Huila 2050

Preparándose para el cambio climático

CONCEPTUAL AND METHODOLOGICAL FRAMEWORK FOR THE ANALYSIS OF VULNERABILITY TO CLIMATE CHANGE

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This study contains the conceptual and methodological proposal to analyze vulnerability to climate change in Huila Department, following the concepts and definitions adopted by the Inter-Governmental Panel on Climate Change (IPCC), which establishes the exposure, sensitivity, adaptive capacity and variables of a territory in order to define its vulnerability. The structure of this proposal makes it possible to assess the vulnerability in different analysis units which include, in this case, the vultnerability of the Department and the differentiated vulnerability of its 37 municipalities. This analysis facilitates the creation of development options compatible with the climate, establishing the bases on which to promote adaptation and mitigation measures within the framework of the formulation of Plan Huila 2050: Preparing for Climate Change.

In general terms, it has been found that the increase in temperature and the demand for water, together with the reduction in rainfall are, among other situations, proof that Huila Department is not free from the effects of global climate change. According to the IDEAM's projections for 2040, it is possible to conclude, in general, that the temperature will increase by close to 2°C in 75% of the Department, precipitation will fall by 67%, and even that certain ranges of precipitation above 2,500 mm per annum will disappear. These changes, added to the loss of natural vegetation coverages and the reduction in bio-diversity, have caused considerable environmental impacts which have placed this Department on alert. The increase in productive activities and the politico-economic and social conflicts test Huila's adaptive capacity to take up this challenge. Thus, in spite of there being differences among municipalities in the aspect of exposure to climate change, it is the sensitivity and adaptive capacity factors of each municipality that determine its vulnerability.

Based on the vulnerability analysis, it has been noted that the municipalities of Guadalupe, Tarqui, Agrado, Aipe and Acevedo have a degree of vulnerability between very high and high and they will, therefore, be the ones most likely to suffer the adverse effects of climate change. By contrast, the vulnerability of the municipalities of Pitalito, Pital, La Argentina, La Plata, Tesalia, Iquira, Teruel, Santa Maria, Villavieja, Baraya, Rivera, Campoalegre and Gigante is low or very low, while vulnerability of the other 19 municipalities is medium. The factors which most influence the differences in municipal vulnerability are the degree of runoff and the Environmental Sensitivity Index (ESI), both of them sensitivity measurements, the Living Conditions Index (LCI), the Fiscal Performance Index (FPI) and representativeness with regard to the inclusion of the different ecosystems in the protected areas systems, all of the latter being measurements of adaptive capacity. It is important to bear in mind that Huila Department has great opportunities for both adaptation to, and the mitigation of climate change, such as the presence of large and extensive forest masses and high barren plateaux on the high mountain range and in the south of the Department, the network of protected areas and its growing capacity for political, social and economic management of the Departmental Government

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INTRODUCTION

This document presents the conceptual and methodological framework used to analyze Huila Department's vulnerability to climate change, within the framework of the Huila 2050 project: Preparing for Climate Change. It sets out an approach to determining the vulnerability of the territory based on the integration of abiotic, biotic and socio-economic information, with emphasis on the nature of potential impacts and adaptive capacity, which, in turn, facilitate optimization of decision taking and the assessment and, understanding of the characteristics of the territory.

The document is structured in three chapters. The first chapter describes the conceptual framework for the analysis and the municipal level, identifying the necessary indicators in terms of potential impacts (exposure and sensitivity) and adaptive capacity. The latter component was structured in four dimensions: **i) socio-cultural; ii) politico-institutional, iii) economic-productive and iv) biophysical**.

Chapter 2 describes the methodological framework for the calculation of vulnerability to climate change, detailing each of the indicators used to determine the potential impact on the territory and its adaptive capacity. Each indicator is detailed in terms of its definition, importance, source of the respective information, the mathematical calculations used and the results obtained for each one. All of this has allowed us to determine these two variables.

Finally, Chapter 3 describes the analysis of the potential impact and adaptive capacity of the Department, which allowed us to determine the vulnerability of the territory and to reach our conclusions and make our recommendations regarding the relative vulnerability of each municipality and the factors that influence vulnerability at departmental level.

Municipality of La PLata

The general conceptual framework proposed to gain an understanding of vulnerability to climate change in Huila Department follows the concepts and definitions adopted by the IPCC in 2001, according to which the exposure, sensitivity, and adaptive capacity are the variables that define the vulnerability of a territory. Therefore, we began by estimating the degree of **exposure** to the climatic threats of the territory, which are acquired through the construction of the climatic change scenarios over time, and the **sensitivity** of the formative of the territory which, taken all together, give rise to the potential impacts on a territory.

Adaptive capacity is measured by a mult-criteria temporary space sustained in 4 dimensions: biophysical, economic–productive, socio-cultural and politico–institutional (Figure 1). These elements are assessed and incorporated into the model in order to provide an estimate of territorial vulnerability to climate change. The structure of the model makes it possible to emphasize evaluation of the vulnerability of different analysis units which, in the case of this project, are the municipalities.

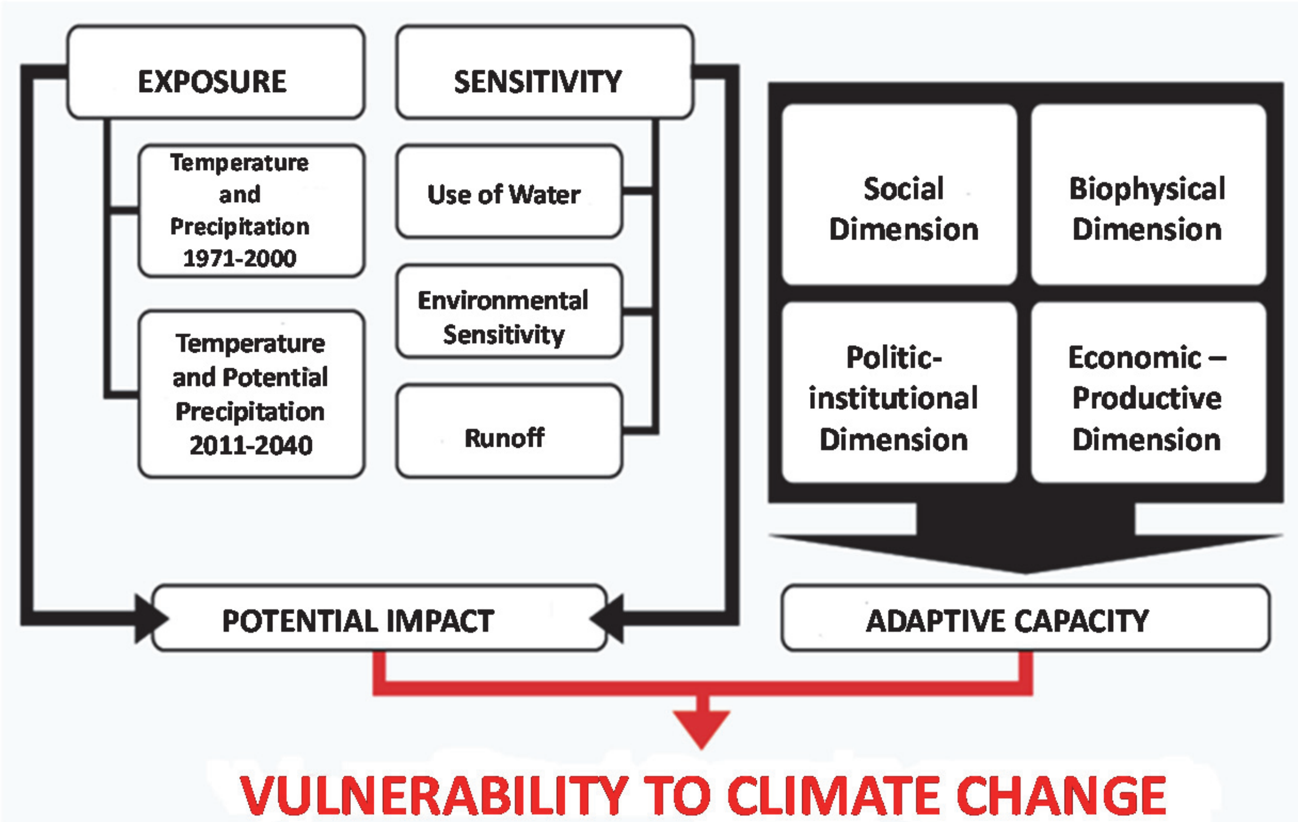


Figure 1. Conceptual framework to determine the vulnerability to climate change in Huila Department

In the first instance, in each analysis unit (municipalities) the level of **exposure** is identified on the basis of present and potential scenarios to 2011 – 2040 of changes in temperature and precipitation. In addition, we identify **sensitivity**, understood according to the biophysical characteristics of the territory in terms of use of water, run-off and environmental sensitivity, which demonstrate the present scenario. Later, these elements (exposure and sensitivity) are interrelated in order to define the potential impact or the difference between the present average and what is being projected.

Parallel to the foregoing, the process of evaluating **adaptive capacity** is begun by focusing on four dimensions: i) **socio-cultural** , in which the demographic aspects and quality of life are analysed and serve as an instrument of knowledge that allows us to describe, compare, explain and predict a social phenomenon or a society; ii) **politico–institutional**, which refers to those decisions that are established as a guide for the members of the State and serve to examine the performance of governmental management of the factors and actors who participate, from society in the natural government–citizen relationship ; iii) **economic-productive** relationship which includes the production, trade in and consumption of goods and services, conditions of the productive factors, the existing economic infrastructure and conditions of demand, and; iv) **biophysical** in the ecological processes and/or biodiversity, which include the natural environment in the aspects of natural resources, technological processes, life support conditions and biodiversity. It is these dimensions that will determine the way in which the territory is prepared to deal with climate change in the region.

For the purposes of this study, we decided to measure the performance of each municipality in each indicator in a manner relative to the other municipalities, as no information is yet available that relates each indicator quantitatively to the degree of vulnerability. This analysis also assumes that each indicator has the same weight. This methodology allows us to add up the relative performance of each indicator in the municipality, in line with the concept that high vulnerability is the result of high impact potential and low adaptive capacity. This sum for each municipality was then compared with those of other municipalities in order to organize them in terms of their relative vulnerability. It is possible to identify the most vulnerable municipalities on the basis of the results of this analysis.

While the most vulnerable municipalities will need special attention from the highest authorities (Department, nation), it is difficult to develop a common strategy to serve both these and other municipalities of the Department without identifying which indicators have contributed most to the resilience of the municipalities. To obtain this information it was necessary to carry out statistical analyses of grouping and principal components. according to these analyses, the municipalities are grouped in terms of the behaviour of their indicators and the importance of each of these is identified by separating the behaviour clusters. The results are complementary to those of the analysis described above, as they did not directly identify the most vulnerable municipalities, but rather contributed to identifying the factors which most influence vulnerability and which can thus contribute to the development of regional strategies and policies that help all the municipalities to strengthen their resilience.

1.1 Study area

Huila Department is located between 3° 55’ 12” and 1° 30’04” N and 74° 25’24” and 76° 35’16” W in an altitude range from 15 to 4,300 metres above sea level. It is located in the south-west of the country between Cundinamarca, Tolima, Cauca, Caqueta and Meta Departments. In the extreme north, It is located in the source of the River Riachon (municipality of Colombia); while in the extreme south it is located on Pico de la Fragua (Municipality of Acevedo). The western border is in the municipality of San Agustin on the Papas high barren plateau, the Colombian Massif and to its extreme east between the Las Oseras highland, the eastern mountain range in the municipality of Colombia, covering a surface area of close to 19,890 km^2, equivalent to 1.7% of the entire country. In its interior, there are 37 municipalities and 4 districts where close to 1,200,000 of Colombian inhabitants are located (Figure 2). According to the 2011 – 2023 Huila Department Regional Environmental Management Plan, it is subdivided into four regions: the Northern region with 15 municipalities, covering almost half Departmental territory, the Southern zone with 9, the central zone with 8 and the western zone with 5, respectively. The municipalities of the point of reference for the development of this conceptual framework and form the analysis units used to assess vulnerability to climate change in the Department.

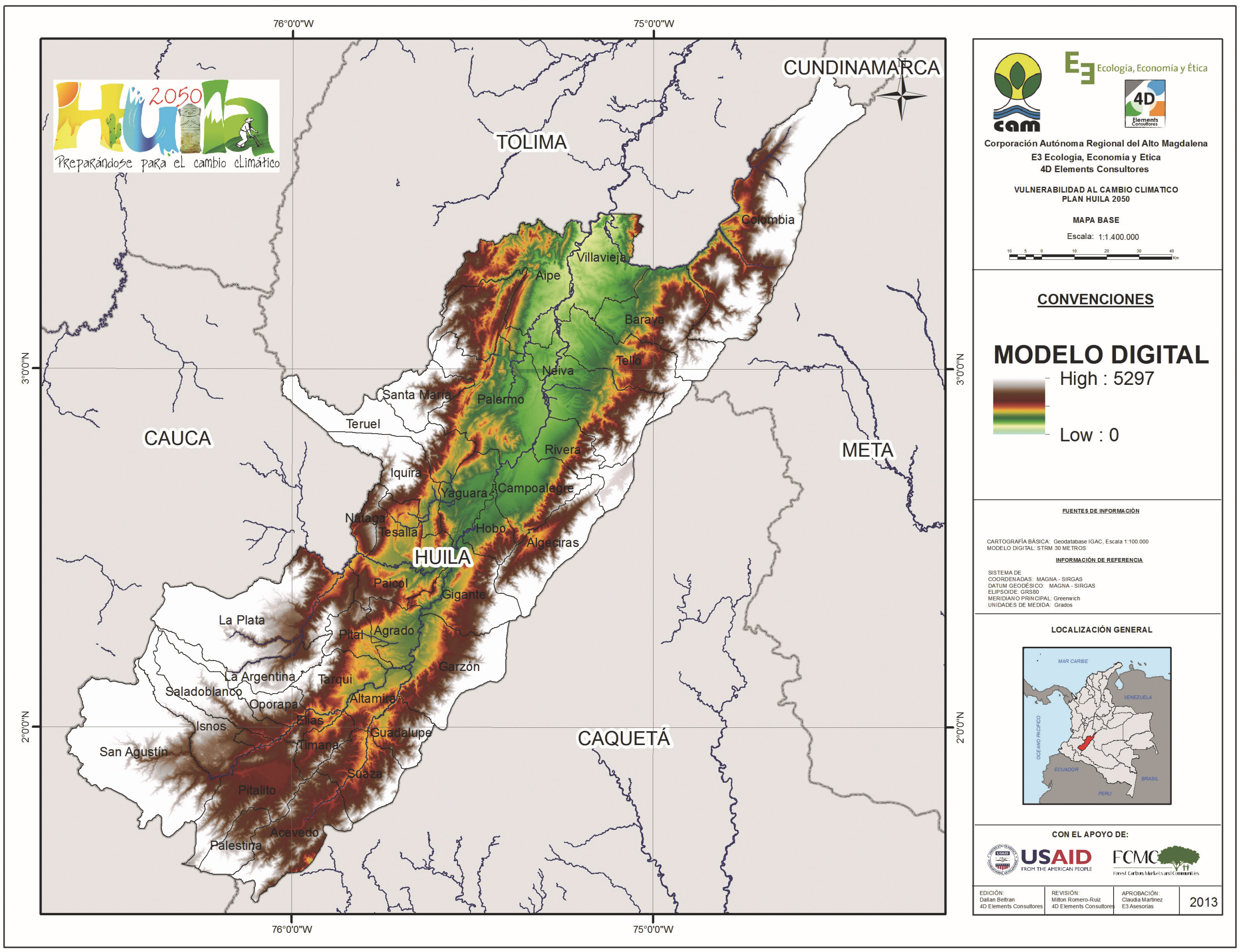


Figure 2. Digital model of land and Politic-Administrative Division of Huila Department.

Municipality of Nataga

As mentioned in the conceptual framework, the vulnerability analysis model is based on the definitions proposed by the IPCC (2001), according to which vulnerability to climate change is a multi-dimensional concept, which, in turn, is a function of exposure, sensitivity and adaptive capacity (IPCC 2001).

2.1 Potential Impact

The potential impact of climate change is defined as the effects, whether beneficial, harmful or mitigatable, which can affect the normal functioning of the system and are therefore considered a "climatic threat". The potential impact is determined as a function of the exposure and sensitivity of a system.

2.1.1 Exposure

Exposure consists of the type and degree to which the system is exposed to climatic variations. In this study, it is analysed by means of a comparison of the present climate and the climatic change scenarios[1] that will have been caused by 2011-2040 by IDEAM (2010).

Climatic Scenario

A possible and normally simplified representation of climate towards the future, based on a series of consistent climatic ratios, which were constructed for use exclusively in the investigation of potential consequences of anthropogenic climate change, almost always for the creation impact models. Climatic scenarios are constructed using climatic models that estimate the effects on global temperature of the different representations of development into the future and their emissions of greenhouse gases (emission scenarios). These scenarios are based on the present situation in order to indicate the expected changes. The present climate is defined according to the average values of the principal climatic variables for the period from 1971 and 2000 and their variation. The scenarios are important inputs for the creation of climate change impact models on society and nature and to analyse the effects of mitigation and adaptation strategies.

[1] The climate models are numerical representations of the climatic system based on the physical, chemical and biological properties of their components, their interaction and reactive processes and the count of all or some of their properties. A climatic system can be represented by models of varying complexity. The models are used to create different scenarios, in accordance with suppositions regarding the future development model and the emissions it generates.

Present climate (1971 – 2000)

IDEAM’s official information was available for the description of the present climate and which resulted from the work carried out by (2010), which consisted of complementing the series of time month to month in the period 1971-2000 for approximately 3,241 rain stations, 685 temperature stations and 616 stations, which report relative humidity using the methodology proposed by Jones et al (2004). This methodology posits that, to recreate the climate at local points, statistical relationships between a re-analysis or a regional model can be established on the basis of observations in a given period. Validation of the present climate was according to the method of adjustments by least square minimums, and its being complemented by data was considered if, and only if, the correlation coefficients were zero point eight or more between the observations and the ERA40 model.

$$ERA40_{COR} \approx OBS = A + B * ERA40_{PRECIS}$$

In which A and B are constants, $ERA40_{PRECIS}$ are the results produced by the model and $ERA40_{COR}$ is the adjusted model, which must be approximated to the OBS observations. For this reason, the independent variable was always the result calculated by the *PRECIS* model, while the dependent variable was the data obtained from the IDEAM database (Ruiz, 2010). Figure 3 shows the averages of precipitation and temperature for the period between 1970 and 2000.

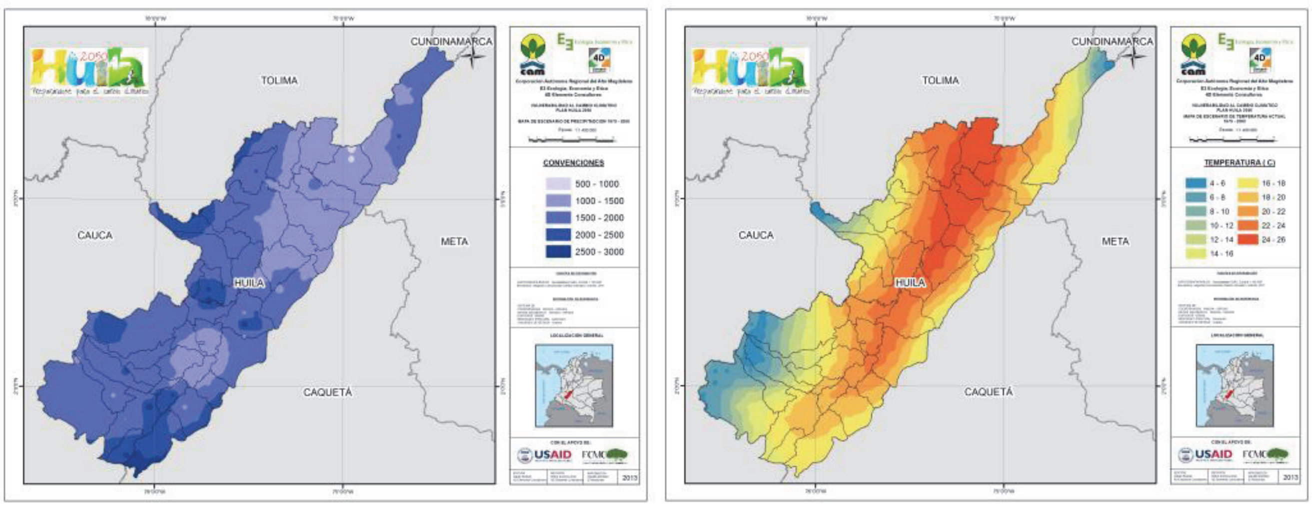


Figure 3. Averages of precipitation (a) and temperature(b) between 1970 and 2000

Climate change scenarios: 2011-2040

Although the climate change scenarios are based on the best scientific information available, they are still scenarios; the validity of their results depends on how close the suppositions of the models are to the development model to be followed, the amount of emissions that would be generated (validity of the emissions scenario used) and with respect to the ratio between emissions and climate variables. To reduce the risk of bias that the application of one single model would cause, IDEAM is using multi-model scenarios: it uses the averages of three different models to estimate future scenarios.

Three regional models were used to create climate change scenarios for Colombia: the Japanese high resolution global model GSM-MRI, with a horizontal resolution of 20kmX20km, *PRECIS* of the United Kingdom, with a horizontal resolution of 25kmX25km, and the WRF model with which results at 4kmX4km were produced for the Andean region. The technique selected to calculate regional climatic change was dynamic–statistical, which was used with high resolution results of the GSM-MRI and PRECIS models, in such a way that the statistical ratios between the regional models and historic data were constructed, taking into account the quality of the baseline information in line with the information put forward by Jones et al. (2004).

Finally, using a multi-model assembly, the results of the climatic averages for 2011-2040, 2041-2070 and 2071-2100 were produced for Temperature, Precipitation and Relative Humidity, using the results provided by the PRECIS model. However, according to discussions with IDEAM and taking into account that Huila 2050: Preparing for Climate Change, has its sights set on 2050, it was decided that 2011-2040 would be used for this study (Figure 4).

✓ **Calculations of the Indicator**

Description of the indicator: This expresses the average change in temperature or precipitation, weighted for the area in which it is projected that the change will occur.

Information for the calculation of changes in the area and the interpretation of change for precipitation and temperature in Huila Department correspond to the averages obtained by the multi-model assembly for each of the variables between the baseline 1971-2000 (t1) and the change scenario for 2011 and 2040 (t2). The temperature ranges are shown on 4^{o}C. For the baseline, they are between 4^{o}C and 26^{o}C, while for the change scenario, they are between 4^{o}C. and 28^{o}C, thus showing a tendency to an increase in temperature. As to precipitation, the ranges are shown in mm/year. The baseline ranges vary between 500mm/year and 3000mm/year, while for the change scenario they are from 500mm/year and 2500mm/year, that is with a tendency to a reduction in precipitation.

The measurement unit of this indicator is adimensional and varies between 1 (change) and 2 (no change). The extreme value 1 is obtained when the change in the temperature of the precipitation variable is low and shows no change in the area, while the value of the indicator comes close to 2 when the change in the variable between t1-t2 in the area of interest increases and its change is very high. To normalise this variable for each municipality, the percentage of the area in each category inside it is estimated and later multiplied by the range in time and the total of each category is added. Once this datum is standardized, a classification is established in accordance with the assignment of five quartiles (Tables 1 and 2).

Table 1. Classification of the ranges of variation in temperature between 1971-2000 and 2011-2040

Description	Qualification	Color
No variation in temperature is shown	1	Very Low
Low variation in temperature is shown	> 1.00 - < 1.19	Low
Medium variation in temperature	> 1.19 - < 1.23	Medium
High variation in temperature	> 1.23 - <1.31	High
Very high variation in temperature	> 1.31 - > 1.55	Very High

Table 2. Classification of ranges in variation in precipitation between 1971 and 2000 and 2011- 2040

Description	Qualification	Color
No variation in precipitation is shown	< 1	Very Low
Low variation in precipitation is shown	> 1 - < 1.27	Low
Medium variation in precipitation	> 1.27 - < 1.49	Medium
High variation in precipitation	> 1.49 - 1.63	High
Very high variation in precipitation	> 1.63 - > 1.96	Very High

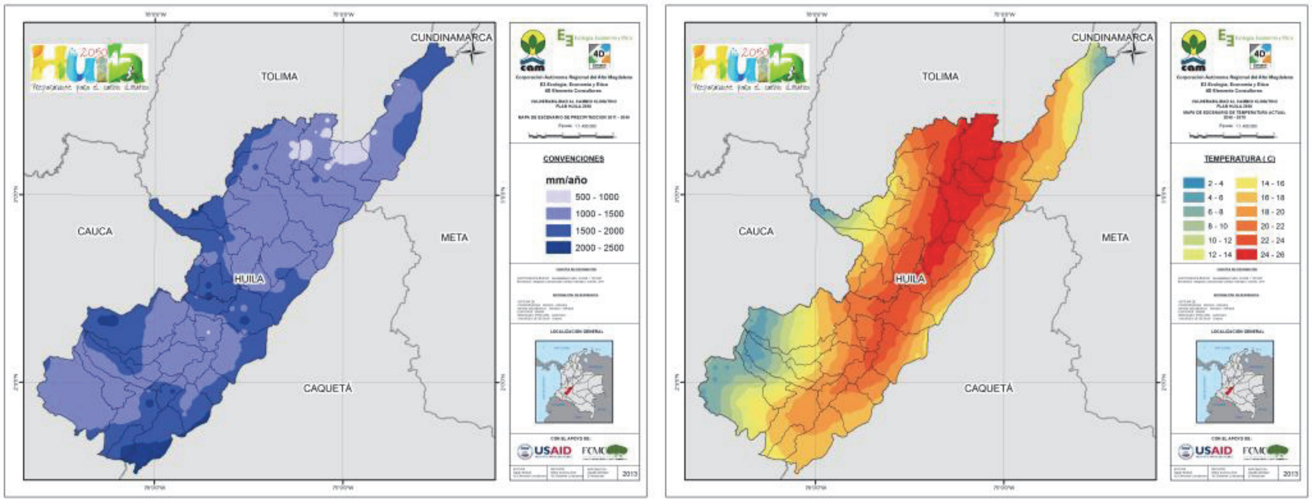


Figure 4. Precipitation scenarios (a) and temperature (b) between 2011 and 2040

✓ **Result**

Figure 5, shows the temperature change data for the period between 1970-2000 and 2011-2040. According to the results obtained, the municipalities with the highest temperature change values will be: Acevedo, Altamira, Guadalupe, Hobo, Palestina, Suaza, Tarquí and Timana and Suaza, these being the ones which show the highest change value, while the lowest value will be that of the municipality of Villavieja (Table 3). With regard to precipitation, the largest changes are projected for the municipalities of Acevedo, Isnos, Oporapa, Palestina, Pitalito, Saladoblanco, San Agustín, Teruel, Timaná and Yaguará, while those with the lowest values were Rivera and Tarquí (Table 3).

Table 3. Calculations of temperature change for the municipalities of Huila Department on the baseline scenario (1971 – 2000) versus the change scenario for the period 2011-2040.

Municipality	A. MPIO	No change 2040		Chance 2040		Normal	Cat.
	Ha	Ha	%	Ha	%		
Timaná	18.521	8.255	0.45	10.267	0.55	1.55	VERY HIGH
Tarqui	34.972	21.588	0.62	13.384	0.38	1.38	VERY HIGH
Suaza	43r.568	21.739	0.50	21.829	0.50	1.50	VERY HIGH
Palestina	22.345	13.940	0.62	8.405	0.38	1.38	VERY HIGH
Hobo	19.517	13.297	0.68	6.220	0.32	1.32	VERY HIGH
Guadalupe	25.329	15.509	0.61	9.820	0.39	1.39	VERY HIGH
Altamira	18.175	11.900	0.65	6.275	0.35	1.35	VERY HIGH
Acevedo	61.214	39.945	0.65	21.269	0.35	1.35	VERY HIGH
Yaguará	32.627	25.060	0.77	7.567	0.23	1.23	HIGH
Santa María	31.251	23.529	0.75	7.722	0.25	1.25	HIGH
San Agustín	135.695	103.497	0.76	32.197	0.24	1.24	HIGH
Saladoblanco	42.096	29.882	0.71	12.214	0.29	1.29	HIGH
Pital	20.231	14.275	0.71	5.955	0.29	1.29	HIGH
Nátaga	13.008	9.615	0.74	3.393	0.26	1.26	HIGH
La Plata	127.187	87.438	0.69	39.748	0.31	1.31	HIGH
La Argentina	32.059	23.016	0.72	9.042	0.28	1.28	HIGH
Isnos	39.990	29.507	0.74	10.483	0.26	1.26	HIGH
Garzón	68.060	51.659	0.76	16.401	0.24	1.24	HIGH
Elías	8.090	5.593	0.69	2.497	0.31	1.31	HIGH
Teruel	50.492	39.933	0.79	10.559	0.21	1.21	MEDIUM
Pitalito	63.374	48.558	0.77	14.815	0.23	1.23	MEDIUM

Municipality	A. MPIO	No change 2040		Chance 2040		Normal	Cat.
	Ha	Ha	%	Ha	%		
Oporapa	17.376	13.375	0.77	4.001	0.23	1.23	MEDIUM
Iquira	43.248	34.012	0.79	9.236	0.21	1.21	MEDIUM
Colombia	170.335	133.300	0.78	37.034	0.22	1.22	MEDIUM
Campoalegre	46.598	36.754	0.79	9.844	0.21	1.21	MEDIUM
Algeciras	56.648	44.582	0.79	12.067	0.21	1.21	MEDIUM
Agrado	26.036	20.064	0.77	5.972	0.23	1.23	MEDIUM
Tesalia	37.326	30.739	0.82	6.587	0.18	1.18	LOW
Tello	56.083	47.320	0.84	8.763	0.16	1.16	LOW
Rivera	36.943	29.748	0.81	7.195	0.19	1.19	LOW
Palermo	90.884	75.159	0.83	15.725	0.17	1.17	LOW
Paicol	27.888	23.128	0.83	4.760	0.17	1.17	LOW
Neiva	124.139	101.567	0.82	22.572	0.18	1.18	LOW
Gigante	53.592	46.179	0.86	7.412	0.14	1.14	LOW
Baraya	71.753	62.732	0.87	9.022	0.13	1.13	LOW
Aipe	80.219	71.851	0.90	8.367	0.10	1.10	LOW
Villavieja	54.531	54.352	1.00	179	0.00	1.00	VERY LOW

Table 4. Calculations of change in precipitation for the municipalities of Huila Department, on the baseline scenario (1971-2000) versus the change scenario for the period 2011-2040.

Municipality		No change 2040		Change 2040		Normal	
	Ha	Ha	%	Ha	%		
Acevedo	61.142	19.450	41.692	0.32	0.68	1.68	VERY HIGH
Isnos	39.979	1.856	38.123	0.05	0.95	1.95	VERY HIGH
Oporapa	17.376	4.848	12.528	0.28	0.72	1.72	VERY HIGH
Palestina	22.327	6.301	16.026	0.28	0.72	1.72	VERY HIGH
Pitalito	63.350	14.493	48.857	0.23	0.77	1.77	VERY HIGH
Saladoblanco	42.094	15.105	26.990	0.36	0.64	1.64	VERY HIGH
San Agustín	135.484	7.795	127.689	0.06	0.94	1.94	VERY HIGH
Teruel	50.388	12.606	37.782	0.25	0.75	1.75	VERY HIGH
Timaná	18.521	2.761	15.761	0.15	0.85	1.85	VERY HIGH
Yaguará	32.631	1.145	31.486	0.04	0.96	1.96	VERY HIGH
Aipe	80.011	29.610	50.401	0.37	0.63	1.63	HIGH
Hobo	19.517	7.498	12.019	0.38	0.62	1.62	HIGH
La Argentina	32.057	15.969	16.088	0.50	0.50	1.50	HIGH
La Plata	127.035	54.904	72.131	0.43	0.57	1.57	HIGH
Palermo	90.884	38.328	52.556	0.42	0.58	1.58	HIGH
Pital	20.233	9.179	11.054	0.45	0.55	1.55	HIGH
Santa María	31.201	11.798	19.403	0.38	0.62	1.62	HIGH
Agrado	26.036	17.825	8.211	0.68	0.32	1.32	MEDIUM
Baraya	71.699	50.464	21.234	0.70	0.30	1.30	MEDIUM
Elías	8.090	4.163	3.926	0.51	0.49	1.49	MEDIUM
Garzón	68.004	47.337	20.668	0.70	0.30	1.30	MEDIUM
Guadalupe	25.298	15.797	9.501	0.62	0.38	1.38	MEDIUM
Íquira	43.179	26.888	16.290	0.62	0.38	1.38	MEDIUM
Nátaga	12.933	6.612	6.321	0.51	0.49	1.49	MEDIUM
Suaza	43.550	22.124	21.426	0.51	0.49	1.49	MEDIUM
Tesalia	37.326	15.119	22.207	0.41	0.59	1.59	MEDIUM
Villavieja	54.429	39.271	15.158	0.72	0.28	1.28	MEDIUM
Algeciras	56.597	50.939	5.658	0.90	0.10	1.10	LOW
Altamira	18.175	17.521	654	0.96	0.04	1.04	LOW
Campoalegre	46.593	40.974	5.618	0.88	0.12	1.12	LOW
Colombia	170.034	130.735	39.300	0.77	0.23	1.23	LOW
Gigante	53.583	39.000	14.583	0.73	0.27	1.27	LOW
Neiva	124.114	90.523	33.591	0.73	0.27	1.27	LOW

Municipality		No change 2040		Change 2040		Normal	
	Ha	Ha	%	Ha	%		
Paicol	27.872	21.458	6.414	0.77	0.23	1.23	LOW
Tello	56.054	52.751	3.302	0.94	0.06	1.06	LOW
Rivera	36.909	36.909	0	1.00	0.00	1.00	VERY LOW
Tarqui	34.972	34.972	0	1.00	0.00	1.00	VERY LOW

Calculations of change between ranges showed that there is a change of areas between all the ranges where the areas of temperature ranges in °C are lower and increase or new ones arise with higher ranges, as in the case of change between the range of 24-26ºC to 26-28ºC over an area of 1496 Ha., where the last of these had not been recorded for the baseline (Table 5). Index

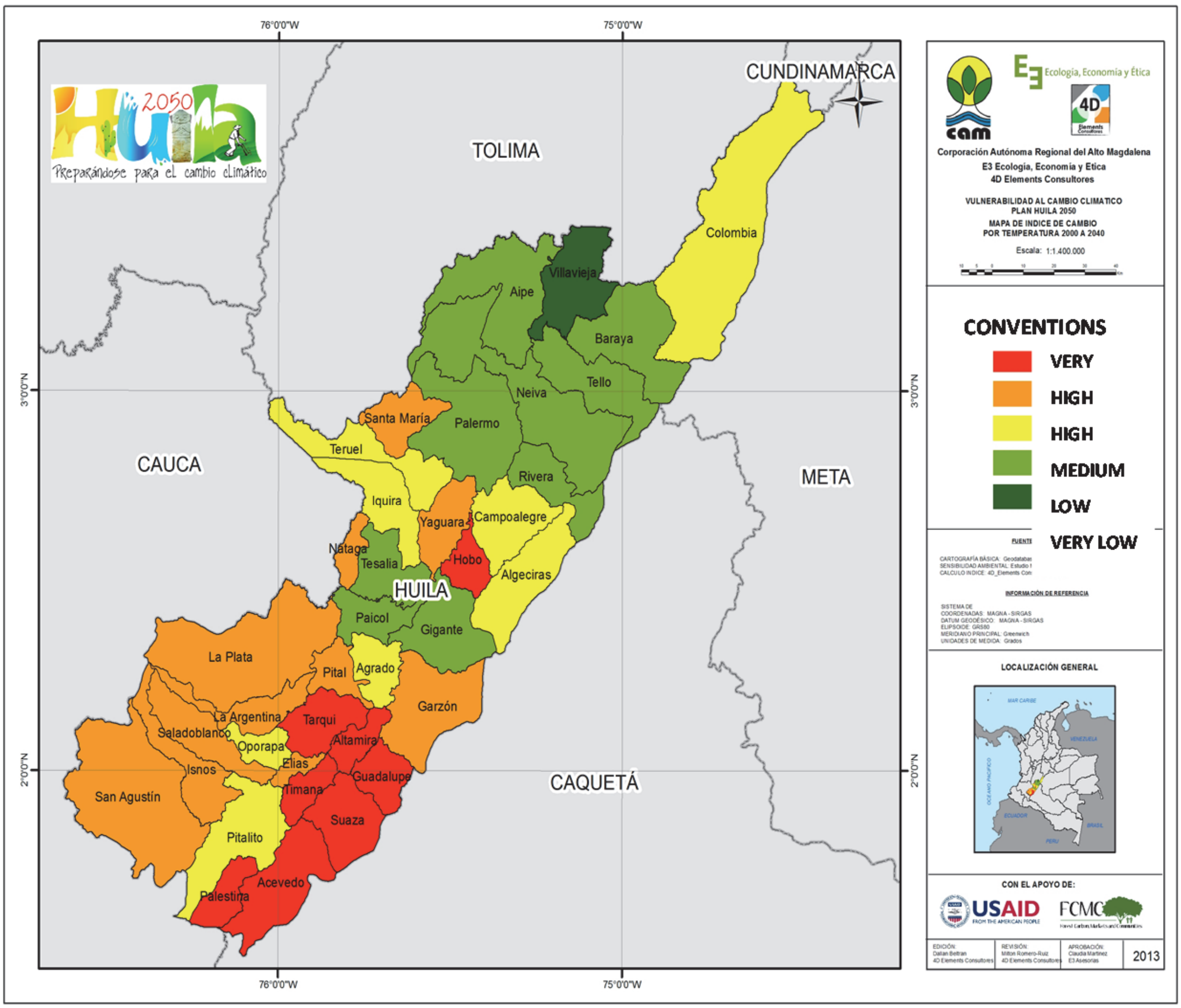


Figure 5. Temperature change Index Map 2000-2040

In the case of precipitation, figure 6 shows the changes in this variable within the periods analysed 1970-2000 and 2011-2040. According to the second communication from IDEAM on Climate Change, 78% of Colombia in the period 2011-2040 would show a variation of 10%, which is within the normal range. In addition, it is predicted that precipitation would be down by -30%, -10% as maximum values of reduction and this would be recorded in 20% of national territory for the period shown.

Table 5. Change in the temperature Range between the baseline scenario (1971-2000) versus change scenario for the period 2011-2040.

Present	2011-2040											
Range T ºC	4-6	6-8	8-10	10-12	12-16	14-16	16-18	18-20	20-22	22-24	24-26	26-28
46	12,189	29,384										
68		80,67	13,909									
810			41,793	11,386								
1012				41,015	18,76							
1214					66,278	28,615						
1416						100.164	55,627					
1618							225,239	100,701				
1820								246,312	78,06			
2022									199,349	65,086		
2224										239,131	35,771	
24 – 26											210,453	1,496

Huila is one of the Departments where events of reduction occur in precipitation in respect of the rainfall baseline. In 6 of the changes in precipitation, it was noted that the highest range, 2500-3000 mm/year, disappears for the 2011-2040 scenario, an alert in terms of availability of water for different sectors of the region.

Table 6. Change in the ranges of precipitation between the baseline scenario (1971-2000) versus the change scenario for the period 2011-2040.

Present	2011-2040			
Range (mm/year)	500-1000	1000-1500	1500-2000	20002500
5001000	283190			
1000-1500	4708923	52522711		
15002000		63207491	43907686	
20002500			20001687	3053303
25003000				2282757

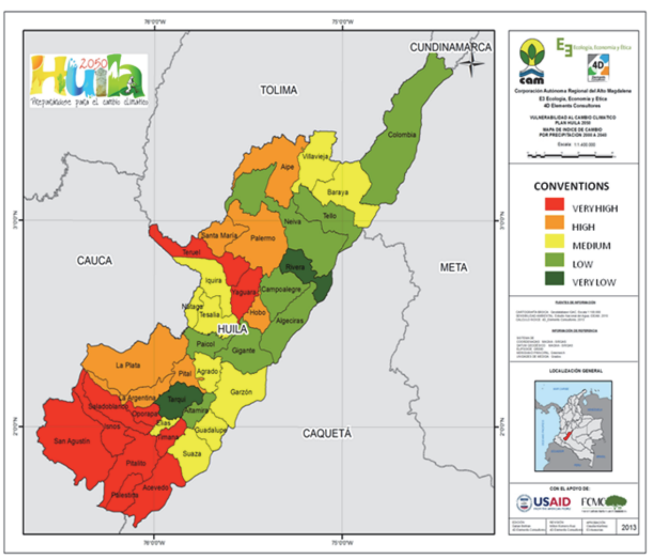


Figure 6. Map of Change in Precipitation Index 2000-2040.

2.1.2. Sensitivity

Sensibility is defined as the degree to which a system can be positively or negatively affected by stimuli relating to climate[2]. Sensitivity links the behavior of the system with climatic parameters in order to identify critical thresholds in relation to the climatic threat and exposure, which makes it possible to identify negative and positive impacts. It was proposed that the following indicators be used for their identification: Environmental Sensitivity Index (ISD), runoff and the use of water.

[2] Climate change vulnerability and adaptation indicators. Mike Harley, Lisa Horrocks and Nikki Hodgson (AEA), Jelle van Minnen (PBL). European Topic Centre on Air and Climate Change.

Environmental Sensitivity Index

✓ Definition

The Environmental Sensitivity Index (ESI) takes into account the susceptibility of the functioning and/or intrinsic conditions of the environment to be affectd by the climate. The intrinsic factors that can affect sensitivity are the quality of the soil (slopes and depth that affect sensitivity to erosion), aridity (precipitation minus evapo-transpiration), the type of ecosystem and the vegetal coverage (or lack of it).

✓ Importance

This indicator assesses the capacity of an environmental system to respond to the inherent conditions of the territory or analysis unit, because of its structure, function, composition and/or capacity to resist external or tensioning events**.**

✓ Obtaining information

The IDEAM methodology, in which the variables listed are described on Table 7.

Table 7. Variables, source, criteria and description of the variables to calculate the Environmental Sensitivity Index (ESI).

Variables	Source	Criteria	Description
Soils	IGAC 2005	% of Slopes	Characteristics of the landscape of the first order in regional physiography, which contribute to a general reading of the topography and hydrological variability elements that permit decisions to be taken, planning models to be implemented and management of environmental systems or environmental units.
		Actual Depth	
Aridity	IDEAM 2008	Precipitation	Hydrological variables that form part of the ratio of rain and evapotranspiration of the environmental systems evaluated in ccomparison with annual and multi-anual behavior, characterizing availability of the recourse with a direct effect on rainfall, indispensable inputs for the construction of scenarios to gain an understanding of water dynamics.
		Potential Evapo-transpiration (annual)	
Ecosystems	IDEAM, IGAC, IAVH, IIAP, INVEMAR, SINCHI	Area in hectares of transformed, intervened or degraded natural biomass	This refers to the map of Colombian land, marine and coastal ecosystems constructed in 2007 by IDEAM et al. (IDEAM et al. 2010) in which the biomes, types of biomes and ecosystems existing in Colombia and which serve as a national reference to determine the diversity of the ecosystems in the Colombian interior.
Coverage	IDEAM 2007	Area in hectares and natural or transformed coverages	Defined areas which, because of their characteristics which are similar in function, composition and structure, form part of a vegetal division in the landscape or analysis unit observed.
Erosion	IDEAM 2008	Area of dry zones in hectares	Characteristic element of a landscape with a natural propensity for this factor for erosion caused by anthropic activities that magnify the natural system and increase the risks.

✓ Calculation of the indicator

According to IDEAM (2010), environmental sensitivity can be measured by integration of information on aridity, soils, erosion, vegetation coverage and ecosystems.

To calculate the aridity of a region, a calculation of precipitation on potential evapotranspiration, is taken as a basis. The results are subdivided into four ranges (in accordance with Thomas, 1997, adapted by UNEP, 1992 (cited by IDEAM, 2012)), which made it possible to define the aridity of an area. These ranges correspond to environments: dry sub-humid when the ratio varies between 0.50 and <0.65; B: Semi-arid between 0.20 and <0.50; C: Arid 0.02 and <0.20; and D: Hyper-arid <0.02. Following classification and by cartographic superimposing, the zones which, because of the climate, soils, coverage of the land and ecosystems have dry environmental characteristics and which also show evidence of degradation by erosion o salinisation (IDEAM, 2012) in order to classify and determine vulnerable coverages.

The measurement unit of the Environmental Sensitivity Index (ESI) is adimensional and varies between 0 and 1. The extreme value zero, is obtained when the environmental sensitivity (ES) in the area of interest h existing in t time, particular is nil. The indicator comes close to 1 when environmental sensitivity ES is in an area of interest h, in a t time, is very high. To standardize this variable for each municipality the percentage in area of each category in its interior is estimated. Once estimated, it is multiplied by the range assigned to the environmental sensitivity and finally the total of each category is added together. This value is then standardized through the maximum value of the target found. In this line of thought, Table 8 shows the qualification made as follows:

Table 8. Classification of the ranges of variation of environmental sensitivity.

Description	Qualification	Color
Very low environmental sensitivity	1	VERY LOW
Low environmental sensitivity	2	LOW
Medium environmental sensitivity	3	MEDIUM
High environmental sensitivity	4	HIGH
Very high environmental sensitivity	5	VERY HIGH

Result

✓ At national level, Huila Department has no very high environmental sensitivity values, as they are located in the northern zone of the country (more specifically, in La Guajira Department). However, analysis of sensitivity in the interior of the Department in the five categories referred to, we found that the municipalities of the center center-south (Paicol, Pital, Agrado, Tarqui, Altamira, Tesalia, Nataga and Hobo) as well as those of the center (Aipe, Neiva, Tello, Baraya and Villavieja) show a high degree of environmental sensitivity. This is explained by the presence of dry coverages and ecosystems, with degraded soils and high indices of aridity and desertification. For their part, the municipalities of the South South the Department (La Plata, La Argentina, Saladoblanco, Opoga, Isnos, San Agustin, Pitalito, Palestina and Acevedo), together with the municipality of Santa Maria, have a very low Environmental Sensitivity Index, in contrast to the former, where forest coverages predominate and the soils have good depth and the aridity and erosion indices are low. Finally the municipalities located towards the eastern mountain range (Rivera, Algeciras, Gigante, Garzon and Suaza) and those on the borders between Cauca and Tolima Departments (Teruel and Iquira) have a low Environmental Sensitivity Index and Colombia, Palermo, Yaguara, Campoalegre, Elias, Timana and Guadalupe have a medium ESI (Figure 7).

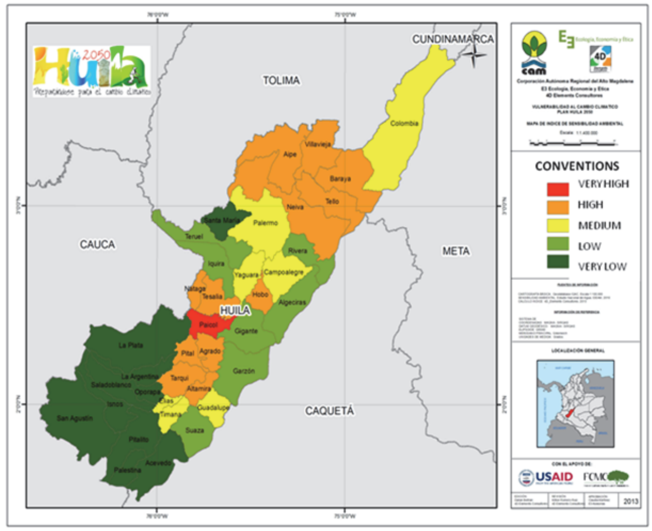


Figure 7. Map of the categories of the Environmental Sensitivity Index (ESI) in the interior of Huila Department.

Runoff

✓ **Definition**

Runoff, or the flow of surface water, includes water precipitated, which, because it does not filter into the soil, runs or flows freely over the surface of the land and becomes concentrated in irregularities or overfills the channels of the hydric systems (this is known as non-specific water input). This hydrological variable is focused on the sheet of water that circulates on the surface and is measured in millimeters. Runoff is directly related to precipitation, the type of rock, topography and climatic conditions of the analysis unit or hydrographic basin.

✓ **Importance**

This hydrological variable is transcendental within the framework of knowledge of the hydrological regime and the evolution of a hydrographic basin in its drainage network and contributory slopes, because it reflects the low flow conditions in hydric systems or micro-units of analysis (streams or bodies of water), also allows territories to be planned through the risk management component by understanding the capacity of the environmental system to contain flash flooding, taking into account the location of the population centers or cities. In addition, on a climatic change scenario, runoff is directly proportional to precipitation, that is, torrential rains cause flashing flooding, increased erosion, instability of terrain, river bed sedimentation, intense mass removal phenomena and increased dragging of contaminants, as in the case of urban basins. By contrast, when rain is scarce, there is silting of the terrain, drying of bodies of water, salinization of soils, which is evidenced by loss of soils regulationcapacity and infiltration of rain that can lead to aridity.

✓ **Qualification Criteria**

Calculation of this variable is by taking into account IDEAM's methodology, according to which the ratio parameters are annual precipitation (mm) and real evapo-transpiration (mm). The information provided and referenced in the 2010 National Water Study carried out by IDEAM was used to calculate the surface runoff in Huila Department and, later, sectorization was applied to the Department's thirty-seven (37) municipalities, with the intention of learning the representativeness of each one in hydric terms, specifically, surface runoff.

✓ **Calculation of the indicator**

$$\boldsymbol{Esc = P - ETR}$$

In which:

Esc: Surface hydric runoff (mm)
P: Precipitation (mm)
ETR: Real evapo-transpiration (mm)

The information required to calculate runoff is the annual average runoff (mm) for the year 2010 provided by IDEAM, the ranges of which are between 0 mm/annual and values higher than 6,000 mm/year. In the case of Huila, the measurement unit of this indicator is in millimeters and varies from 400 to 1600 mm. Analysis of the extreme value of 400 mm is obtained when the Esc runoff in the area of interest h existing in the particular time t is low. The indicator approaches 1600 when runoff Esc in an area of interest h, in t time, is high. This value is then classified in five percentiles according to the values shown on the following table.

Table 9. Classification of runoff ranges.

Qualification	Range	Color
Very low runoff	< 416	VERY LOW
Low runoff	> 416 < 700	LOW
Medium runoff	> 700 < 874	MEDIUM
High runoff	> 874 < 1405	HIGH
Very high runoff	> 1405	VERY HIGH

✓ **Result**

Although annual average runoff in Colombia is estimated at between 300 and over 6,000 mm, these values are between 400 and 1600 mm in the case of Huila Department. However, average runoff is approximately 900 mm in the period analyzed. At municipal level, the lowest values are found in the municipalities of Villavieja, Campoalegre, Tello, Hobo and Baraya, where runoff varies from 400 to 600 mm, while the highest levels are located in the municipalities in the south of the Department, Acevedo, Sauza, Palestina and San Agustin, where the average values are from 1400 to 1600 mm (Figure 8).

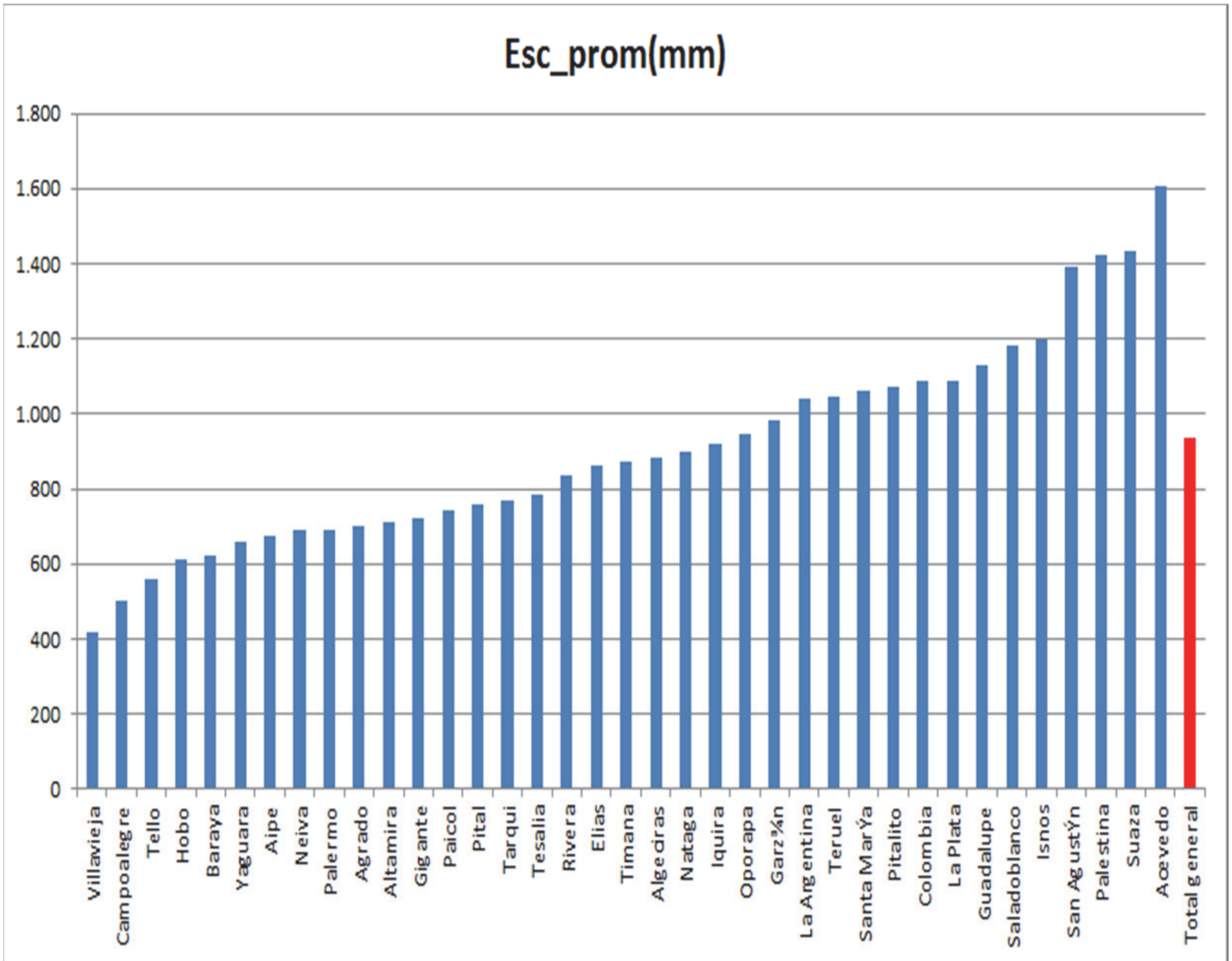


Figure 8. Runoff values in the interior of Huila Department.

✓ **Result**

Once the municipalities had been categorized, it was found that the municipalities in the north, Villavieja, Aipo, Baraya, Tello, Neiva, Palermo, Campoalegre, Yaguara and Hobo) have very low or low runoff. For their part, the central municipalities, such as Tesalia, Paicol, Gigante, Pita, Agrado, Tarqui, Altamira, Elias, Timana and Rivera, have very low medium runoff. The municipalities in the extreme south of the Department (Acevedo, Suaza, Palestina, Pitalito, San Agustin, Isnos, Saladoblanco, Oporapa, La Argentina and La Plata), as well as Colombia in the extreme north, have high or very high runoff. (Figure 9).

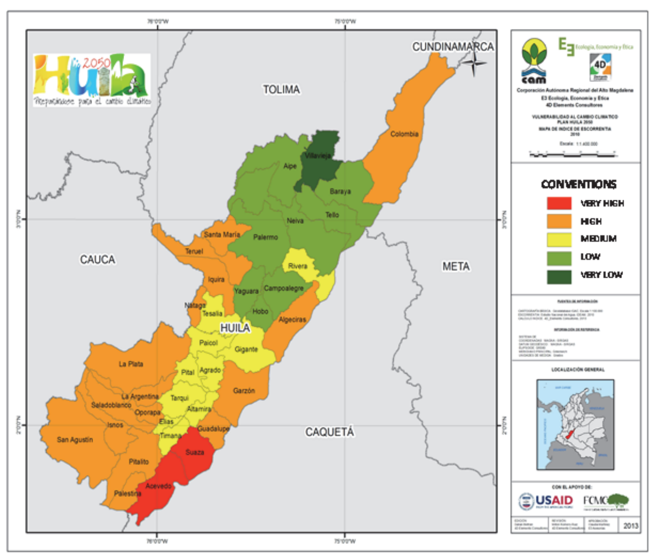


Figure 9. Map of Runoff categories in the interior of Huila Department

Use of water index

The use of water index allows us to determine the quantity of water used by the different sectors (agriculture and livestock, industrial, human consumption, etc.), in a specific period (annual, monthly) in a spatial unit, in relation to the surface water supply available in the same units of time and space (IDEAM, 2010).

✓ Importance

Basins can be in situations of excess or insufficient water supply for their needs and guarantee harmony in the functioning of natural sub-systems and human settlements. Limitations on the hydric supply needed to satisfy these demands have a direct influence on the degradation of the ecosystems and the populations' quality of life. It is therefore necessary to treat the basins with great pressure on their water resources by means of integral strategies to restore the balance of the functioning of the system. This factor is associated with the water resource risk and vulnerability determinants on scenarios with extreme phenomena and drinking water supply issues.

✓ Calculation of the indicator:

The following formula is used to calculate this indicator:

$$\boldsymbol{IUA} = \left(\frac{\boldsymbol{Dh}}{\boldsymbol{Oh}}\right) * \mathbf{100}$$

In which:
IUA= Water use index
Dh= Sectoral water demand
Oh= Surface water supply available (Result of quantification of the natural water supply deducting water supply corresponding to the environmental volume) (IDEAM, 2010).

Information for calculation of the Water Use index consists of the average annual use of water by the different sectors. This index is adimensional and varies from 1 to 50. The extreme value 1 is obtained when pressure of demand is very low in comparison with the supply available. The indicator approaches 50 when pressure of demand is very high in relation to such availability. This value is classified by five percentiles in accordance with the following values (Table 10):

Table 10. Classification of ranges of the Water Use Index.

Qualification	Range	Color
Very low pressure of demand on the available supply	< 1	VERY LOW
Lowpressure of demand on the available supply	> 1 < 10	LOW
Medium pressure of demand on the available supply	> 10.01 < 20	MEDIUM
High pressure of demand on the available supply	> 20.01 < 50	HIGH
Very High pressure of demand on the available supply	> 50	VERY HIGH

✓ Result

In Huila Department, the central zone has the areas with the highest Use of Water Index. These areas are mainly the Department's principal agricultural, livestock and population zones. The municipalities of Aipe, Neiva, Palermo, Campoalegre, Yaguara, Hobo, Algeciras, Gigante and Garzon have a very high Use of Water Index and these are the areas where most of the population is located. For their part, the municipalities of San Agustin, Isnos, Saladoblanco, Oporapa, Tarqui, Elias, Timana, Altamira, Guadalupe and Agrado have a high Use of Water Index. These are low population density locations, but are important productive areas. The municipalities of Villavieja, Baraya, Teruel, Rivera, Nataga, Paicol, La Plata, La Argentina and Acevedo have a low Use of Water Index and that of the municipality of Colombia is very low. These are low population areas with little presence of crops.

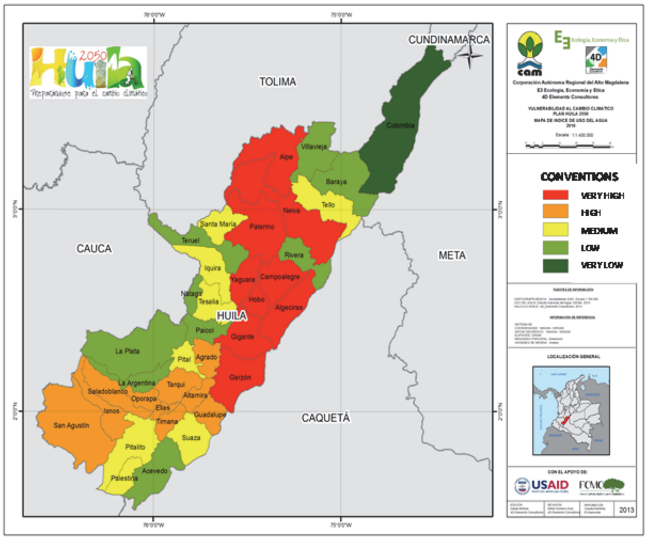


Figure 10. Map of the Use of Water Index

2.1. Adaptive Capacity

When the potential climatic impacts are understood, the ability to adjust to them lies in the system's adaptation capacity. adaptation can change negative impacts or make it possible to take advantage of positive impacts through autonomous or reactive actions (when the effects of present variability or climate change are evident) and planned or anticipated in order to prevent future risks.

The following sections show the present status of the municipalities in Huila Department in terms of their adaptive capacities, based on the indicators defined for the 4 dimensions: biophysical, social, politico-institutional and economic-productive. Definition of the indicators is based on a process of revision of the literature and validation by experts in this aspect and data availability. All the indicators are qualified in accordance with 5 categories which, in some cases, have been defined by the entities that produce the information and in others were defined within the framework of this study.

There is a color code for all the indicators which indicates the degree of adaptive capacity according to the indicator in question of each municipality, as described in table 11.

Table 11. Schematic representation of the level of adaptive capacity for each of the dimensions evaluated.

Color	Adaptive Capacity Level
(red)	Very Low
(orange)	Low
(yellow)	Medium
(light green)	High
(dark green)	Very High

These colors are independent of the qualification range of each indicator in which the municipalities are located. For this reason, it will be noted that, in some cases, the highest qualifications are in red and the lowest are in dark green. This occurs in the case of indicators that are in inverse proportion to the respective adaptive capacity, that is, the higher the value of the indicator, the lower the adaptive capacity. In other cases, the highest qualifications are in dark green and the lowest in red. This is the case of indicators that are directly in proportion to their adaptive capacity, that is, the higher the value of the indicator, the higher the adaptive capacity.

2.2.1 Biophysical dimension

Table 12 shows the three variables used to analyze the biophysical dimension, with their respective coverage, source and year. These are the Ecosystem Representativeness Index; the rate of change in forests and the use of the soil.

Table 12. Biophysical dimension analysis variables.

Indicator	Coverage	Source	Year
Ecosystem Representativeness	National	Parks, CAM	2013
Rate of change in coverage	National	IDEAM	1990, 2000, 2005,2010, 2012
Use of the soil	Municipal	IDEAM	2010

Ecosystem representativeness in areas of interest

✓ **Definition**

According to Pressey et al. 2004, representativeness is defined as the "proportion of species, types of vegetation or other features contained in a system of protected areas in terms of a threshold level within an area of interest". It refers to the idea that natural variability existing in a region must be represented in its protected areas (Mackay et al. 1988). In the case of Colombia, the Biological Diversity Convention recommends that the minimum proportion of representativeness be 17%, that is, that at least 17% of each ecosystem in Huila Department should consist of protected areas.

- ✓ **Importance**

Today, representativeness is one of the most important criteria in the assessment of systems of protected areas in their different categories and determining conservation priorities (Awimbo et al.) National Biodiversity Policy (MADS – 2012) states that, as a conservation strategy, the representativeness of the existing different continental and marine ecosystems must be guaranteed and the institutional organization for the conservation and management of ecosystems with strategic value must be strengthened. Likewise, it undertakes to establish a follow-up system for this policy and to formulate indicators to monitor the existence and coverage of ecosystems. For this reason, the importance of this indicator, which shows whether or not an ecosystem is well represented in the protected areas system declared at national, departmental or local level, taking a particular representativeness goal as a reference for each one. It is thus of vital importance to identify the conservation gaps existing in a territory and in the new protected areas selection process.

Finally, ecosystems are important for human well-being. Different ecosystems have adapted naturally to their biophysical environment and each one provides a package of optimum ecosystemic services for this setting. Society benefits both directly and indirectly from the services and any change in the loss of ecosystems and their ecological functions would imply an impact on society. The climate affects ecosystems, but, over time, their components gradually adjust to new conditions without the system itself having lost its functions. The climate change that is at present under way is faster than the previous one and ecosystems require all of their diversity and dynamics in order to be able to adapt in the best possible way. Calculation of this indicator in different periods will provide dynamic information which will make it possible to formulate policies, prioritize them and measure their achievements in later stages.

- ✓ **information sources**

Table 13 shows the criteria, description and sources of information to calculate the representativeness Index.

Table 13. Criteria for the identification of Representativeness.

	Variables	Description	Source
Ecosystems	Ecosystem	This refers to the map of Colombian land, marine and coastal ecosystems prepared in 2007 by IDEAM et al. (IDEAM et al. 2010) in which the biomes, types of biomes and ecosystems existing in Colombia and which serves as a national reference to determine the diversity of the ecosystems in the Colombian interior.	IDEAM ET AL (2010) (1:500.000)
Protected areas	NATIONAL PROTECTED AREAS	A geographically defined area which has been designated, regulated and administered to achieve the specific objectives of conservation at national level.	UAESPNN, 2012; (SCALE 1:100.000)
	municipal or departmental protected areas	Conservation areas geographically defined by regional authorities and the private reserves of civil society registered with the uaespnn.chieve the specific objectives of conservation at national level..	CI (2008), CARS (SCALE 1:100.000)
	protected areas on the single protected areas register	Designated, regulated and administered to achieve the specific objectives of conservation at national level.	SINAP (2012) (SCALE 1:100.000)

- Calculation of the indicator according to Rudas et al. (2005) representativeness can be calculated according to the following formula:

$$RE_{iht} = \frac{\left(\dfrac{APE_{iht}}{ATE_{iht}}\right) \cdot 100}{MR_{iht}}$$

in which:

RE_{iht} is the (adimensional) measurement of the representativeness of the i ecosystem present in an h area of interest in t time.

APE_{iht} is the protected surface (hectares) of an ecosystem i in the area of interest h in a time t.

ATE_{iht} is the total surface area (hectares) of a i ecosystem in the area of interest h in a time t.

MR_{iht} is the representativeness goal for the i ecosystem, in the h area of interest in a time t.

The measurement unit of this indicator is adimensional and varies from between O and ^{00}. The 0 extreme is obtained when the representativeness in the h area of interest existing i the particular time t is nil. the indicator is close to a °° when a ∞ when the representativeness in an h area of interest, in a t time approaches the value goal defined. This value is then standardized through the maximum REPRESENTATIVENESS value found. Finally, the value is classified in five percentiles according to the values shown in Table 14.

Table 14. Classification of the ranges of variation in representativeness with respect to the natural protected areas present up to 2013

Description	Range	Qualification	Color
Very Low representativeness	0 < 0,14	1	
Low representativeness	1,15 < 0,71	2	
Medium representativeness	0,71 < 2,28	3	
High representativeness	2,28 < 3,86	4	
Very high representativeness	> 3,86	5	

- ✓ **Result**

23% (437.434 has) of the territory of Huila Department, the area of which is 1.900.838 Ha, falls within one category of protected area or another. A total of 132,33 Has is located under the figure of National Natural Parks, the PNN Purace being the one with the largest area (80,826 has), followed by the PNN Nevado del Huila (34,901 ha), Cueva de los Guacharos (5,149 has), Sumapaz (4.159 ha), Alto Fragua–Indiwasi (3,264 has), Serranía de los Churumbelos (3,264 has) and the Picachos Mountain Range (1,.085 has). In addition, a total of 219,691 Has are in regional protected areas, where the Guacharos-Puracé biological corridor has the largest area with close to 64.439 has followed by Cerro Miraflores (39,250 has), Ecoregion La Tatacoa Desert (35,346 ha), Cerro Banderas-Ojo Blanco (25,863 Has), Siberia–Ceibas (25,702 has) and Serranía Minas (29,092 has). finally, at the level of municipal areas, there are 22 areas with an area of between 187 and 12,119 has. with regard to the representativeness goal established in this country, the department exceeds the 17% established in the framework agreement of biological biodiversity at 0.35% of that goal.

Table 15. Representativeness by municipality in Huila Department.

Municipality	AMES* ha	NOAMES ha	TOTAL ha	A/T %	REPRESENTATI-VENESS	Ranges
Agrado	0	26.036	26.036	0	0	VERY LOW
Guadalupe	0	25.318	25.318	0	0	VERY LOW
Nátaga	0	12.982	12.982	0	0	VERY LOW
Paicol	0	27.881	27.881	0	0	VERY LOW
Yaguará	0	32.631	32.631	0	0	VERY LOW
Suaza	0	43.561	43.561	0	0	VERY LOW
Aipe	1	80.150	80.152	0	0	VERY LOW
Palermo	466	90.418	90.885	0,51	0,03	VERY LOW
Colombia	4.159	166.083	170.243	2,44	0,14	VERY LOW
Tesalia	1.395	35.931	37.326	3,74	0,22	LOW
Pitalito	4.565	58.800	63.365	7,2	0,42	LOW

Municipality	AMES* ha	NOAMES ha	TOTAL ha	A/T %	REPRESENTATI-VENESS	Ranges
Neiva	9.831	114.307	124.138	7,92	0,47	LOW
Timaná	1.725	16.796	18.521	9,31	0,55	LOW
Tello	5.940	50.131	56.071	10,59	0,62	LOW
Baraya	7.829	63.903	71.731	10,91	0,64	LOW
Campoalegre	5.603	40.989	46.593	12,03	0,71	LOW
Rivera	5.191	31.737	36.928	14,06	0,83	MEDIUM
La Plata	20.921	106.222	127.142	16,45	0,97	MEDIUM
Tarqui	7.588	27.384	34.972	21,7	1,28	MEDIUM
Acevedo	14.710	46.482	61.192	24,04	1,41	MEDIUM
Elías	1.991	6.099	8.090	24,61	1,45	MEDIUM
Isnos	10.026	29.964	39.990	25,07	1,47	MEDIUM
Altamira	4.694	13.481	18.175	25,83	1,52	MEDIUM
Saladoblanco	11.964	30.130	42.094	28,42	1,67	MEDIUM
Algeciras	17.011	39.620	56.632	30,04	1,77	MEDIUM
Pital	6.951	13.282	20.233	34,35	2,02	MEDIUM
Garzón	26.350	41.690	68.040	38,73	2,28	MEDIUM
Gigante	21.146	32.443	53.588	39,46	2,32	HIGH
Oporapa	7.484	9.891	17.376	43,07	2,53	HIGH
Hobo	8.579	10.938	19.517	43,96	2,59	HIGH
Íquira	20.352	22.872	43.224	47,08	2,77	HIGH
Villavieja	30.286	24.217	54.503	55,57	3,27	HIGH
Palestina	13.558	8.781	22.339	60,69	3,57	HIGH
Teruel	30.924	19.532	50.457	61,29	3,61	HIGH
Santa María	19.770	11.464	31.233	63,3	3,72	HIGH
San Agustín	90.687	44.936	135.623	66,87	3,93	HIGH
La Argentina	25.735	6.322	32.057	80,28	4,72	VERY HIGH
Total general	437434	1463404	1900838	23,01	1,35	MEDIUM

*AMES: Special Management Areas (national, regional and municipal parks, civil society reserves;
NO AMES*: Area without special management zones; Total area of the Municipality; A/T: total area of the AMES divided by the total area of the municipality; REPRESENTATIVENESS: % of the municipality which is representative of the range.

However, when the municipal level analysis was made, it was found that representativeness in the territory is not the same in all parts of the Department when there are municipalities with nil values, as in the case of Agrado, Guadalupe, Nátaga, Paicol, Yaguará, Suaza and Aipe, or very low values, as in Palermo, Colombia, Tesalia, Pitalito, Neiva, Timaná, Tello, Baraya and Campoalegre. Moreover, the representativeness of Rivera, La Plata, Tarqui, Acevedo, Elías, Isnos, Altamira, Saladoblanco, Algeciras, Pital and Garzón is medium, exceeding the 17% goal. Finally, the representativeness of the other municipalities is high or very high. The municipality of La Argentina is highlighted in this category (Table 15, Figure 11).

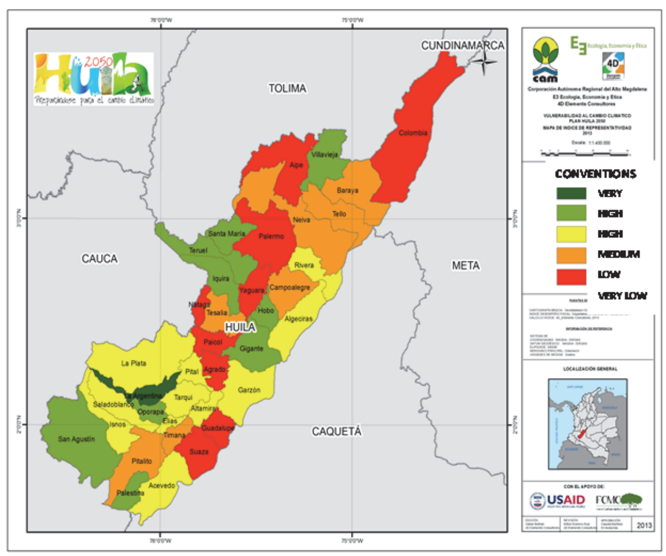


Figure 11. Map of the Representativeness Index.

Average rate of change of the forest coverages surface area

✓ **Definition**

The average rate of change in the forest coverages surface area is defined as the quantity in hectares of forest coverage which is transformed into another type of coverage, either for agricultural purposes or expansion, mining, oil industry, road projects, among others, within a specific period of time.

✓ **Importance**

This indicator provides a measurement of change in the status of the ecosystems in relation to their vegetation coverage in a particular area of interest and during a specific period of time, which leads to the difference between instances of time, years 1 and 2. Their importance lies in their usefulness in identifying the incidence of a particular policy in relation to the conservation of ecosystems and provides a more real panorama of the levels of automation of the biodiversity in the region. The identification of ecosystems and the measurement of the changes in their coverage, helps to monitor the biological patrimony existing in different areas of interest taking into consideration one of the higher levels of manifestation of biodiversity, i.e the ecosystem level.

Finally, this indicator is important as a part of human well-being The transformation of the forest coverage is widely relating to the elimination of natural forest ecosystems, which have adapted to their biophysical environment and each of them provides a package of optimum ecosystem services for this environment. Society benefits from these service either directly or indirectly. A high rate of change in the forest coverage is an indication of high pressure on the resources, with a high risk of degradation and a reduction in adaptive capacity: it loses its diversity, its functions and its intrinsic capacities to respond to changes in their biophysical environment. The calculation of this indicator in different periods will provide dynamic information which will contribute, in later stages, to the formulation of policies, their prioritization and the measurement of their achievements.

✓ **Information sources**

The variables and sources of information used to calculate the Average Change Rate Index of the Surface of Forest Coverages were those described in Table 16.

Table 16. Variable definition to calculate trends in change of coverages.

Variables	Description	Source
Forest/ non-forest coverage 1990	Forest Coverage is defined as land mainly covered by trees in 1990, which may contain bushes, palm trees, bamboo, grasses and lianas, in which tree coverage predominates with a minimum density of 30% canopy, a minimum canopy height (*in situ*) of 5 meters at the time of their identification, and a minimum area of 1.0 ha. Tree coverage on commercial forest plantations (conifers and/or deciduous trees), palm crops and trees planted for agricultural production are excluded (Cabrera et. al 2011).	IDEAM et al. (2011) (Res: 30 meters)
Forest and non-forest coverage 2000	Forest coverage is defined as land mainly covered by trees in 2000 which may contain bushes, palm trees, bamboo, grasses and lianas, in which tree coverage predominates with a minimum density of 30% canopy (*in situ*) of 5 meters at the time of their identification and a minimum area of 1.0 ha. Tree coverage on commercial forest plantations (conifers and/or deciduous trees), palm crops and trees planted for agricultural production (Cabrera et. al 2011).	IDEAM et al. (2011) (Res: 30 meters)
Forest and non-forest coverage 2005	Forest coverage is defined as land mainly covered by trees in 2005 which may contain bushes, palm trees, bamboo, grasses and lianas, in which tree coverage predominates with a minimum density of 30% canopy (*in situ*) of 5 meters at the time of their identification and a minimum area of 1.0 ha. Tree coverage on commercial forest plantations (conifers and/or deciduous trees), palm crops and trees planted for agricultural production (Cabrera et al. 2011)	IDEAM et al. (2011) (Res: 30 meters)
Forest / non-forest Coverage 2010*	Forest coverage is defined as land mainly covered by trees in 2010, which may contain bushes, palm trees, bamboo, grasses and lianas, in which tree coverage predominates with a minimum density of 30% canopy (*in situ*) of 5 meters at the time of their identification and a minimum area of 1.0 ha. Tree coverage on commercial forest	IDEAM et al. (2011) (Res: 30 meters)

Variables	Description	Source
	plantations (conifers and/or deciduous trees), palm crops and trees planted for agricultural production (Cabrera et. al 2011)	
Forest / non-forest Coverage 2012*	Forest coverage is defined as land mainly covered by trees in 2010 which may contain bushes, palm trees, bamboo, grasses and lianas, in which tree coverage predominates with a minimum density of 30% canopy (*in situ*) of 5 meters at the time of their identification and a minimum area of 1.0 ha. Tree coverage on commercial forest plantations (conifers and/or deciduous trees), palm crops and trees planted for agricultural production (Cabrera et. al 2011)	IDEAM et al. (2013) (Res: 30 metros)

*Although the information for 2010 and 2012 is available, it is only used as a reference because of problems of banding and cloudiness.

✓ **Calculation of the indicator**

According to Puyravaud J.P. 2003, the average annual rate of change in the surface of ecosystems may be calculated on the basis of the following equation:

$$TCE_{iht1-2} = \frac{(ln\,ATE_{iht2} - ln\,ATE_{iht1}) \cdot 100}{(t_2 - t_1)}$$

In which:

TCE_{iht1-2} is the average annual rate of change of the total surface area (percentage) of an i ecosystem, in an h area of interest between two t time instants 1 and 2.

ATE_{iht1} is the total surface area (hectares) of an i ecosystem, in an h area of interest in initial instant of time 1.

ATE_{iht2} is the total surface area (hectares) of an i ecosystem, in an h area of interest in final time instant 2.

t_1 is the year corresponding to initial instant of time 1.

t_2 is the year corresponding to final instant of time 2.

The measurement unit of this indicator is a percentage, that can vary between negative, because it can decrease entirely in a single year (-100), or increase until it populates the entire world (in theory) with very high increase percentages. The extreme value of -100 is obtained when the total surface of the i ecosystem, in the h area of interest existing at initial time 1$t_{1,}$ is not recorded in final t2, (total deforestation). The indicator approaches 0 when, after the period evaluated has passed (difference between 1 and 2), the total surface area of the ecosystem shows no changes. Finally, the indicator increases its a value to positive as the total surface area of the i ecosystem in the h area of interest increases (regeneration) after the end of the period evaluated. Once these values have been obtained, they are ranked in five categories according to the quartiles method which allows division of these values as shown on Table 17.

Table 17. Classification of ranges of changes in coverages

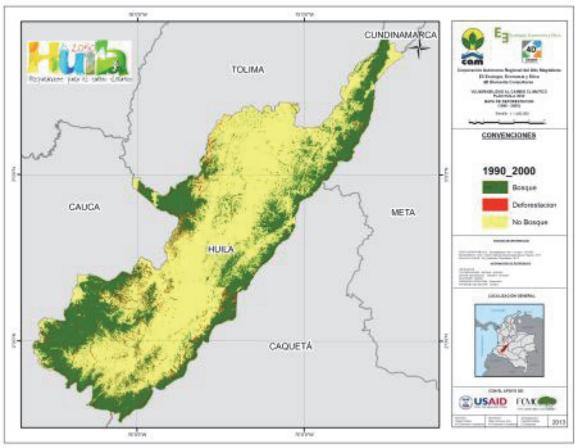
QUALIFICATION	RANGE	COLOR
Very Low	< -0,73	VERY LOW
Low	> -0,73 < 0,1	LOW
Medium	> 0,55 < 1,96	MEDIUM
High	> 1,96 < 3,85	HIGH
Very High	> 3,85	VERY HIGH

✓ **Result**

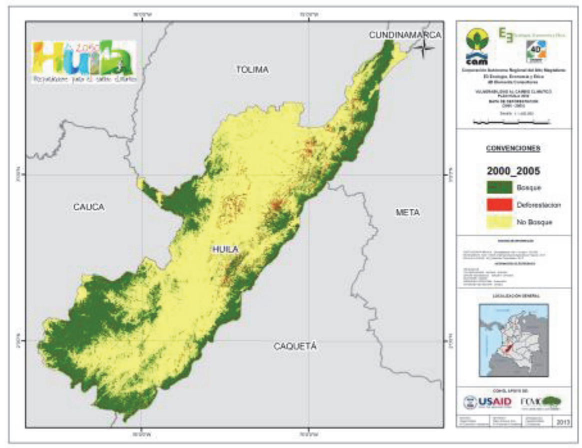
Figure 12 shows the zones in Huila Department with the presence of forest, non-forest, deforestation and clouds for the periods 1990-2000, 2000-2005, 2005-2010 and 2010-2012. We highlight that, for the first decade analyzed, the percentage of the area without information was less than 1%, while for the years 2005 and 2010 was 2.31% and 14.84%, respectively. For 1990, the Department was found to have 690,652 Has of forest, representing 36% of its territory, the area of forest gradually went down as far as 567,147 Has (31%) in 2005 and reached 432,236 Has (24%) in 2010. The change in coverage between 2010 and 2012, although the information was available, it was used only as a reference to the problems of banding and clouding, which do not allow the actual area of the forest to be determined.

According to the calculations made, it was noted that the municipalities with the largest area of forest coverage for the 1990-2000 period were: Colombia, San Agustín, La Plata and Acevedo. For 2000-2005, San Agustín had the largest area of forest, followed by Colombia, La Plata and Acevedo (Figures 13 y 14).

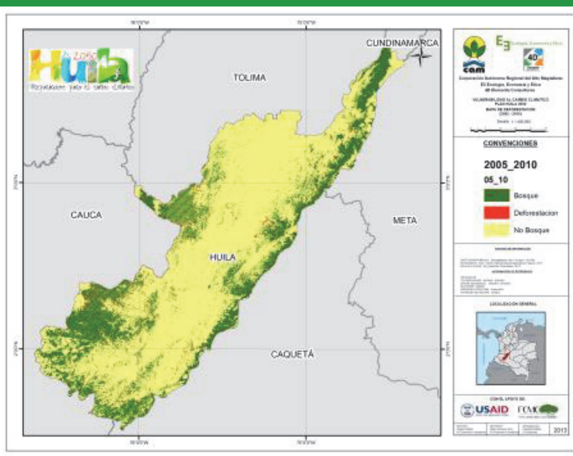
1990 – 2000



2000 – 2005



2005 – 2010



2010 – 2012

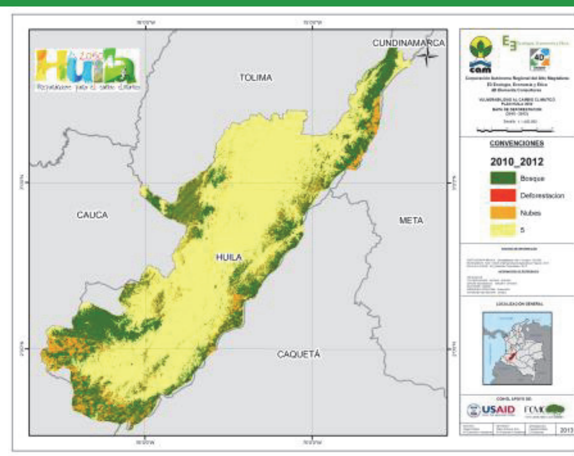
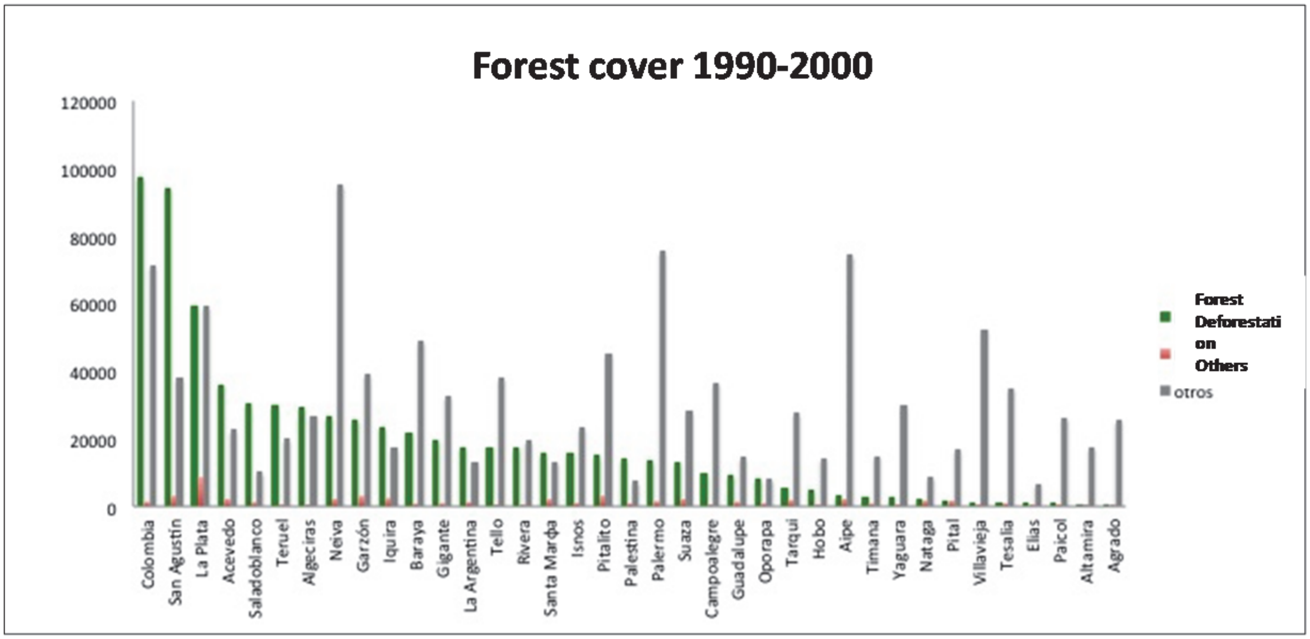


Figure 12. Maps of forest-non-forest for the periods 1990-2000; 2000-2005; 2005-2010 and 2010-2012 for Huila Department



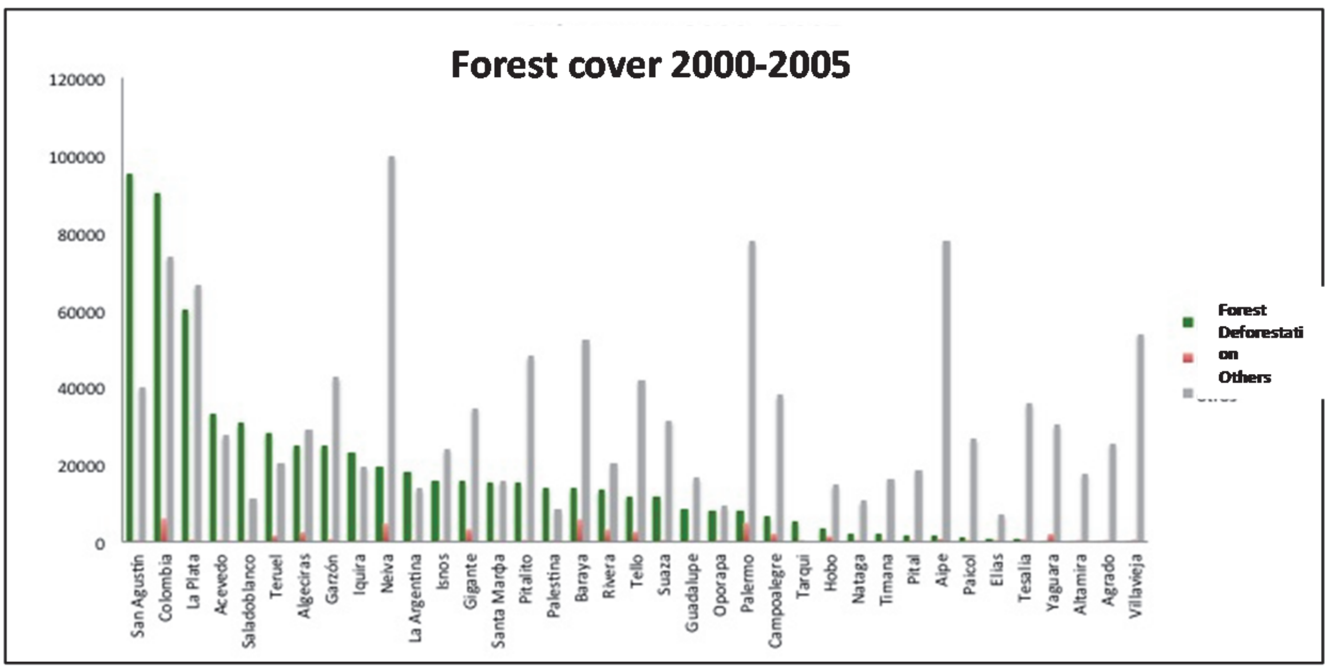
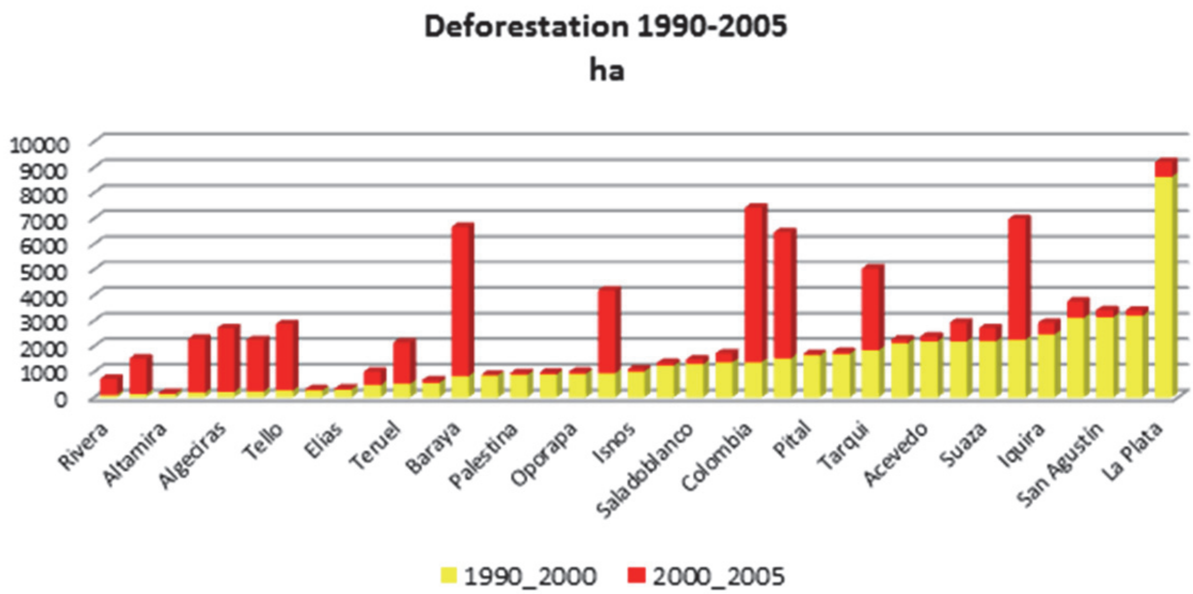


Figure 13. Area of coverages of forest, deforestation and others for the municipalities of Huila Department in the period 1990-2000.

Figure 14. Area of forest coverages, deforestation and others in the municipalities of Huila Department for the period 2000-2005.



The largest deforestation in hectares for the period between 1990 and 2000 occurred in the municipalities of the southern sector of the Department, specifically in La Plata, Pitalito and San Agustin, while in the period between 2000 and 2005 most of the deforestation occurred in the municipalities of the Northern zone, in particular Colombia, Baraya, Neiva and Palermo (Figure 14).

In terms of the ratio of the rate of change to area of forest in each municipality, it was found that the highest values of the forest and non-forest coverages change rate from 2000 to 2005 took place in the municipalities of Agrado (13.49) followed by a wide difference by the municipalities of Paicol (2.29) and Altamira (2.19) (Table 18). The high value of the rate of change in the municipality of Agrado is the result of 210.08 Ha of forest which, in 2000, increased to 412.45 Ha for the 2005 period. According to this, the level of this indicator is low (-0.44), because the trend in this municipality is to an increase in forest coverage. It was noted that the municipality of Rivera showed a high indicator value (3.85), because the rate of change has a high negative value (-5.13), with a tendency to change from forest to another type of coverage. Municipalities such as Palestina and Pitalito have a *very low* value (-0,02 and -0,05, respectively), which is due to the forest coverage having a large area within each municipality and this has increased or has remained relatively constant, as in the case of Palestina (Table 18).

Table 18. Rate of change from forest to non-forest in the period 2000-2005 and level of the indicator for each of the municipalities of Huila Department.

Municipalities	Area HA	Forest_00 HA	%	Forest_05 HA	%	Rate_CAM 00_05	TC*% Forest 2005	Norma-lized	Indicator level
La Argentina	32.057	17.615	54,95	18.175	56,7	0,63	0,35	-0,73	VERY LOW
Agrado	26.036	210	0,81	412	1,58	13,49	0,21	-0,44	LOW
La Plata	127.142	59.135	46,52	60.105	47,29	0,33	0,15	-0,32	LOW
Pital	20.233	1.517	7,5	1.659	8,2	1,79	0,15	-0,3	LOW
Isnos	39.990	15.656	39,15	15.878	39,71	0,28	0,11	-0,23	LOW
San Agustín	135.623	94.447	69,66	95.105	70,15	0,14	0,10	-0,2	LOW
Paicol	27.881	943	3,38	1.057	3,79	2,29	0,09	-0,18	LOW
Altamira	18.175	377	2,07	421	2,31	2,19	0,05	-0,1	LOW
Saladoblanco	42.094	30.592	72,67	30.652	72,82	0,04	0,03	-0,06	LOW
Pitalito	63.365	15.074	23,79	15.152	23,91	0,10	0,02	-0,05	LOW
Palestina	22.339	13.980	62,59	13.991	62,64	0,02	0,01	-0,02	LOW
Tarqui	34.972	5.305	15,17	5.117	14,63	-0,72	-0,11	0,22	LOW
Villavieja	54.503	1.446	2,65	132	0,24	-47,89	-0,12	0,24	LOW
Iquira	43.224	23.518	54,42	23.191	53,67	-0,28	-0,15	0,31	LOW
Nátaga	12.982	2.372	18,3	2.268	17,49	-0,89	-0,16	0,33	LOW
Santa María	31.233	15.684	50,23	15.421	49,39	-0,34	-0,17	0,34	LOW
Elias	8.090	1.020	12,61	948	11,72	-1,45	-0,17	0,35	LOW
Oporapa	17.376	8.210	47,25	8.040	46,27	-0,42	-0,19	0,4	LOW
Tesalia	37.326	1.264	3,39	754	2,02	-10,32	-0,21	0,43	LOW
Garzón	68.040	25.722	37,81	24.792	36,44	-0,74	-0,27	0,55	MEDIUM
Aipe	80.152	3.336	4,16	1.424	1,78	-17,03	-0,30	0,62	MEDIUM
Timana	18.521	2.613	14,11	2.246	12,13	-3,02	-0,37	0,76	MEDIUM
Yaguará	32.631	2.588	7,93	437	1,34	-35,60	-0,48	0,98	MEDIUM
Teruel	50.457	29.955	59,39	28.257	56,03	-1,17	-0,65	1,35	MEDIUM
Suaza	43.561	13.182	30,26	11.542	26,5	-2,66	-0,70	1,45	MEDIUM
Guadalupe	25.318	9.365	37	8.292	32,76	-2,43	-0,80	1,65	MEDIM
Colombia	170.243	97.575	57,33	90.360	53,09	-1,54	-0,82	1,68	MEDUM
Acevedo	61.192	36.247	59,25	33.261	54,37	-1,72	-0,93	1,93	MEDIUM
Palermo	90.885	13.837	15,22	8.037	8,84	-10,87	-0,96	1,98	HIGH
Neiva	124.138	26.631	21,45	19.467	15,68	-6,27	-0,98	2,03	HIGH
Campoalegre	46.593	9.740	20,91	6.517	13,99	-8,04	-1,12	2,32	HIGH
Gigante	53.588	19.800	36,95	15.712	29,32	-4,63	-1,36	2,8	HIGH
Hobo	19.517	5.061	25,93	3.391	17,38	-8,01	-1,39	2,87	HIGH
Algeciras	56.632	29.439	51,99	24.898	43,97	-3,35	-1,47	3,04	HIGH
Tello	56.071	17.539	31,28	11.682	20,84	-8,13	-1,69	3,5	HIGH
Baraya	71.731	21.803	30,4	13.776	19,21	-9,18	-1,76	3,64	HIGH
Rivera	36.928	17.356	47,01	13.426	36,36	-5,13	-1,87	3,85	VERY HIGH
Total	1.900.839	690.151	1.175	625.996	1.065	-1,95			
		Percentile 1				< -0,73			VERY LOW
		Percentile 2				> -0,73 < 0,1			LOW
		Percentile 3				> 0,55 < 1,96			MEDIUM
		Percentile 4				> 1,96 < 3,85			HIGH
		Percentile 5				> 3,85			VERY HIGH

Figure 15 shows that the municipalities in the south west, together with Villavieja, have a low or very low percentage of forest transformation, while those of the municipalities of the central zone show the highest deforestation rate. The deforestation rate of the others is medium.

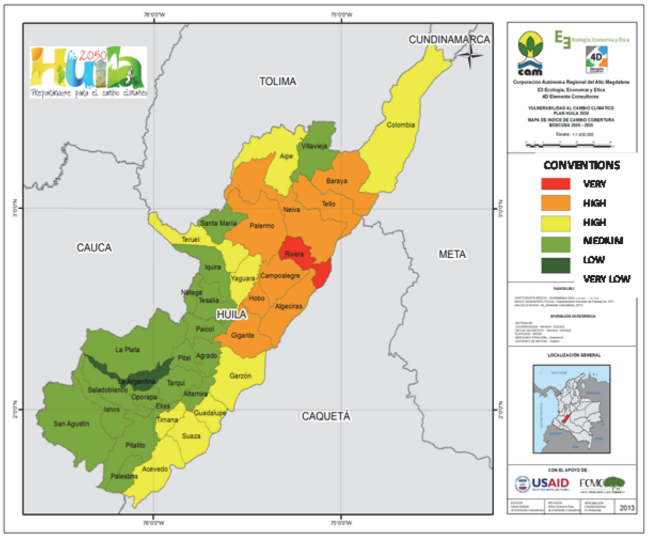


Figure 15. Map of Forest Coverage Change Rate Index 2000-2005.

Land use area

✓ **Definition**

According to FAO 1997, use of soil is defined as the types of land use expressed in the different economic, social, productive or conservation activities and are divided into classes: *Artificialized Territories, Agricultural Territories, Forests and Semi-natural Areas, Humid Areas, Surface water, Clouds and Shade* (IDEAM – IGAC, 2008).

✓ **Importance**

This indicator permits identification of the activities in terms of the area of the region, which contributes to the description, characterization and identification of possible conflicts regarding use of the soil for a given region and favors land use planning and savers land use planning. Different uses of the land have different sensitivities. Different uses of land have different types of sensitivity. However, having a certain amount of forest (for example 17%) also contributes to the adaptive capacity, Likewise, having a variety of systems facilitates faster adaptation to changes in the environmental surroundings. At municipal level, having 17% of forest and different crop systems, which also apply good practices, is indicative of a greater adaptive capacity (while at the same time having lower sensitivity).

✓ **Information sources**

Information is provided by the map of coverages of land use prepared by IDEAM – IGAC, 2007.

✓ **Calculation of the indicator:**

This was determined on the basis of the percentage of the area in Ha, taking into account the types of artificial, agricultural and natural uses, calculating the percentage of agricultural use of the total area and the natural areas, which could determine a conflict with regard to the conservation of natural areas. Once the areas and percentages of the area of each type had been calculated, an adimensional measurement unit varying between 0 and 1 was established. The extreme 0 value is obtained when the agricultural use areas are smaller than the natural ones. The indicator comes close to 1 when the area of agricultural use is very high. For the standardization of this variable for each municipality, the percentage of the area of each category in the interior was estimated. This value was then standardized according to the highest value of the goal encountered. Table 19 shows the classification values of the ranges defined for this indicator.

Table 19.Ranges of classification of uses of the soil in Huila Department.

Range	Category
< 1505	VERY LOW
> 1505- 4264	LOW
> 4264 - 5684	MEDIUM
> 5684 - 7144	HIGH
> 7144	VERY HIGH

✓ **Result**

The calculations made showed that the municipalities with the highest values for this indicator were Agrado, Altamira, Elias, Nataga, Paicol, Palermo, Pitalito, Tesalia and Yaguara, in which the natural coverages have been reduced to a large extent, giving rise to percentages of agricultural use of over 70%, which indicates large areas of crops or livestock farming. In addition, Colombia was the municipality with the lowest values in terms of the percentage of agricultural use at 15%.

The municipalities with medium values vary from 58% to 70%, among them Aipe, Campoalegre, Gigante, Guadalupe, Hobo, Pital, Rivera, Tarqui and Timana.

Table 20. Use of soil in artificial, agricultural and natural areas, and category of use in 2010 in each municipality in Huila Department.

Municipality	General Total	Artificial land (ha)	Agricultural	Natural (ha)	Total use (ha)	Percentage of use	Category
Agrado	26,036	133	18,914	6,989	19,048	73.16	VERY HIGH
Altamira	18,175	60	12,961	5,154	13,021	71.64	VERY HIGH
Elias	8,09	11	5,776	2,303	5,787	71.54	VERY HIGH
Nataga	12,982	39	10,568	2,375	10,607	81.71	VERY HIGH
Paicol	27,881	53	21,807	6,021	21,86	78.40	VERY HIGH
Palermo	90,887	317	68,14	22,43	68,457	75.32	VERY HIGH
Pitalito	63,366	1,065	46,766	15,535	47,831	75.48	VERY HIGH
Tesalia	37,326	75	27,028	10,223	27,13	72.61	VERY HIGH
Yaguara	32,631	225	23,421	8,985	23,647	72.47	VERY HIGH
Aipe	80,152	159	46,702	33,292	46,86	58.46	HIGH
Campoalegre	46,63	352	32,682	13,596	33,034	70.84	HIGH
Gigante	53,588	117	33,722	19,749	33,84	63.15	HIGH
Guadalupe	25,318	91	16,805	8,422	16,896	66.73	HIGH
Hobo	19,517	56	12,342	7,12	12,397	63.52	HIGH
Pital	20,233	78	14,189	5,965	14,268	70.52	HIGH
Rivera	36,928	223	23,096	13,609	23,319	63.15	HIGH
Tarqui	34,972	135	21,2	13,638	21,335	61.00	HIGH
Timana	18,522	136	13,097	5,29	13,233	71.44	HIGH
Baraya	71,731	54	39,036	32,642	39,09	54.49	MEDIUM
Garzón	68,04	396	34,751	32,893	35,147	51.66	MEDIUM
Iquira	43,224	35	23,383	19,806	23,418	54.18	MEDIUM
Isnos	39,99	67	21,876	18,047	21,943	54.87	MEDIUM
Neiva	124,215	3,463	66,446	54,306	69,909	56.28	MEDIUM
Oporapa	17,376	20	9,363	7,992	9,383	54.00	MEDIUM
Santa María	31,233	18	17,341	13,875	17,358	55.58	MEDIUM
Suaza	43,561	63	24,696	18,802	24,759	56.84	MEDIUM
Tello	56,071	101	27,548	28,421	27,649	49.31	MEDIUM
Acevedo	61,192	49	26,044	35,098	26,094	42.64	LOW
Algeciras	56,632	103	20,787	35,741	20,89	36.89	LOW
La Argentina	32,057	57	11,86	20,139	11,918	37.18	LOW
La Plata	127,142	162	52,145	74,836	52,306	41.14	LOW
Palestina	22,339	18	8,468	13,853	8,485	37.99	LOW
Saladoblanco	42,095	31	10,701	31,363	10,731	25.49	LOW
San Agustín	135,623	144	27,163	108,317	27,307	20.13	LOW
Teruel	50,457	35	14,728	35,694	14,763	29.26	LOW
Villavieja	54,503	142	18,564	35,797	18,706	34.32	LOW
Colombia	170,26	97	25,527	144,636	25,624	15.05	VERY LOW

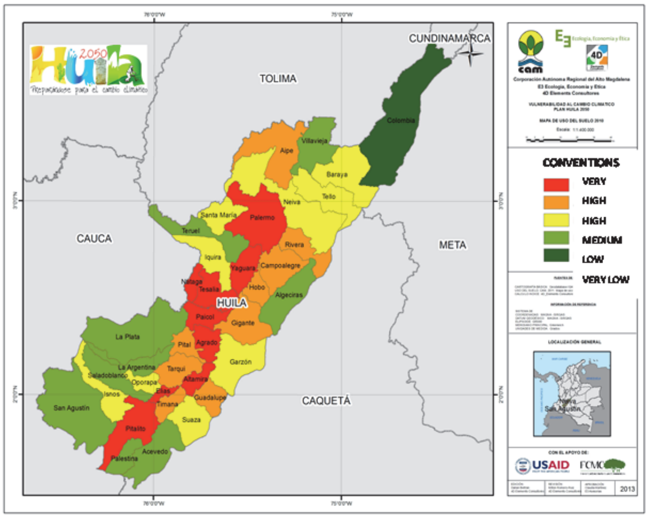


Figure 16. Map of use of Soil in 2010

2.2.2 Social dimension

Table 21 shows the four indicators used to analyze the social dimensions, with their respective coverage, source and year.

Table 21. Indicators used to analyze the social dimension with their respective coverage, source and year.

Indicator	Coverage	Source	Year
Rurality Index (RI)	Municipal	UNDP	2011
Human Development Index adjusted for Violence and Land Concentration	Municipal	UNDP	2011
Living Conditions Index (LCI)	Municipal	DANE	2005
Inter-annual variation in total incidence of dengue (dengue + severe dengue)	Municipal	Huila Health Sector	2008 - 2012

Rurality Index (RI)

✓ **Definition**

This index measures the level of rurality of the municipalities, taking into account population density and distance from populated areas. It is a useful tool with which to classify Colombian municipalities and define differentiated rural development policies and strategies to overcome the gaps existing between the regions and among the municipalities. Specifically, a community is rural if: a) its density is less than 150 inhabitants per km^2 and b) it requires more than one hour of overland transport to reach a city of more than 100,000 inhabitants (UNDP, 2011). The higher the value, the greater the rurality level.

✓ **Importance**

This index proposed by UNDP includes three aspects that are useful for determining the adaptive capacity of the municipalities to the effects of climate change: a). It combines population density with the distance from the smallest to the largest populations; b) it uses the municipality as a whole rather than only the size of the conurbations (main town, population center and dispersed rural population in the same municipality); and c) it assumes rurality as a continuum (it uses more or less rural municipalities rather than urban and rural ones).

As explained by UNDP (2011), “Rural areas are usually identified according to agricultural and livestock activities, but this approach leaves out consideration of other aspects of regional development. Thus, the absence of governmental policies seeking explicitly to strengthen development hubs that are appropriate to the peculiarities of each region has been one of the problems of Colombian rurality.

The Rurality Index makes it obligatory to view the municipality and the territory as a single whole and, on this basis, sectoral policies have to be conceived from the territorial point of view.

It can therefore be a very useful tool for classification of Colombian municipalities and to define differentiated rural development policies and strategies to overcome the gaps between regions and among municipalities, from an integral territorial standpoint, and not only with an economic focus based on the combination of machines and persons (UNDP, 2011). The productivity and competitiveness of the cities have been constructed on the basis of the absolutization of investment, understood as the accumulation of capital goods or machines. Better quality of life in the cities has been created at the cost of deterioration of natural resources and ignoring the reduction in the quality of life of the rural population. This development style has become unbalanced and needs radical reform.”

In this sense, it is understood that the most rural municipalities have a greater adaptive capacity because, from the point of view of rural development, from a territorial viewpoint, their inhabitants have better quality of life than those who are predominantly urban.

✓ Information Sources

Information on this index was obtained from the National Human Development Report published by UNDP in the year 2011.

✓ Qualification criteria

The official ranges of the Rurality Index established in the Human Development Report of 2011 are the following: i). 0,1-25; ii) 25.1-50; iii) 50.1-75; and iv) 75.1-100.

However, it was defined that, for this study, all the indicators would be qualified according to 5 ranges; in this case, taking into account that, the higher the Rurality Index, the greater the adaptive capacity. Table 22 shows the ranges used to categorize this indicator.

Table 22. Classification of Rurality Index ranges.

Ranges	Categories
0.1 – 25	VERY LOW
25.1 - 39,9	LOW
40 – 50	MEDIUM
50.1 – 75	HIGH
75.1 - 100	VERY HIGH

The foregoing took into account that the National Human Development Report (2011) suggested that, if it is necessary to define a border between more developed and less developed rural municipalities for certain types of analysis, this would be established at the point where the Rurality Index is 40. Below 40, municipalities are more urban than rural (UNDP, 2011).

✓ Calculation of the indicator

According to UNDP (2011), the following variables were taken into consideration for the construction of the Rurality Index:

1. Population density (persons /km^2): this is the average number of person living within a square kilometer of the municipality or Department.
2. Average distance to cities (km): the average Euclidean distance from cities (km): the average Euclidean distance, in kilometers, from a municipality to cities considered “large”.

It is easy to determine the size of conurbations because the area of the municipalities and information on the population are known, so it is possible to calculate the population density, but not to access data on the overland traveling times between municipalities simply because this type of updated statistics are not produced in Colombia. Therefore, it was necessary to estimate the distances in kilometers from a straight line on the map from each municipality to large cities (González, et al. 2011).

By using the digital mesh, the Euclidean distances were calculated from each of the municipalities of the country to each of the strata (distance to the closest municipality of each stratum) and an average distance was constructed with the resulting four values. For the construction of the Rurality Index (RI) per municipality, UNDP (2011) used the statistical technique called “principal components” and on that basis the population density and the distance to the closest urban centers would be the variables that make up this index were defined. Application of this technique to the natural logarithm of these two variables provides the following expression for the indicator”:

$$\mathrm{I_k} = \mathrm{Ln}\left[\frac{\mathrm{Distance_k}}{\mathrm{Density_k^2}}\right]$$

Given that the greater the value of this indicator the lower the population density, greater is the value of $\mathrm{I_k}$, the large values of this indicator evidence rurality in a municipality. The following amendment is made in order to guarantee that this indicator is restricted to values between 0 and 100, which facilitates its use and interpretation:

$$\mathrm{I_k^*} = 100\,\frac{\mathrm{I_k} - \mathrm{Min(I_k)}}{\mathrm{Max(I_k)} - \mathrm{Min(I_k)}}$$

The RI is calculated on the basis of censuses, as they are the only acceptable source for data on municipal populations. The Rurality Index must be interpreted as a ranking that can vary the positions according to the variation in the distribution of the population from one census year to another. Data on the year 2005 were used for the purposes of this study.

✓ **Result**

The following (Table 23) shows the information for the Rurality Index for the municipalities of Huila Department organized according to the categories described above and their position at departmental level. The lower the index, the more urban is the municipality.

Table 23. Rurality Index in Huila Department municipalities.

Municipality	IR	Category	Position
Colombia	60,4	HIGH	1
Baraya	56,7	HIGH	2
Villavieja	55	HIGH	3
Teruel	55	HIGH	4
Paicol	53,6	HIGH	5
Altamira	53,6	HIGH	6
San Agustín	52,6	HIGH	7
Saladoblanco	52,1	HIGH	8
Tesalia	51,7	HIGH	9
Yaguará	51,2	HIGH	10
Tello	50,6	HIGH	11
Aipe	50,3	HIGH	12
Íquira	49,6	MEDIUM	13
Suaza	49,6	MEDIUM	14
Agrado	49,6	MEDIUM	15
La Argentina	49,2	MEDIUM	16
Santa María	49,1	MEDIUM	17
Palermo	48,9	MEDIUM	18
Hobo	48,8	MEDIUM	19
Algeciras	47,8	MEDIUM	20
Elías	47,6	MEDIUM	21
Tarqui	47,1	MEDIUM	22
Acevedo	46,7	MEDIUM	23
Nátaga	46,4	MEDIUM	24
Rivera	45,8	MEDIUM	25
Palestina	45,2	MEDIUM	26
Gigante	45,1	MEDIUM	27
Isnos	44,4	MEDIUM	28
La Plata	43,8	MEDIUM	29
Pital	43,8	MEDIUM	30
Guadalupe	43,7	MEDIUM	31
Oporapa	43,2	MEDIUM	32
Campoalegre	43,1	MEDIUM	33
Timaná	40	MEDIUM	34
Garzón	39,8	LOW	35
Pitalito	37	LOW	36
Neiva	32,3	LOW	37

According to Table 23, 22 municipalities (60%) have a medium degree of rurality, 12 (32%) are high and the remaining 3 are low [sic]. Colombia, Baraya, Villavieja and Teruel are highlighted with the greatest indices of rurality, while Garzón, Pitalito and Neiva are among the last of these, that is, they are predominantly urban municipalities. Their spatial distribution of the municipalities according to their RI is shown on Figure 17.

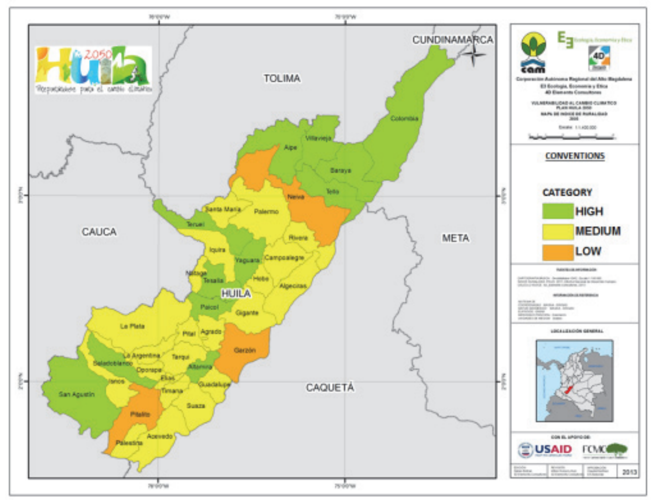


Figure 17. Spatial distribution of the Huila Department municipalities according to the Rurality Index (RI).

Human Development Index (HDI) adjusted for Violence and Land Concentration

✓ **Definition**

The Human Development Index (HDI), adjusted for violence and land concentration, includes the number of homicides and displacement intensity. This is a violence index, which is included in life expectancy to evidence the impact of this phenomenon at the long and health life level of Colombians (UNDP, 2011).

✓ **Importance**

If we were to only take the municipal Human Development Index (HDI), factors which affect quality of life in Colombia would not be taken into account. Therefore, the negative impact of violence and inequality involved in land concentration are factors it is fundamental to take into consideration as part of a municipality's capacity to adapt to climate change. The long and healthy life level of populations reflects the presence of the state in matters of providing citizens with the public services of education, health and security, among other things. For this reason, the higher the index, the greater is the adaptive capacity of municipalities.

✓ Information Sources

The information included in this index was obtained from the UNDP National Human Development Report published in the year 2011.

✓ Qualification criteria

Table 24 shows the official Human Development Index ranges adjusted for violence and land concentration presented in the 2011 Human Development Report.

Table 24. Classification of the ranges of the Human Development Index adjusted for violence and land concentration.

Ranges	Categories
< 0,61	VERY LOW
> 0,61 < 0,63	LOW
> 0,64<0,65	MEDIUM
> 0,66 < 0,67	HIGH
> 0,67	VERY HIGH

✓ Calculation of the indicator

The following variables were taken into consideration to construct he Human Development Index, adjusted for violence and land concentration.

Displacement Intensity (DI): is constructed by comparing the displaced population in the territorial unit with the total population of the same territorial unit (%). Given the recent statistics, a forced displacement of 8% of the population is established as the highest level. The expression for this case is the following:

$$ID = \frac{(\%displaced\ population - 0)}{(0.08 - 0)}$$

The maximum value of the datum of the municipality with the greatest displacement intensity was taken in order to calculate the municipal indicator.
Homicide intensity (IHI): this represents the number of homicides in the territorial unit of the entire population of the same unit (%). The highest level for the estimation was 1% of the population of the territorial unit.

$$IH = \frac{(\%homicides - 0)}{(0.01 - 0)}$$

The datum of the municipality with the highest homicide rate per 10,000 inhabitants was taken in order to calculate the municipal indicator.

Violence index (VI): this is obtained from the average of the above indicators.

$$IV = 1 - \frac{ID + IH}{2}$$

Life Expectancy Index (LEI): this represents the average number of years' life expectancy of newborns if the mortality conditions observed do not change in they course of their lives.

$$IEV = \frac{Average\ probability\ of\ life\ (y}{Average\ probability\ of\ death\ (years}$$

T.N. "Average life expectancy (years)"
The long and healthy life component is obtained by integrating the violence index with that of life expectancy:

$$Long\ and\ Health\ life\ index\ (\mathrm{LHLI}) = \frac{2}{3}IEV + \frac{1}{3}IV$$

Concentration of land ownership. The Agustin Codazzi Geographical Institute (IGAC) constructs this measurement by identifying each property on the land register.

Concentration index (IGINI,: The expression for the ownership concentration index is as follows:

$$IGINI = 1 - \left(\frac{Gini - 0}{1 - 0}\right)$$

The higher the value of the IGINI (not the higher the GINI index), the lower the concentration of properties, that is, the land is distributed more equitably. The decent standard of living level, which is generally related to income, is complemented by the IGINI according to the following expression:

$$Decent\ standard\ of\ living\ (DSL)\ index = \frac{2}{3} IPIB + \frac{1}{3} IGINI$$

The Human Development Index Adjusted for Violence and Land Concentration is constructed on the basis of the following formula:

$$IDHM = \frac{IVLS + IVD + IED}{3}$$

✓ **Result**

The following is the information on Human Development Adjusted for Violence and Land Concentration for the municipalities of Huila Department (Table 25), organized according to the categories described above.

Table 25. Index of Human Development Index Adjusted for Violence and Land Concentration.

Muninipality	IHD	Category	Position
Yaguará	0,68	VERY HIGH	1
Neiva	0,67	HIGH	2
Altamira	0,67	HIGH	3
Baraya	0,65	MEDIUM	4
Nátaga	0,65	MEDIUM	5
Pitalito	0,65	MEDIUM	6
Tesalia	0,64	MEDIUM	7
Campoalegre	0,64	MEDIUM	8
Rivera	0,64	MEDIUM	9
Villavieja	0,64	MEDIUM	10
Timaná	0,64	MEDIUM	11
La Argentina	0,64	MEDIUM	12
Palermo	0,64	MEDIUM	13
Paicol	0,64	MEDIUM	14
Garzón	0,64	MEDIUM	15
Suaza	0,64	MEDIUM	16
Acevedo	0,64	MEDIUM	17
Agrado	0,63	LOW	18
Santa María	0,63	LOW	19
Guadalupe	0,63	LOW	20
La Plata	0,63	LOW	21
Elías	0,63	LOW	22
Aipe	0,63	LOW	23
Pital	0,63	LOW	24
Algeciras	0,62	LOW	25
Isnos	0,62	LOW	26
Palestina	0,62	LOW	27
San Agustín	0,62	LOW	28
Gigante	0,62	LOW	29
Íquira	0,62	LOW	30
Teruel	0,62	LOW	31
Hobo	0,62	LOW	32
Tarqui	0,62	LOW	33
Saladoblanco	0,61	LOW	34
Oporapa	0,61	LOW	35
Tello	0,61	LOW	36
Colombia	0,59	VERY LOW	37

According to the above table, 1 municipality (3%) has very low HDI Adjusted for Violence and Land Concentration, 19 municipalities (51%) have a low level, 14 (38%) have medium level, 2 (5%) have a high level and 1 (3%) a very high level. Yaguara, Neiva and Altamira are highlighted as the ones with the highest values, while Oporapa, Tello and Colombia have the lowest ones. The spatial distribution of the municipalities according to with their adjusted HDI is shown in Figure 18.

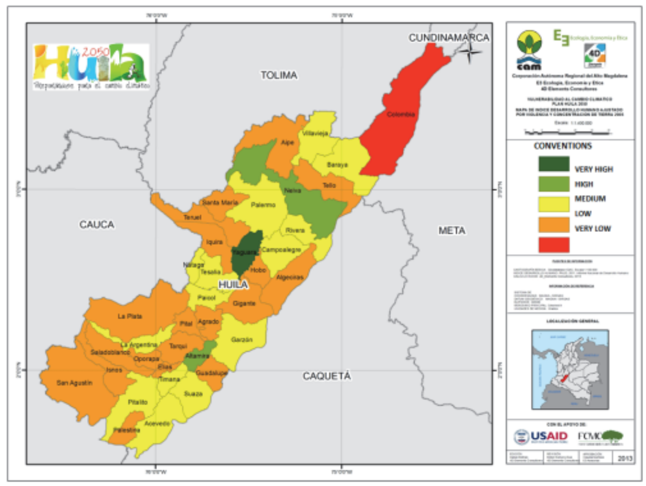


Figure 18. Spatial distribution of the municipalities of Huila Department according to their Human Development Index (HDI) Value, Adjusted for Violence and Land Concentration

Living Conditions Index (LCI)

✓ ***Definition***

Table 26. Variables of the LCI and minimum standards guaranteed by the Constitution.

Variables of LCI	*Minimum Standards*	*Minimum Points*
Collective physical wealth		
Elimination of excreta	*Low tide* (bajamar) *or latrine*	*2,97*
Water supply	*Public tap, tanker truck, water trucks (Water carriers [aguateros)*	*4,01*
Cooking fuel	*Petrol, gasoline*	*4,83*
Rubbish collection	*Public service collection*	*6,62*

Variables of LCI	Minimum Standards	Minimum Points
Individual human capital		
Maximum schooling of head of household	Nine years' education (secondary incomplete)	9,41
Average schooling of persons 12 years and over	Nine years 'education (secondary incomplete)	9,66
Proportion of young people 12-18 who attend secondary school/university	All attend	5,66
Proportion of children 5-11 years of age who attend an educational establishment	All attend	5,69
Basic social capital		
Proportion of children under 6 years of age remaining at home		5
Overcrowding in the home (number of persons per room)	Fewer than 3 persons	7,87
Individual physical wealth		
Predominant material of floors in the home		3,18
Predominant material of walls of the home	Adobe or wattle and daub	2,29
LCI	(Minimum Standards guaranteed by the Constitution)	67,19

✓ *Importance*

The LCI is a multi-dimensional indicator that measures the incidence, intensity and distribution of the poor in order to identify those who receive transfers from the General Participations of the Nation System, mainly based on an equitable criterion. It facilitates identification of the vulnerable population in each municipality in order to determine which aspects which deserve special attention in matters of public policy in order to improve the physical and human assets of the population. The better the provision of these assets, the better will be the living conditions of the population and, therefore, will increase the capacity of the municipalities to adapt to climate change.

✓ *Information sources*

The source of the information that forms this index is the National Planning Department Social Mission (National Planning Department (NPD) and UNDP, which made the calculations based on the data obtained by the General Population Census carried out by DANE in the year 2005. The municipal data were downloaded from https://www.dnp.gov.co/LinkClick.aspx?fileticket=kitQkMaNUi8%3d&tabid=337

✓ Qualification criteria

The official range of the index is 0 to 100. However, the Geographical Information System for Land Use Planning and Organization - SIGOT provides the ranges for cartographic representation described on Table 27.

Table 27.Classification of ranges of the Living Conditions Index.

Ranges	Categories
<= 50	VERY LOW
> 50,01 < 67,18	LOW
> 67,19 < 70	MEDIUM
> 70,01 < 80	HIGH
> 80	VERY HIGH

✓ Calculation of the Indicator

The LCI is calculated according to the NPD (National Planning Department)-UNDP Social Mission (Sarmiento et al., 1997), according to which each of the variables has been weighted in line with its discriminating power. The total amount gives the value of the index for each home, which is standardized to vary between 0 and 100. The points assigned to each of the categories of the variables that make up this index are shown on Table 28.

The calculation algorithm used by the NPD-UNDP Social Mission (Sarmiento et al., 1997) consists of creating new variables according to the categories identified by the model and assigning the corresponding points to them. The following is the sum of these points per component factor and the LCI is then calculated for each home as the sum of the total points of the 4 component factors. The aggregate measurement of the indicator is the average of the points assigned to the homes in the sample (Table 29).

Table 28. Points for calculation of the LCI (NPD-UNDP Social Mission)

FACTOR	VARIABLE	CATEGORY	POINTS
Access to and quality of the services	Elimination of excreta	No sanitation service	0
		Toilet connected to septic tank, toilet without connection, latrine	2,77638
		Low tide *(bajamar)*	2,96622
		Toilet with connection to sewage system	7,14265
	Water supply source	River, stream, spring, source, bottled water	0
		Well, rainwater, cistern	0,77646
		Public tap, tanker truck, water carriers (aguateros)	4,01172
		Water supply through pipes, other source through piping	6,98816
	Cooking fuel	Firewood, coal, waste material or do not cook	0
		Petrol, gasoline	4,8324
		Gas, electricity	6,67331
	Rubbish collection	Dumping on a yard	0
		Burning or burying	1,58639
		Dumping in a river	2,59314
		Public collection	6,62014
Education and Human capital	Maximum schooling of head of household	No education	0
		Incomplete primary	3,46426
		Incomplete primary	7,37326
		Incomplete secondary	9,40968
		Complete secondary	10,53322
		Incomplete university	11,42269
		Complete university	11,51632
		Postgraduate and doctorates	11,51632
	Average schooling of persons of 12 years and older	0 = Schooling	0
		0 < Schooling <= 4	2,38766
		4 < Schooling <= 5	6,53763
		5 < Schooling <= 10	9,66432
		10 < Schooling <= 11	11,54033
		11 < Schooling <= 15	12,10882
		15 < Schooling	12,3078
	Proportion of young people between the ages of 12 – 18 who attend secondary school / university	0 = Proportion of attendance	0
		0 < Proportion of attendance < 1	4,37408
		Proportion of attendance = 1	5,65614
		Homes without children from 12-18 years of age	5,65614
	Proportion of children of 5 – 11 who attend an educational establishment	0 = Proportion of attendance	0
		0 < Proportion of attendance < 1	0
		Proportion of attendance = 1	5,69468
		Homes without children from 5-11 years of age	9,94619
Size and composition of the home	Proportion of children under 6 years of age in the home	0,65 < proportion of children	0
		0,00 proportion of children < 0,65	0,7188
		Proportion of children = 0,00	7,44939
	Overcrowding in the home (number of persons per room)	7 <= Overcrowding	0
		6 <= Overcrowding < 7	2,4677
		5 <= Overcrowding < 6	3,72897
		4 <= Overcrowding < 5	5,01766
		3 <= Overcrowding < 4	5,84022
		2 <= Overcrowding < 3	7,86922
		0 <= Overcrowding < 2	12,80462
Housing quality	Predominant material of floors in the home	Earth or sand	0
		Rough wood, planks	3,18360
		Cement	4,33323
		Tiles, bricks, polished wood, marble, carpet, rugs	6,78725
	Predominant material of walls of the home	No walls	0
		Bamboo, sugarcane, matting	0
		Rough wood	0,58653
		Wattle and daub	0,70788
		Zinc, fabric, cardboard	1,63824

FACTOR	VARIABLE	CATEGORY	POINTS
		Adobe or wattle and daub *(tapia pisada)*	2,28545
		Blocks, bricks	6,10802

✓ **Results**

Table 26 shows the results of the Living Conditions Index in Huila Department municipalities organized according the categories described above.

Table 29. Living Conditions Index (LCI) for municipalities in Huila Department

Municipality	LCI	Category	Position
Baraya	72,07	HIGH	5
Rivera	71,99	HIGH	6
Tesalia	70,62	HIGH	7
Palermo	70,28	HIGH	8
Pitalito	69,91	HIGH	9
Garzón	69,52	MEDIUM	10
Gigante	68,4	MEDIUM	11
Aipe	68,05	MEDIUM	12
Hobo	67,61	MEDIUM	13
Timaná	64,55	LOW	14
Villavieja	63,47	LOW	15
Algeciras	62,56	LOW	16
Elías	62,38	LOW	17
Paicol	62,29	LOW	18
Agrado	62,25	LOW	19
Tarqui	59,76	LOW	24
Pital	59,4	LOW	25
La Argentina	59,11	LOW	26
Nátaga	58,27	LOW	27
Suaza	57,7	LOW	28
Santa María	57,69	LOW	29
San Agustín	56,75	LOW	30
Tello	55,5	LOW	31
Isnos	55,38	LOW	32
Oporapa	54,11	LOW	33
Saladoblanco	54,09	LOW	34
Palestina	53,38	LOW	35
Colombia	49,95	VERY LOW	36
Acevedo	49,09	VERY LOW	37

According to the above table, two municipalities (5%) have very low LCI, 22 (59%) have a low LCI, 5 municipalities (14%) have medium LCI, 7 (19%) have a high LCI and 1 (3%) a very high LCI. The municipalities with the highest LCI values are Neiva, Yaguará and Campoalegre, and those with the lowest are Colombia and Acevedo. The spatial distribution of the municipalities according to their adjusted LCI are shown in Figure 19.

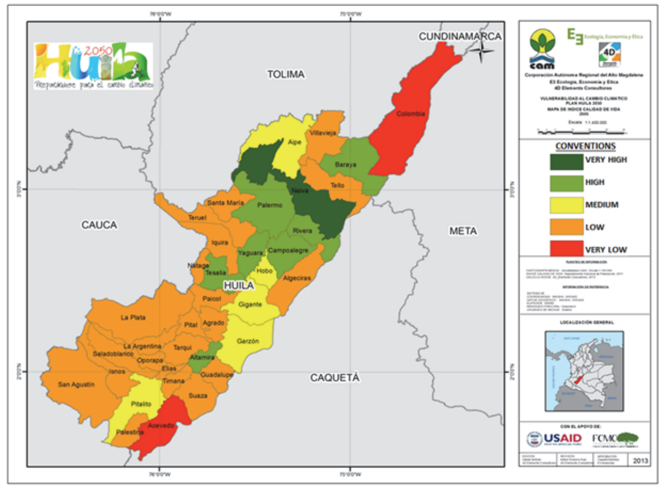


Figure 19. Spatial distribution of the municipalities of Huila according to the Living Conditions Index (LCI).

Inter-annual Variation in the Incidence of Dengue

✓ **Definition**

This measures the inter-annual variation in the total number of cases of dengue (dengue + severe dengue) per 100,000 inhabitants at municipal level reported by the Huila Health Department for the years 2008 to 2012.

✓ **Importance**

The high level of Internet–annual variability of cases of dengue makes this one of the most useful climate sensitive diseases for the development of an early alert system, as mentioned by CEPAL (CEPAL, 2013) and Kuhn (Kuhn et al., 2005). This indicator Index is important for determining the adaptive capacity of a municipality in terms of public health. The development of early alert systems depends directly on the capacity of a municipality to improve the space and time planning of the interventions oriented towards control of both the disease and its vectors (CEPAL, 2013).

The adaptive capacity would be reflected in the presence of early alert systems, which would be an institutional indicator. A tendency to increase could be an indicator that the programs to combat dengue (elimination of breeding locations, prevention of contagion, etc.) have been impossible to implement and thus signifies low organizational capacity to deal with this threat. In addition, a high incidence of dengue per se affects the physical capacity of the population to carry out any activity. For example, it reduces their capacity to work the land. Both components must be taken into consideration in the analysis of adaptive capacity. For the purposes of this study only the inter-annual variation of cases of dengue as an indicator of the trend in each municipality is taken into account.

- ✓ **Information sources**

Information of the number of cases was taken from the Dengue Epidemiological Bulletin No. 35 of 2013 provided by the Huila Departmental government.

- ✓ **Qualification criteria**

The ranges of the variation in the incidence of dengue produced for this study are shown below. These ranges are produced by standardizing the sum of the inter-annual variation through the minimum value found, which corresponds to the maximum value of the negative variation in the incidence. The categories were defined on the basis of the premise that the low values indicate that the trend of the disease has been reduced and the high values that it has increased. The larger the number, the greater the inter-annual variation. Thus the standardized data are distributed from zero (0) and one (1), in which those close to zero indicate a negative variation or a lower increase, and those close to one (1) a positive variation or a greater increase in the inter-annual incidence values.

Table 30. Classification of the ranges of Inter-Annual Variation in the Incidence of Dengue.

Inter-annual Variation	Ranges	Categories
-60 a 162	> 0,0 - < 0,13	VERY LOW
201 a 522	≥ 0,13 - <0,32	LOW
575 a 850	≥0,32 - <0,50	MEDIUM
940 a 1.866	≥0,50 - <1,00	HIGH
≥1.942	≥1,00	VERY HIGH

- ✓ **Calculation of the indicator**

The incidence of dengue is calculated as the number of persons who contract the disease for every 100,000 inhabitants (http://www.ins.gov.co/temas-de-interes/Paginas/dengue.aspx). For this study, the indicator was calculated on the basis of the sum of the inter-annual variation in the incidence between the years 2008 to 2012. The results of this sum indicate a tendency to reduction in the incidence when the number is negative and an increase when the number is positive. It is assumed that, the greater the number (positive or negative), the greater the total inter-annual variation.

- ✓ **Result**

Table 31 shows the results of variation in the incidence of dengue (standardized) for the municipalities of Huila Department organized according to the categories described above.

Table 31. Inter-annual Variation (standardized) of total Incidence of Dengue of municipalities in Huila Department.

Municipality	Interannual Variation	Normal	Category	Position in the Dept.
Paicol	-59,6	0,00	VERY LOW	1
Yaguará	-58,3	0,00	VERY LOW	2
Colombia	-16,7	0,02	VERY LOW	3
Oporapa	0,0	0,03	VERY LOW	4
La Argentina	44,5	0,05	VERY LOW	5
Acevedo	55,1	0,06	VERY LOW	6
Altamira	109,0	0,08	VERY LOW	7
Palestina	147,9	0,10	VERY LOW	8
Santa María	162,0	0,11	VERY LOW	9
Gigante	201,4	0,13	LOW	10
Villavieja	243,7	0,15	LOW	11
Pitalito	307,8	0,18	LOW	12
Baraya	401,5	0,23	LOW	13
Campoalegre	410,8	0,23	LOW	14
Saladoblanco	420,8	0,24	LOW	15
La Plata	428,7	0,24	LOW	16
Teruel	463,1	0,26	LOW	17
Nátaga	522,0	0,29	LOW	18
San Agustín	575,1	0,32	MEDIUM	19
Isnos	647,5	0,35	MEDIUM	20
Algeciras	668,0	0,36	MEDIUM	21
Tesalia	673,0	0,37	MEDIUM	22
Íquira	717,5	0,39	MEDIUM	23
Hobo	760,2	0,41	MEDIUM	24
Pital	761,9	0,41	MEDIUM	25
Neiva	771,3	0,42	MEDIUM	26
Suaza	850,4	0,45	MEDIUM	27
Tello	939,6	0,50	LOW	28
Palermo	954,8	0,51	LOW	29

Municipality	Interannual Variation	Normal	Category	Position in the Dept.
Garzón	1.076,0	0,57	LOW	30
Tarqui	1.234,5	0,65	LOW	31
Elías	1.414,5	0,74	LOW	32
Agrado	1.463,1	0,76	LOW	33
Guadalupe	1.605,7	0,83	LOW	34
Timaná	1.825,2	0,94	LOW	35
Rivera	1.865,9	0,96	LOW	36
Aipe	1.942,3	1,00	VERY LOW	37

According to the above Table, the municipalities with the lowest variation in the incidence of Dengue are Paicol (-59,6), Yaguará (-58,3) and Colombia (-16,7), while Aipe (1.825,2), Rivera (1.865,9) and Timaná (1.942,3) show the greatest variations. A high variation means low adaptive capacity to deal with this threat. The spatial distribution of the municipalities according to their inter-annual variation in the total incidence of dengue is shown in Figure 20.

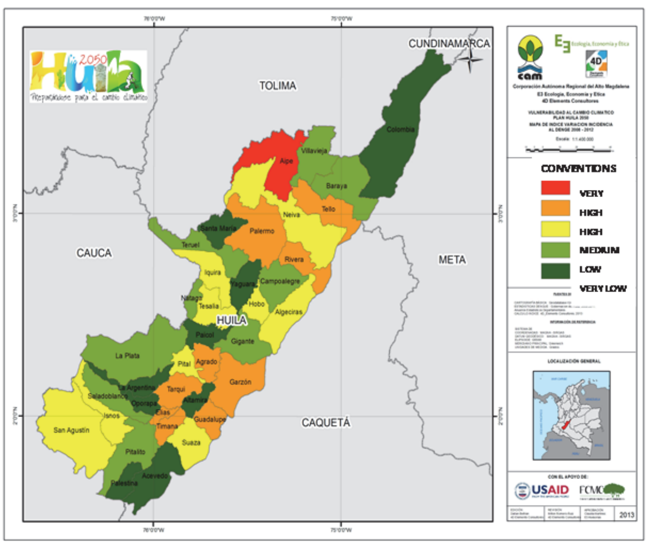


Figure 20. Spatial distribution of the municipalities of Huila Department according to the inter-annual variation in total incidence of dengue

2.2.3. Politico-institutional dimension

Table 32 shows the four variables used for the analysis of the politico-institutional dimension, with their respective coverage, source and year.

Table 32. Indicators used in the analysis of the social dimension, with their respective coverage, source and year.

Indicator	Coverage	Source	Year
Fiscal Performance Index	Municipal	NPD	2011
Investment in Risk Management x 1,000 inhabitants	Municipal	Governmental	2012
Investment in the Environment x 1,000 inhabitants	Municipal	Rudas, G.	2013

Fiscal Performance Index (IDF)

✓ **Definition**

This index follows up the performance of the territorial administrations in the area of public finance. It assesses and reflects the fiscal management achieved in the 2011 term, which corresponds to the last year of government of the territorial administrations, emphasizing the progress of the fiscal management of the outgoing local officials (NPD, 2011).

✓ **Importance**

A municipality's performance in planning and spending their annual budget effectively is directly beneficial to their capacity to adapt to climate change in order to reduce potential damage, benefit from opportunities or, in general, to deal with the consequences of this phenomenon.

✓ **Information sources**

Information on this index was obtained from the Fiscal Performance of Departments and Municipalities Report published by the National Planning Department (NPD) in the year 2011, which also contains the detailed description on the calculation of this index.

✓ **Qualification criteria**

The official range of the Fiscal Performance Index is from 0 to 100. The Geographical Information System for Territorial Planning and Organization - SIGOT shows the following ranges for the cartographic representation of this indicator (Table 33).

Table 33. Classification of Ranges of Fiscal Performance Index.

Ranges	Categories
< 40	VERY LOW
> 40,1 < 60	LOW
> 60,1 < 70	MEDIUM
> 70,1 < 80	HIGH
> 80,1	VERY HIGH

These ranges are also classified as follows: i) deteriorating entities (<40); ii) entities at risk (40.1-60); iii) vulnerable entities (601-70); iv) sustainable entities (70.1-80) and v) solvent entities (>80.1).

✓ **Calculation of the indicator**

The information presented in this section was taken from the Departments' and Municipalities' Fiscal Performance Report published by the National Planning Department (NPD) in the year 2011. The results indicators that make up the Fiscal Performance Index are:

Self-financing of operating expenses: Self-financing of operating expenses measures the part of the free use resources used for the payroll and for general operating expenses of the central administration of the territorial entity. It is desirable for this indicator to be equal to, or lower than the limit fixed by Law 617 of 2000, according to the respective category. The information is obtained on the basis of the budget spending reported to the NPD. Current free use income is both fiscal and non-fiscal, and the resources which, by law or under an administrative act, are for a specific investment or other purpose, are excluded.

Debt service support: the debt support indicator is obtained as a proportion of available income backing debt service. This indicator relates to the indicators under Laws 358 of 1997 and 819 of 2003 and total debt is not expected to be beyond the payment capacity of the entity nor to compromise its liquidity for the payment of other expenses.

Dependency of transfers and royalties of the Nation: Dependency of transfers and royalties is a measure of the importance of these resources in relation to total financial resources, that is, it indicates the weight of these resources in total income and their magnitude reflects the degree to which such transfers and royalties become fundamental resources for the financing of territorial development. An indicator of over 60% shows that the territorial entity mainly finances its expenses with resources transferred by the Nation and royalties. The amount of the transfers does not include co-financing resources, because they are non-homogeneous to all the territorial entities and, if they were taken into account, they would give rise to distortions in the assessment.

Generation of own resources: To complement the foregoing indicator, the generation of own income is referred to, that is, the relative weight of fiscal income in total current income. This is a measurement of the fiscal efforts made by administrations. Territorial entities are expected to take full advantage of their fiscal capacity to guarantee resources to complement the transfers and royalties that contribute to financing the expenses necessary to fulfill their competencies. The indicator is included in order to assess the effort made by the territorial entities to generate their own fiscal incomes, as the indicator of transfers and royalties along would leave the analysis incomplete. This indicator is important to explicitly assess territorial fiscal efforts.

Magnitude of the investment: The public investment magnitude indicator allows quantification of the degree of investment made by a territorial entity with respect to total expenses. This indicator is expected to be higher than 50%, which means that more than half the expenses are being used for investment. For the purposes of calculating this indicator, not only the gross formation of fixed capital is understood to be investment, but also what is referred to as social investment, which includes the payrolls of doctors and teachers, training, subsidies, school supplies, etc., regardless of the source of financing.

Savings capacity: Finally, the savings capacity indicator is the balance between current income and current expenses and it is equal to current savings as a percentage of current income. This indicator is a measurement of the solvency of the territorial entity which allows it to produce its own surplus for investment that complements the use of transfers by the Nation and royalties. This indicator is expected to be positive, that is, that the territorial entities will generate savings.

The process of construction of the total performance indicator can be summarized as follows:
Determining a measurement of the sector that synthesizes the group of variables that form it, based on an analysis of the principal components [sic]. Formally, for the sector and its k variables, the indicator will be:

Indicator del sector fiscal : $Ii=f(\alpha1X1+ \alpha2X22+\ldots+ \alpha kXk)$

This indicator possesses the important structural information of the variables of which it is composed.
Once global fiscal performance is gained, it is possible to use multi-varied techniques to analyze the relations of causality and inter-dependence between the variables of the study. In addition, it will make it possible to analyze sensitivity to change in the parameters of the decentralization model.

It is necessary to "direct" the variables in such a way that, as the value of each one increases, so does its importance. For their part, the synthetic indicators obtained must be carried to a scale that makes them easy to understand, apply and interpret. This definition is achieved by changing the scale in such a way that the possible range of values among which it is found will be from 0 to 100 points. This change of scale does not change the organization achieved with the initial index, such that values close to zero continue to signify lower performance, while values near to 100 do the opposite.

Final qualification is calculated as follows:

$$\text{Calificación} = \alpha1*X1+\alpha2*X2+\alpha3*X3+\alpha4*X4+\alpha5*X5+\alpha6*X6$$

In which,

i: 1, 2,.....1102 municipalities
αi: 1,2,....6 estimated weighting factors of each of the indicators calculated.
Xi: 1,2,....6. Number of indicators included in the assessment.

✓ **Result**

The following (Table 34) shows the results of the Fiscal Performance Index for the municipalities of Huila Department, organized according to the categories described above.

Table 34. Fiscal Performance Index for municipalities of Huila Department.

Municipio	IDF 2011	Categoría	Posición
Neiva	78,53	HIGH	1
Palermo	77	HIGH	2
Rivera	76,58	HIGH	3
Pitalito	73,37	HIGH	4
Garzón	72,84	HIGH	5
Aipe	72,23	HIGH	6
Yaguará	71,65	HIGH	7
Tesalia	71,48	HIGH	8
Gigante	71,05	HIGH	9
Campoalegre	70,79	HIGH	10
Oporapa	69,91	MEDIUM	11
Guadalupe	69,8	MEDIUM	12
Isnos	69,77	MEDIUM	13
Paicol	68,27	MEDIUM	14
Timaná	67,88	MEDIUM	15
Tello	67,57	MEDIUM	16
Acevedo	67,06	MEDIUM	17
Pital	66,37	MEDIUM	18
La Plata	66	MEDIUM	19
Altamira	65,99	MEDIUM	20
San Agustín	65,46	MEDIUM	21
Santa María	64,22	MEDIUM	22
Agrado	64,14	MEDIUM	23
La Argentina	63,48	MEDIUM	24
Palestina	63,38	MEDIUM	25
Hobo	62,77	MEDIUM	26
Suaza	62,55	MEDIUM	27
Tarqui	62,34	MEDIUM	28
Villavieja	62,31	MEDIUM	29
Saladoblanco	62,15	MEDIUM	30
Nátaga	61,31	MEDIUM	31
Baraya	60,24	MEDIUM	32
Íquira	60,21	MEDIUM	33
Algeciras	60,14	MEDIUM	34
Elías	59,62	LOW	35
Teruel	51,83	LOW	36
Colombia	51,63	LOW	37

According to the foregoing table, 34 municipalities (65%) showed a medium Fiscal Performance Index level in 2011, the municipalities that had the highest levels on the Fiscal Performance Index were Neiva, Palermo and Rivera and those with the lowest were Elías, Teruel and Colombia. The spatial distribution of the municipalities according to their level on the Fiscal Performance Index is shown in Figure 21.

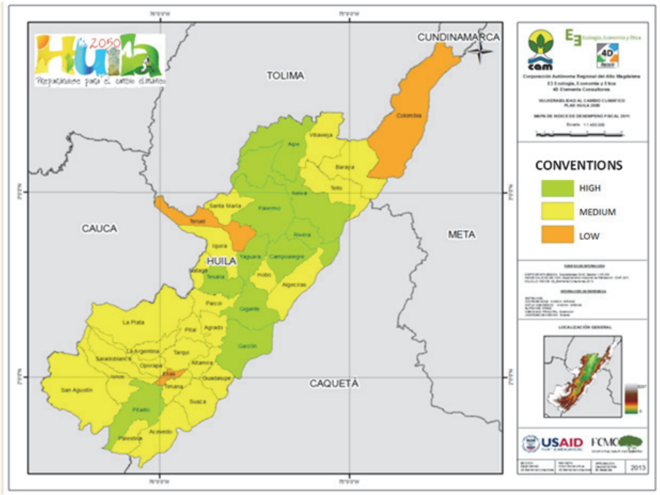


Figure 21. Spatial distribution of the municipalities of Huila Department according to their level on the Fiscal Performance Index -2011

Investment in Risk Management x 1,000 inhabitants

✓ **Definition**

This indicator measures the annual municipal investment in disaster risk management in current Colombian pesos per 1,000 inhabitants. Larger investment is associated with a higher adaptive capacity, in that it implies a greater institutional response capacity to control the processes of creation or construction of the risk or a reduction in the existing risk for the purposes of strengthening sustainable development processes and the integral security of the population, as stated in the Municipal Guide to Risk Management: (http://www.sigpad.gov.co/sigpad/archivos/GMGRColombia.pdf).

✓ **Importance**

To the extent to which each municipality invests more resources in risk management, so it will be better prepared to deal with the effects of climate change. It is a direct indicator of adaptive capacity.

✓ **Information sources**

Information regarding this indicator was obtained on the basis of the total amounts of annual investment in millions of Colombian pesos that each municipality made in risk management during 2012. The information was provided by the Huila Departmental Government in September 2013, on a scanned PDF table, in which the components of the said investment are not detailed.

✓ **Qualification criteria**

The ranges of investment in risk management for which the categories used in the study were based on the total amount of the municipal investment in 2012, standardized per thousand inhabitants and taking the estimated total population for that year based on the 2005 census. These amounts were standardized according to the maximum amount invested in 2012. Table 35 shows the ranges and categories.

Table 35. Classification of the ranges of the risk management investment indicator.

Investment in GR X 1.000 hab (2012)	Normal	Categories
$994.776 to $3.574.982	0,00	VERY LOW
$3.631.797 to $5.754.996	0,01	LOW
$5.897.983 to $11.457.298	0,02	MEDIUM
$15.862.187 to $132.389.925	0,06	HIGH
≥$229.944.327	1,00	VERY HIGH

✓ **Calculation of the indicator**

This indicator was calculated in pesos by taking annual municipal investment in risk management and standardizing it for every 1,000 inhabitants in order to be able to compare the amount among the municipalities.

✓ **Result**

The following Table 36 shows the results for the investment indicator in disaster risk management for the municipalities of Huila Department, organized according to the previously defined categories.

Table 36.Investment in Risk Management x 1,000 inhabitants (2012) in the municipalities of Huila Department.

Municipality	IGR X 1.000 Inhabitants 2012 ($)	Normal	Category	Position in Dept.
Pitalito	994.776	0,00	VERY LOW	37
Neiva	1.244.193	0,00	VERY LOW	36
Yaguará	1.677.716	0,00	VERY LOW	35
Villavieja	1.852.054	0,00	VERY LOW	34
Aipe	2.240.675	0,01	VERY LOW	33
Tarqui	2.471.768	0,01	VERY LOW	32
Acevedo	2.648.550	0,01	VERY LOW	31
Agrado	2.699.595	0,01	VERY LOW	30
Palermo	3.574.892	0,01	VERY LOW	29
Tesalia	3.631.797	0,01	LOW	28
Colombia	4.548.485	0,02	LOW	27
Tello	4.624.089	0,02	LOW	26
La Plata	4.863.784	0,02	LOW	25
Guadalupe	4.884.049	0,02	LOW	24
Pital	5.173.796	0,02	LOW	23
Íquira	5.244.628	0,02	LOW	22
San Agustín	5.643.468	0,02	LOW	21
Altamira	5.754.996	0,02	LOW	20
Palestina	5.897.983	0,02	MEDIUM	19
Algeciras	5.991.725	0,02	MEDIUM	18
Baraya	7.228.407	0,03	MEDIUM	17
Suaza	7.629.938	0,03	MEDIUM	16
Isnos	7.978.117	0,03	MEDIUM	15
Teruel	9.437.726	0,04	MEDIUM	14
Paicol	9.507.507	0,04	MEDIUM	13
Rivera	9.636.170	0,04	MEDIUM	12
Oporapa	11.457.298	0,05	MEDIUM	11
Timaná	15.862.187	0,06	HIGH	10
Campoalegre	19.977.030	0,08	HIGH	9
Santa María	22.750.356	0,10	HIGH	8
Elías	23.711.285	0,10	HIGH	7
Garzón	28.878.514	0,12	HIGH	6
Nátaga	31.882.817	0,13	HIGH	5
La Argentina	41.237.360	0,18	HIGH	4
Saladoblanco	63.703.692	0,27	HIGH	3
Gigante	132.389.925	0,57	HIGH	2
Hobo	229.944.327	1,00	VERY HIGH	1

According to the foregoing Table, the municipalities which showed the highest investment in risk management per 1,000 inhabitants in 2012 were Hobo, Gigante and Saladoblanco. In addition, those with the lowest investment in risk management per 1,000 inhabitants were Neiva, Pitalito and Yaguara. The spatial distribution of the municipalities according to their investment in risk management is shown in Figure 22.

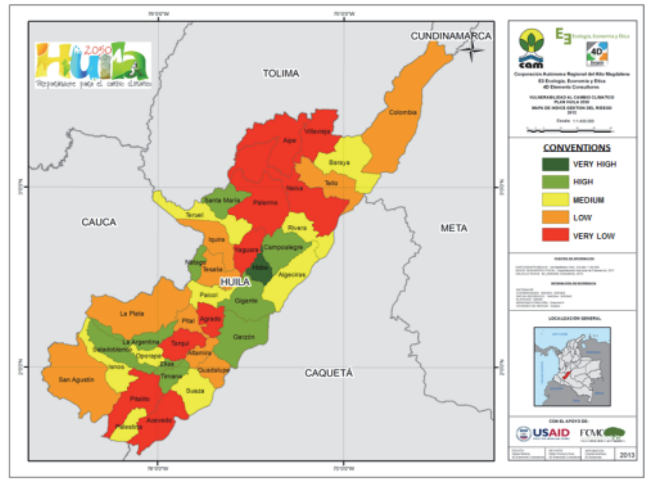


Figure 22. Spatial distribution of the municipalities of Huila according to their investment in risk management x 1,000 inhabitants in 2012.

Investment in the Environment x 1,000 inhabitants

✓ **Definition**

This measures annual municipal investment in environmental issues in current Colombian pesos for each 1,000 inhabitants. According to Rudas (2013), this investment consists of the amount of the municipal budget targeted to the conservation of biodiversity, the management of hydrographic basins and of solid and liquid waste, control of the emission of greenhouse gases, productive reconversion, re-forestation activities and restoration, purchasing properties for conservation and in environmental education.

✓ **Importance**

As each municipality invests more resources in environmental issues, it is likely that their adaptive capacity to deal with climate change impacts will increase. Investments in environmental issues can contribute to increasing municipal resilience, which is a direct indicator of adaptive capacity to deal with climate change impacts.

✓ **Information sources**

The information for this indicator was obtained from the Guillermo Rudas "*Identificación de recursos públicos y privados susceptibles de ser canalizados hacia la mitigación y adaptación al* *cambio climático en el departamento de Huila" (*Identification of public and private resources which can be channeled into climate change mitigation and adaptation in Huila Department" (Rudas, 2013). The data used here are those of 2011.

✓ Qualification criteria

The ranges of investment in environmental issues generated for this study were based on the total amount of municipal investment in the year 2011, standardized per 1,000 inhabitants, taking the total population estimated for that year and based on the 2005 census. These amounts were standardized on the basis of the maximum amount invested in 2011 and the ranges are shown on Table 37.

Table 37. Classification of the ranges of the Investment in the Environment Index.

Investment in environment x 1.000 hab (2011)	Ranges	Categories
\$25.826 to \$5.547.229	<0,03	VERY LOW
\$5.867.179 to \$8.307.964	≥0,03 - <0,05	LOW
\$9.100.310 to \$18.219.050	≥0,05 - <0,11	MEDIUM
\$19.344.235 to \$83.815.352	≥0,11 - <1,00	HIGH
≥\$179.379.330	1,00	VERY HIGH

These ranges were produced by standardizing maximum and minimum municipal values. The categories were defined on the basis of the premise that lower investment in the environment indicates low adaptive capacity. As the investment increases, so will the adaptive capacity of the municipalities.

✓ Calculation of the indicator

This indicator was calculated by taking the annual municipal investment in the environment in pesos during 2011 and standardizing it for every 1,000 inhabitants in order to be able to compare the amounts among the municipalities.

✓ Result

Table 38 below shows the results of the investment in the environment for the municipalities of Huila Department organized according to the categories defined above.

Table 38. Investment in the environment x 1,000 inhabitants (2011) in the municipalities of Huila Department.

Municipality	Investment in Environment x 1.000 inhabitants in 2011 (\$)	Normal	Category	Position in dept.
Isnos	25.826	0,00	VERY LOW	37
Algeciras	913.090	0,00	VERY LOW	36
Colombia	2.483.711	0,01	VERY LOW	35
Guadalupe	3.307.505	0,02	VERY LOW	34
Santa María	3.855.390	0,02	VERY LOW	33
Baraya	4.138.807	0,02	VERY LOW	32
Acevedo	4.307.657	0,02	VERY LOW	31
Timaná	4.810.850	0,03	VERY LOW	30
Palestina	4.985.319	0,03	VERY LOW	29
La Argentina	5.547.229	0,03	VERY LOW	28
Oporapa	5.867.179	0,03	LOW	27
Campoalegre	6.247.490	0,03	LOW	26
Garzón	6.440.622	0,04	LOW	25
Pitalito	7.049.352	0,04	LOW	24
Rivera	7.475.223	0,04	LOW	23
Gigante	7.800.917	0,04	LOW	22
Saladoblanco	7.866.825	0,04	LOW	21
La Plata	8.307.964	0,05	BAJO	20
Nátaga	9.100.310	0,05	MEDIUM	19
Aipe	9.861.969	0,05	MEDIUM	18
Suaza	10.575.558	0,06	MEDIUM	17
Tello	11.556.187	0,06	MEDIUM	16
San Agustín	14.337.297	0,08	MEDIUM	15
Tarqui	15.160.272	0,08	MEDIUM	14
Tesalia	15.795.499	0,09	MEDIUM	13
Agrado	17.559.615	0,10	MEDIUM	12
Teruel	18.219.050	0,10	MEDIUM	11
Íquira	19.344.235	0,11	HIGH	10
Pital	19.432.580	0,11	HIGH	9
Hobo	25.817.326	0,14	HIGH	8
Paicol	33.857.512	0,19	HIGH	7
Neiva	36.223.761	0,20	HIGH	6
Villavieja	37.654.801	0,21	HIGH	5
Elías	43.482.167	0,24	HIGH	4
Altamira	49.084.936	0,27	HIGH	3
Yaguará	83.815.352	0,47	ALTO	2
Palermo	179.379.330	1,00	VERY HIGH	1

According to the above Table, the municipalities which showed the highest investment in the environment per 1,000 inhabitants in 2011 were Palermo, Yaguará and Altamira, while Isnos, Algeciras and Colombia made the smallest ones. The spatial distribution of the municipalities according to investment in the environment x 1.000 inhabitants in 2011 is shown in Figure 23.

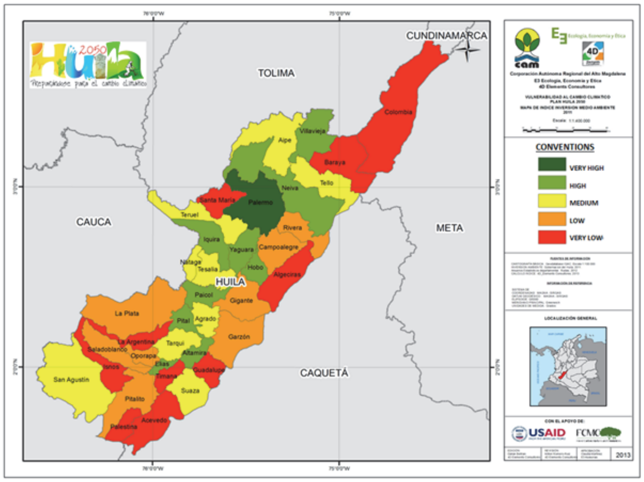


Figure 23. Spatial distribution of the municipalities of Huila Department according to Investment in the Environment x 1,000 inhabitants in 2011

2.2.4. Economic-productive dimension

Table 39 shows the three indicators used to analyze the economic-productive dimension, together with their respective coverage, source and year.

Table 39. Indicators used to analyze the social dimension with their respective coverage, source and year.

Indicator	Coverage	Source	Year
Land Gini	Municipal	IGAC, Uniandes, U. Antioquia	2012
Variety of crops	Municipal	Huila Departmental government	2007-2010
Agricultural yield	Municipal	Huila Departmental government	2007-2011

Land GINI

✓ **Definition**

The Land Gini is an indicator of the concentration of private land ownership based on the rural land ownership Registers (IGAC, 2012). This indicator varies from zero (0) to one (1). The closer they are to one, the higher the concentration of ownership index (few owners with a lot of land), while the closer they are to zero shows better distribution of the land (many owners with a lot of land).

✓ **Importance**

In general, the Gini are held to be quality indicators that allow identification of how the wealth of a society is distributed. The land Gini, specifically, is an indicator of adaptive capacity as it makes it possible to determine the level of concentration of land in a particular municipality. The greater the concentration of the land, the lesser the adaptive capacity, because the number of small scale amounts of land reduces their productivity and resilience against extreme phenomena.

✓ **Information sources**

The information for this indictor was obtained from the Rural Property Distribution in Colombia published by the IGAC in 2012.

✓ **Qualification criteria**

Table 40 shows the ranges for Huila Department according to the Atlas of Rural Property in Colombia (the maximum was adjusted according to 2012 data, because the atlas gives the 2009 maximum, which was 0,862).

Table 40. Classification of land Gini ranges.

RANGES	CATEGORIES
0,591 - 0,645	VERY LOW
0,646 - 0,699	LOW
0,700 - 0,753	MEDIUM
0,754 - 0,808	HIGH
0,809 - 0,906	VERY HIGH

✓ **Calculation of the indicator**

The land Gini is a much used indicator because the area of properties provides basic information on inequality in terms of land tenure (IGAC, 2012).

The Gini land index is a measurement of the dispersion of distribution and is commonly used to measure inequality in the distribution of income, wealth and land. The land Gini of the Rural Property Distribution Atlas was calculated using the following formula:

$$Gini = \frac{n+1}{n} - \frac{2}{n^2 \mu_y} \sum_{i=1}^{n} (n+1-i) y_i$$

In which:

n = Total rural population

μ_y = Average of the total area of land
y_i = Area of land of the "i" property

It is noteworthy that this Gini does not capture all the dimensions of ownership in Colombia. While a high percentage of concentration results from the possession of large areas of land by few owners, it is possible that a certain number of owners possess more than one property, which is also a concentration of ownership.

✓ **Result**

The following (Table 41) sows the results of the land Gini for the municipalities of Huila Department organized according to the categories described above.

Table 41. Land GINI (2012) for municipalities of Huila Department

Municipality	Land GINI 2012	Category	Position
Santa María	0,603	VERY LOW	1
Acevedo	0,612	VERY LOW	2
Íquira	0,64	VERY LOW	3
Palestina	0,65	LOW	4
Nátaga	0,661	LOW	5
La Argentina	0,661	LOW	6
Pitalito	0,666	LOW	7
Suaza	0,678	LOW	8
Saladoblanco	0,679	LOW	9
Algeciras	0,679	LOW	10
Pital	0,681	LOW	11
Teruel	0,687	LOW	12
Isnos	0,701	MEDIUM	13
Agrado	0,705	MEDIUM	14
La Plata	0,706	MEDIUM	15
Tesalia	0,715	MEDIUM	16
Hobo	0,722	MEDIUM	17
Guadalupe	0,724	MEDIUM	18
Timaná	0,725	MEDIUM	19
Oporapa	0,728	MEDIUM	20
Palermo	0,743	MEDIUM	21
Paicol	0,755	HIGH	22
Elías	0,758	HIGH	23
Yaguará	0,763	HIGH	24
Altamira	0,768	HIGH	25
Aipe	0,771	HIGH	26
Baraya	0,774	HIGH	27
Tarqui	0,783	HIGH	28
Garzón	0,792	HIGH	29
Rivera	0,8	HIGH	30
San Agustín	0,817	VERY HIGH	31
Gigante	0,832	VERY HIGH	32
Neiva	0,833	VERY HIGH	33
Tello	0,839	VERY HIGH	34
Campoalegre	0,86	VERY HIGH	35
Villavieja	0,862	VERY HIGH	36
Colombia	0,906	VERY HIGH	37

According to the above Table, the municipalities with the highest concentration of land in 2012 were Colombia, Villavieja and Campoalegre, while those with the lowest concentration were Santa María, Acevedo and Íquira. The spatial distribution of the municipalities according to the land Gini are shown in Figure 24.

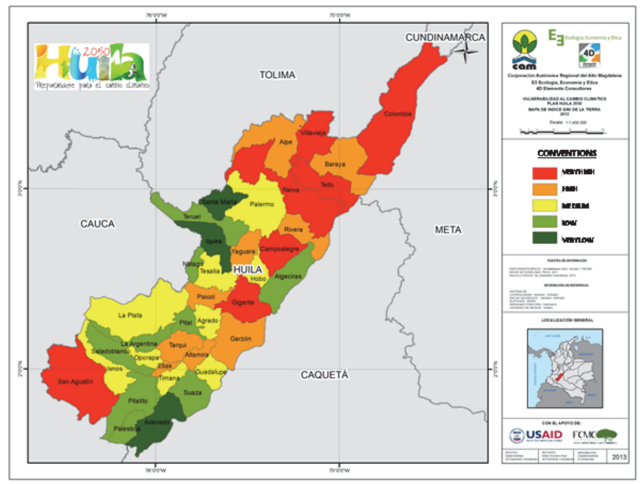


Figure 24. Spatial distribution of Huila municipalities according to Land Gini in 2012

Agricultural Yield

✓ **Definition**

This indicator measures the average yield in tonne/ha of annual, semi-permanent, permanent and transitory crops in each municipality in 2010, taking the area cultivated into account. While the yield of each crop is different (maize is not the same as coffee), the average can be considered a global yield indicator at municipal level, because it contains comparable values for each of the crops in all the municipalities. Thus, the greater the average value, the larger the global yield of the crops.

✓ **Importance**

This is an adaptive capacity indicator, as greater yield indicates better quality of the land and/or more access to human capital (education, experience), social capital (information, organization) or financial capital (investment in technology). Consequently, the greater the yield, the greater the adaptive capacity. Better yield does not necessarily imply that the best practices are being applied in terms of mitigation and adaptation to climate change. It is rather an indication that the potential exists for the necessary changes to be made if there is the will to do so.

✓ **Information sources**

Information on production (tonnes) and area cultivated (hectares) for this indicator was provided by the Huila Departmental Government, specifically the Agriculture and Mining Department.

✓ **Qualification criteria**

✓ The ranges of agricultural yield produced for this study were based on the results of the average global (tonne/ha) yield in each municipality, which were standardized starting with the maximum value, as shown on Table 42.

Table 42. Classification of the ranges of the agricultural yield index

AVERAGE YIELD (TON/HA)	RANGE	CATEGORY
≥4,8 - <6,1	<0,31	VERY LOW
≥6,1 - <6,7	≥0,32 - <0,48	LOW
≥6,7 - <6,9	≥0,48 - <0,54	MEDIUM
≥6,9 - <8,6	≥0,54 - <1,00	HIGH
≥8,6	1,0	VERY HIGH

✓ **Calculation of the indicator**

✓ This indicator was calculated as the average annual yield of annual, semi-permanent, permanent and transitory crops reported for each municipality in the 2007 to 2010 year-books according to the area cultivated in each municipality

✓ **Result**

Table 43 shows the agricultural yield results in the municipalities of Huila Department, organized according to the categories described above.

Table 43. Agricultural yield (2010) in Huila municipalities

Municipa-lity	Yield in 2010 (ton/ha)	Normal	Category	Position in Dept.
Yaguará	4,8	0,00	VERY LOW	37
Teruel	5,0	0,04	VERY LOW	36
Saladoblanco	5,3	0,13	VERY LOW	35
Íquira	5,3	0,13	VERY LOW	34
Santa María	5,5	0,17	VERY LOW	33
Oporapa	5,6	0,19	VERY LOW	32
San Agustín	5,8	0,26	VERY LOW	31
Acevedo	5,9	0,28	VERY LOW	30
Palermo	6,0	0,31	VERY LOW	29
Palestina	6,1	0,32	LOW	28
Nátaga	6,1	0,32	LOW	27
Campoalegre	6,3	0,38	LOW	26
La Argentina	6,3	0,39	LOW	25
Tello	6,3	0,40	LOW	24
Tesalia	6,5	0,45	LOW	23
Neiva	6,6	0,46	LOW	22
Paicol	6,6	0,47	LOW	21
Elías	6,6	0,47	LOW	20
Isnos	6,7	0,48	MEDIUM	19
Hobo	6,7	0,48	MEDIUM	18
Tarqui	6,8	0,51	MEDIUM	17
Timaná	6,8	0,51	MEDIUM	16
Colombia	6,8	0,52	MEDIUM	15
Guadalupe	6,8	0,53	MEDIUM	14
Suaza	6,9	0,53	MEDIUM	13
Altamira	6,9	0,54	MEDIUM	12
Baraya	6,9	0,54	MEDIUM	11
Agrado	6,9	0,54	HIGH	10
Pitalito	6,9	0,55	HIGH	9
La Plata	7,3	0,66	HIGH	8
Rivera	7,4	0,67	HIGH	7
Gigante	7,5	0,71	HIGH	6
Algeciras	7,6	0,73	HIGH	5
Aipe	7,7	0,74	ALTO	4
Pital	7,8	0,77	HIGH	3
Villavieja	8,2	0,88	ALTO	2
Garzón	8,6	1,00	VERY HIGH	1

According to the above Table, the municipalities which showed the largest agricultural yield were Garzón, Villavieja and Pital, while those with a lowest yield were Yaguara, Teruel and Saladoblanco. The spatial distribution of the municipalities according to their agricultural yield is shown in Figure 25.

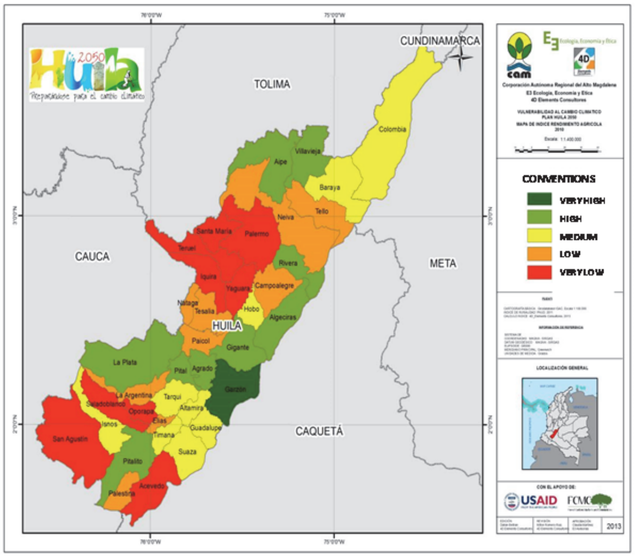


Figure 25. Spatial distribution of the municipalities of Huila Department according to their agricultural yield in 2010

Crop variety

✓ **Definition**

This measures the total number of crops existing in 2010 at municipal level as a ratio of the total number of crops at Departmental level. It includes annual, semi-permanent, permanent and transitory crops reported by the Huila Departmental Government Agriculture and Mining Department.

✓ **Importance**

This indicator measures adaptive capacity, because the greater the diversity of crops, the greater the resilience of the municipalities to climate change impacts. In this aspect, a larger variety of crops represents greater adaptive capacity, as it generates a more resilient economy based on crop variety.

✓ **Information sources**

The information used to calculate this indicator was provided by the Department of Agriculture and Mining of the Huila Departmental Government.

✓ **Qualification criteria**

The categories of the variety of crops grown for this study are based on the sum of the number of crops in each municipality during 2010 and their proportion (%) of the total number of crops at Departmental level. This total was standardized on the basis of the maximum number of crops found at municipal level.

Table 44. Classification of ranges for the Crop Variety Index.

NO. OF CROPS 2010	RANGES	CATEGORY
≤0,42	≤0,45	VERY LOW
>0,42 - ≤0,53	>0,45 - ≤0,58	LOW
>0,53 - ≤0,67	>0,58 - ≤0,77	MEDIUM
>0,67 - ≤0,82	>0,77 - ≤1,00	ALTO
>0,82	1,00	VERY HIGH

✓ **Calculation of the indicator**

The annual, semi-permanent and permanent crops reported for the Department during 2010, among which were avocados, plantains, citric fruits, cocoa, sugarcane, sugarcane panela, coffee, *badea*, bananas, *curuba, cholupa, gulupa, guanabana,* guava, *granadilla*, *lulo, mango, maracuyá,* blackberry, pawpaws, *pitaya*, *tomate de arbol,* grapes, *arracacha, spring onions and* yucca*.*

Likewise, the following transitory crops were taken into account: rice, *auyama*, peas, bulb onions, beans, green beans, vegetables, white corn, yellow corn, melons, potatoes, cucumbers, capsicums, water melon, sorghum, blonde tobacco and tomatoes.

This indicator was calculated as follows:

$$Crop\ variety\ index = \frac{\{CaCspCp + Ct\}Municipal}{\{CaCspCp + Ct\}Departmental}$$

In which:

CaCspCp = annual, semi-permanent and permanent crops
CT = transitory crops (semester A and semester B)

✓ **Result**

Table 45 shows the results of the Crop Variety Index in the municipalities of Huila Department, organized according to the categories described above.

Table 45. Crop Variety Index (2010) for municipalities of Huila Department.

Municipality	No. of crops 2010	Normal	Category	Position in dept.
Yaguará	0,13	0,00	VERY LOW	37
Altamira	0,40	0,39	VERY LOW	36
Saladoblanco	0,40	0,39	VERY LOW	35
Villavieja	0,40	0,39	VERY LOW	34
Acevedo	0,42	0,42	VERY LOW	33
La Argentina	0,42	0,42	VERY LOW	32
Oporapa	0,42	0,42	VERY LOW	31
Paicol	0,42	0,42	VERY LOW	30
Teruel	0,42	0,42	VERY LOW	29
Santa María	0,44	0,45	LOW	28
Agrado	0,47	0,48	LOW	27
Íquira	0,47	0,48	LOW	26
Aipe	0,49	0,52	LOW	25
Tello	0,49	0,52	LOW	24
Nátaga	0,51	0,55	LOW	23
Tarqui	0,51	0,55	BAJO	22
Elías	0,53	0,58	MEDIUM	21
Palermo	0,53	0,58	MEDIUM	20
Palestina	0,53	0,58	MEDIUM	19
Hobo	0,56	0,61	MEDIUM	18
Suaza	0,56	0,61	MEDIUM	17
Colombia	0,58	0,65	MEDIUM	16
San Agustín	0,58	0,65	MEDIUM	15
Pitalito	0,60	0,68	MEDIUM	14
Guadalupe	0,62	0,71	MEDIUM	13
Isnos	0,62	0,71	MEDIUM	12
Tesalia	0,62	0,71	MEDIUM	11
Baraya	0,67	0,77	HIGH	10
Campoalegre	0,67	0,77	HIGH	9
Pital	0,67	0,77	HIGH	8
Timaná	0,67	0,77	HIGH	7
Neiva	0,73	0,87	HIGH	6
Algeciras	0,76	0,90	HIGH	5
Gigante	0,78	0,94	HIGH	4
Rivera	0,78	0,94	HIGH	3
Garzón	0,80	0,97	HIGH	2
La Plata	0,82	1,00	VERY HIGH	1

According to the above Table, the municipalities with the largest variety of crops in 2010 were La Plata (0,82), Garzón (0,80) and Rivera (0,78), while the smaller variety was reported in Saladoblanco (0,40), Altamira (0,40) and Yaguará (0,13). The spatial distribution of the municipalities according to their variety of crops is shown in Figure 26.

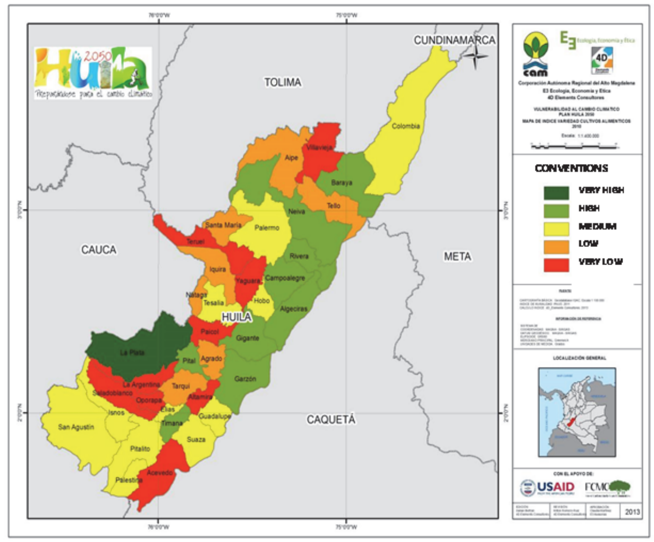


Figure 26. Spatial distribution in the municipalities of Huila Department according to crop variety (2010)

Municipality of Algeciras

Once each of the indicators had been calculated, and taking the 37 municipalities of the Department into consideration, the typology of Huila Department was established in terms of two synthetic indicators: Potential Impact and Adaptive Capacity. The synthetic indicator of the Potential Impact is based on a combination of the Exposure and Sensitivity synthetic indicators. The Adaptive Capacity indicator is based on a combination of those of the biophysical, social, politico-institutional and economic-productive dimensions.

3.1. Potential impact

Firstly, assessment of the synthetic indicators of Exposure and Sensitivity is presented to determine the Potential Impact in Huila Department.

3.1.1. Exposure

Table 46 shows the exposure values for each municipality, taking the temperature and precipitation indicators into account.

Table 46. Indicators selected for the construction of the exposure synthetic indicator (classified according to the quartiles method).

1=Municipality; 2=Temperature; 3=Precipitation; 4=Exposure

1	2	3	4
Acevedo	5	5	5
Palestina	5	5	5
Timaná	5	5	5
Guadalupe	5	3	4
Hobo	5	4	4
Isnos	4	5	4
La Argentina	4	4	4
La Plata	4	4	4
Oporapa	3	5	4
Pital	4	4	4
Pitalito	3	5	4
Saladoblanco	4	5	4
San Agustín	4	5	4
Santa María	4	4	4
Suaza	5	3	4
Teruel	3	5	4
Yaguará	4	5	4
Agrado	3	3	3
Aipe	2	4	3
Altamira	5	2	3
Elías	4	3	3
Garzón	4	3	3
Íquira	3	3	3
Nátaga	4	3	3
Palermo	2	4	3
Tarqui	5	1	3
Algeciras	3	2	2
Baraya	2	3	2
Campoalegre	3	2	2
Colombia	3	2	2
Gigante	2	2	2
Neiva	2	2	2
Paicol	2	2	2
Tello	3	2	2
Tesalia	2	3	2
Villavieja	1	3	2
Rivera	2	1	1

\+ EXPOSURE -

Figure 27 shows the result of the analysis of the combination of the variables involved in exposure. We highlight that high and very high exposure is concentrated in the municipalities of the southern and western zones of the Department, while low and very low exposure predominates in the central and northern zones. The most exposed municipalities are Acevedo, Palestina and Timaná in the extreme south-east and show the greatest change in temperature and precipitation between the baseline and the projections under the climate change scenarios. Exposure in fourteen municipalities in the southern and eastern zones (Guadalupe, Hobo, Isnos, La Argentina, La Plata, Oporpa, Pital, Pitalito, Saladoblanco, San Agustín, Santa María, Suaza, Teruel and Yaguará) is high.

In addition, the municipalities with average exposure values are: Garzón, Altamira, Elías, Tarqui y Agrado (located in the eastern zone) and Nátaga, Íquira, Palermo and Aipe (western zone). Finally, the municipalities of the east and north, Gigante, Paicol Tesalia, Algeciras, Campoalegre, Neiva, Tello, Baraya, Villavieja and Colombia have very low exposure and the municipality of Rivera has the lowest level of exposure - very low.

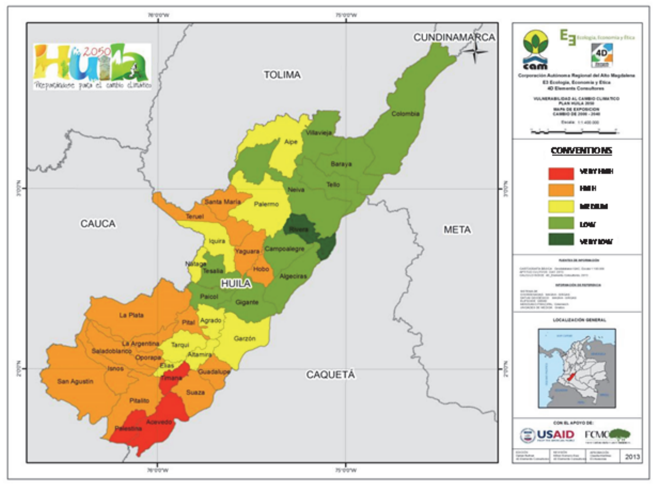


Figure 27. Exposure of the municipalities of Huila Department

3.1.2. Sensitivity

Figure 28 shows the results for the synthetic indicator of sensitivity. In the case of this indicator, it was noted that the most sensitive area is the central zone of the Department and the municipalities located on the eastern mountain range have high degree of sensitivity. There are medium and low degrees of sensitivity mainly in the extreme north and south of the Department, as well as in the municipalities of Íquira, Teruel and Santa María. The high level of sensitivity of the municipality of Rivera and its exposure are highlighted.

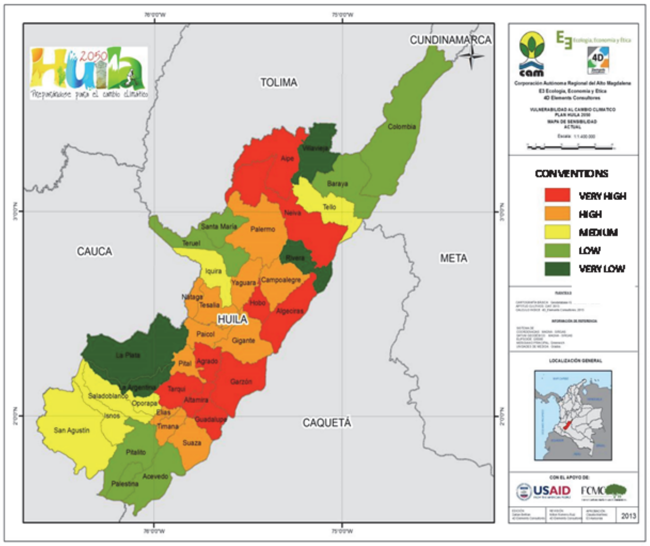


Figure 28. Sensitivity of the municipalities of Huila Department

At municipal level we found that Agrado has a very high level of sensitivity. Both the Use of Water Index and the Environmental Sensitivity Index are high for this municipality (the former of which suggests that there is high demand for water supply) and the medium Runoff (which indicates good water infiltration and retention). Aipe, Algeciras, Altamira, Garzón, Guadalupe, Hobo, Neiva and Tarqui also show very high sensitivity and it is noteworthy the Use of Water Index varies from high to very high, while the Environmental Sensitivity Index and Runoff are show levels varying from low to high (Table 47).
The municipalities that show lower sensitivity are La Argentina, La Plata, Rivera and Villavieja, which suggests that they are municipalities that use water correctly or their demand is in line with supply.

The municipalities with average values of sensitivity are Iquira, Isnos, Oporapa, Saladoblanco, San Agustín and Tello. The majority of these have low or very low values on the Environmental Sensitivity Index. However, the Use of Water Index and Runoff are high for the majority of them.

Table 47. Indicators selected for the construction of the synthetic sensitivity indicator (classified according to the quartiles method).

1=Municipality; 2=Use of water index; 3=Environmental Sensitivity index (esi); 4=Runoff (es); 5=Sensitivity.

1	2	3	4	5
Agrado	4	4	3	3.67
Aipe	5	4	2	3.67
Algeciras	5	2	4	3.67
Altamira	4	4	3	3.67
Garzón	5	2	4	3.67
Guadalupe	4	3	4	3.67
Hobo	5	4	2	3.67
Neiva	5	4	2	3.67
Tarqui	4	4	3	3.67
Campoalegre	5	3	2	3.33
Elías	4	3	3	3.33
Gigante	5	2	3	3.33
Nátaga	2	4	4	3.33
Paicol	2	5	3	3.33
Palermo	5	3	2	3.33
Pital	3	4	3	3.33
Suaza	3	2	5	3.33
Tesalia	3	4	3	3.33
Timaná	4	3	3	3.33
Yaguará	5	3	2	3.33
Íquira	3	2	4	3.00
Isnos	4	1	4	3.00
Oporapa	4	1	4	3.00
Saladoblanco	4	1	4	3.00
San Agustín	4	1	4	3.00
Tello	3	4	2	3.00
Acevedo	2	1	5	2.67
Baraya	2	4	2	2.67
Colombia	1	3	4	2.67
Palestina	3	1	4	2.67
Pitalito	3	1	4	2.67
Santa María	3	1	4	2.67
Teruel	2	2	4	2.67
La Argentina	2	1	4	2.33
La Plata	2	1	4	2.33
Rivera	2	2	3	2.33
Villavieja	2	4	1	2.33

\+ SENSITIVITY -

3.1.3. Potential impact

Figure 29 shows the result of the combination of exposure and sensitivity and makes it possible to finally obtain the impact indicator. It is noted that the areas of the central-southern-eastern and central-eastern zones are where the municipalities with the high and very high potential impact, as well as the municipality of Aipe located in the north-west of the Department. Moreover, the municipalities of the south and some of those of the central-northern area are the ones that show a potential medium impact and those of the extreme north and central-western zone are the ones with a lower potential impact.

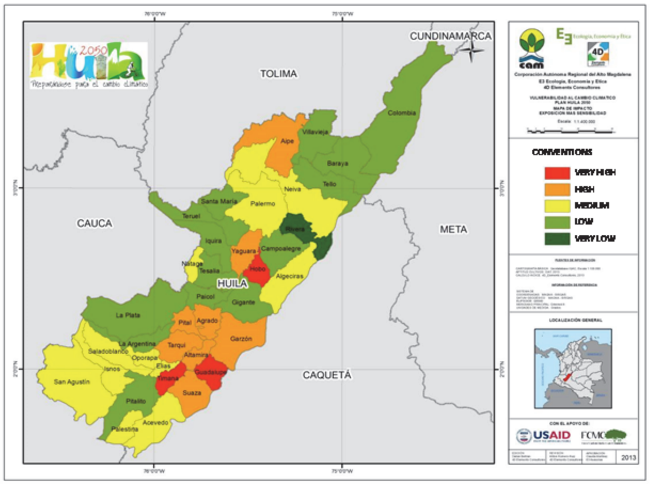


Figure 29. Potential impact of climate change on the municipalities of Huila Department

In terms of potential impact it is noted that the municipalities of Hobo, Guadalupe and Timaná are those that show the highest levels of impact, followed by Tarqui, Garzón, Altamira, Aipe, Agrado, Yaguará, Suaza and Pital, regarding which we noted high exposure and high sensitivity (in the majority of them), or medium exposure and very high sensitivity . For their part, the municipalities of Neiva, Algeciras, Palermo, Nátaga, Elías, San Agustín, Saladoblanco, Oporapa and Isnos show a medium potential impact associated with exposure and sensitivity, in general, medium or high. Those that show a low impact are Tesalia, Paico, Gigante, Campoalegre, Íquira, Tello, Teruel, Santa María, Pitalito, Colombia, Baraya, La Plata, La Argentina and Villavieja. Finally, Rivera shows the lowest value for this indicator (Table 48).

Table 48. Indicators selected for the construction of the synthetic potential impact indicator (classified according to the quartile method).

1=Municipality; 2=Exposition; 3=Sensitivity; 4=Potential impact

1	2	3	4
Rivera	1	1	1
Villavieja	2	1	2
La Argentina	4	1	2
La Plata	4	1	2
Baraya	2	2	2
Colombia	2	2	2
Pitalito	4	2	2
Santa María	4	2	2
Teruel	4	2	2
Tello	2	3	2
Íquira	3	3	2
Campoalegre	2	4	2
Gigante	2	4	2
Paicol	2	4	2
Tesalia	2	4	2
Acevedo	5	2	3
Palestina	5	2	3
Isnos	4	3	3
Oporapa	4	3	3
Saladoblanco	4	3	3
San Agustín	4	3	3
Elías	3	4	3
Nátaga	3	4	3
Palermo	3	4	3
Algeciras	2	5	3
Neiva	2	5	3
Pital	4	4	4
Suaza	4	4	4
Yaguará	4	4	4
Agrado	3	5	4
Aipe	3	5	4
Altamira	3	5	4
Garzón	3	5	4
Tarqui	3	5	4
Timaná	5	4	5
Guadalupe	4	5	5
Hobo	4	5	5

\+ POTENTIAL IMPACT -

3.1.4. Adaptive capacity, Biophysical dimension

Table 49 shows the results for the construction of the synthetic adaptive capacity indicator in its biophysical dimension according the quartile method used for this analysis. In short, it was noted that the municipalities of Palermo, Yaguará, Rivera, Paicol, Nátaga, Guadalupe, Campoalegre and Agrado show very low levels in the biophysical dimension of adaptive capacity, mainly associated with very low representativeness, a vey high and high use of the soil and a medium rate of change in the forested surface area. For their part, the municipalities of Timaná, Tesalia, Tello, Suaza, Pitalito, Neiva and Baraya have low levels, mainly due to low representativeness, medium to very high use of the soil and a predominantly high rate of change in the forested surface area.

The municipalities of Hobo, Gigante, Elías, Altamira, Tarqui, Pital, Garzón, Colombia, Algeciras, Isnos and Acevedo, have medium levels as a result of their average medium values for the three indicators analyzed. The municipalities with high levels are Teruel, Santa María, Saladoblanco, Oporapa, La Plata, Íquira, Villavieja, San Agustín and Palestina, which, on average, have high levels of representativeness and low levels of change in the surface area of their forests and use of the soil. It was found that only the municipality of La Argentina has a very high level associated with very high representativeness and very low levels in the rate of change of the forest surface area and use of the soil.

Figure 30 shows the results for the biophysical dimension of adaptive capacity, with very low and low levels in the municipalities of the center of the Department and in three municipalities located in the south-east. For their part, the majority of the municipalities in the eastern zone have a medium level (with the exception of Rivera and Guadalupe, which have low levels), contrasting with the western municipalities, which have high and very high levels (with the exception of Aipe and Palermo with very low levels and Isnos with a medium level.

Table 49. Indicators selected for the construction of the synthetic indicator of adaptive capacity in its biophysical dimension (classified according to the quartiles method).

1=Municipality: 2=Representativeness; 3=Rate of change in forest surface; 4=Use of the soil; 5=Biophysical dimension

1	2	3	4	5
La Argentina	1	1	2	1,33
Palestina	2	2	2	2,00
San Agustín	2	2	2	2,00
Villavieja	2	2	2	2,00
Íquira	2	2	3	2,33
La Plata	3	2	2	2,33
Oporapa	2	2	3	2,33
Saladoblanco	3	2	2	2,33
Santa María	2	2	3	2,33
Teruel	2	3	2	2,33
Acevedo	3	3	2	2,67
Isnos	3	2	3	2,67
Algeciras	3	4	2	3,00
Colombia	5	3	1	3,00
Garzón	3	3	3	3,00
Pital	3	2	4	3,00
Tarqui	3	2	4	3,00
Altamira	3	2	5	3,33
Elías	3	2	5	3,33
Gigante	2	4	4	3,33
Hobo	2	4	4	3,33
Baraya	4	4	3	3,67
Neiva	4	4	3	3,67
Pitalito	4	2	5	3,67
Suaza	5	3	3	3,67
Tello	4	4	3	3,67
Tesalia	4	2	5	3,67
Timaná	4	3	4	3,67
Agrado	5	2	5	4,00
Aipe	5	3	4	4,00
Campoalegre	4	4	4	4,00
Guadalupe	5	3	4	4,00
Nátaga	5	2	5	4,00
Paicol	5	2	5	4,00
Rivera	3	5	4	4,00
Yaguará	5	3	5	4,33
Palermo	5	4	5	4,67

+ ADAPTIVE CAPACITY -

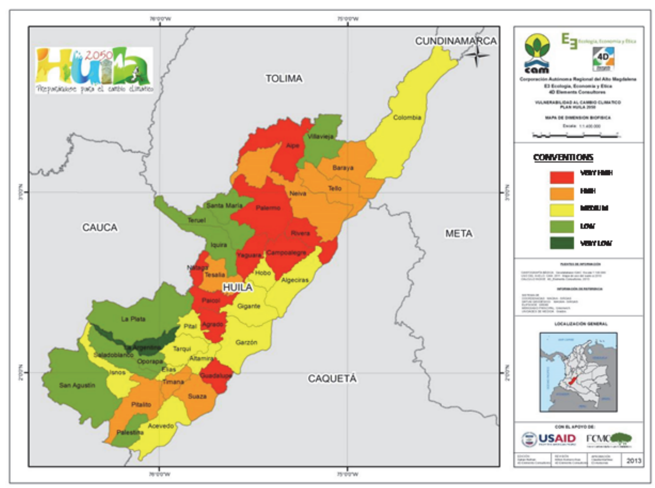


Figure 30. Adaptive capacity of the municipalities of Huila Department in the biophysical dimension.

3.1.5. Socio-Cultural dimension

Table 50 shows the results for the construction of the synthetic indicator of adaptive capacity in its socio-cultural dimension according to the quartiles method used for this analysis.

Table 50. Indicators selected for the construction of the synthetic indicator of adaptive capacity in its socio-cultural dimension (classified according to the quartiles method).

1=Municipality; 2=Adjusted HDI; 3=LCI; 4=Dengue variation; 5=RI; 6=Socio-cultural dimension.

1	2	3	4	5	6
Yaguará	1	2	1	2	1,5
Altamira	2	2	1	2	1,75
Baraya	3	2	2	2	2,25
Campoalegre	3	2	2	3	2,5
Neiva	2	1	3	4	2,5
Paicol	3	4	1	2	2,5
Tesalia	3	2	3	2	2,5
La Argentina	3	4	1	3	2,75
Villavieja	3	4	2	2	2,75
Acevedo	3	5	1	3	3
Gigante	4	3	2	3	3
Nátaga	3	4	2	3	3
Oporapa	4	4	1	3	3
Palermo	3	2	4	3	3
Palestina	4	4	1	3	3
Pitalito	3	3	2	4	3
Rivera	3	2	4	3	3
Saladoblanco	4	4	2	2	3
Santa María	4	4	1	3	3
Teruel	4	4	2	2	3
Colombia	5	5	1	2	3,25
Hobo	4	3	3	3	3,25
La Plata	4	4	2	3	3,25
San Agustín	4	4	3	2	3,25
Suaza	3	4	3	3	3,25
Aipe	4	3	5	2	3,5
Algeciras	4	4	3	3	3,5
Garzón	3	3	4	4	3,5
Íquira	4	4	3	3	3,5
Isnos	4	4	3	3	3,5
Pital	4	4	3	3	3,5
Tello	4	4	4	2	3,5
Timaná	3	4	4	3	3,5
Agrado	4	4	4	3	3,75
Elías	4	4	4	3	3,75
Guadalupe	4	4	4	3	3,75
Tarqui	4	4	4	3	3,75

\+ ADAPTIVE CAPACITY -

Based on the analysis carried out, it was found that four municipalities (Tarqui, Guadalupe, Elías and Agrado) have very low adaptive capacity in terms of the socio-cultural dimension; all of them show low levels on the Human Development Index; all of them have low levels on the adjusted Human Development Index and the Living Conditions Index; high for the Inter-Annual Variation of Dengue and a medium Rurality Index. The municipalities of Timaná, Tello, Pital, Isnos, Íquira, Garzón, Algeciras, Aipe, Suaza, San Agustín, La Plata, Hobo and Colombia show low adaptive capacity in this dimension. In general terms, all these municipalities have low levels on the adjusted Human Development Index and the Living Conditions Index, as well as medium Inter-Annual Dengue Variation levels and the Rurality Index, with the exception of Colombia, which has a very low level on the adjusted Human Development Index and the Living Conditions Index, a very high level for Variation of Dengue and a high level for the Rurality Index.

For their part, the municipalities with medium adaptive capacity in this dimension are: Teruel, Santa María, Saladoblanco, Rivera, Pitalito, Palestina, Palermo, Oporapa, Nátaga, Gigante and Acevedo. In general, these municipalities have an adjusted Human Development Index and a medium to high Living Conditions Index; a high or very high Inter-Annual Dengue Variation and a medium or high Rurality Index. Villavieja, La Argentina, Tesalia, Paicol, Neiva, Campoalegre, Baraya and Altamira have a high adaptive capacity in the socio-cultural dimension. These municipalities have a medium Human Development Index, a high or low Living Conditions Index, a medium or high Dengue Variation and a medium or high Rurality Index. Finally, we highlight that Yaguara, with a very high adaptive capacity in this dimension, a very high Human Development Index, a high Living Conditions Index, a low Dengue Variation and a high Rurality Index.

Figure 31 shows the adaptive capacity for the socio-cultural dimension. It was noted that the distribution is not homogenous and the nearby municipalities have very high to very low levels. A cluster of municipalities with medium levels in the south-eastern zone (Oporapa, Saladoblanco, Pitalito, Palestina and Acevedo) and in the central area (Teruel, Santa María, Palermo and Rivera).

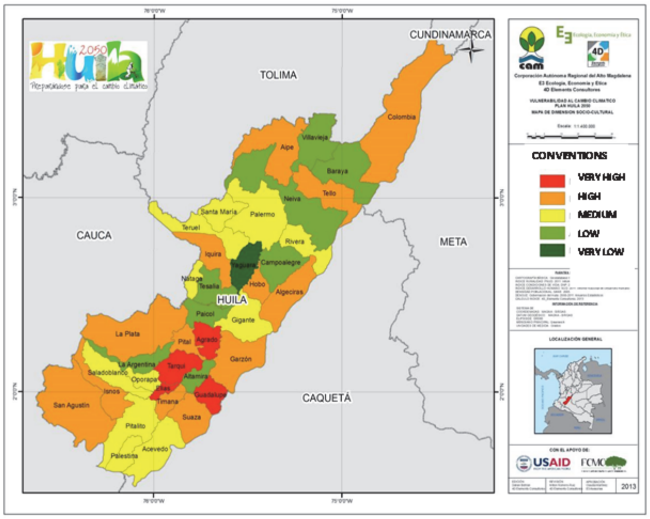


Figure 31. Adaptive capacity of the municipalities of Huila Department in the socio-cultural dimension

3.1.6. Politic-institutional dimension

Table 51 shows the results for the construction of the synthetic adaptive capacity indicator in its politico-institutional dimension according to the quartiles method used for this analysis.

In this dimension we found that the municipalities of Colombia, Acevedo and Guadalupe have very low adaptive capacity. This is due to a medium to low Fiscal Performance Index and a very low to low Investment in Risk Management, as well as very low Investment in the Environment. In addition, the municipalities of Tarqui, Pitalito, Palestina, La Plata, Isnos, Baraya, Algeciras and Agrado have a low adaptive capacity in this dimension, mainly due to a medium Fiscal Performance Index, very low to medium Investment in Risk Management and very low to low Investment in the Environment.

Among the municipalities with medium adaptive capacity in this dimension are Villavieja, Timaná, Teruel, Tello, Santa María, San Agustín, Oporapa, La Argentina and Aipe. These municipalities have a medium Fiscal Performance Index, Investment in Risk Management and Investment in the Environment which vary from very low to high. The municipalities of Yaguará, Tesalia, Suaza, Saladoblanco, Rivera, Pital, Neiva, Íquira, Altamira, Palermo, Paicol, Nátaga, Gigante, Garzón, Elías and Campoalegre, which have a medium to high adaptive capacity in this dimension, an investment in Risk Management that varies from very low to high and an Investment in the Environment from low to very high. Finally, the municipality of Hobo has a very high adaptive capacity in this dimension, with a medium Fiscal Performance Index, a very high Investment in Risk Management and high Investment in the Environment.

Table 51. Indicators selected for the construction of the synthetic indicator of adaptive capacity in its politic-institutional dimension (classified according to the quartiles method).

Municipality	Fiscal Performance index	Investment in risk management	Investment in the environment	Politico-Institutional dimension
Hobo	3	1	2	2,00
Campoalegre	2	2	4	2,67
Elías	4	2	2	2,67
Garzón	2	2	4	2,67
Gigante	2	2	4	2,67
Nátaga	3	2	3	2,67
Paicol	3	3	2	2,67
Palermo	2	5	1	2,67
Altamira	3	4	2	3,00
Íquira	3	4	2	3,00
Neiva	2	5	2	3,00
Pital	3	4	2	3,00
Rivera	2	3	4	3,00
Saladoblanco	3	2	4	3,00
Suaza	3	3	3	3,00
Tesalia	2	4	3	3,00
Yaguará	2	5	2	3,00
Aipe	2	5	3	3,33
La Argentina	3	2	5	3,33
Oporapa	3	3	4	3,33
San Agustín	3	4	3	3,33
Santa María	3	2	5	3,33
Tello	3	4	3	3,33
Teruel	4	3	3	3,33
Timaná	3	2	5	3,33
Villavieja	3	5	2	3,33
Agrado	3	5	3	3,67
Algeciras	3	3	5	3,67
Baraya	3	3	5	3,67
Isnos	3	3	5	3,67
La Plata	3	4	4	3,67
Palestina	3	3	5	3,67
Pitalito	2	5	4	3,67
Tarqui	3	5	3	3,67
Guadalupe	3	4	5	4,00
Acevedo	3	5	5	4,33
Colombia	4	4	5	4,33

\+ ADAPTIVE CAPACITY -

In this dimension it was noted that the municipalities in the central zone are the ones with very high and high levels of adaptive capacity in the politico-institutional dimension, in contrast to the municipalities of the north and south of the Department, where the levels are low and very low. There were small groups of municipalities with medium adaptive capacity in the politico-institutional dimension in the north-west (Aipe, Villavieja y Tello), the west (Teruel y Santa María) and the south (La Argentina, Oporapa y Timaná).

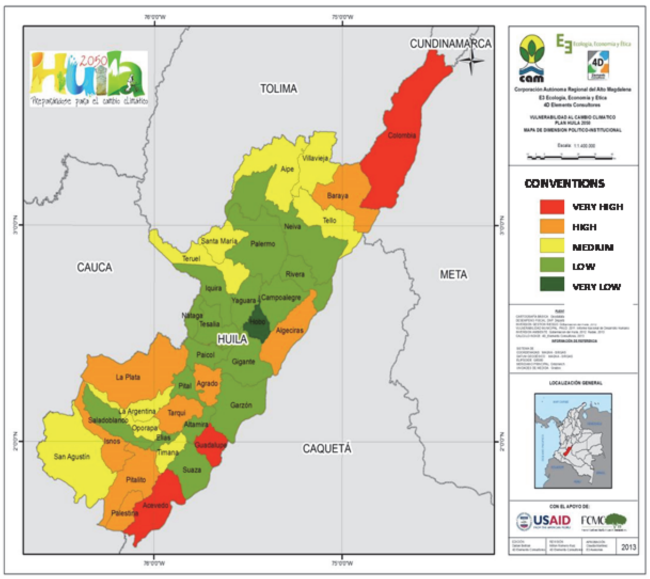


Figure 32. Adaptive capacity of the municipalities of Huila Department in the politic-institutional dimension.

3.1.7. Economic-productive dimension

Table 52 shows the results for the construction of the synthetic indicator of adaptive capacity in its economic-productive dimension according to the quartiles method used for this analysis.

For this dimension, the municipalities of Yaguará, Tello, San Agustín, Paicol, Oporapa, Villavieja, Teruel, Saladoblanco and Altamira show a very low adaptive capacity, with very low to high Gini Land And Agricultural Yield levels and very low to medium Crop variation. The municipalities of Tarqui, Palermo, Neiva, La Argentina, Elías, Colombia, Campoalegre and Acevedo, have low adaptive capacity in this dimension and Land Gini and Crop Variation from very low to high and very low and medium Agricultural Yield.

In addition, the municipalities with medium adaptive capacity in this dimension are: Tesalia, Santa María, Nátaga, Íquira and Aipe, which have between low and very high Land Gini, very low Agricultural Yield and predominantly low Crop Variation. Among the municipalities with high adaptive capacity are Palestina, Isnos, Hobo, Gigante, Baraya, Agrado, Timaná, Suaza, Rivera, Pitalito and Garzón with very low to high land Gini, medium to very high Agricultural Yield and low to high Crop Variation. Finally, Pital, La Plata and Algeciras have very high adaptive capacity in this dimension due to predominantly high land Gini, Crop Variation and Agricultural Yield.

Lastly, as in the case of the economic- productive dimension, there are no large groups of municipalities that fall within this dimension. In it, there were high adaptive capacity groups formed by some western municipalities (Hobo, Gigante, Agrado y Garzón) and in the south (including Pitalito, Palestina, Timaná and Suaza). To the north, there is a cluster of municipalities with low adaptive capacity (Neiva, Palermo Campoalegre) and on in the south La Argentina, Elías and Tarqui (Figure 33).

Table 52. Indicators selected for the construction of the synthetic indicator of adaptive capacity in its economic-productive dimension (classified according to the quartiles method).

Municipality	Land Gini	Agricultural yield	Crop variation	Economic Productive dimension
Algeciras	2	2	2	2,00
La Plata	3	2	1	2,00
Pital	2	2	2	2,00
Garzón	4	1	2	2,33
Pitalito	2	2	3	2,33
Rivera	4	2	2	2,67
Suaza	2	3	3	2,67
Timaná	3	3	2	2,67
Agrado	3	2	4	3,00
Baraya	4	3	2	3,00
Gigante	5	2	2	3,00
Guadalupe	3	3	3	3,00
Hobo	3	3	3	3,00
Isnos	3	3	3	3,00
Palestina	2	4	3	3,00
Aipe	4	2	4	3,33
Íquira	1	5	4	3,33
Nátaga	2	4	4	3,33
Santa María	1	5	4	3,33

ADAPTIVE CAPACITY +

-

Municipality	Land Gini	Agricultural yield	Crop variation	Economic Productive dimension
Tesalia	3	4	3	3,33
Acevedo	1	5	5	3,67
Campoalegre	5	4	2	3,67
Colombia	5	3	3	3,67
Elías	4	4	3	3,67
La Argentina	2	4	5	3,67
Neiva	5	4	2	3,67
Palermo	3	5	3	3,67
Tarqui	4	3	4	3,67
Altamira	4	3	5	4,00
Saladoblanco	2	5	5	4,00
Teruel	2	5	5	4,00
Villavieja	5	2	5	4,00
Oporapa	3	5	5	4,33
Paicol	4	4	5	4,33
San Agustín	5	5	3	4,33
Tello	5	4	4	4,33
Yaguará	4	5	5	4,67

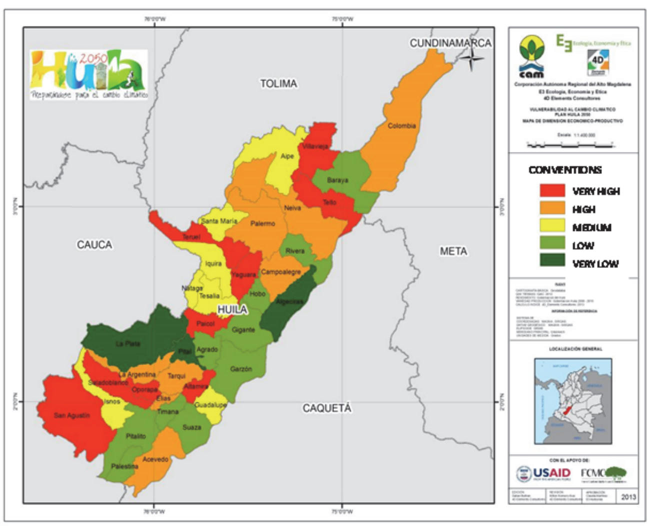


Figure 33. Adaptive capacity of the municipalities of Huila Department in the economic-productive dimension

3.2. Adaptive capacity

The total adaptive capacity of each municipality was calculated as the average of the qualifications assigned to each of the dimensions: biophysical, socio-cultural, political-institutional and economic-productive. The ranges of this were assigned according the quartiles methodology.

In accordance with the foregoing, it was decided that seven municipalities (19%) had very low adaptive capacity (Guadalupe, Tello, Tarqui, Colombia, Agrado, Aipe and Acevedo). In the biophysical, socio cultural and political-institutional dimensions, these municipalities have very low to medium levels and in the economic-productive dimension, the levels vary from very low to high.

11% of the municipalities (San Agustín, Palermo, Paicol and Elías) have a adaptive capacity with levels from very low to high in the biophysical and socio-cultural dimensions; high and medium in the political-institutional dimension and low and very low in the economic-productive dimension. 16 municipalities (43%) show a medium adaptive capacity associated with very low to high levels in the biophysical dimension, low to high in the socio-cultural dimension and low to high political-institutional dimensions and very low to very high in the economic-productive dimension.

The municipalities of Tesalia, Santa María, Palestina, La Plata, La Argentina, Íquira and Garzón have a high adaptive capacity associated with high levels in the biophysical dimension and levels varying from very high to low in the other dimensions.

Three municipalities (Pital, Hobo and Gigante) show very high adaptive capacity with medium levels in the biophysical dimension, low and medium in the socio-cultural dimension and very high to high in the politico-institutional and economic-productive dimensions.

Table 53 shows the levels for each of the dimensions and the total adaptive capacity of the municipalities of Huila Department.

Table 53. Indicators selected for the construction of the synthetic indicator of adaptive capacity (classified according to the quartiles method).

1=Municipality; 2=Biophysical dimension; 3=Socio-cultural dimension; 4=Politic- Institutional dimension; 5=Economic-Productive dimension; 6=Adaptive capacity

1	2	3	4	5	6
Gigante	3,33	3	2,11	2,81	2,50
Hobo	3,33	3,25	2,19	2,93	2,50
Pital	3,00	3,5	2,17	2,89	2,50
Garzón	3,00	3,5	2,17	2,89	2,75
Íquira	2,33	3,5	1,94	2,59	2,75
La Argentina	1,33	2,75	1,36	1,81	2,75
La Plata	2,33	3,25	1,86	2,48	2,75
Palestina	2,00	3	1,67	2,22	2,75
Santa María	2,33	3	1,78	2,37	2,75
Tesalia	3,67	2,5	2,06	2,74	2,75
Algeciras	3,00	3,5	2,17	2,89	3,00
Altamira	3,33	1,75	1,69	2,26	3,00
Baraya	3,67	2,25	1,97	2,63	3,00
Neiva	3,67	2,5	2,06	2,74	3,00
Rivera	4,00	3	2,33	3,11	3,00
Saladoblanco	2,33	3	1,78	2,37	3,00
Suaza	3,67	3,25	2,31	3,07	3,00
Villavieja	2,00	2,75	1,58	2,11	3,00
Campoalegre	4,00	2,5	2,17	2,89	3,25
Isnos	2,67	3,5	2,06	2,74	3,25
Nátaga	4,00	3	2,33	3,11	3,25
Oporapa	2,33	3	1,78	2,37	3,25
Pitalito	3,67	3	2,22	2,96	3,25
Teruel	2,33	3	1,78	2,37	3,25
Timaná	3,67	3,5	2,39	3,19	3,25
Yaguará	4,33	1,5	1,94	2,59	3,25
Elías	3,33	3,75	2,36	3,15	3,50
Paicol	4,00	2,5	2,17	2,89	3,50
Palermo	4,67	3	2,56	3,41	3,50
San Agustín	2,00	3,25	1,75	2,33	3,50
Acevedo	2,67	3	1,89	2,52	3,75
Aipe	4,00	3,5	2,50	3,33	3,75
Agrado	4,00	3,75	2,58	3,44	4,00
Colombia	3,00	3,25	2,08	2,78	4,00
Tarqui	3,00	3,75	2,25	3,00	4,00
Tello	3,67	3,5	2,39	3,19	4,00
Guadalupe	4,00	3,75	2,58	3,44	4,25

\+ ADAPTIVE CAPACITY -

For total adaptive capacity, clusters of municipalities with medium adaptive capacity were noted in the central-north and south of the Department. The majority of the municipalities with high and very high adaptive capacity are in the center-couth, where there are also some with very low adaptive capacity. In the north we also found some municipalities with very low adaptive capacity, while the municipalities with a low level are located throughout the Department. (Figure 34).

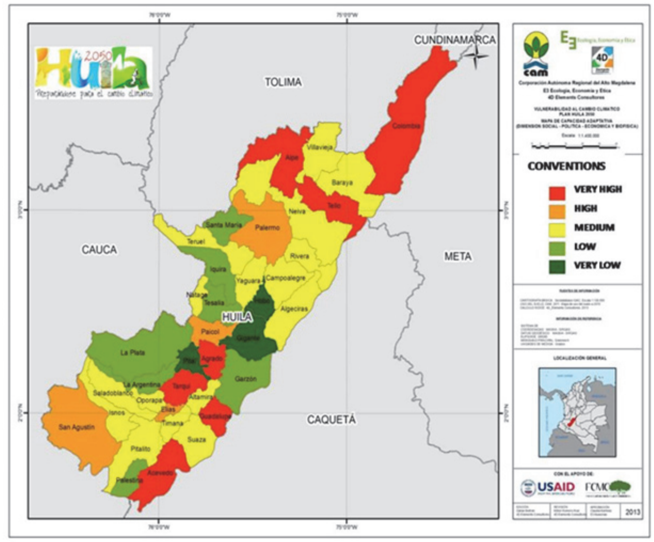


Figure 34. Adaptive capacity of the municipalities of Huila Department.

3.3. Vulnerability to climate change

Table 54 shows the results of the vulnerability analysis of the municipalities of Huila Department, based on the information presented previously. We noted that six municipalities((Guadalupe, Agrado, Aipe, Tarqui, Acevedo and Timaná) have very high or high vulnerability and, therefore, will be the most likely to suffer negative effects of climate change. By contrast, 13 municipalities (Baraya, Campoalegre, Pital, Pitalito, Teruel, Villavieja, Íquira, La Argentina, La Plata, Rivera, Santa María, Tesalia and Gigante) have very low or low vulnerability. There is medium vulnerability in the other 18 municipalities.

Table 54. Synthetic indicators of potential impact, adaptive capacity and vulnerability (classified according to the quartiles method).

Municipality	Potential impact	Adaptive capacity	Vulnerability
Guadalupe	5	5	5
Agrado	4	5	4,5
Aipe	4	5	4,5
Tarqui	4	5	4,5
Acevedo	3	5	4
Timaná	5	3	4
Altamira	4	3	3,5
Colombia	2	5	3,5
Elías	3	4	3,5
Palermo	3	4	3,5
San Agustín	3	4	3,5
Suaza	4	3	3,5
Tello	2	5	3,5
Yaguará	4	3	3,5
Algeciras	3	3	3
Garzón	4	2	3
Hobo	5	1	3
Isnos	3	3	3
Nátaga	3	3	3
Neiva	3	3	3
Oporapa	3	3	3
Paicol	2	4	3
Palestina	3	2	3
Saladoblanco	3	3	3
Baraya	2	3	2,5
Campoalegre	2	3	2,5
Pital	4	1	2,5
Pitalito	2	3	2,5
Teruel	2	3	2,5
Villavieja	2	3	2,5
Íquira	2	2	2
La Argentina	2	2	2
La Plata	2	2	2
Rivera	1	3	2
Santa María	2	2	2
Tesalia	2	2	2
Gigante	2	1	1,5

\+ VULNERABILITY -

The spatial distribution of the municipalities according to vulnerability is shown in Figure 35. The municipalities with high and very high vulnerability are located in the south-east of the Department, with the exception of Aipe. There was no easily identifiable pattern of geographic distribution of the municipalities with medium low and very low vulnerability.

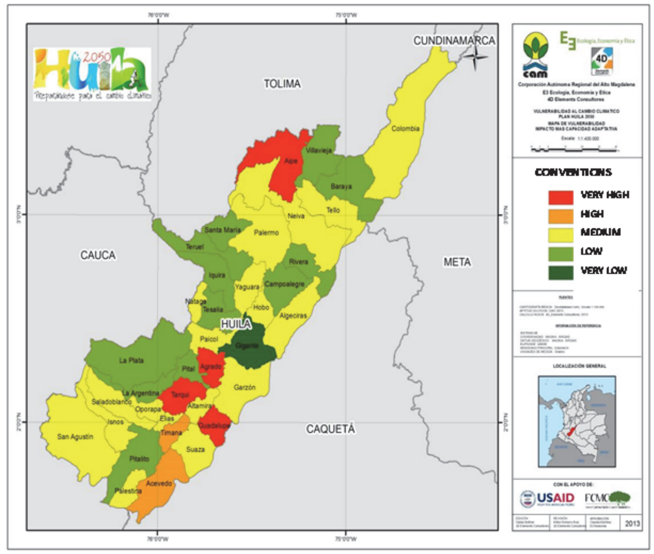


Figure 35. Vulnerability to climate change of the municipalities of Huila Department

Finally, and for descriptive purposes, each municipality is typified according to a contingency matrix which shows potential impact and adaptive capacity (Table 55). The different levels of potential impact are shown horizontally (in the columns[sic]) while the levels of adaptive capacity are shown vertically (in lines [sic]). The colors in the interior of the Table indicate the final vulnerability level of the different groups of municipalities.

Table 55. Classification of the municipalities according to their potential impact level and adaptive capacity.

	POTENTIAL IMPACT +				
ADAPTIVE CAPACITY + -	1	2	3	4	5
1		Gigante		Pital	Hobo
2		Íquira La Argentina La Plata Santa María Tesalia	Palestina	Garzón	
3	Rivera	Baraya Campoalegre Pitalito Teruel Villavieja	Algeciras Isnos Nátaga Neiva Oporapa Saladoblanco	Altamira Suaza Yaguará	Timaná
4		Paicol	Elías Palermo San Agustín		
5		Colombia Tello	Acevedo	Agrado Aipe Tarqui	Guadalupe

Based on this classification it was possible to conclude that:

- The municipality of Rivera has a very low potential impact and medium adaptive capacity. While its final vulnerability level is low, this municipality can work to improve its capacity to increase its ability to deal with the impacts of climate change.

- The municipality of Gigante has low potential impact and very high adaptive capacity. This places it in a very favorable situation with regard to the possible impacts of climate change, but it is nevertheless important to maintain conditions that favor its adaptive capacity.

- The cluster of municipalities that include Iquira, La Argentina, La Plata, Santa Maria and Tesalia show low potential impact and high adaptive capacity. These municipalities are also in a favorable situation to cope with the impacts of climate change, although they must also work on maintaining its adaptive capacity at a good level.

- A second cluster, formed by the municipalities of Baraya, Campoalegre, Pitalito, Teruel and Villavieja, have low impact potential and medium adaptive capacity. It is already important for these municipalities to work on strengthening their adaptive capacity in order to reduce the negative consequences of climate change, although the impacts of this phenomenon on their territory is moderate.

- For their part, the municipalities of Paicol, Colombia and Tello have low potential impact and very low and low adaptive capacity, respectively. This indicates that, although the impacts of climate change on their territory are expected to be low, they also have low capacity to respond to them and, therefore, there could be negative consequences. It is thus important to work on strengthening their adaptive capacity in order to reduce the possibility of negative consequences of climate change and to take advantage of any opportunities that may arise.

- The municipality of Palestina has medium potential impact and high adaptive capacity values. It is, therefore, relatively well equipped to respond to the impacts of climate change, although it still has room for improvement.

- The cluster of municipalities that includes Algeciras, Isnos, Nátaga, Neiva, Oporapa and Saladoblanco has medium values for both potential impact and adaptive capacity; this also results in medium vulnerability. It is therefore important for them to work on improving their adaptive capacity in order to deal with the impacts of climate change more effectively.

- Elías, Palermo, San Agustín and Acevedo have medium impact potential and low and very low adaptive capacity, respectively. It is crucial for these municipalities to work on strengthening their capacity, which has much room for improvement, in order to reduce the negative impacts of climate change and take advantage of the opportunities that this phenomenon could bring.

- The municipalities of Pital, Hobo and Garzón have high to very high impact potential, and their adaptive capacity is also high to very high. The impacts of climate change on these municipalities may be mitigated by their adaptive capacity. However, it is very important for them to work on maintaining this at high levels to ensure that this is in fact the case.

- For their part, Altamira, Suaza, Yaguará and Timaná have high and very high potential impact values and medium adaptive capacity. It is also important for these municipalities to work on strengthening their adaptive capacity in order to deal with the impacts of climate change on their territory which are expected to be considerable.

- The rest of the municipalities (Agrado, Aipe, Tarqui and Guadalupe) show very high vulnerability associated with a high to very high impact potential and very low adaptive capacity. Efforts to strengthen the different aspects that determine adaptive capacity must be as high as possible in these municipalities in order for them to succeed in mitigating the high impacts of climate change foreseeable for their territory.

The analysis carried out succeeds in identifying the degree of vulnerability of each municipality, but also shows that the municipalities are vulnerable for different reasons. For example, on comparing the four most vulnerable municipalities, we noted that their vulnerability is due to different degrees of exposure (which cannot be dealt with) and different degrees of sensitivity, combined with low adaptive capacity. The latter is due to differences in performance in relation go the indicators of adaptive capacity, for example: Guadalupe has strengths in the economic-productive dimension and weaknesses in the biophysical dimension; Aipe shows relatively good fiscal performance, but invests little in risk management and shows weaknesses in the biophysical and socio-cultural dimensions; Agrado has forest, but its protected areas are only slightly representative of its ecosystems and the municipality has seen a sharp rise in dengue. In other words, they are municipalities that require special, but differentiated, attention, both in their approach and in relation to the actors who will be responsible for strengthening the different components of their resilience to climate change.

3.4 Cluster Analysis

In order to be able to determine which of the factors measured by the indicators included in the vulnerability analysis contributes most to the resilience of the different municipalities, it was necessary to establish a new cluster based on a statistical analysis that seeks to group together the municipalities with similar performance with regard to the indicators. This analysis allowed us to identify four large clusters of municipalities (Figure 36).

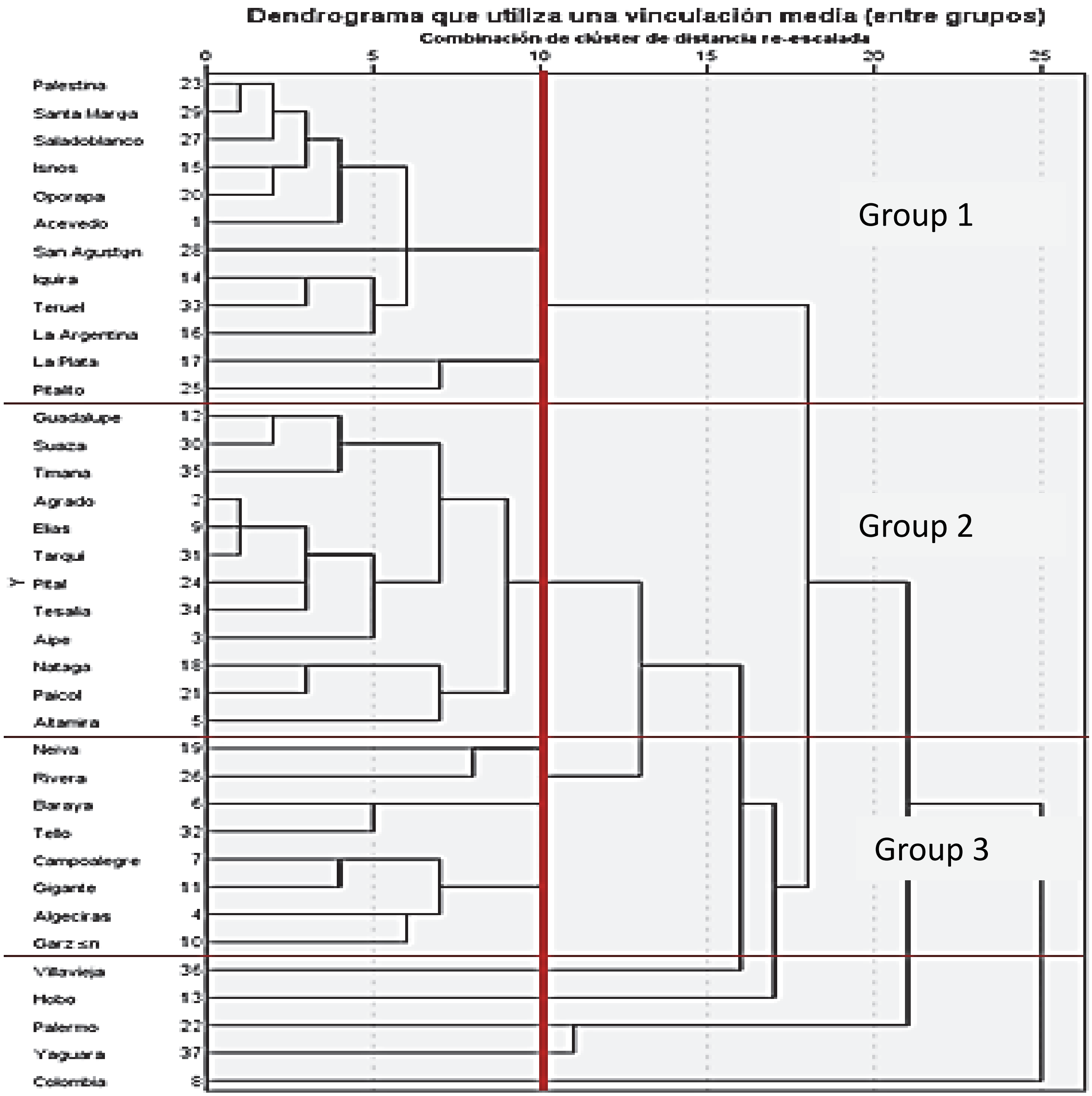


Figure 36. Dendogram of clusters of municipalities in Huila Department

3.5 Analysis of main components at departmental level

An analysis of the main components was also made, on the basis of which the factors that most affect vulnerability to climate change of the municipalities of Huila Department were identified. This analysis took all the indicators into consideration, although runoff, forest surface and use of the soil are also included in the Environmental Sensitivity Index (ESI). We decided to do so because we considered that they are factors of the greatest importance (runoff) or have different effects on vulnerability (forest surface and use of the soil contribute to both environmental sensitivity and adaptive capacity). An analysis of the correspondence between municipalities' performance relating to these factors and the environmental Sensitivity Index did not produce correlations, indicating that, in spite of forming part of the ESI, their individual performance is not correlated with ESI performance and studying it separately adds information to the analysis.

For the purpose of the analysis, we established that all the indicators included should be assigned the same weight. If, for reasons of scientific evidence or socio-political or economic priorities, it became necessary to assign differentiated weights to more indicators, the result of the analysis would vary.

The indicators which, according to the analysis made, contribute most to the differences in vulnerability are: Living Conditions Index (LCI), Runoff, Environmental Sensitivity Index (ESI), use of the soil, the Fiscal Performance Index (FPI) and representativeness (Table 56).

Table 56. Result of the analysis of th main components based on the 18 indicators used to determine the vulnerability of Huila to climate change.

Component	Initial auto-values		
	Total	% Variation	% Accumulated
Total LCI	4,799	26,664	26,664
Runoff	2,667	14,815	41,479
ESI	2,408	13,378	54,857
Use of the Soil	1,625	9,025	63,882
FPI 2011	1,321	7,337	71,219
Representativeness	1,005	5,584	76,803
Adjusted HDI	0,835	4,64	81,443
Rurality Index	0,62	3,445	84,888
Precipitation	0,555	3,083	87,971
Land Gini	0,504	2,797	90,769
Temperature	0,48	2,665	93,434
IVC 2010	0,366	2,033	95,466
Investment in the Environment 2011	0,283	1,57	97,037
Crop Yields	0,172	0,955	97,991
Annual Variation in Dengue 2008-2012	0,157	0,87	98,861
Investment in Risk Management 2012	0,087	0,486	99,347
Use of Water Index	0,074	0,413	99,76
Change in Coverage	0,043	0,24	100

It is clear that these six indicators explain 77% of the correlations between the indicators used o describe vulnerability to climate change and the cluster of the municipalities.

This result shows that the difference in vulnerability among the municipalities is mainly due to factors of sensitivity and adaptive capacity in the socio-cultural, politico-institutional and biophysical dimensions. According to this result, it does not depend directly on factors of exposure (temperature and rainfall).

The four clusters with similar indicator performance, to which we referred above (Figure 37), can therefore be described as follows:

- Cluster one: Palestina, Santa María, Saladoblanco, Isnos, Oporapa, Acevedo, San Agustín, Íquira, Teruel, La Argentina, La Plata and Pitalito. Although these are municipalities with potential impact and varied vulnerability, they are characterized by a greater threat of reduction in precipitation; greater environment sensitivity, although, in general, they a larger forested coverage with fewer changes and better representativeness and lower runoff than the municipalities in the other groups. As to the indicators of adaptive capacity, they show, on average, relatively lower performance in land distribution, crop yields, fiscal performance, investment in the environment, HDI and quality of life index.

- Cluster two: Guadalupe, Suaza, Timaná, Agrado, Elías, Tarqui, Pital, Tesalia, Altamira, Nátaga, Paicol and Aipe. This group includes the four most vulnerable municipalities. With regard to their performance in the determining factors, they are, in general, under a greater threat of change in temperature, lesser representativeness of their protected areas, a larger proportion of their land with a conflict of use and a more marked increase in the occurrence of dengue during the last five years. In the case of the other indicators, they show intermediate performance, with the exception of investment in risk management, which relatively lower than in the other municipalities.

- Cluster three: Neiva, Rivera, Baraya, Tello, Campoalegre, Gigante, Algeciras and Garzón. These municipalities are characterized, in general, by better performance in almost all the adaptive capacity indicators, with the exception of investment in risk management, investment in the environment and the Rurality Index.

- Cluster four: Hobo, Villavieja, Palermo, Yaguará and Colombia. Although their performance indicators are varied, this group is different in that, in general, it shows better performance in investment in risk management and the environment, as well as having a higher Rurality Index. As a group, it also shows less crop variety.

The foregoing information provides important inputs, both for the Huila Departmental Government and for the CAM for the development of strategies to increase the resilience of the municipalities and the Department. An example of this is a strategy aimed at increasing the Quality of Life Index, which will contribute to the well being of the population, while at the same time strengthening the resilience of the municipalities, in particular, those of Cluster One. Planning strategies for the conservation and use of the land would strengthen the municipalities' mitigation capacity, as well as strengthening their adaptive capacity and their sensitivity, especially the municipalities of Cluster Two, which includes the most vulnerable ones.

This paper is the first approximation of a municipal level study carried out in Colombia on the vulnerability to climate change of a particular territory. It constructs a conceptual and methodological framework in accordance with the outlines developed by the IPCC and is based on climatic projections for 2011-2040 developed by IDEAM. It is noteworthy that the experience of the agricultural vulnerability in upper Cauca (AVA), financed by CDKN, was taken as a reference. In it, the process of construction of the battery of indicators was begun and identified nearly 60 indicators that would facilitate implementation of this approach. However, the lack of information and the absence of historical series, spatial resolution and the dates on which when it was taken made it obligatory, in the process, to select variables that contained information for the construction and approximation of each of the indicators which, in this case, were 12. On the basis of this experience, it was decided to hold an Indicators Workshop that could be used to calculate the vulnerability of the municipalities of Huila Department and could be scalable for other Departments. At this workshop, aided by the knowledge of experts of governmental and private entities, a battery of indicators with reliable information at municipal level, was agreed on. It should be clarified that, while work was done using official data, the years of the data used vary because there is no monitoring system in either the Department or the country to allow regular measurement of each of these indicators (e.g. LCI to 2005) versus the Rurality Index to 2011).

It is therefore important to take into account that this type of studies produce dynamic results, which can change when the taking of data and their updating change, which does not necessarily imply affecting the Department's short term priorities. Moreover, they contribute by orientating strategies for the approach to the situations which cause or maintain vulnerability to climate change. Consequently, it may be said that this present radiography of the municipalities of Huila can be taken as a baseline on which it is possible to construct gradually as the systems of data taking in the region are strengthened.

Thus, it may be said that the only variables that a governor cannot control are precipitation and temperature, unless there are strong mitigation measures on the management of the environment on a particular terrain. It is important to evaluate the adaptive capacity of a territory taking into account the fact the it can change or improve and the majority of these changes are in the hands of the governors. To this effect, it is essential to suggest that the changes made must be constantly monitored. Therefore, it is a priority to carry out this type of studies regularly and to update them at least every five years, in order to determine, in detail, each municipality's adaptive capacity level. It is also equally important to analyze which of the variables involved and the indices immersed in each synthetic indicator in each of the dimensions were the causes of the qualification or range in which each municipality is found so that the corrective measures to improve the variables within this component can be implemented.

Once this information had been calculated and obtained in a general manner, it was found that the increase in temperature, reduction in precipitation and increase in demand for water, among other things, are evidence that Huila Department is not free from the effects of global climate change. For Huila Department, during the period 2011-2040, with respect to the baseline, it was noted that precipitation will be reduced in 70% of the area of the Department, with rainfall percentage of between 70% and 90%, while in 30% of the territory of the Department there will be an increase in precipitation with values of 90% and 110%. As to temperature, it was noted that, in 99.86% of the Departmental area, it will increase by between 1 and 2°C and the rest between 2 and 3°C, which are in small areas of the municipalities of Aipe and Villavieja.

These changes, added to the loss of natural coverages and the reduction in biodiversity, have caused considerable environmental impacts that have placed the Department on alert. The increase in productive activities and the politico-economic and social conflicts test Huila's adaptive capacity to deal with this challenge. Based on the analysis of vulnerability carried out, it was noted that the municipalities of Guadalupe, Tarqui, Agrado, Aipe and Acevedo had a very high and high degree of vulnerability and, consequently, they will be the most likely to be affected by climate change. By contrast, the municipalities of Pitalito, Pital, La Argentina, La Plata, Tesalia, Íquira, Teruel, Santa María, Villavieja, Baraya, Rivera, Campoalegre and Gigante show vulnerability between low and very low. Vulnerability in the remaining 19 municipalities is medium.

At Departmental level, vulnerability to climate change depends mainly on sensitivity and adaptive capacity factors, which may be modified through activities undertaken at municipal and Departmental levels.

Huila Department has great opportunities for the adaptation and mitigation of climate change, such as the presence of large and extensive forests and high plateaux in its high mountain range areas and in the south the Department, the network of protected areas and the Departmental Government's growing capacity for political, social and economic actions. However, it must also be taken into account that present interests in the use of soil in the different sectors of the Department (livestock, oil, mining, hydro-electric) make it necessary to re-define the future and foresee the activities that represent greater Departmental sustainability in order to promote competitiveness towards 2050. This vision of use of the soil must also be examined within each municipality, taking both their restrictions and their opportunities to deal with climate change in the region into consideration. This is because the policies and the adaptation measures implemented must be adjusted to take these restrictions into consideration in order to be able to organize and maintain the territory's viability in time in the event of possible change it its conditions.

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