified in total under conservation status as per NOM-059-SEMARNAT-2010, of which 8 are endangered species, 29 are threatened and 63 under special protection. The group with the highest number of species is birds, followed by reptiles, terrestrial mammals, amphibians and bats (chiroptera). The presence of four species of felines under conservation status was noted: jaguar, jaguarundi, ocelot and oncilla, besides noticing trails of puma and lynx, although these last two species are not under protection status.
	Species under conservation status according to NOM-059-SEMARNAT-2010	101 species of fauna were identified in total with potential distribution in the SA, under conservation status according to NOM-059-SEMARNAT-2010, of which 8 are endangered species, 29 are threatened and 63 under special protection.
Socio-economic environment		
Landscape	Decrease of landscape quality	Decrease of the landscape quality is due only to clearing and grubbing of vegetation for development of agricultural activities, which take place on the plain surrounding the plateaus.
Demography	Growth rate	Even if the growth rate in the two municipalities is positive, there has been no significant increase.
Marginalization	Marginalization Rate	The municipalities of Llera de Canales and Casas show medium marginalization rates. The main deficiencies, among others, are low salaries, low educational levels, deficiency in water and drain services.