



FUNDING PROPOSAL TO THE GREEN CLIMATE FUND

-IRES-CUBA-
**INCREASED CLIMATE RESILIENCE OF RURAL
HOUSEHOLDS AND COMMUNITIES THROUGH THE
REHABILITATION OF PRODUCTIVE AGROFORESTRY
LANDSCAPES IN SELECTED LOCALITIES OF THE
REPUBLIC OF CUBA**

APPENDIX 2.2

Effects of Climate Change on the Physical-
Geographic and Socioeconomic Conditions of
Selected Territories of the Central and Eastern
Regions of the Republic of Cuba

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Contents

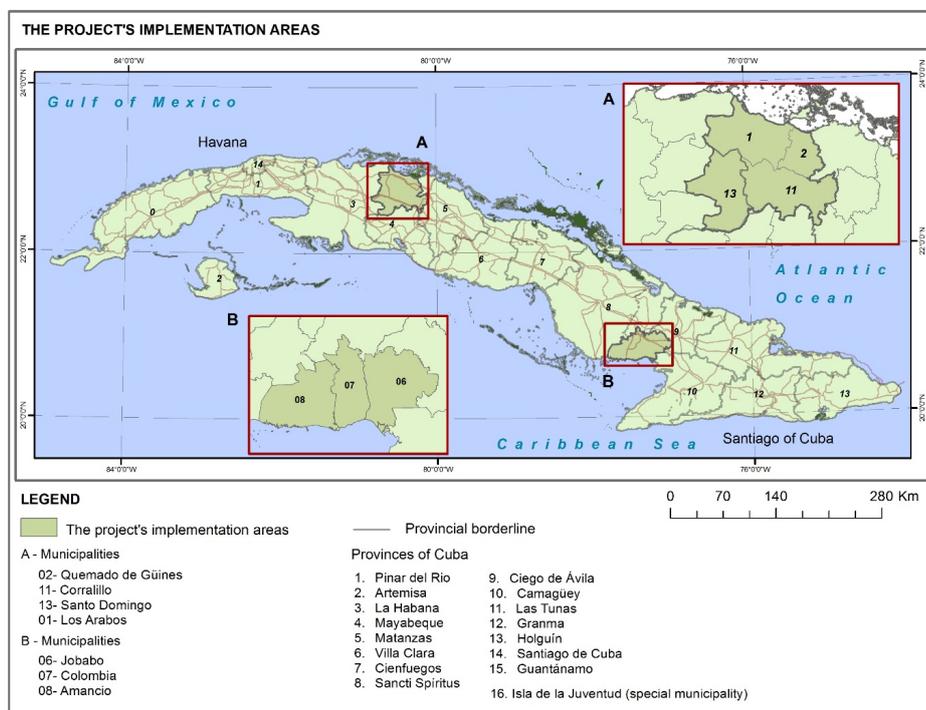
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I. INTRODUCTION

As the effects of climate change on Cuba's physical-geographical and socio-economic conditions are accentuated, the areas affected by the agricultural drought increase and the cultivated lands decrease, a chain of processes that cause the decrease of agricultural lands is generated, the expansion of areas occupied by invasive plants such as Marabu, more compatible with arid environments, food production decreases, urban and rural employment decreases, and the exodus of the population in general, rural in greater magnitude, increases, at the beginning in search of better income, and then as a survival mechanism. These processes create tensions in the territories and migrations towards urban spaces that do not have the capacity to generate employment or appropriate infrastructure for the reception of migrants. It is a dynamic that feeds back from the fact that no measures to prevent and mitigate land degradation are adopted, and plans and projects are not drawn up to combat drought, climate variability and other consequences derived from climate change.

Seven municipalities of Cuba have been selected for this research, hereinafter referred to as project implementation areas (AIP), four belonging to the Central region and three to the Eastern region. The area occupied by these municipalities is 5 104.6 km², with a resident population in 2017 of 240 939 inhabitants for an average density of 47.20 inhabitants / km². As can be seen in the table, they differ in the amount of population and area, as well as in their density. They represent 4.65% of the total surface of Cuba and 2.14% of its population. Its density is less than half the value of this indicator for the country, which is 102.2 inhabitants / km² (Table 1). Its location is shown in figure 1.

Figure 1. Location of the project implementation areas (AIP)



Source: Prepared by the authors

Table 1. Surface extension, resident population and population density, year 2016

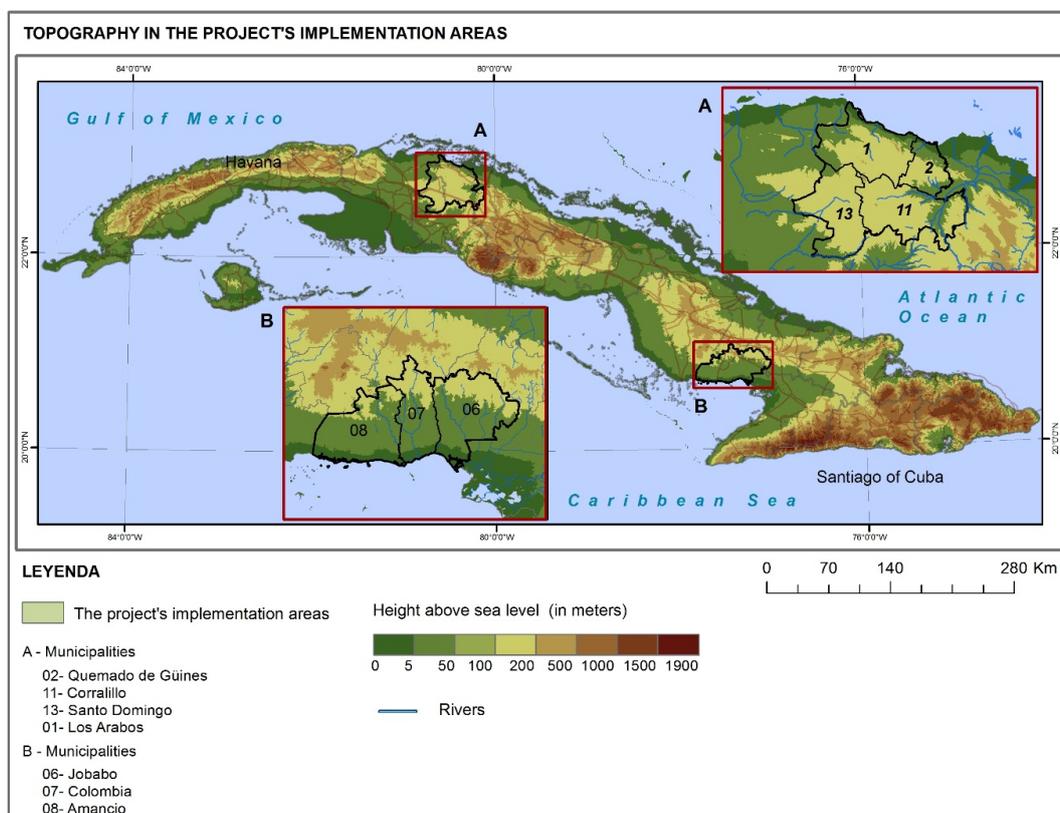
| Municipality | Surface (km ²) | Total Population (Inhabitants) | Density (Inhab/km ²) | Masculinity Index (men for every 1000 women) (a) |
|-------------------|----------------------------|--------------------------------|----------------------------------|--------------------------------------------------|
| Central Region | 2 806,5 | 120 757 | 43,03 | 1 029 |
| Los Arabos | 758,4 | 24 274 | 32,01 | 1 033 |
| Corralillo | 837,3 | 26 089 | 31,16 | 1 031 |
| Quemado de Güines | 332,8 | 21 586 | 64,86 | 1 050 |
| Santo Domingo | 878,1 | 50 035 | 56,98 | 1 016 |
| Eastern Region | 2 298,1 | 120 182 | 52,30 | 1 057 |
| Jobabo | 885,6 | 43 611 | 49,24 | 1 072 |
| Colombia | 560,0 | 32 412 | 57,88 | 1 042 |
| Amancio | 852,5 | 38 491 | 45,15 | 1 051 |
| Total | 5 104,6 | 240 939 | 47,20 | 1 043 |

(a) 2017

Source: ONEI (2017). Statistical yearbook of Cuba. Edition 2018. Havana

From the point of view of the relief, they are characterized by being part of the cumulative marine-fluvial plains and abrasive plains with an average height between 25 and 40 meters in the eastern region and between 50 and 65 m in the central region.

Figure 2. Physical-geographical characteristics



Source: Prepared by the authors from the Cartographic Database of Cuba at 1:25 000 scale

The municipalities under study are classified by experiencing the processes described in the introductory paragraph, both in their physical-geographical and socio-economic and territorial conditions, depressed in their levels of economic activity, with increasing exoduses of their population, reduction of cultivated area and therefore, food production, expansion of the area covered by Marabu (*Dichrostachys cinérea*) and a significant increase in the aging population and feminization of these spaces that face the consequences of an agricultural drought that has been going on for several decades, derived from the effects of climate change in these regions of the Center and East of the country.

This situation leads us to consider as a starting hypothesis:

The municipalities studied have a complex physical-geographical, socioeconomic and territorial problems and a high vulnerability to the effects of climate change.

Overall Objective

The objective of the research is to demonstrate that the areas under study experience the effects of climate change with great intensity, which are evident in the frequency and force of extreme weather events that affect them, the expansion of the agricultural area affected by drought, the reduction of cultivated lands, the expansion of the areas occupied by the Marabu, the exodus of the population in general, and in greater magnitude, the rural, first in search of better income and then as a survival mechanism.

These factors, together with the low rates of forest cover reported in the territories and the scarce presence of isolated trees in the rural scenario, predict a decrease in rainfall, and a more arid climate, an environment in which invasive plant species such as Marabu can be reproduced more easily, affecting the resilience capacity of these territories and the communities present in the AIP.

The implementation of projects aimed at mitigating the effects of the situation described in this research will contribute to reverting the deplorable physical-geographic, socioeconomic and territorial processes of the current scenario, recovering agricultural and livestock spaces, in order for those rural households currently more vulnerable to change climate change in AIPs, to become better adapted to the impacts through the rehabilitation of productive agroforestry landscapes, reversing the chain of processes that are now downward, as evidenced in the results of this study.

The modules to be implemented operate under sustainable systems that fulfill relevant functions in the scenario in which they are developed and that focus on ensuring greater resilience of vulnerable people, households and ecosystems.

II. METHODOLOGY

The application of representation tools, spatial and statistical analysis in GIS together with digital image processing techniques represents an important point of this work, in addition to the analysis of the official statistics of the Balance of Use and Tenure of the land developed by the National Center for Land Control of the Ministry of Agriculture (MINAG) and the National Office of Statistics and Information (ONEI) in all matters relating to the population, which were processed for the preparation of the tables and the examination of the population dynamics in its complexity for the territories studied. The methodology used is easily extrapolated to other territories that have the same problem and can serve as the basis for different investigations. The methodology used can be summarized in four stages:

(a) Cartographic representation and analysis of the statistical information contained in various

publications of the ONEI (Demographic Yearbooks of Cuba, Demographic series for different periods of time by place of residence and sex, studies of migrations and aging for several years, among others), of the MINAG (Balance of land use and tenure for several years prepared by the National Center for Land Control).

(b) Cartography of the state of Marabu in the areas of Project Intervention (AIP) from the digital image processing of the Sentinel satellite, February 2, 2019 and analysis of its special dynamics

(c) Analysis of the climatic variables studied (trajectory of hurricanes in the Atlantic Ocean basin) and agricultural drought maps of Cuba

(d) Analysis of the influence of climate change on the expansion of Marabu and population variations in the human settlements present in the AIP, with special emphasis on rural settlements (migration, aging and feminization of these spaces).

The main materials used were the following: national topographic maps of Cuba at 1:25 000 scale; Sentinel 2A satellite image of the year 2019, (with a spatial resolution of 10 x 10 m); map of agriculture prepared by the Soil and Fertilizer Directorate of MINAG for 2015, Balance of use and land tenure for several years of the National Center for Land Control of MINAG; Several ONEI Publications on population and its characteristics for several years, data of the Meteorological Service of the United States and other interesting data obtained through the consultation of documents of Cuban Institutions. For example, the System of Monitoring and Early Warning of the Agricultural Drought executed by the Center for Agricultural Meteorology of INSMET. The drought maps were taken from Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baéz, S. González, J. Sille, P. Rosario and L. Duarte (2006). The meteorological and agricultural drought in the Republic of Cuba and the Dominican Republic. Volume I, 172 pp.

III. DISTRIBUTION OF THE POPULATION IN THE AIP

The analyzed municipalities are located in the Central Region, towards the central and northern part of the island. Those grouped in the Eastern region, are located in southern and eastern parts of the country, positions that place them in different physio geographic frames and under the differentiated effect of meteorological and climatological phenomena that affect them over time.

An evaluation of selected demographic indicators for the territories under study and their variation over time constitutes evidence of the processes of various nature events that have occurred in recent years and that largely derive from the effect of processes and physio geographic phenomena linked to climate change, which highlights the agricultural drought that for several decades and with increasing trend is present in these territories.

In 2009, the total population of the studied area (Central and Eastern regions), which comprises the seven municipalities analyzed and related in Appendix 2.2.3, reached 248,994 inhabitants; of them, 127,605 men and 121 389 women, for a masculinity index of 1 051 men for every 1 000 women. The urban population represents 62.2% and the rural population 37.8%. The population over 60 years old represented 17.68% of the total population, 17.64% of males and 17.22% of females; the urban population of 60 years and over was 60.73% and the rural population of 39.27%; presented a masculinity index of 1 047 men for every 1 000 women (Appendix 2.2.1).

In 2017, approximately eight years later, the total population of the seven municipalities analyzed was 240 939 inhabitants, 8 055 inhabitants less; structured in 123 317 men (51%) and 118 252 women (49%) reported an approximate decrease of 4,288 men and 3,137 women. There is evidence of abandonment by the population of the studied territories where the woman is the most affected,

reporting a masculinity index of 1 043 men for every thousand women, 8 fewer men for every 1 000 women. The analysis of gender shows that the most unfavorable situation in these territories is suffered by women, given the abandonment of a greater number of men in search of greater and better opportunities for work and life. A feminization process of the studied rural spaces is underway.

The 2017 analysis for the population of 60 years and older shows a growth of 5.9 thousand inhabitants within the population of 60 years and older, emphasizing that this population group increases in urban spaces by 6369 inhabitants and decreases 448 in rural areas, which attests to the presence of a significant migration of this age group towards urban spaces. Demographic aging is occurring on the territories studied (17.68% in 2009 and 20.73% in 2017). The situation described makes it difficult to replace the labor force and its development in the short and medium term in all the municipalities analyzed, with particular emphasis on rural areas. Likewise, an evident feminization is reported in the aging process of the whole territory, with a percentage growth of the urban population and an index of masculinity that decreases for this population group of 60 years and older, reaching a value of 999 men for each a thousand women.

III.1. Distribution of the Population in the AIP – Central Region

The analysis for 2009 of the municipalities of the Central region showed a total of 127,864 inhabitants; 65 379 men and 62 485 women, for a masculinity index of 1 046 men per 1 000 women. The urban population represents 67.04% and the rural population 32.96%. The population aged 60 and over represented 20%; the urban population aged 60 years and over 19.88% and the rural population 20.13%. In 2017.

Approximately eight years later, the population of the four municipalities analyzed was 120,757 inhabitants, 7,107 less inhabitants; Structured in 61 235 men (4 144 fewer than in 2009) and 59 522 women (2 963 fewer). There is evidence of an abandonment by the population of the studied territories, urban rural migration (exodus of the rural population), by which women are the most affected, with a variation in the masculinity index that decreases by 17 men per thousand women (1 029). Gender analysis shows that the most unfavorable situation in this region affects women, given the abandonment of men in search of greater and better opportunities for work and life, while women, in particular aged 60 years and older, increase their number. A process of feminization of rural spaces in the municipalities of the Central region is underway (Appendix 2.2.2, Tables 2 and 3).

Table 2. Selected indicators of the population of the municipalities of the AIP in the Center region, year 2009.

| Municipality | Population | | | | | Index masculinity (men for every 1000 women) | Percentage | |
|-------------------|------------|--------|--------|--------|--------|----------------------------------------------|------------|-------|
| | Total | Male | Female | Urban | Rural | | urban | rural |
| Los Arabos | 24 829 | 12 701 | 12 128 | 13 869 | 10 960 | 1 047 | 55,86 | 44,14 |
| Population ≥60 | 4 665 | 2 410 | 2 255 | 2 629 | 2 036 | 1 069 | 56,36 | 43,64 |
| % | 18,79 | 18,97 | 18,59 | 18,96 | 18,58 | | | |
| Corralillo | 27 554 | 14 043 | 13 511 | 19 441 | 8 113 | 1 039 | 70,56 | 29,44 |
| Population ≥60 | 5 582 | 2 855 | 2 727 | 3 851 | 1 731 | 1 047 | 68,99 | 31,01 |
| % | 20,26 | 20,33 | 20,18 | 19,81 | 21,34 | | | |
| Quemado de Güines | 22 474 | 11 630 | 10 844 | 14 211 | 8 263 | 1 072 | 63,23 | 36,77 |

| | | | | | | | | |
|----------------|---------|--------|--------|--------|--------|-------|-------|-------|
| Population ≥60 | 4 670 | 2 378 | 2 292 | 2 767 | 1 903 | 1 038 | 59,25 | 40,75 |
| % | 20,78 | 20,45 | 21,14 | 19,47 | 23,03 | | | |
| Santo Domingo | 53 007 | 27 005 | 26 002 | 38 201 | 14 806 | 1 039 | 72,07 | 27,93 |
| Population ≥60 | 10 659 | 5 352 | 5 307 | 7 451 | 3 208 | 1 008 | 69,90 | 30,10 |
| % | 20,11 | 19,82 | 20,41 | 19,50 | 21,67 | | | |
| Central Region | 127 864 | 65 379 | 62 485 | 85 722 | 42 142 | 1 046 | 67,04 | 32,96 |
| Population ≥60 | 25 576 | 12 995 | 12 581 | 16 698 | 8 878 | 1 033 | 65,29 | 34,71 |
| % | 20,00 | 19,88 | 20,13 | 19,48 | 21,07 | | | |

Source: ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2012) Demographic series 2000-2010. Magnetic support.

When this analysis is carried out for the population aged 60 and over, there is a growth of 2.5 thousand inhabitants in the population aged 60 and over, highlighting that this population group increases in urban spaces by 886 inhabitants and 1,638 in the rural areas. As for all the territory studied, they are facing demographic aging in these municipalities, which affects their sustainable development. Likewise, a feminization is reported in the evident aging process of rural spaces, with a percentage growth of the urban population, a decrease in the rural population and an index of masculinity that increases for this population group of 60 years and over until reaching a value of 976 men per thousand women.

Table 3. Selected indicators of the population of the municipalities of the AIP in the Central region, year 2017.

| Name | Population | | | | | Index masculinity (men for every 1000 women) | Percentage | |
|-------------------|------------|--------|--------|--------|--------|----------------------------------------------|------------|-------|
| | Total | Male | Female | Urban | Rural | | urban | rural |
| Los Arabos | 24 119 | 12 257 | 11 862 | 14 650 | 9 469 | 1 033 | 60,74 | 39,26 |
| Population ≥60 | 5 290 | 2 683 | 2 607 | 3 352 | 1 938 | 1 029 | 63,36 | 36,64 |
| % | 21,93 | 21,89 | 21,98 | 22,88 | 20,47 | | | |
| Corralillo | 25 834 | 13 117 | 12 717 | 19 039 | 6 795 | 1 031 | 73,70 | 26,30 |
| Population ≥60 | 6 031 | 2 973 | 3 058 | 4 401 | 1 630 | 972 | 72,97 | 27,03 |
| % | 23,35 | 22,67 | 24,05 | 23,12 | 23,99 | | | |
| Quemado de Güines | 21 359 | 10 942 | 10 417 | 13 906 | 7 453 | 1 050 | 65,11 | 34,89 |
| Population ≥60 | 5 217 | 2 597 | 2 620 | 3 295 | 1 922 | 991 | 63,16 | 36,84 |
| % | 24,43 | 23,73 | 25,15 | 23,69 | 25,79 | | | |
| Santo Domingo | 49 445 | 24 919 | 24 526 | 35 905 | 13 540 | 1 016 | 72,62 | 27,38 |
| Population ≥60 | 11 562 | 5 628 | 5 934 | 8 351 | 3 211 | 948 | 72,23 | 27,77 |
| % | 23,38 | 22,59 | 24,19 | 23,26 | 23,71 | | | |
| Central Region | 120 757 | 61 235 | 59 522 | 83 500 | 37 257 | 1 029 | 69,15 | 30,85 |
| Population ≥60 | 28 100 | 13 881 | 14 219 | 19 399 | 8 701 | 976 | 69,04 | 30,96 |
| % | 23,27 | 22,67 | 23,89 | 23,23 | 23,35 | | | |

Source: ONEI (2017). The aging of the population 2017. Havana

III.2. Distribution of the Population in the AIP – Eastern Region

The population of the municipalities of the Eastern region for 2009 reached 121 130 inhabitants, of which 62 226 are men and 58 904 women, for a masculinity index of 1 056 men for every 1 000 women. The urban population represents 57% and rural 43%. The population aged 60 and over represented 15.23%; the urban population of 60 years and more 14.51% and the rural population 16.18%. In 2017, approximately eight years later, the population of the three municipalities analyzed was 120 182 inhabitants, 948 inhabitants less; in its structure, 62,082 men and 58,730 women, an estimated decrease of 144 men and 174 women was reported. There is evidence of abandonment by the population of the studied territories where women are the most affected, with a variation in the value of the masculinity index that increases by approximately one man per thousand women (Appendix 2.2.2, Tables 4 and 5).

Table 4. Selected indicators of the population of the municipalities of the AIP in the East region, year 2009.

| Municipality | Population | | | | | Index masculinity (men for every 1000 women) | Percentage | |
|-------------------|------------|--------|--------|--------|--------|----------------------------------------------|------------|-------|
| | Total | Male | Female | Urban | Rural | | urban | rural |
| Jobabo | 47 580 | 24 608 | 22 972 | 18 299 | 29 281 | 1 071 | 38,46 | 61,54 |
| Population ≥60 | 7 330 | 3 924 | 3 406 | 2 453 | 4 877 | 1 152 | 33,47 | 66,53 |
| % | 15,41 | 15,95 | 14,83 | 13,41 | 16,66 | | | |
| Colombia | 32 779 | 16 750 | 16 029 | 22 532 | 10 247 | 1 045 | 68,74 | 31,26 |
| Population ≥60 | 5 044 | 2 531 | 2 513 | 3 504 | 1 540 | 1 007 | 69,47 | 30,53 |
| % | 15,39 | 15,11 | 15,68 | 15,55 | 15,03 | | | |
| Amancio Rodríguez | 40 771 | 20 868 | 19 903 | 28 335 | 12 436 | 1 048 | 69,50 | 30,50 |
| Population ≥60 | 6 069 | 3 062 | 3 007 | 4 079 | 1 990 | 1 018 | 67,21 | 32,79 |
| % | 14,89 | 14,67 | 15,11 | 14,40 | 16,00 | | | |
| Eastern Region | 121 130 | 62 226 | 58 904 | 69 166 | 51 964 | 1 056 | 57 | 43 |
| Population ≥60 | 18 443 | 9517 | 8 926 | 10 036 | 8 407 | 1 066 | 54,42 | 45,58 |
| % | 15,23 | 15,29 | 15,15 | 14,51 | 16,18 | | | |

Source: ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2012) Demographic series 2000-2010. Magnetic support.

When this analysis is carried out for the population aged 60 and over, a growth of 3.4 thousand inhabitants is observed, highlighting that this population group increases in urban spaces by 3,668 inhabitants and decreases by 271 in rural areas, as a result of the urban rural migration that is reported. As for all the territory studied, there is an aging demographic of these municipalities, which affects their sustainable development. Likewise, an evident feminization is reported in the aging process of rural spaces, with a percentage growth of the urban population, a decrease in the rural population and a masculinity index that increases for this population group of 60 years and over.

Table 5. Selected indicators of the population of the municipalities of the Eastern region, year 2017.

| Municipality | Population | | | | | Index masculinity (men for every 1000 women) | Percentage | |
|-------------------|------------|--------|--------|--------|--------|----------------------------------------------|------------|-------|
| | Total | Male | Female | Urban | Rural | | urban | rural |
| Jobabo | 47 350 | 24 503 | 22 847 | 18 012 | 29 338 | 1 072 | 38,04 | 61,96 |
| Population ≥60 | 8 394 | 4 368 | 4 026 | 3 788 | 4 606 | 1 085 | 45,13 | 54,87 |
| % | 17,73 | 17,83 | 17,62 | 21,03 | 15,70 | | | |
| Colombia | 32 185 | 16 747 | 16 068 | 22 564 | 10 251 | 1 042 | 70,11 | 31,85 |
| Population ≥60 | 6 342 | 3 224 | 3 118 | 4 666 | 1 676 | 1 034 | 73,57 | 26,43 |
| % | 19,70 | 19,25 | 19,41 | 20,68 | 16,35 | | | |
| Amancio Rodríguez | 40 647 | 20 832 | 19 815 | 28 360 | 12 287 | 1 051 | 69,77 | 30,23 |
| Population ≥60 | 7 104 | 3 487 | 3 617 | 5 250 | 1 854 | 964 | 73,90 | 26,10 |
| % | 17,48 | 16,74 | 18,25 | 18,51 | 15,09 | | | |
| Eastern Region | 120 182 | 62 082 | 58 730 | 68 936 | 51 876 | 1 057 | 57,36 | 43,16 |
| Population ≥60 | 21 840 | 11 079 | 10 761 | 13 704 | 8 136 | 1 030 | 62,75 | 37,25 |
| % | 18,17 | 17,85 | 18,32 | 19,88 | 15,68 | | | |

Source ONEI (2017). The aging of the population 2017. Havana

Due to the importance of this population aging process and its high level of manifestation in both regions (Central and Eastern), its behavior will be analyzed in the following section for the period 2009-2017.

III.3. Distribution of the population 60 years and over (Central and Eastern Regions)

The observed variation 2009-2017 shows that the population aged 60 years and older of all seven municipalities studied, increases by 5,921 inhabitants, the urban in 6 369 and the rural decreases by 448 inhabitants. For the population of the municipalities of the Central region, these values represented an increase in the total population of 2 524 inhabitants, of the urban population in 2,701 and a decrease in the rural population of 177 inhabitants; for the Eastern region the variation of the total population was of a growth of 3 397 inhabitants, of such, 3668 urban while the rural diminishes by 271 inhabitants. In all the AIP, the total and urban population aged 60 and over increases, with a decrease in the population in rural areas, a population that moves to urban spaces; the masculinity index shows the process of feminization that is underway in these territories, together with the aging of its population (Appendix 2.2.3, Table 6).

Table 6. Variation of the indicators analyzed for the population aged 60 and over. 2009-2017

| Municipality | Variation Population 60 and over 2009-2017 | | | | |
|-------------------|--------------------------------------------|-------|--------|-------|-------|
| | Total Population | Male | Female | Urban | Rural |
| Central Region | 2 524 | 886 | 1638 | 2701 | -177 |
| Los Arabos | 625 | 273 | 352 | 723 | -98 |
| Corralillo | 449 | 118 | 331 | 550 | -101 |
| Quemado de Güines | 547 | 219 | 328 | 528 | 19 |
| Santo Domingo | 903 | 276 | 627 | 900 | 3 |
| | | | | | |
| Eastern Region | 3 397 | 1 562 | 1835 | 3668 | -271 |
| Jobabo | 1 064 | 444 | 620 | 1335 | -271 |
| Colombia | 1 298 | 693 | 605 | 1162 | 136 |
| Amancio | 1 035 | 425 | 610 | 1171 | -136 |
| | | | | | |
| Total | 5 921 | 2 448 | 3473 | 6369 | -448 |

Source: Prepared from the preceding tables

IV. DYNAMICS OF THE POPULATION AND THE CULTIVATED AREAS IN THE AIP

The studied territories display a complex dynamic in their demographic indicators, (aspect analyzed in the previous section). A similar situation occurs with the cultivated area. In the period 1995-2015 a marked tendency of decline was reported of the cultivated area that reached 36 216 ha. in the municipalities of the Central region, and 51 982 ha. in the municipalities of the East region, making a total of 88 198 ha. Not irrelevant results, considering that the population of these two regions depends on food supplies from other regions of the country and imports them from abroad.

When analyzed by municipality, the greatest drop off in this indicator was observed in the Corralillo municipality of the Central Region, as well as in Jobabo of the East region (Table 7).

Table 7. Variations in the cultivated area 1995-2015 (ha)

| Municipalities | 1995 | 2005 | 2007 | 2012 | 2015 | 1995-2015 |
|-------------------|---------|---------|---------|---------|---------|-----------|
| Central Region | 124 982 | 98 254 | 87 094 | 99 036 | 88 766 | -36 216 |
| Los Arabos | 25 126 | 16 997 | 15 699 | 15 473 | 17 441 | -7 685 |
| Corralillo | 36 236 | 26 433 | 24 061 | 21 431 | 19 212 | -17 025 |
| Quemado de Güines | 20 827 | 19 459 | 17 785 | 15 872 | 15 841 | -4 986 |
| Santo Domingo | 42 791 | 35 363 | 29 547 | 38 497 | 36 271 | -6 520 |
| Eastern Region | 101 483 | 67 737 | 57 668 | 72 894 | 49 501 | -51 982 |
| Jobabo | 39 846 | 26 589 | 21 311 | 29 195 | 13 035 | -26 811 |
| Colombia | 23 715 | 17 336 | 17 250 | 16 405 | 17 804 | -5 911 |
| Amancio | 37 921 | 23 811 | 19 107 | 27 293 | 18 661 | -19 260 |
| Total | 226 465 | 165 991 | 144 763 | 171 930 | 138 267 | -88 198 |

Note: Decimal values have been approximated to the unit.

Source: Prepared by the authors based on the Balance of Use and Land Tenure of the MINAG (several years).

At the same time, there is a notable decrease in the population within the studied area of approximately 19634 inhabitants between 1995 and 2015. The population of the Central region decreases in the same period by 8,745 inhabitants and the Eastern region by 10889 inhabitants. In the first one, the Santo Domingo municipality stands out for its decrease in the demographic amount with a loss of 3,735 inhabitants; in the Eastern region, the greatest reduction in population is reported at the Jobabo municipality with 5,825 (Table 8).

Table 8. Population dynamics, years 1995-2015

| Municipalities | 1995 | 2005 | 2007 | 2012 | 2015 | 1995-2015 |
|-------------------|---------|---------|---------|---------|---------|-----------|
| Central Region | 131 757 | 129 364 | 128 249 | 131 068 | 123 012 | -8 745 |
| Los Arabos | 27 160 | 25 475 | 25 144 | 24 787 | 24 416 | -2 744 |
| Corralillo | 27 077 | 27 747 | 27 202 | 26 843 | 26 393 | -684 |
| Quemado de Güines | 23 271 | 22 532 | 22 507 | 28 425 | 21 689 | -1 582 |
| Santo Domingo | 54 249 | 53 610 | 53 396 | 51 013 | 50 514 | -3 735 |
| Eastern Region | 126 351 | 123 358 | 122 159 | 116 420 | 115 462 | -10 889 |
| Jobabo | 50 036 | 49 157 | 48 415 | 44 851 | 44 211 | -5 825 |
| Colombia | 32 680 | 32 887 | 32 740 | 32 612 | 32 537 | -143 |

| | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|
| Amancio | 43 635 | 41 314 | 41 004 | 38 957 | 38 714 | -4 921 |
| | | | | | | |
| Total | 258 108 | 252 722 | 250 408 | 247 488 | 238 474 | -19 634 |

Source: ONEI (several years). Demographic yearbook of Cuba. Havana; ONEI (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008). Demographic series 1982-2002). Center for demographic studies. T II. Havana.

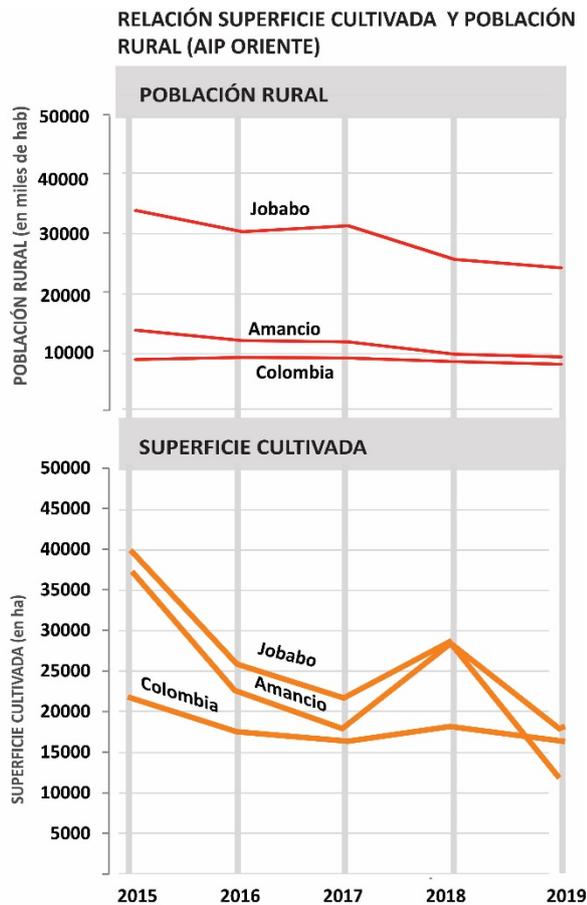
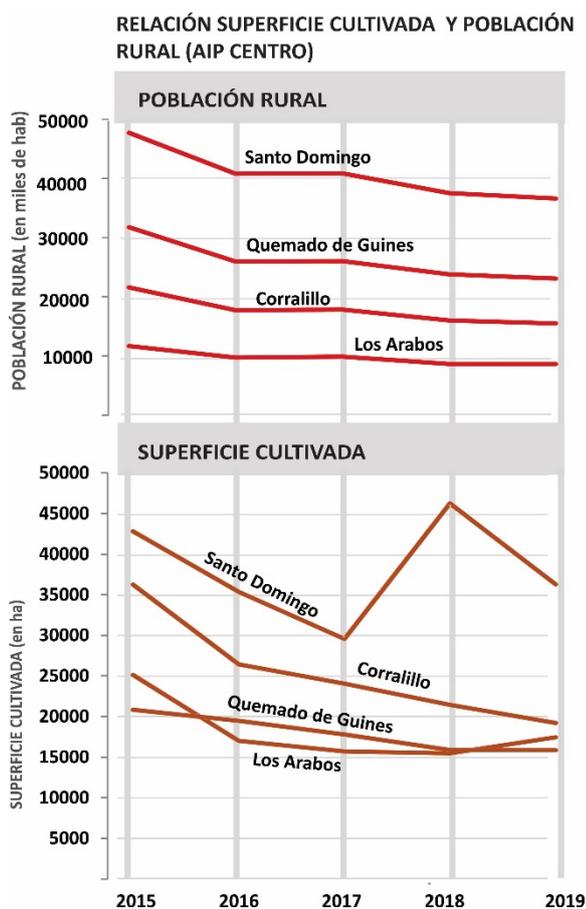
The behavioral analysis of the rural population reveals that the demographic loss reaches more than 23 thousand inhabitants between 1995 and 2015. The rural population of the Central region decreases in equal period by 11175 inhabitants and the Eastern region by 12779 inhabitants. In the first, the municipalities Corralillo and Los Arabos, with 3097 and 3044 inhabitants, respectively, stand out due to their demographic decline; in the eastern region the greatest reduction in population is reported at the Jobabo municipality, with 8251 inhabitants (Table 9).

Table 9. Rural Population Dynamics. Years 1995-2015

| Municipalities | 1995 | 2005 | 2007 | 2012 | 2015 | 1995-2015 |
|-------------------|---------|--------|--------|--------|--------|-----------|
| Central Region | 48 902 | 41 939 | 41 995 | 38 636 | 37 727 | -11 175 |
| Los Arabos | 12 602 | 10 672 | 10 837 | 9 568 | 9 558 | -3 044 |
| Corralillo | 10 005 | 8 042 | 7 976 | 7 409 | 6 908 | -3 097 |
| Quemado de Güines | 10 221 | 8 260 | 8 271 | 7 870 | 7 626 | -2 595 |
| Santo Domingo | 16 074 | 14 965 | 14 911 | 13 789 | 13 635 | -2 439 |
| | | | | | | |
| Eastern Region | 56 004 | 51 770 | 52 347 | 45 193 | 43 225 | -12 779 |
| Jobabo | 31 593 | 28 543 | 29 403 | 24 542 | 23 342 | -8 251 |
| Colombia | 10 099 | 10 405 | 10 300 | 9 784 | 9 412 | -687 |
| Amancio | 14 312 | 12 822 | 12 644 | 10 867 | 10 471 | -3 841 |
| | | | | | | |
| Total | 104 906 | 93 709 | 94 342 | 83 829 | 80 952 | -23 954 |

Source: ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008).

Graph 1. Evolution of the cultivated area and the rural population (AIP Central and EAST Region) in the period 1995-2015.



Source: Prepared by the authors from: ONE (several years). Demographic yearbook of Cuba. Havana; ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008). Demographic series 1982-2002). Center for demographic studies. Balance of Land of the MINAG (several years).

The per capita analysis of the cultivated area per inhabitant is strongly influenced by the decrease in population and its reported aging within the two regions and municipalities of the studied area, in a context where processes and physical-geographic phenomena (meteorological and climatic) linked together to climate change, which highlights the agricultural drought that has been present in these territories for several decades, the loss of agro productivity of soils, the frequency of hurricanes and the expansion of Marabu, the latter favored by the set of factors mentioned above and that influences the decrease in values of the cultivated area. This indicator decreases in the region by 0.298 has cultivated per inhabitant, 0.227 in the Central region and 0.384 in the Eastern region. The Corralillo municipality stands out with a reduction of 0.610 has cultivated per inhabitant and Amancio with 0.387 (Table 10).

Table 10. Variations Per capita of cultivated area per inhabitant, 1995-2015 (ha/inhabitant).

| Municipalities | 1995 | 2005 | 2007 | 2012 | 2015 | 1995-2015 |
|-------------------|-------|-------|-------|-------|-------|-----------|
| Central Region | 0,949 | 0,760 | 0,679 | 0,756 | 0,722 | -0,227 |
| Los Arabos | 0,925 | 0,667 | 0,624 | 0,624 | 0,714 | -0,211 |
| Corralillo | 1,338 | 0,953 | 0,885 | 0,798 | 0,728 | -0,610 |
| Quemado de Güines | 0,895 | 0,864 | 0,790 | 0,558 | 0,730 | -0,165 |
| Santo Domingo | 0,789 | 0,660 | 0,553 | 0,907 | 0,718 | -0,071 |
| Eastern Region | 0,803 | 0,549 | 0,472 | 0,540 | 0,429 | -0,374 |
| Jobabo | 0,796 | 0,541 | 0,440 | 0,651 | 0,295 | -0,502 |
| Colombia | 0,726 | 0,527 | 0,527 | 0,196 | 0,547 | -0,178 |
| Amancio | 0,869 | 0,576 | 0,466 | 0,701 | 0,482 | -0,387 |
| Total | 0,877 | 0,657 | 0,578 | 0,654 | 0,580 | -0,298 |

Source: Prepared by the authors from the preceding tables.

When this analysis is carried out considering only the rural population, the tendency to reduce the value of this indicator is similar. A loss of 0.451 ha of cultivated area per rural inhabitant is reported; for the Central region this value is minus 0.203 and for the Eastern region minus 0.667. With the largest reductions in the municipalities of Corralillo and Amancio (Table 11 and Illustration 2).

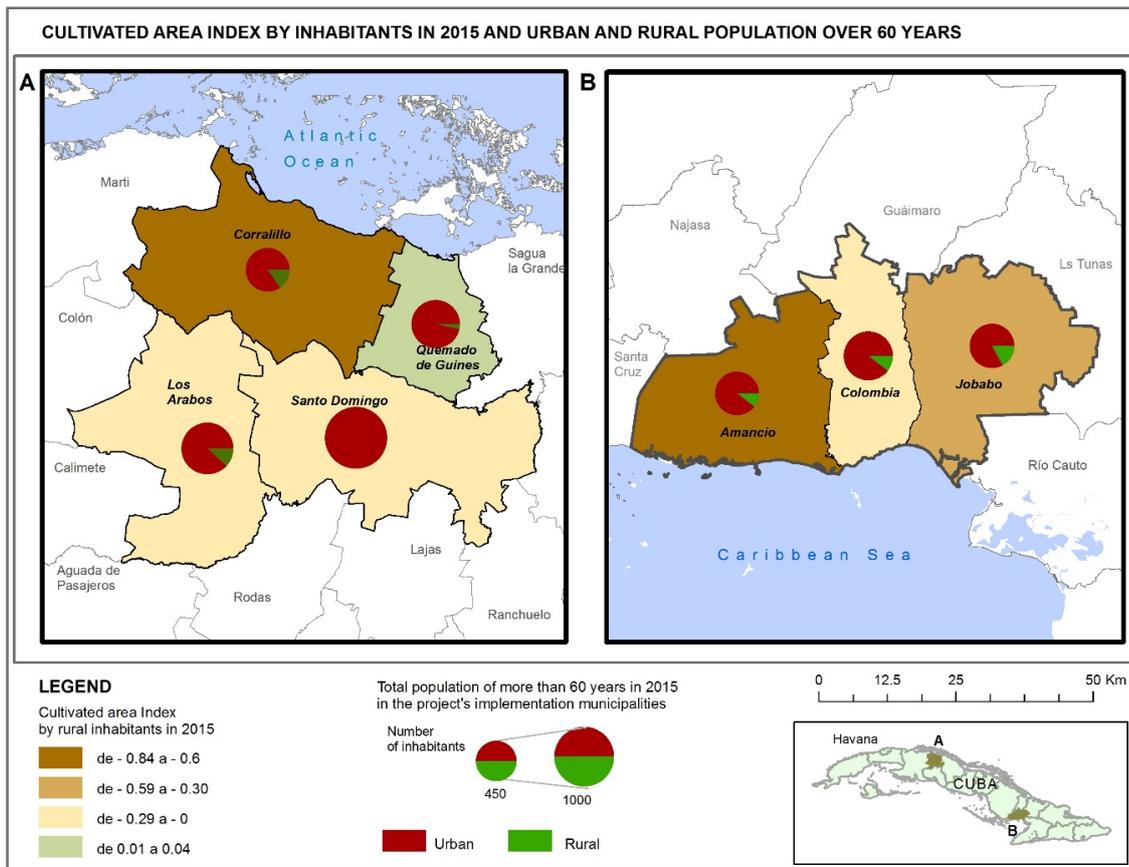
Table 11. Variations per Capita of cultivated rural area per rural inhabitant, years 1995-2015 (ha/rural inhabitant).

| Municipality | 1995 | 2005 | 2007 | 2012 | 2015 | 1995-2015 |
|-------------------|-------|-------|-------|-------|-------|-----------|
| Central Region | 2,556 | 2,343 | 2,074 | 2,563 | 2,353 | -0,203 |
| Los Arabos | 1,994 | 1,593 | 1,449 | 1,617 | 1,825 | -0,169 |
| Corralillo | 3,622 | 3,287 | 3,017 | 2,893 | 2,781 | -0,841 |
| Quemado de Güines | 2,038 | 2,356 | 2,150 | 2,017 | 2,077 | 0,040 |
| Santo Domingo | 2,662 | 2,363 | 1,982 | 3,355 | 2,660 | -0,002 |
| Eastern Region | 1,812 | 1,308 | 1,102 | 1,392 | 1,145 | -0,667 |
| Jobabo | 1,261 | 0,932 | 0,725 | 1,190 | 0,558 | -0,703 |
| Colombia | 2,348 | 1,666 | 1,675 | 0,655 | 1,892 | -0,457 |
| Amancio | 2,650 | 1,857 | 1,511 | 2,512 | 1,782 | -0,867 |
| Total | 2,159 | 1,771 | 1,534 | 1,932 | 1,708 | -0,451 |

Source: Prepared by the authors from preceding tables.

The analysis in figure 3 shows a differentiated behavior of the surface area cultivated per capita per rural inhabitant, with values that represent a per capita loss of 0.84 to 0.6 ha in the Corralillo municipalities in the Central region and Amancio in the East region; a decline in the range from 0.5 to 0.30 ha of cultivated area per capita in the municipality of Jobabo; from 0.29 to 0.01 in the municipalities of Los Arabos, Santo Domingo and Colombia and below that value in Quemado de Güines. It is important to highlight the weight of the population aged 60 and over in the rural areas of the AIP and, in particular, as mentioned above, their tendency to migrate to urban spaces (see Table 6).

Figure 3. Variation of the index of cultivated area per inhabitant in 2016 - urban and rural population over 60 years.

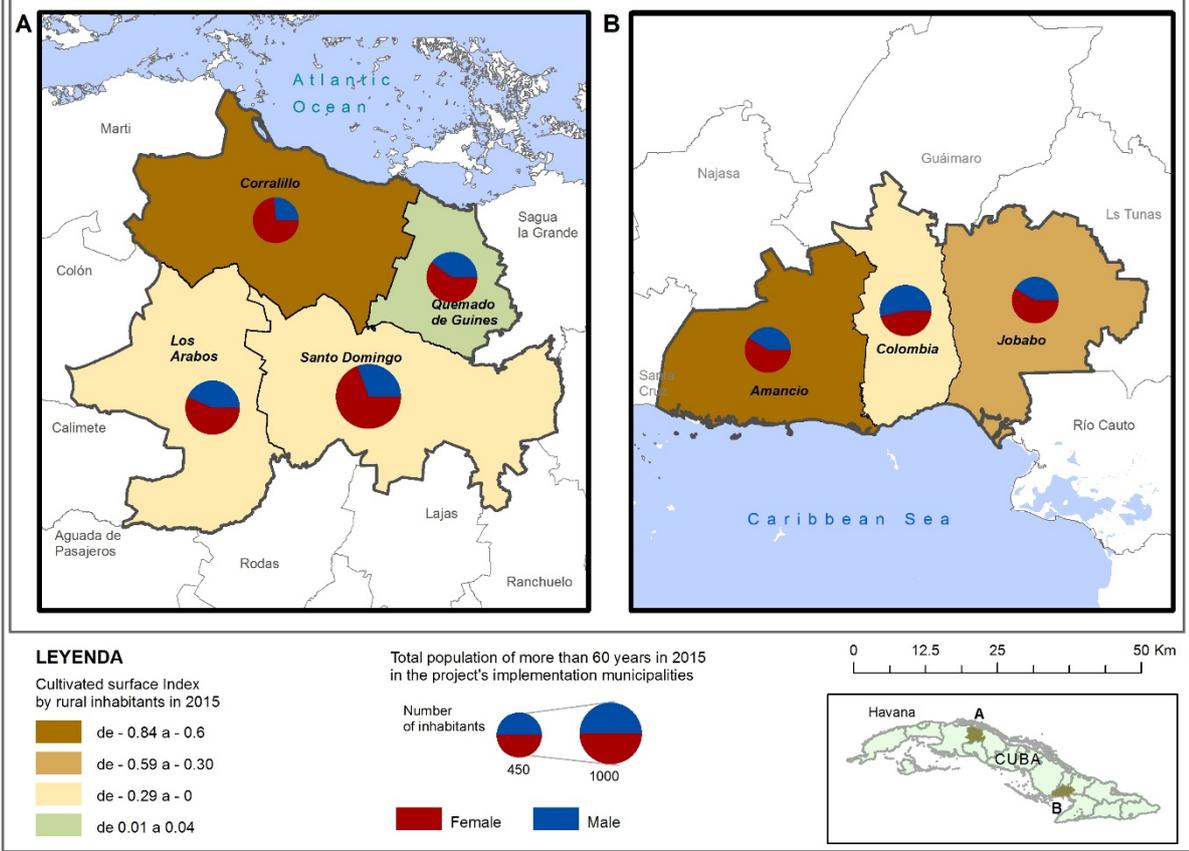


Source: Prepared by the authors from: ONE (several years). Demographic yearbook of Cuba. Havana; ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008). Demographic series 1982-2002). Center for demographic studies. T II. Havana. Balance of use and land tenure of the MINAG (several years).

Figure 4 incorporates the gender issue into the analysis of the variation of the per capita index of area cultivated in the AIP. The demographic processes, as highlighted in previous sections, show an increase in the participation of women, which points to an ongoing process of feminization of the population of these municipalities. The masculinity index varies in this age group of 60 years and over, being 1 047 men for every 1000 women in 2009 to 999 in 2017 (see Table 6, Appendix 2.2.3).

Figure 4. Variation of the index of the cultivated land per inhabitant in 2016, and female and male population aged 60 years and over.

CULTIVATED SURFACE INDEX BY INHABITANTS IN 2015 AND URBAN AND RURAL POPULATION OVER 60 YEARS



Source: Prepared by the authors from: ONE (several years). Demographic yearbook of Cuba. Havana; ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008). Demographic series 1982-2002). Center for demographic studies. T II. Havana. Balance of use and land tenure of the MINAG (several years).

AIPs display a considerable loss of cultivated area as well as population residing in these territories. The negative trend is present in all the calculated values of the indicators constructed from the ratio of cultivated area and the total rural population of the municipalities. Processes associated with the increase of droughts, resulting in the exodus of the rural population and the abandonment of land by smallholder farmers in their different organizational forms; the frequency of extreme weather events, the proliferation of Marabu as an invasive plant that spreads rapidly in arid environments and whose control is difficult and expensive for the smallholder farmer, are associated with the climatic variability that is observed today in those territories, the adjacent municipalities as well as in other zones of the country (Table 12).

Table 12. Summary of the variation in selected indicators, years 1995-2015

| Municipality/Region | Variation 1995-2015 | | Variation, Cultivated Land Per Capita 1995-2015 | |
|---------------------|----------------------|--------------------------------|-------------------------------------------------|---------------------------------|
| | Cultivated Land (ha) | Population Total (Inhabitants) | In relation to total population | In relation to rural population |
| Central Region | -36 216 | -8 745 | -0,227 | -0,203 |
| Los Arabos | -7 685 | -2 744 | -0,211 | -0,169 |
| Corralillo | -17 025 | -684 | -0,610 | -0,841 |
| Quemado de Güines | -4 986 | -1 582 | -0,165 | 0,040 |
| Santo Domingo | -6 520 | -3 735 | -0,071 | -0,002 |
| | | | | |
| Eastern Region | -51 982 | -10 889 | -0,374 | -0,667 |
| Jobabo | -26 811 | -5 825 | -0,502 | -0,703 |
| Colombia | -5 911 | -143 | -0,178 | -0,457 |
| Amancio | -19 260 | -4 921 | -0,387 | -0,867 |
| | | | | |
| Total | -88 198 | -19 634 | -0,298 | -0,451 |

Source: prepared from preceding tables.

V. THE EXPANSION OF MARABU 2012-2019 AND ITS INFLUENCE IN THE DYNAMICS OF THE POPULATION

V.1. Population Dynamics within the AIP affected my Marabu

The municipalities involved in the territory of implementation of the project reveal, as a common feature, a decline in the total population between 2012 and 2017, a process previously mentioned. It has been assumed for these calculations that the population decline responds to emigration to other municipalities, provinces or outside the country. Other indicators that influence these values are not analyzed since these municipalities show natural growth and fertility rates above the national average, which makes the influence of the migratory factor on the obtained values more evident (ONEI, several years. Cuba).

For neighboring or border municipalities, with the exception of Jagüey Grande in Matanzas, which is experiencing significant growth associated with the development of various economic projects related to the citrus agroindustry and other agricultural and livestock products, and the municipality of Las Tunas, head of that province, a condition that transforms it into a population-receiving territory, behavior similar to the capital cities of the remaining provinces. The rest of the municipalities have negative migration rates (Table 13).

This set of municipalities where the project is planned to be implemented, as well as in the adjacent municipalities, stand out for their high negative migratory balance rates of more than 4 per thousand inhabitants: Santa Cruz del Sur, Guáimaro, Cifuentes and Jobabo; with negative rates between 3 and 4 per thousand inhabitants, the municipalities of Santo Domingo, Quemado de Güines, Najasa and Corralillo; with negative rates between 2 and 3 the municipalities Amancio, Calimete, Marti, Sagua La Grande, Los Arabos and Ranchuelo.

Table 13. Dynamics and distribution of the population of the municipalities of the AIP and surroundings. Years 2012-2017.

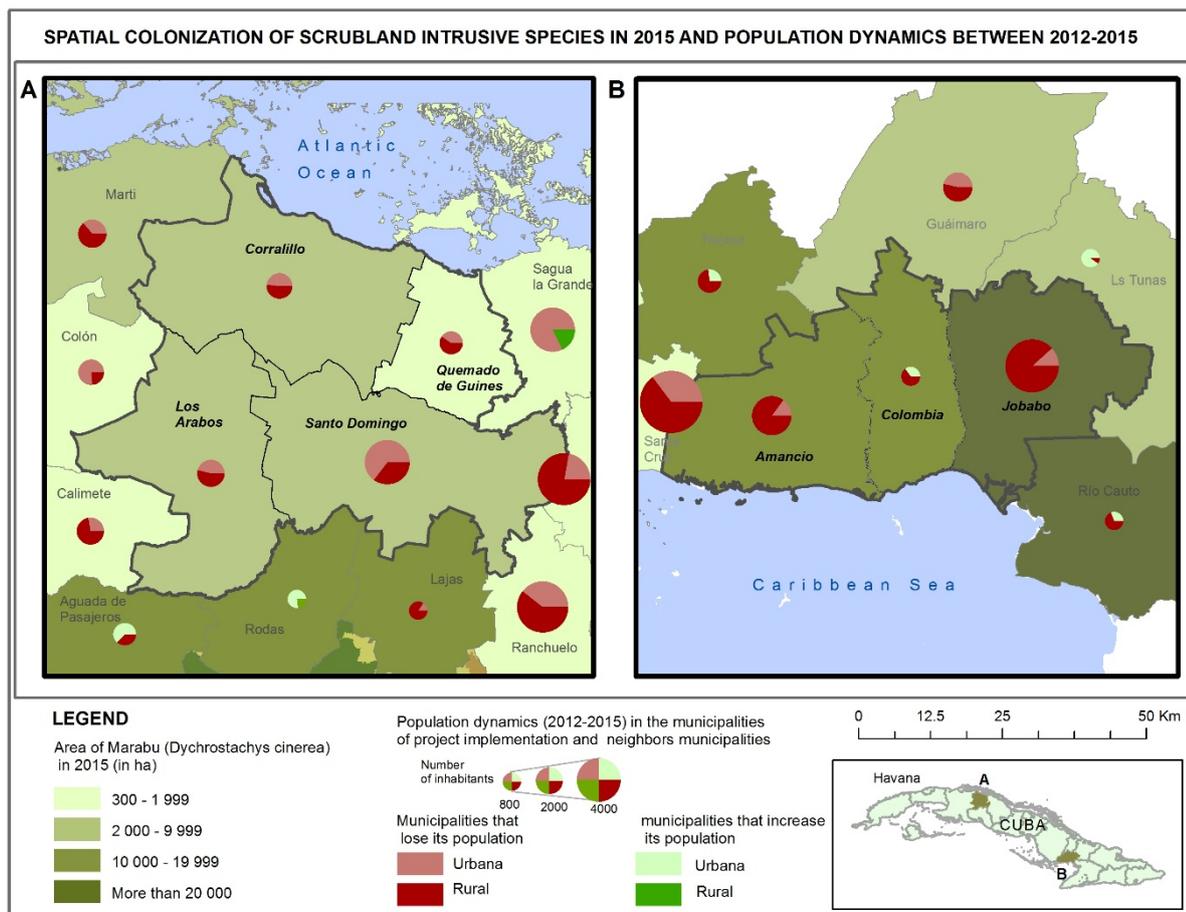
| Municipality | Province | 2012 | 2015 | 2017 | Migratory balance rate 2012-2017 (Per thousand inhabitants) |
|---------------------|-------------|---------|---------|---------|----------------------------------------------------------------------|
| Los Arabos | Matanzas | 24 787 | 24 416 | 24 119 | -2,77 |
| Marti | Matanzas | 22 786 | 22 507 | 22 236 | -2,47 |
| Colón | Matanzas | 70 248 | 70 350 | 69 881 | -0,53 |
| Perico | Matanzas | 31 191 | 31 042 | 30 774 | -1,36 |
| Jagüey Grande | Matanzas | 59 722 | 60 284 | 60 391 | 1,11 |
| Calimete | Matanzas | 28 751 | 28 499 | 28 100 | -2,32 |
| Corralillo | Villa Clara | 26 843 | 26 393 | 25 834 | -3,91 |
| Quemado de Güines | Villa Clara | 22 089 | 21 689 | 21 359 | -3,42 |
| Sagua La Grande | Villa Clara | 53 077 | 52 516 | 51 687 | -2,69 |
| Cifuentes | Villa Clara | 28 425 | 27 835 | 27 323 | -4,03 |
| Santo Domingo | Villa Clara | 51 013 | 50 514 | 49 445 | -3,17 |
| Ranchuelo | Villa Clara | 54 889 | 54 244 | 53 329 | -2,93 |
| Aguada de Pasajeros | Cienfuegos | 32 159 | 32 249 | 32 098 | -0,19 |
| Rodas | Cienfuegos | 34 376 | 34 139 | 33 848 | -1,56 |
| Lajas | Cienfuegos | 21 999 | 22 037 | 21 826 | -0,79 |
| Guáimaro | Camagüey | 39 118 | 38 276 | 37 551 | -4,17 |
| Najasa | Camagüey | 15 816 | 15 579 | 15 260 | -3,64 |
| Santa Cruz del Sur | Camagüey | 45 710 | 44 762 | 43 229 | -5,74 |
| Las Tunas | Las Tunas | 202 105 | 207 648 | 210 412 | 3,95 |
| Jobabo | Las Tunas | 44 851 | 44 211 | 43 123 | -4,01 |
| Colombia | Las Tunas | 32612 | 32 537 | 32 186 | -1,32 |
| Amancio | Las Tunas | 38957 | 38714 | 38111 | -2,22 |
| Río Cauto | Granma | 47189 | 47381 | 46804 | -0,82 |

Note: The municipalities in bold are part of the project implementation area; the rest are municipalities bordering these.

Source: ONEI (2012). National Nomenclature of Human Settlements of the Population and Housing Census of 2012. Havana; ONEI (2018). National Statistical Information System (SIEN), of demography 2017.

An assessment of the demographic situation of these municipalities based on the migratory condition that predominates in this group shows that independent of registering positive rates of natural growth, as well as of fertility (ONEI, 2017), the related internal conditions, among others factors, with processes and physio geographic phenomena linked to climate change, among them the increase of drought, the loss of agricultural productivity of the soils and the expansion of invasive plants, such as Marabu, turn them into municipalities emitting population, which leads to a negative growth and population exodus (Figure 5).

Figure 5. Area covered by shrubs of Marabu in 2015 and dynamics of the population according to place of residence in the period 2012-2015 in the AIP



Source: Prepared by the authors from: ONE (several years). Demographic yearbook of Cuba. Havana; ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008). Demographic series 1982-2002). Center for demographic studies. T II. Havana. Balance of use and land tenure of the MINAG (several years).

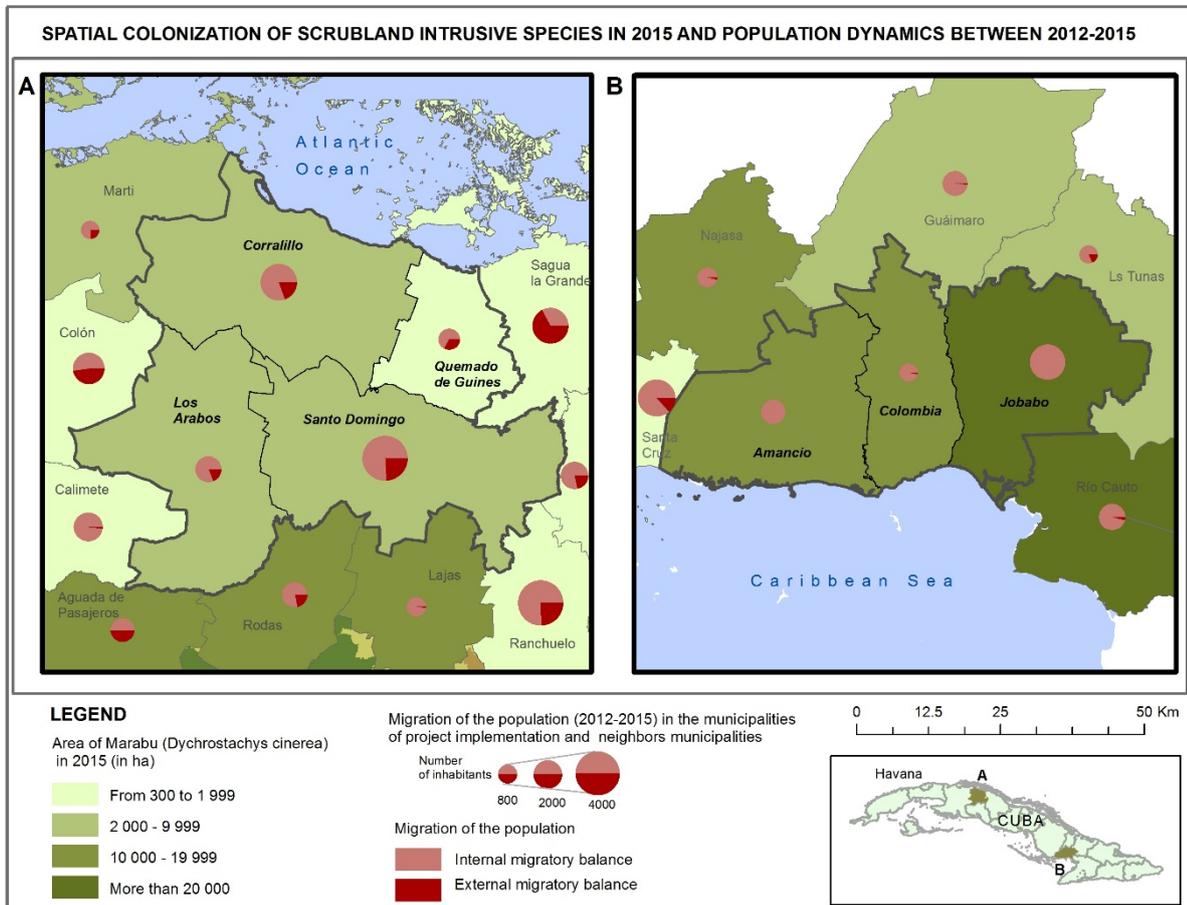
Figure 5 shows the area occupied by Marabu shrubs in the municipalities of the AIP and neighboring municipalities of the Central region, with values ranging from 300 – 1 999 ha in Colón, Calimete, Quemado de Güines, Sagua La Grande and Ranchuelo up to a range that boasts values of more than 20,000 ha in the southern municipalities of Aguada de Pasajeros, Rodas and Lajas. This confirms the thesis that the expansion of the coverage of Marabu goes beyond the municipalities linked to the project and makes the propagation of the shrubs a process that exceeds the limits of the municipalities analyzed, exposing the importance of these effects on the bottom of cultivated lands. For the Eastern region, the domain of Marabu shrubs covers ranges exceeding 10 000 ha, with a maximum coverage in the municipality of Jobabo and the adjacent municipalities. **Río Cauto** in the province of Granma. The analysis of the quantitative information for both regions makes this an evident fact that dominates the population decline, both for urban and rural areas of all the municipalities studied.

Figure 6 The area occupied by Marabu shrubs in the municipalities of the AIP and neighboring areas for 2015, and the migration process 2012-2015 reported in those territories show that all Municipalities, both those included in the AIP and the adjacent ones, experience emigration, internally from rural to urban areas and externally outside their limits (IPF, 2012. National study of

internal migration 1976-2010, ONEI, 2016. Statistical yearbook by provinces and municipalities, Ed. 2018). Havana).

Values of migratory balance rate are negative in all cases (see Table 13).

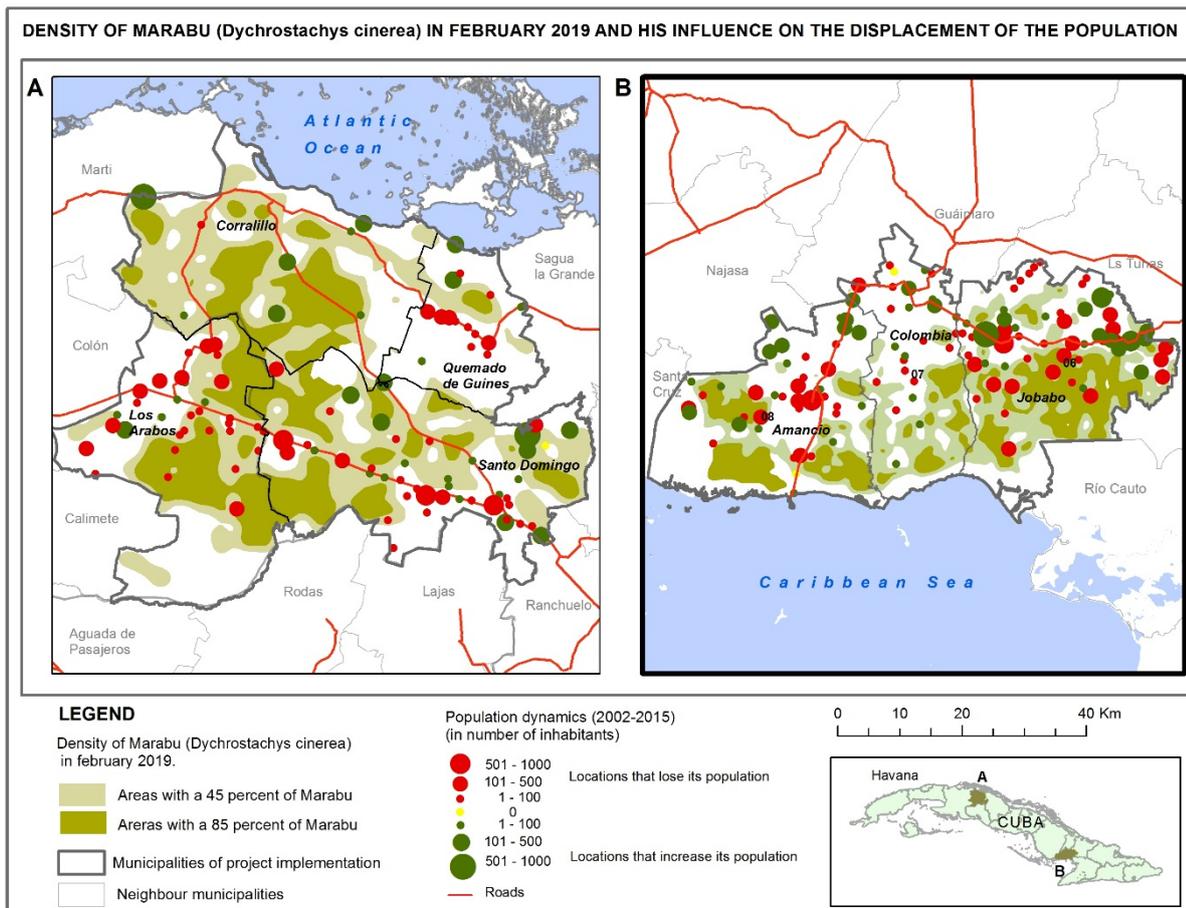
Figure 6. Area covered by Marabu between 2015 and 2019 and the migratory balance rate of the population by location 2012-2015.



Source: Prepared by the authors with inputs from: ONE (several years). Demographic yearbook of Cuba. Havana; ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008). Demographic series 1982-2002). Center for demographic studies. T II. Havana. Balance of use and land tenure of the MINAG (several years).

From the study of satellite images for 2019, figure 6 shows very important points of the territory with high densities of Marabu shrubs, forming a kind of north to south corridor in the Central region that covers a large part of the total surface of the municipalities Corralillo, Los Arabos and Santo Domingo, where the coverage densities of Marabu, with values of 45% and up to 85% predominate in the territory. In the Eastern region there is a corridor of Marabu areas with 45% density, along the entire central and southern part of the three municipalities and reaching the vicinity of the coastal area. Although the localities whose population declined in the region between the years 2002-2015 predominate, a small number of them report little significant increases (Table 13 and Figure 7).

Figure 7. Shrub density of Marabu and variation of population by locality 2002-2015



Source: Prepared by the authors based on images of the Sentinel 2a satellite (February 2019) and the Demographic Yearbook of Cuba. Havana; ONEI (several years).

V.2. Dynamics of Marabu Shrubs for the period 2015-2019

Figure 7 shows a marked relationship between the areas whose coverage of Marabu grows or remains in the course of the years 2015-2019, with small decreases in the eastern end of the Corralillo municipality, the southern portion of Los Arabos and small plots in the Quemado de Güines and Santo Domingo municipalities of the Centro region. In the Eastern region a wide distribution of areas covered with shrubs is detected, that extend from the central part of the Amancio, Colombia and Jobabo municipalities that extends and increases in density towards the coast. However, the common denominator in terms of the migration balance rate by localities for both regions and their municipalities is negative (Table 14 and Figure 8).

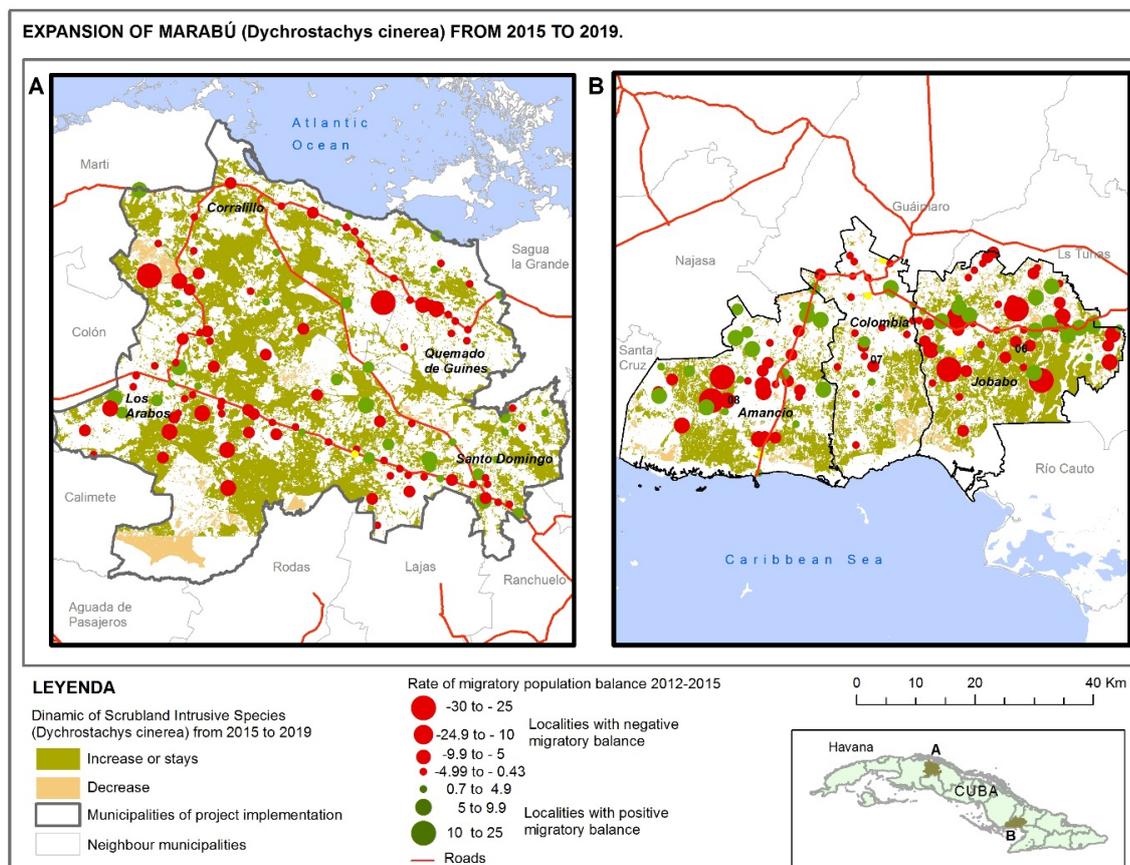
The behavioral study of the area occupied by Marabu shrubs and its dynamics between 2015 and 2019, from the interpretation of satellite images for 2019, shows a percentage growth of 31,14 for the AIP within the Central region, with higher percentage values of growth in the municipalities of Corralillo and Santo Domingo; for the AIPs of the Eastern region, a percentage growth of 22,25, with higher percentages of growth in the Jobabo municipality of 27.66 (Table 14).

Table 14. Covered area of Marabu in each municipality in the years 2015 and 2019.

| MUNICIPALITY | Total Area (Km ²) | Marabu infested areas 2015 (%) | Marabu infested areas 2019 (%) |
|-------------------|-------------------------------|--------------------------------|--------------------------------|
| Central Region | 2 815,86 | 10,07 | 40,40 |
| Los Arabos | 757,61 | 12,01 | 35,93 |
| Santo Domingo | 885,10 | 10,51 | 24,24 |
| Quemado de Güines | 333,26 | 0,63 | 5,49 |
| Corralillo | 839,89 | 10,60 | 31,50 |
| Eastern Region | 2 298,77 | 25,69 | 31,44 |
| Jobabo | 888,48 | 39,89 | 35,93 |
| Colombia | 561,33 | 13,40 | 24,24 |
| Amancio | 848,95 | 19,14 | 31,50 |
| Total | 5 114,63 | 17,09 | 71,9 |

Source: Prepared by the authors based on the Balance of Use and Land Tenure of the MINAG (several years). Images from the Sentinel 2a satellite (February 2019).

Figure 8. Variation in the area occupied by Marabu shrubs in the AIP and migration status of the localities.



Source: Prepared by the authors based on images of the Sentinel 2a satellite (February 2019) and the Demographic Yearbook of Cuba. Havana; ONEI (several years).

VI. IDLE LANDS AND NATURAL PASTURES, AND THEIR CORRESPONDENCE WITH THE EXPANSION OF MARABU SHRUBS

The analysis of the distribution of lands covered with natural pastures and other lands that are considered idle, according to the MINAG declaration for 2015 in its Land Use Balance, evidences for the municipalities of the Central region, that by 2015 they occupied approximately 55% of the total area of the region, with a maximum value of 60% in Los Arabos of the total municipal area and a minimum of 42% in Quemado de Güines. In this analysis, the lands declared as covered with natural pastures with a relatively high level of Marabu shrub infestation are considered, which is confirmed from the satellite image analysis of 2019 and the map of agriculture prepared by the Directorate of Soils and fertilizers from MINAG in 2015 (Table 15).

Table 15. Covered surface of natural pastures and declared idle lands in the municipalities of the Central region, year 2016

| Municipality | Total Area (km ²) | Natural Pastures (a) | Idle Lands (b) | Total (a + b) | % Lands of Municipal Surface | | |
|-------------------|-------------------------------|----------------------|----------------|---------------|------------------------------|----------|---------------|
| | | (km ²) | | | Of natural pastures (c) | Idle (d) | Total (c + d) |
| Central Region | 2 815,86 | 953 | 608 | 1561 | 33,84 | 21,59 | 55,44 |
| Los Arabos | 757,61 | 276 | 176 | 452 | 36,43 | 23,23 | 59,66 |
| Corralillo | 839,89 | 296 | 189 | 484 | 35,24 | 22,50 | 57,63 |
| Quemado de Güines | 333,26 | 92 | 47 | 140 | 27,61 | 14,10 | 42,01 |
| Santo Domingo | 885,10 | 289 | 196 | 485 | 32,65 | 22,14 | 54,80 |

Source: Prepared from the Balance of land use, MINAG (2015).

The distribution of the lands covered with natural pastures and other lands that are considered idle for the municipalities of the Eastern region occupied in 2015 approximately 55% of the total area of the region, with a maximum value of 65.48% of the surface total of the municipality in Jobabo, and a minimum of 38.45% in Colombia. In this analysis, the lands declared as covered with natural pastures with a relatively high level of Marabu scrub infestation are considered, which is confirmed from the satellite image analysis of 2019 and the map of agriculture prepared by the Directorate of Soils and fertilizers of the MINAG for 2015 (Table 16).

Table 16. Covered area of natural pastures and declared idle lands in the municipalities of the Eastern region, 2015

| Municipality | Total Surface (Km ²) | Natural Pastures (a) | Idle Lands (b) | Total (a + b) | % Lands of Municipal Surface | | |
|--------------|----------------------------------|----------------------|----------------|---------------|------------------------------|----------|---------------|
| | | (Km ²) | | | Of natural pastures (c) | Idle (d) | Total (c + d) |
| East Region | 2 298,77 | 596 | 680 | 1 276 | 25,96 | 29,60 | 55,56 |
| Colombia | 561,33 | 117 | 98 | 215 | 20,85 | 17,60 | 38,45 |
| Jobabo | 888,48 | 281 | 300 | 581 | 31,71 | 33,77 | 65,48 |
| Amancio | 848,95 | 197 | 281 | 478 | 23,31 | 33,17 | 56,48 |

Source: Prepared by the authors based on the Balance of Use and Land Tenure of the MINAG (several years).

VII. LANDHOLDERS IN THE AIP AND THEIR RELATION WITH THE EXPANSION OF MARABU

VII.1 Landholders, cultivated area and Marabu covered area of in the period 2012-2015.

The analysis of the three indicators at the level of the territories studied for the year 2012 shows a non-uniform distribution, with a greater number of landholders in the Central region (53%), who own 61% of the cultivated area and 36% of the covered area of Marabu. Studied at the municipality scale, Santo Domingo stands out in the Central region, and Jobabo in the Eastern region with 24% and 22% of the landholders and 29% and 18% of the cultivated area respectively. When the area covered by Marabu is assessed, the municipalities of Amancio and Colombia report the highest values with 28% and 25% respectively. The ratio of hectares of cultivated area per hectare of Marabu covered area is 1.7 (Table 17).

Table 17. Landholders, cultivated area and Marabu covered area, year 2012

| Municipality | Landholders | Cultivated Area | Area covered by Marabu |
|-------------------|-------------|-----------------|------------------------|
| Central Region | 9 865 | 99 036 | 34 317 |
| Los Arabos | 1 062 | 15 474 | 5 204 |
| Corralillo | 2 807 | 21 432 | 14 903 |
| Quemado de Güines | 1 452 | 15 873 | 777 |
| Santo Domingo | 4 544 | 46 258 | 13 433 |
| Eastern Region | 8 847 | 62 895 | 61 036 |
| Jobabo | 4 160 | 29 195 | 9 564 |
| Colombia | 1 504 | 6 406 | 24 312 |
| Amancio | 3 183 | 27 294 | 27 159 |
| Total | 18 712 | 161 930 | 95 352 |

Source: Prepared from the balance of use and land tenure, MINAG (2012).

In 2013, the share of landholders in the Central region (81%) increased in the total number of holders of the territory studied, where the municipality of Santo Domingo stands out with 45% of the total number of holders. The municipalities of Jobabo and Amancio reveal the highest percentage of cultivated area with 39% and 28% respectively. In terms of the areas covered by Marabu, the municipalities of Santo Domingo and Colombia stand out with 27 and 20% respectively. For every 1.7 hectares of cultivated area, one ha of Marabu is reported (Table 18).

Table 18. Landholders, cultivated area and Marabu covered area, year 2013

| Municipality | Landholders | Cultivated Area | Area covered by Marabu |
|-------------------|-------------|-----------------|------------------------|
| Central Region | 11 812 | 25 218 | 88 356 |
| Los Arabos | 1 942 | 3 942 | 15 368 |
| Corralillo | 1 992 | 13 539 | 20 138 |
| Quemado de Güines | 1 355 | 935 | 13 090 |
| Santo Domingo | 6 523 | 6 802 | 39 759 |
| Eastern Region | 2 683 | 78 432 | 60 653 |
| Jobabo | 35 | 40 782 | 7 552 |
| Colombia | 1 628 | 8 257 | 29 186 |
| Amancio | 1 020 | 29 393 | 23 915 |
| Total | 14 495 | 103 649 | 149 008 |

Source: Prepared from the balance of use and land tenure, MINAG (2012).

The Central region maintained the highest participation in total holders (62%) in 2015; the municipalities of Santo Domingo and Jobabo stand out with 29 and 21% respectively. The Central region has 64% of the cultivated area of the territory studied while the Eastern region has 68% of the total area of existing Marabu in the entire territory studied. For each 1.58 hectare of cultivated area, one ha of Marabu is reported (Table 19)

Table 19. Landholders, cultivated area and Marabu covered area, year 2015

| Municipality | Landholders | Cultivated area (ha) | Area covered by Marabu (ha) |
|-----------------------|---------------|----------------------|-----------------------------|
| Central Region | 9 189 | 88 766 | 28 367 |
| Los Arabos | 2 056 | 17 441 | 9 104 |
| Corralillo | 1 603 | 19 212 | 9 751 |
| Quemado de Güines | 1 254 | 15 841 | 210 |
| Santo Domingo | 4 276 | 36 271 | 9 303 |
| Eastern Region | 5 751 | 49 501 | 59 054 |
| Jobabo | 3 186 | 13 035 | 35 286 |
| Colombia | 1 645 | 17 804 | 7 522 |
| Amancio | 920 | 18 661 | 16 246 |
| Total | 14 940 | 138 266 | 87 421 |

Source: Prepared from the balance of use and land tenure, MINAG (2015).

The 2012-2015 comparative analysis of the indicators considered shows a reduction of approximately 3.7 thousand landholders, with a greater reduction in the East region. At the municipality level, the decreases in the number of Amancio and Corralillo landholders stand out. The cultivated area decreases by 23,664 ha in the studied area, with the Jobabo municipality standing out with a loss of more than 16 thousand ha (Table 20 and 21).

Table 20. Variation in the values of landholders, cultivated area and Marabu covered area, years 2012-2015

| Municipality | Landholders | Cultivated Area (ha) | Area covered by Marabu (ha) |
|-----------------------|---------------|----------------------|-----------------------------|
| Central Region | -676 | -10 270 | -5 950 |
| Los Arabos | 994 | 1 968 | 3 900 |
| Corralillo | -1 204 | -2 220 | -5 153 |
| Quemado de Güines | -198 | -31 | - 567 |
| Santo Domingo | -268 | -9 987 | -4 130 |
| Eastern Region | -3 096 | -13 394 | -1 981 |
| Jobabo | -974 | -16 160 | 25 721 |
| Colombia | 141 | 11 398 | -16 790 |
| Amancio | -2 263 | -8 632 | -10 913 |
| Total | -3 772 | -23 664 | -7 930 |

Source: Prepared from the balance of use and land tenure, MINAG (several years).

Table 21. Variation in the values of indicators for landholders, cultivated area and Marabu covered area, years 2013-2015

| Municipality | Landholders | Cultivated Area | Area covered by Marabu (ha) |
|-----------------------|-------------|-----------------|-----------------------------|
| Central Region | -2 623 | 63 549 | -59 988 |
| Los Arabos | 114 | 13 499 | -6 264 |
| Corralillo | -389 | 5 673 | -10 388 |
| Quemado de Güines | -101 | 14 906 | -12 880 |
| Santo Domingo | -2 247 | 29 470 | -30 457 |
| Eastern Region | 3 068 | -28 932 | -1 599 |
| Jobabo | 3 151 | -27 747 | 27 733 |
| Colombia | 17 | 9 548 | -21 664 |
| Amancio | -100 | -10 732 | -7 669 |
| Total | 445 | 34 617 | -61 587 |

Source: Prepared from the balance of use and land tenure, MINAG (several years).

VIII. EXTREME METEOROLOGICAL PHENOMENA, CLIMATE CHANGE, AND THEIR INFLUENCE IN THE AIP

Climate change affects all regions of the world. In some regions, extreme weather events and floods are becoming more frequent, and in others heat waves and droughts are recorded. It is likely that its consequences will intensify in the coming decades.

The AIPs are located in a geographical area historically affected by hurricanes, in the Atlantic Ocean basin. In the last 15 years these destructive organisms have had a significant increase in their frequency and intensity, according to some experts we are in an active cycle, in addition to the possible effect caused by global warming as a result of climate change. The consensus among scientists is that ocean currents are responsible for the current increase in the number of hurricanes and their intensity in the Caribbean. The increase in 0.5 degrees of the average temperature of the waters in the whole planet is an addition to a natural tendency, but never the trigger. At present there are other hypotheses that relate this increase in cyclonic activity to global warming, meaning that recent studies suggest that global warming may have a much greater effect on the number and intensity of hurricanes than it was initially thought.

Global warming raises water temperatures in the oceans by converting them, together with hot air, into fuel for hurricanes, although there is still no conclusive evidence on whether the increase in activity is related to climate change, AIPs are under the influence area of the historical trajectory of hurricanes.

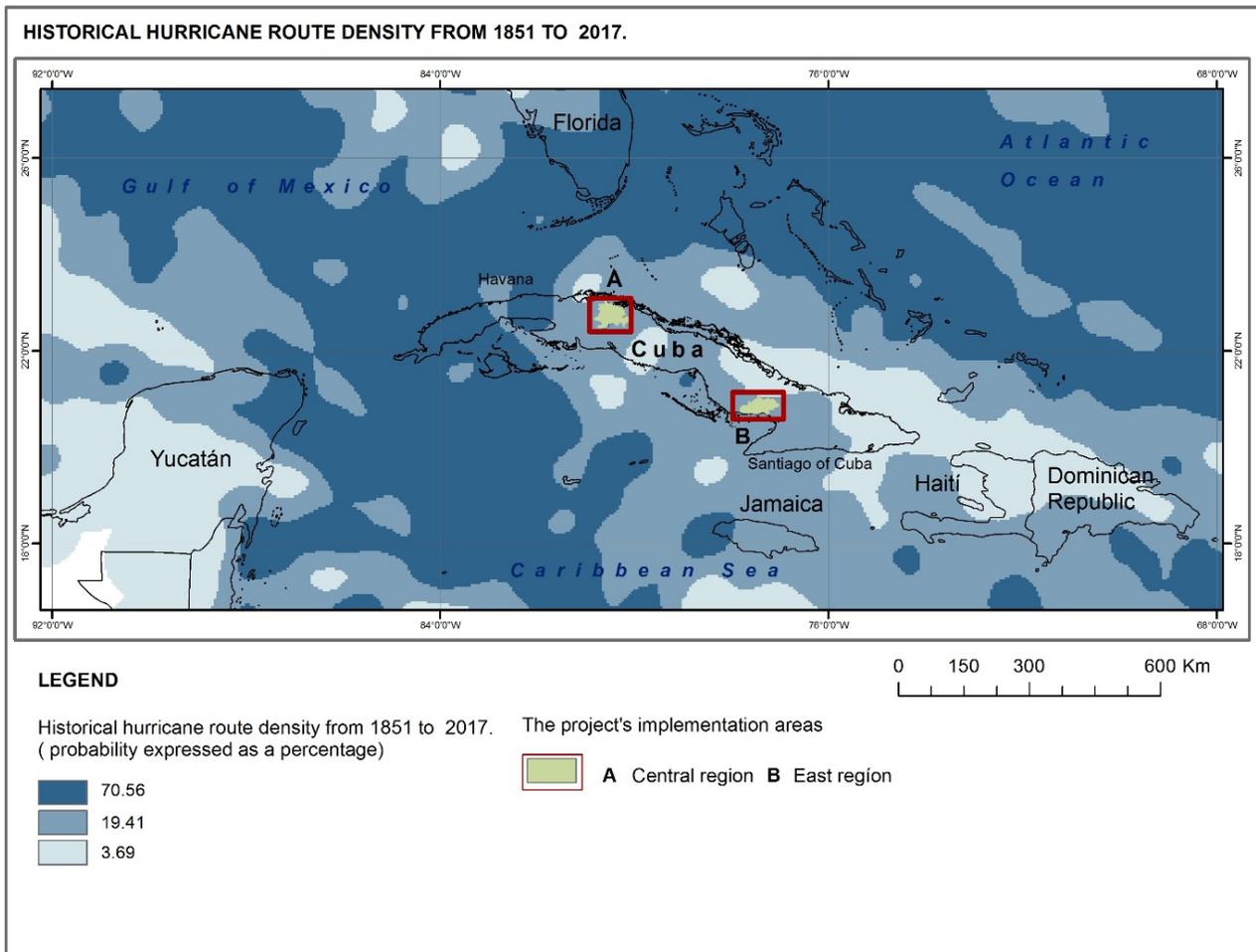
VIII.1 HURRICANES AND THEIR IMPACT IN THE AIP

Tropical cyclones and severe local storms are the extreme weather events that most affect the AIPs. Although the scourge of these events is more frequent towards the west-central region of the country (Figure 10), in the last 15 years we have been experiencing a very active period of hurricane activity in Cuba. Between 2005 and 2017, the country was affected by 11 hurricanes. In recent years, the

Central and Eastern regions of the country especially Las Tunas province, has been affected by 4 tropical organisms.

Figure 10 represents a density surface that visualizes the areas with the highest concentration in the historical trajectories of hurricanes from 1851 to 2017, expressing the probability values in percentages.

Figure 10. Historical trajectories of hurricanes between 1851 and 2017) for the hurricane season (June-November)



Source: Prepared by the authors based on data downloaded from: <https://www.nhc.noaa.gov/data/>

When analyzing the events that have affected Cuba from 2000 to date, the number of hurricanes that have impacted the island and the intensity recorded by these events is remarkable, table 22 summarizes some of the most important.

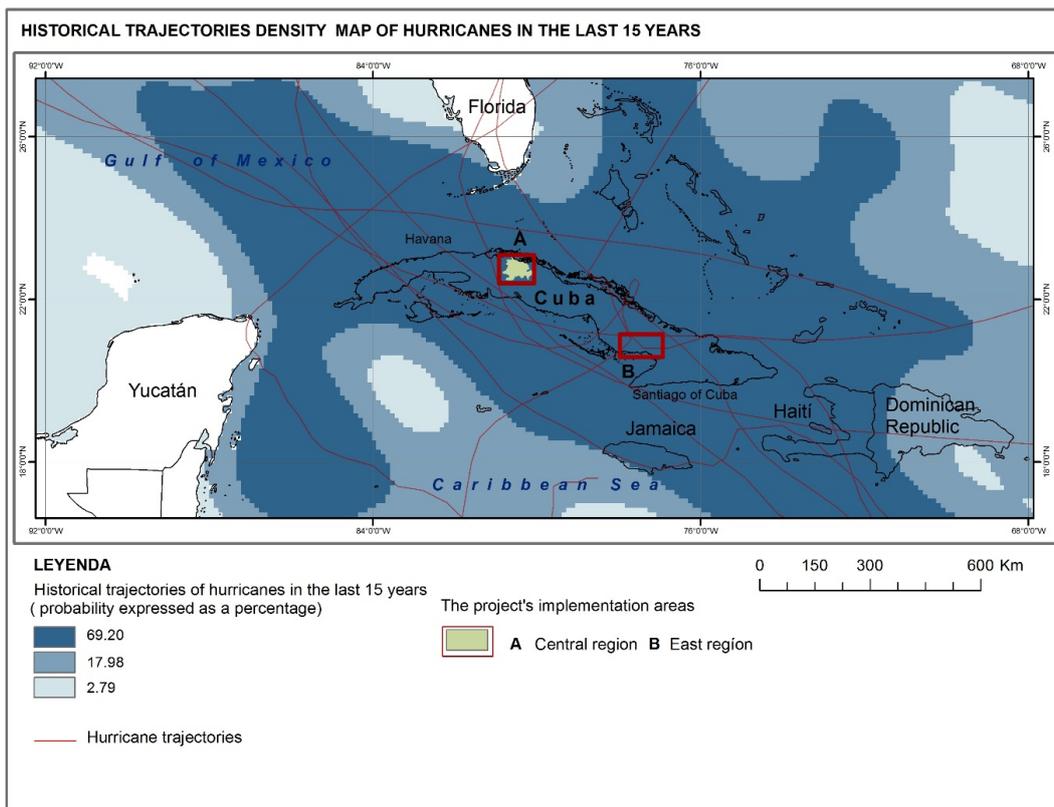
Table 22. Aspect ratio of hurricanes that affected Cuba in the 21st century

| Hurricane | Year | Category | Affected Provinces |
|------------------|-------------|-----------------|----------------------------------------------------------------------------------|
| Michelle | 2001 | 4 | Isla de la Juventud, Matanzas, Cienfuegos and Villa Clara. |
| Isidore | 2002 | 1 | Pinar del Río |
| Lili | 2002 | 2 | Pinar del Río |
| Charley | 2004 | 3 | La Habana, Artemisa, Mayabeque |
| Ivan | 2004 | 5 | Santiago de Cuba, Granma, Cienfuegos, |
| Dennis | 2005 | 4 | Santiago de Cuba, Granma, Cienfuegos, Matanzas La Habana, Artemisa, Mayabeque |
| Wilma | 2005 | 5 | La Habana, Artemisa |
| Gustav | 2008 | 4 | Isla de la Juventud, Pinar del Río |
| Ike | 2008 | 4 | Isla de la Juventud, Pinar del Río |
| Paloma | 2008 | 3 | Camagüey and Las Tunas |
| Sandy | 2012 | 3 | Santiago de Cuba |
| Matthew | 2016 | 4 | Guantánamo |
| Irma | 2017 | 5 | North shore from Guantanamo to Artemisa |

Source: Prepared by the authors with information from <http://www.insmet.cu>

In the model constructed from the trajectories followed by these organisms over the past 15 years, it is worth noting that not only the east is within the areas of greatest probability, but that these areas cover practically the entire island of Cuba and its adjacent seas, which would imply that the AIPs would be more exposed than in previous decades, although it is premature to affirm that the areas most likely in the trajectories of these organisms have moved further north and include practically the entire island of Cuba and not only to the east of Cuba, it is interesting to see the surfaces with higher concentrations taking into account the last 15 seasons (Figure 11).

Figure 11. Historical hurricane trajectories in the last 15 years - For the hurricane season months



Source: Prepared by the authors based on data downloaded from: <https://www.nhc.noaa.gov/data/>

VIII.2 PROTECTION OF THE COASTS BY MANGROVES IN THE AIP

The insular condition of Cuba, with two large islands and more than 1,600 islets or cays, makes mangroves a natural barrier of great importance to mitigate the negative effects of increased mean sea level, coastal flooding and strong winds caused by extreme hydrometeorological phenomena, such as hurricanes, and at the same time preserve their diversity of marine and terrestrial species.

With a length of coasts of 5 746 km on the big island, and an elongated and narrow configuration, practically all of the Cuban territory can be considered "coastal" and "marine". The AIPs located on the north central coast and south east coast have a considerable area in the coastal zone, despite being on different coasts they have very similar geomorphological and geological features, where the biogenic and cumulative marine and fluvial plains predominate with the presence of mangroves and coastal lagoons in most of its configuration.

The length of the coast occupied by these municipalities is 243.19 km, of which 69.31 km in the Central AIP region, and 173.88 km in the East region, which represent 4.2% of the coasts of Cuba and 1.98% and 5.75% of the north and south coasts in each case (Table 23), with an orientation of the coast predominantly between the north and northeast on the north central coast and towards the south and southwest at the south east coast (Chart 2)

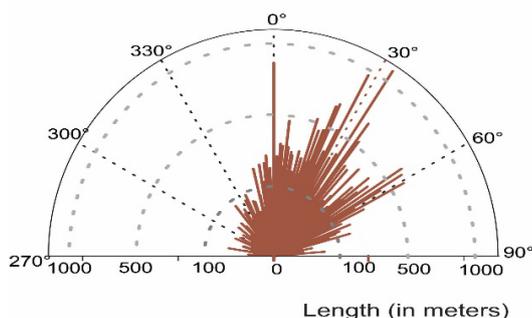
Table 23 - Coast length by municipality, protected by mangroves

| MUNICIPALITY | Coast Length (Km2) | Coast protected by mangroves (Km2) | Coast protected by mangroves (%) | Mangrove surface in 2019 (Ha) |
|-----------------------|--------------------|------------------------------------|----------------------------------|-------------------------------|
| Central Region | 69,31 | 57,19 | 82,51 | 2 014,86 |
| Quemado de Güines | 14,85 | 12,08 | 81,35 | 1 013,48 |
| Corralillo | 54,46 | 45,11 | 82,83 | 1 001,37 |
| East Region | 173,88 | 157,59 | 90,63 | 9 393,30 |
| Jobabo | 41,04 | 36,54 | 89,04 | 3 108,26 |
| Colombia | 16,1835 | 16,18 | 99,98 | 1 726,27 |
| Amancio | 116,65 | 104,87 | 89,90 | 4 558,78 |
| Total | 243,19 | 214,78 | 88,32 | 11 408,16 |

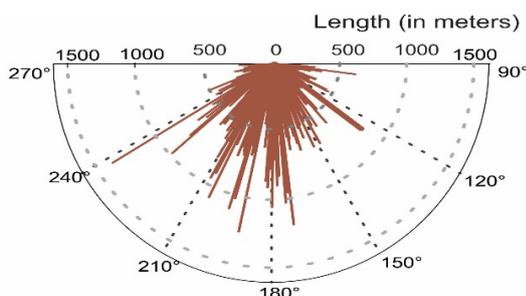
Source: Prepared by the authors based on images from the Sentinel 2a satellite of the month of February 2019.

Graphic 2. Coastal Orientation (in degrees)

AIP Central Region



AIP East Region



Source: Prepared by the authors based on the cartographic base of Cuba at scale 1:25 000

Evolution of the Mangrove Area

Mangrove forests highlight the vegetation formations present on both coasts. The stretches of coast with wide insular platform, as is the case of the territories studied, correspond generally with cumulative biogenic (mangrove) coasts.

The analysis of the data available in the statistics of the information system of the national cadaster of land use for the years 2003 and 2007, issued by the Directorate of Hydrography and Geodesy (MINFAR), in relation to the forest area for the Central region and in its structure, the participation of natural forests and the area covered by mangrove swamps and herbaceous marshes, is observed for the first of the considered years, amounting to 26 088 ha; of them, 11 264 occupied by natural forests and, from this category of use, mangroves and herbaceous marsh vegetation with 1 895 ha. These magnitudes vary for 2007, when the forest area totals 26 106 ha, with a decrease in the area occupied by natural forests of 366 ha and 43.6 ha in the mangroves, including the swamp grass vegetation (table 24).

In 2019, with the use of satellite images, based on its interpretation and analysis, the mangrove area was 2 014.86 ha, which represents an increase of approximately 120 ha in the Central region; 192 ha in the municipality of Corralillo, decrease of 48 ha in Quemado de Güines and 25 ha in Santo Domingo.

The data available for land use for the years 2003 and 2007 on the forest area for the East region, and the participation in its structure of the natural forests and the area covered with mangrove swamps and herbaceous marshes, amounts to 26 717 ha for the first of the considered years; Of these, 13,873 have been occupied by natural forests and, from this category of use, mangroves and herbaceous vegetation are mentioned with 5,540 ha. These magnitudes vary for 2007 and the forest area reaches 27 672 ha, with an increase in the area occupied by natural forests of 692 ha and a decrease of 506 ha of mangroves, including the vegetation of swamp shrubs (table 25).

Table 24. Central Region: land use according to selected use categories (ha).

| Concept | Los Arabos | Corralillo | Quemado de Güines | Santo Domingo | Central Region |
|------------------------------|------------|------------|-------------------|---------------|----------------|
| Year 2003 | | | | | |
| Forest Area. Of which | 11 805,35 | 6 701,15 | 1 667,99 | 5 913,59 | 26 088,08 |
| Natural Forests. Of which | 688,6 | 6 583,65 | 1 618,5 | 2 373,84 | 11 264,59 |
| • Mangrove and swamp scrub | 0 | 808,81 | 1 061,86 | 24,57 | 1 895,24 |
| Year 2007 | | | | | |
| Forest Area. Of which | 12 057,83 | 6 681,22 | 1 551,92 | 5 815,63 | 26 106,6 |
| Natural Forests. Of which | 687,69 | 6 563,72 | 1 473,51 | 2 173,57 | 10 898,49 |
| • Mangrove and swamp scrub | 0 | 784,25 | 1 094,84 | 17,54 | 1 851,63 |
| Variation 2003-2007 | | | | | |
| Forest Area. Of which | 252,48 | -19,93 | -116,07 | -97,96 | 18,52 |
| Natural Forests. Of which | -0,91 | -19,93 | -144,99 | -200,27 | -366,1 |
| • Mangrove and swamp scrub | 0 | -24,56 | -12,02 | -7,03 | -43,61 |
| Year 2019 | | | | | |
| Mangrove (ha) | 0 | 1 001,37 | 1 013,48 | 0 | 2 014,86 |
| Mangrove variation 2003-2019 | | | | | |
| Mangrove | 0 | 192,56 | -48,38 | -24,57 | 119,61 |

Note: The sum of what was declared as mangrove and herbaceous swamp vegetation in the same category are considered in the calculations for 2003 to 2007

Source: Directorate of Hydrography and Geodesy, Ministry of the Revolutionary Armed Forces (MINFAR).

Table 25. East Region: land use according to selected use categories (ha).

| Concept | Jobabo | Colombia | Amancio | East Region |
|------------------------------|-----------|----------|-----------|-------------|
| Year 2003 | | | | |
| Forest Area. Of which | 10 938,3 | 3 608,3 | 12 170,8 | 26 717,4 |
| Natural Forests. Of which | 6 417,9 | 2 656,34 | 4 799,39 | 13 873,63 |
| • Mangrove and swamp scrub | 11 10,07 | 2 307,35 | 2 122,46 | 5 539,88 |
| Year 2007 | | | | |
| Forest Area. Of which | 11 015,28 | 3 999,55 | 12 657,85 | 27 672,68 |
| Natural Forests. Of which | 6 279,1 | 2 916,62 | 5 370,11 | 14 565,83 |
| • Mangrove and swamp scrub | 1 067,52 | 2 304,71 | 1 661,29 | 5 033,52 |
| Variation 2003-2007 | | | | |
| Forest Area. Of which | 76,98 | 391,25 | 487,05 | 955,28 |
| Natural Forests. Of which | -138,8 | 260,28 | 570,72 | 692,2 |
| • Mangrove and swamp scrub | -42,55 | -2,64 | -461,17 | -506,36 |
| Year 2019 | | | | |
| Mangrove (ha) | 3 108,26 | 1 726,27 | 4 558,78 | 11 408,16 |
| Mangrove variation 2003-2019 | | | | |
| Mangrove | 1 998,19 | -581,08 | 2 436,32 | 3 853,42 |

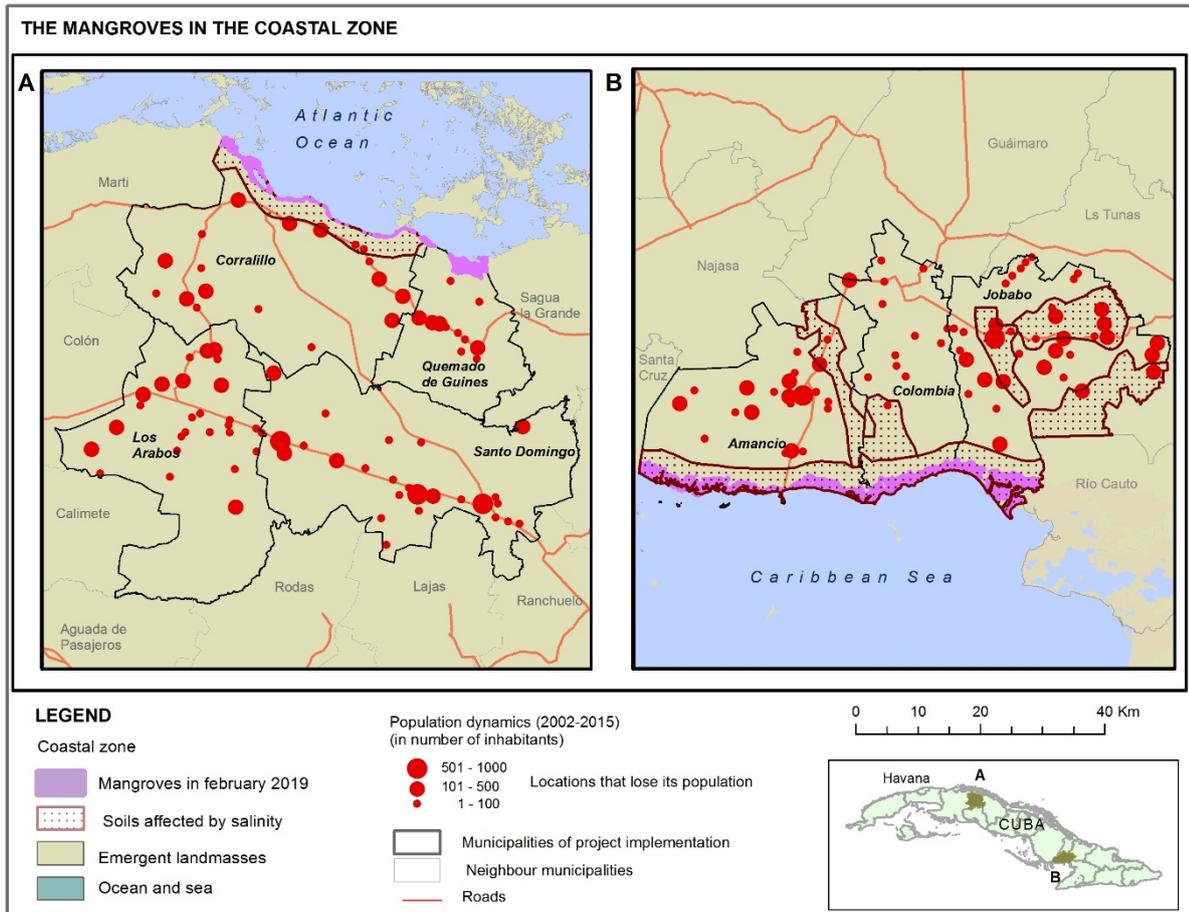
Note: The sum of what was declared as mangrove and swamp vegetation in the same category are considered in the calculations for 2003 to 2007.

Source: Directorate of Hydrography and Geodesy, Ministry of the Revolutionary Armed Forces (MINFAR).

With the use of satellite images, it is observed that in 2019 the mangrove area reached 11,408 ha, which represents an increase of approximately 3 853 ha in the East region, 1 998 ha in the municipality of Jobabo, 2 436 ha in Amancio and a decrease of 581 ha in Colombia. Due to the variability observed in the behavior of the figures for the municipalities that make up the AIPs in both regions, it can be inferred that there is no investment plan to protect the area occupied by mangroves and/or increase it when impacts on its coverage indicator are detected.

There is presence of mangroves in both coasts, in near 80% or more of the coasts of both regions, with a greater representation in the south east coast of the municipalities of Jobabo, Amancio and Colombia; however, the spatial analysis of its distribution for the year 2019 mapped from the digital processing of the satellite image for the month of February (Figure 12 and Figure 3) show that its extension from land to place is very variable with a more favorable situation in the eastern region.

Figure 12. Surface occupied by the mangroves in the coastal areas of the AIP



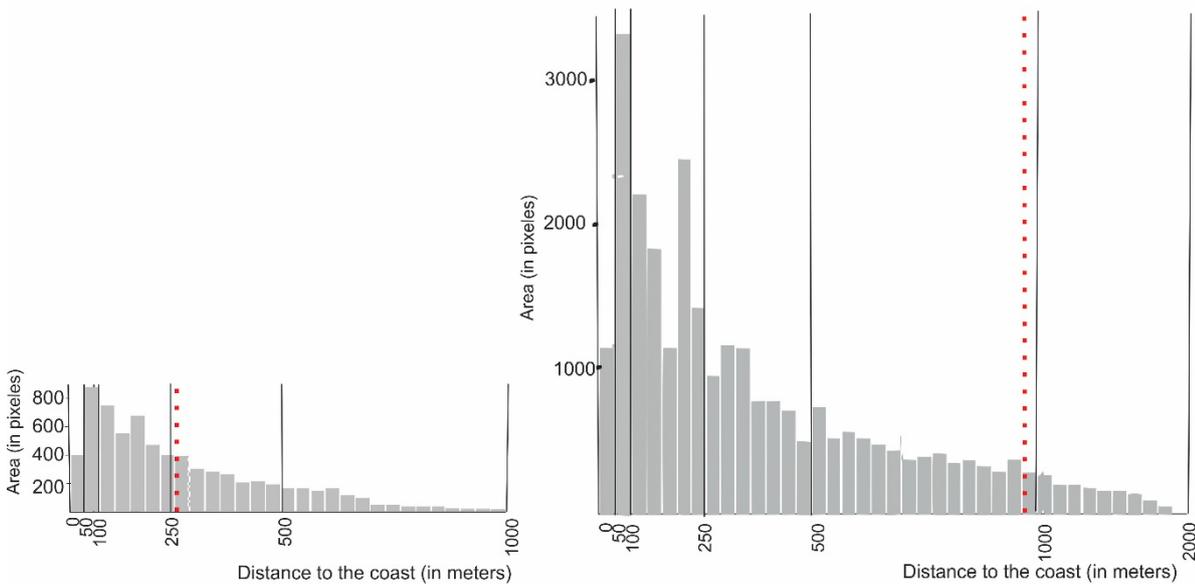
Source: Prepared by the authors based on images of the Sentinel 2a satellite (February 2019) and the Demographic Yearbook of Cuba. Havana; ONEI (several years), and data from CITMA

In most of the two AIPs, the distance between the coastline and the interior limit of the mangrove forest is 50 to 100 meters, and only in very specific areas, especially in the municipality of Jobabo, does the mangrove forest exceed 500 m earth inside. Figure 3 shows these values through the frequency histogram where the great difference between both regions is evidenced. In the municipalities of the AIP of the central region, the mangroves are reduced to small spots on the north coast of the municipalities of Quemado de Güines and Corralillo, in the latter much more degraded and occupying a smaller area, which leaves much of the north coast unprotected against the impact of hurricanes. In a general sense, these ecosystems are degraded on both coasts, mainly due to the effects caused by hurricanes, invasive plant species and man-made affectations throughout the last years.

Graph 3. Distance between the coastline and the interior boundary of the mangrove (in meters)

AIP Central Region

AIP East Region



▪ ▪ ▪ Average distance from the coast to the interior boundary of the Mangrove (in meters)

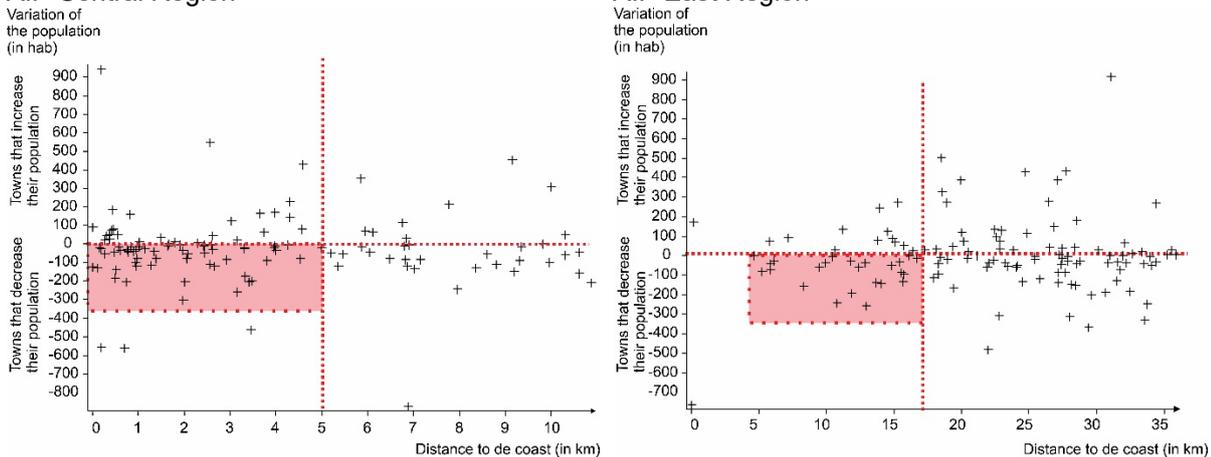
Source: Prepared by the authors based on images from the Sentinel 2a satellite (February 2019).

On the other hand, the analysis of the spatial distribution of the population in the coasts of both regions showed that most of the population localities near the coast are those experiencing negative variations in population, with important losses in their absolute values of total population in a sustained manner from year 2002 to date, (Chart 4), shows the exodus rise in the last 5 years.

Graph 4. Relation between the variation of the population (period 2002-2017) and proximity to the coast.

AIP Central Region

AIP East Region



Source: Prepared by the authors based on images of the Sentinel 2a satellite (February 2019) and the Demographic Yearbook of Cuba. Havana; ONEI (several years).

The distribution of the mangrove areas in the studied AIP in relation to the presence of officially established protected areas in these territories shows some coincidence for the Central region in the Corralillo municipality (8.5%), while for the East region, this coincidence is observed in the

municipality of Colombia in 48% and in Amancio 34%, an aspect that must be considered in the location of the modules to be developed (Table 26).

Table 26. Distribution of mangrove areas in relation to the presence of protected areas in the studied AIP, 2019

| Central Region | | | | |
|----------------------------------------------------------------------------------|------------|------------|---------------|-------------------|
| Concept | Los Arabos | Corralillo | Santo Domingo | Quemado de Güines |
| Total mangrove areas in the municipality (includes mangroves in protected areas) | 0 | 1 001,37 | 0 | 1 013,48 |
| Mangrove area outside protected areas | 0 | 915,66 | 0 | 0 |
| East Region | | | | |
| Concept | Jobabo | Colombia | Amancio | |
| Total mangrove areas in the municipality (includes mangroves in protected areas) | 3 108,26 | 1 726,27 | 4 558,78 | |
| Mangrove area outside protected areas | 0 | | | |

Source: Prepared by the authors based on images from the Sentinel 2a satellite (February 2019)

VIII.3 DROUGHT AND ITS IMPACT ON THE AIP

The variation in the amount of population of the human settlements of the AIP that are shown in figures 6 and 7 is the expression of what happens in these territories affected by an agricultural drought that oscillate in three ranges that start from 42 to 50 days and culminate between 61 to 80 days a year on average, taking into account more than 50 years of observations. Table 27 highlights the relationship between the agricultural drought and the Marabu expansion in 2019, with figures for Marabu coverage reaching 62 km² approximately in the municipalities of the central region and 476 km² in the East region.

Table 27. Relationship between the agricultural drought and the expansion of Marabu, year 2019

| Days per year with agricultural drought (%) | Area occupied by Marabu in 2019 | |
|---------------------------------------------|----------------------------------|----------------------------------|
| | AIP in Las Villas | AIP in Las Tunas |
| From 42 to 50 | 143, 20 km ² (21.58%) | - |
| From 51 to 60 | 497, 65 km ² (75.01%) | 232, 27 km ² (48.78%) |
| From 61 to 80 | 22, 60 km ² (3.41%) | 243, 81 km ² (51.21%) |

Source: Prepared by the authors from the processing of the Sentinel 2a image and information on the agricultural drought in Cuba: Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baéz, S. Gonzalez, J. Sille, P. Rosario and L. Duarte (2006)

Table 28 highlights the correlation between agricultural drought and settlements that decrease their population between 2012 and 2015. In the municipalities of the Central region the number of localities that lose population is 84 for a total population that moves towards other territories equal to 102 356 inhabitants; in the AIP of the East region, the displacement of population to other territories reaches 64 041 inhabitants and 71 is the number of human settlements whose populations decrease.

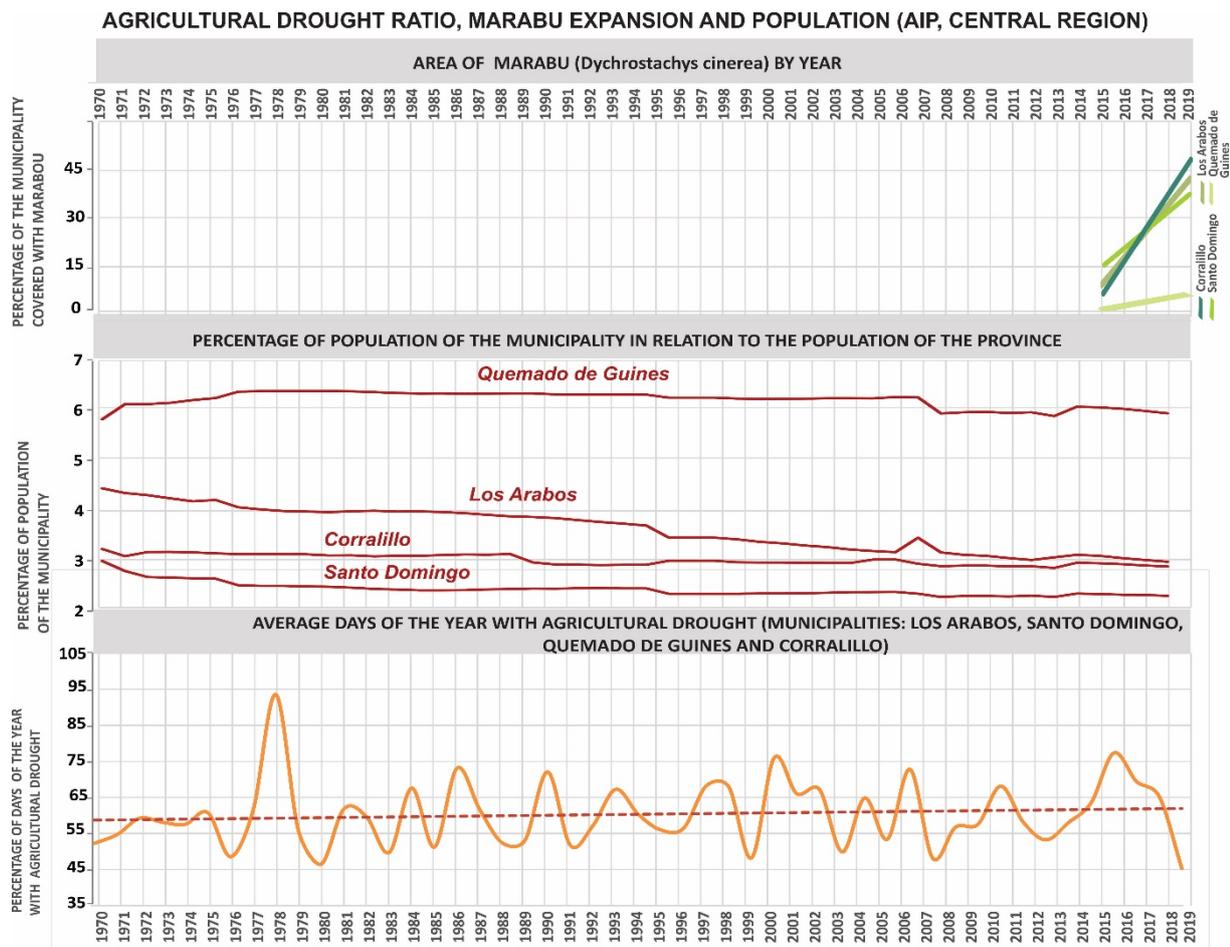
Table 28. Correlation between the agricultural drought, and the localities that lose population, Years 2002-2015

| Days per year with agricultural drought (%) | Settlements that lose population (2002-2015) | | | |
|---------------------------------------------|----------------------------------------------|---------------------------------|----------------------|---------------------------------|
| | AIP in Las Villas | | AIP in Las Tunas | |
| | Number of localities | Decrease in population (inhab.) | Number of localities | Decrease in population (inhab.) |
| From 42 to 50 | 25 | 29 119 | - | - |
| From 51 to 60 | 51 | 61 734 | 44 | 35 190 |
| From 61 to 80 | 8 | 11 503 | 27 | 28 851 |

Source: Prepared by the authors based on the processing of the Sentinel 2^a image and Cuba's Demographic Yearbooks.

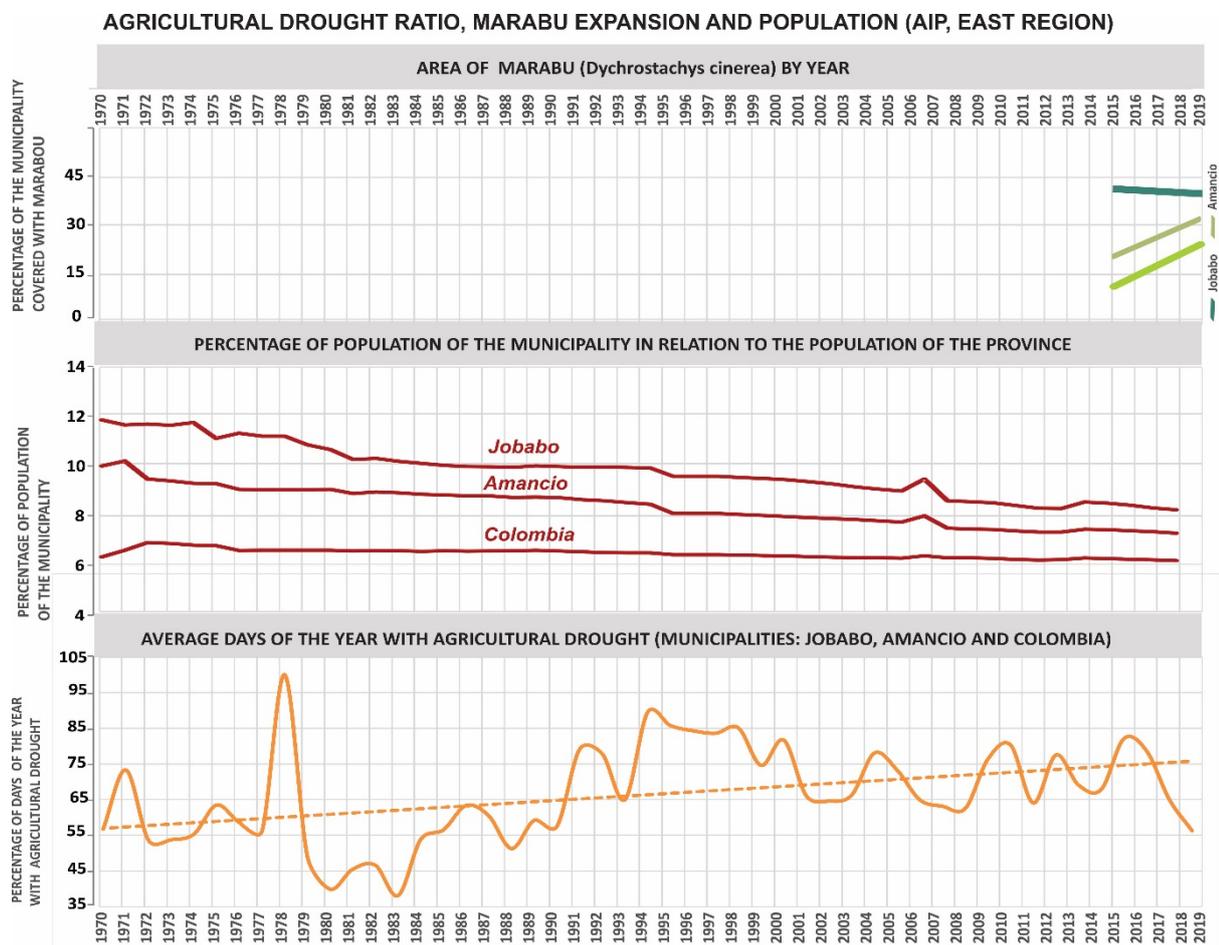
Graphs 5 and 6 reflect the growing trend of agricultural drought in the AIP with a more growing trend in the east region, data calculated from records that begin in 1951 and continue until 2018. In both zones, drought processes have favored the expansion of Marabu and the variation in the amount of population in human settlements.

Graph 5. Drought and its impact on the expansion of Marabu, and the variation of the population in the human settlements (AIP Central Region)



Source: Prepared by the authors from the processing of the Sentinel 2a image, Cuba's Demographic Yearbooks and agricultural drought information in: Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baz, S. Gonzalez, J. Sille, P. Rosario and L. Duarte (2006). The meteorological and agricultural drought in the Republic of Cuba and the Dominican Republic. Volume I, 172 pp,

Graph 6. Drought and its impact on the expansion of the Marabu and the variation of population in the human settlements (AIP East Region).



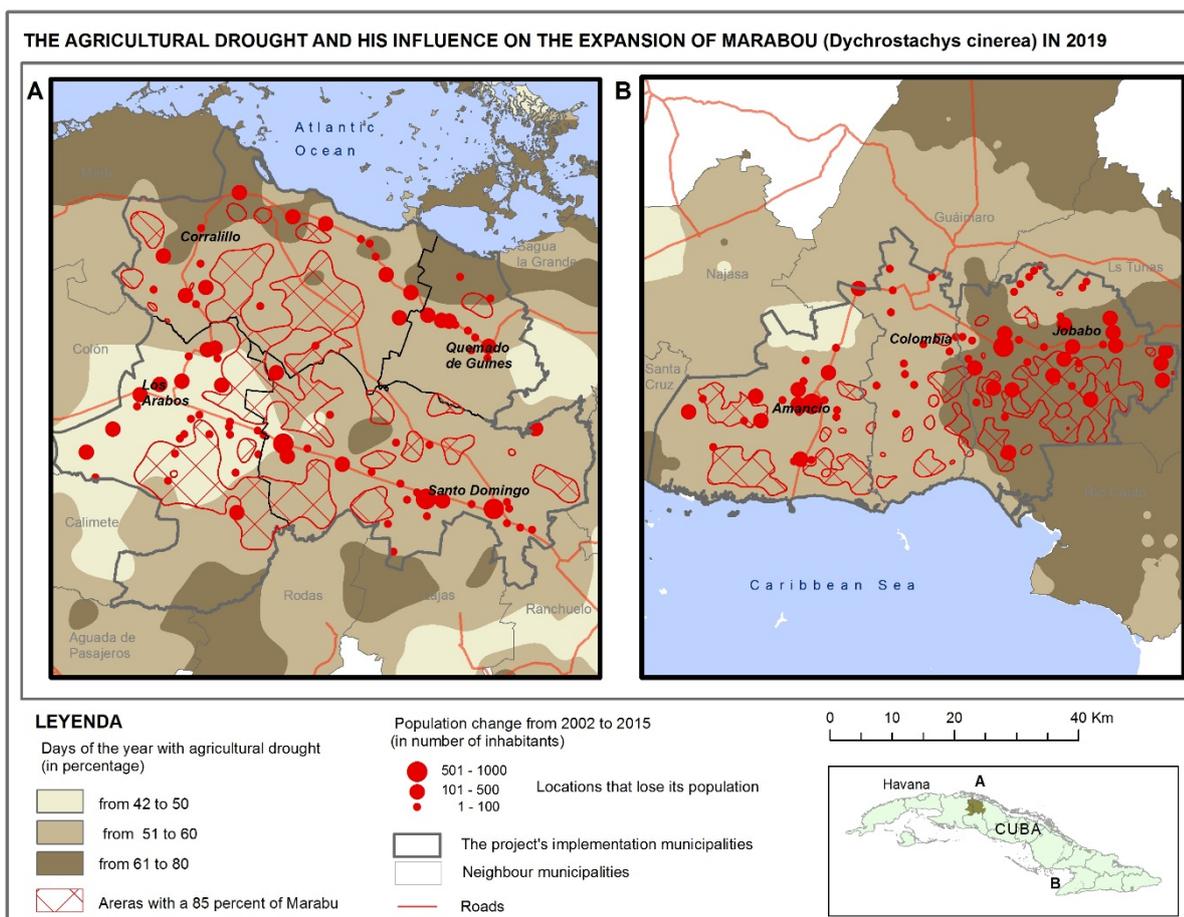
Source: Prepared by the authors from the processing of the Sentinel 2a image, Cuba's Demographic Yearbooks and agricultural drought information in: Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baz, S. Gonzalez, J. Sille, P. Rosario and L. Duarte (2006). The meteorological and agricultural drought in the Republic of Cuba and the Dominican Republic. Volume I, 172 pp.,

As evidenced in this section, population of the human settlements in the municipalities implementing the project, both in the Central and East regions, which have been affected by agricultural drought for more than three decades, report a tendency towards a decrease in their population between the years 1970 and 2019 (Figures 6, 7 and Figure 11).

By way of example and from the statistics prepared by the ONEI, it is indicated that between 2012 and 2017 only five human settlements of Los Arabos municipality gained numbers in population, the remaining urban and rural decreased, including the dispersed population; in Coralillo and Quemado de Güines also only five settlements, the rest decreased in number of population. In Santo Domingo 15 human settlements increased their population, the remaining 30 settlements decreased, which shows that in this region of just over 80 settlements, only about 25 increased, although in unrepresentative magnitudes.

In the municipalities of the East region population declined in nearly 100 settlements, while an increase was reported in approximately 60 settlements. If we go back in the analysis of the years 2002 and 2012 it is observed that only the capitals of the municipalities Los Arabos, Corralillo, Jobabo, Colombia and Amancio increased their population. The remaining two municipal capitals (Quemado de Güines and Santo Domingo) lost population. This fact confirms the existence of an important migration to the municipal capitals and the loss of population in rural areas and small urban settlements (ONEI, 2007, 2012, 2017, figures 4, 5, 6 and 13).

Figure 13. Drought and its impact on the expansion of Marabu and the variation in the amount of population in human settlements



Source: Prepared by the authors from the processing of the Sentinel 2a image, Cuba's Demographic Yearbooks and agricultural drought information in: Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baz, S. Gonzalez, J. Sille, P. Rosario and L. Duarte (2006). The meteorological and agricultural drought in the Republic of Cuba and the Dominican Republic. Volume I, 172 pp.,

IX. WATER DISTRIBUTION, RESERVE AND CURRENT DIFFICULTIES

Population of the municipalities with aqueduct service (AIP Central region)

In this section a brief incursion is made to the population in its various categories, according to place of residence with aqueduct service, which does not mean that this service works on a regular basis, either with permanent frequency or just for days scheduled for pumping water.

The reliable information available comes from the 2002 and 2012 population and housing censuses, so the analysis will be carried out from these two sources. Firstly, the population that has aqueduct service is valued in absolute numbers obtained from the 2012 census. It is then broken down according to place of residence. For the Central region 55% of the resident population has this service (68 575 inhabitants out of a total resident population of 124 732 inhabitants), with maximum percentage values in the municipality of Corralillo (20,750 inhabitants, representing 77% of its population) and becomes lower in Quemado de Güines, 15%, equivalent to 3 247 inhabitants. This service favored the urban population that had greater infrastructure for it and strongly drops off in rural areas, except in the Quemado de Güines municipality, where according to census information, the resident rural population has a greater water supply service (Table 29).

Table 29. Central Region: population with aqueduct service according to place of residence, 2012

| Municipality | Total Population | With Aqueduct Service (one) | | | | |
|-------------------|------------------|-----------------------------|------------|------------|--------------------|-----------------|
| | | Municipality | Urban Area | Rural Area | Rural concentrated | Rural dispersed |
| Los Arabos | 24 787 | 18 714 | 14 215 | 4 526 | 4 171 | 348 |
| Corralillo | 26 843 | 20 750 | 16 530 | 4 178 | 3 345 | 814 |
| Quemado de Güines | 22 089 | 3 247 | 640 | 2 605 | 2 563 | 37 |
| Santo Domingo | 51 013 | 25 864 | 21 515 | 4 344 | 4 181 | 155 |
| Total | 124 732 | 68 575 | 52 900 | 15 653 | 14 260 | 1 354 |

Source: ONEI. Population and housing censuses, 2012

The East region displays a less favorable situation in this indicator of population with aqueduct service than the Central region, with a percentage of 44% (51 296 inhabitants) of its total population with access to it. The Amancio municipality displays the highest percentage values (68% equivalent to 26 323 inhabitants); the municipality least favored with the provision of this service is Colombia with only 22% of its population (7 229 inhabitants). Just like in the Central region, this service favors the urban population that has more infrastructure for it and strongly drops off in rural areas (Table 30).

Table 30. East region: population with aqueduct service according to place of residence, 2012

| Municipality | Total Population | With Aqueduct Service (one) | | | | |
|--------------|------------------|-----------------------------|------------|------------|--------------------|----------------|
| | | Municipality | Urban area | Rural area | Rural concentrated | Rural disperse |
| Jobabo | 44 851 | 17 744 | 11 800 | 6 455 | 6 221 | 620 |
| Colombia | 32 612 | 7 229 | 3 803 | 1 233 | 1 266 | 129 |
| Amancio | 38 957 | 26 323 | 21 516 | 6 118 | 5 353 | 424 |

| | | | | | | |
|-------|---------|--------|-----------|-----------|--------|-------|
| Total | 116 420 | 51 296 | 37 119 | 13 806 | 12 840 | 1 173 |
|-------|---------|--------|-----------|-----------|--------|-------|

Source: ONEI. Population and housing censuses, 2012

In Los Arabos municipality, the percentage of the population that benefits from aqueduct service for water supply dropped off from 77% to 18% between 2002 and 2012, according to the population and housing censuses conducted for both years (ONEI, 2002, 2012); the percentage of the urban population that have access to this service for the period analyzed decreased from 99.6 to 22.2, for a reduction in the coverage, which represents 77% of the urban population; for the rural population the variation is reported from 58.1% to 10% with access to aqueduct service (Table 31).

The coverage of the service in Corralillo municipality increased by 2.7% in the intercensal period, varying from 74.6 to 77.3%; in the urban area it decreased by 2.6%. The coverage of this service in 2012 was 83.7%; the rural population with access varies from 44.2% to 58.9%, while the concentrated rural is 62.6% and the disperse one 46.5%.

Table 31. Central Region: percentages of population with access to water by aqueduct, 2002 and 2012 (%)

| Municipality | Years | 2002 | 2012 | Variation |
|-------------------|-----------------|------|------|-----------|
| Los Arabos | Total municipal | 77,7 | 18 | -59,7 |
| | Urban area | 99,6 | 22,2 | -77,4 |
| | Rural area | 56,2 | 11,3 | -44,9 |
| | Concentrated | 58,1 | 10 | -48,1 |
| | Disperse | 38,6 | 0 | -38,6 |
| Corralillo | Total municipal | 74,6 | 77,3 | 2,7 |
| | Urban area | 86,3 | 83,7 | -2,6 |
| | Rural area | 44,2 | 58,9 | 14,7 |
| | Concentrated | 50,3 | 62,6 | 12,3 |
| | Disperse | 31,9 | 46,5 | 14,6 |
| Quemado de Güines | Total municipal | 45,8 | 14,7 | -31,1 |
| | Urban area | 51,5 | 4,5 | -47 |
| | Rural area | 35,6 | 33,1 | -2,5 |
| | Concentrated | 46,7 | 44,9 | -1,8 |
| | Disperse | 14,5 | 1,7 | -12,8 |
| Santo Domingo | Total municipal | 62,3 | 50,7 | -11,6 |
| | Urban area | 70,1 | 57,8 | -12,3 |
| | Rural area | 42,1 | 31,5 | -10,6 |
| | Concentrated | 55,1 | 38,5 | -16,6 |
| | Disperse | 20,2 | 5,3 | -14,9 |

Source: ONEI. Population and housing censuses, 2002 and 2012

The extent of the aqueduct service experienced a strong drop off in the Quemado de Güines municipality, where the percentage of the population served went from 45.8 in 2002 to 14.7% in 2012, a reduction concentrated in the urban spaces that went from 51.5 to 4.5% of the population with access to this service. The percentages in the rural population served vary from 46.7 to 44.9%; while only 1.7% of the dispersed population have this service.

The population of Santo Domingo with access to water service by aqueduct decreased by 11.6% in the intercensal period; the urban population with access is reduced to 57.8% for a loss percentage of 12.3; the rural one decreases to 31.5 with a percentage reduction of 10.6. The dispersed rural population only reaches 5.3% of its total.

Population of the municipalities with access to aqueduct service (AIP East Region)

The percentage of the population that has access to aqueduct service for water supply increases from 22% to 39.56% in the 2002-2012 intercensal period for the Jobabo municipality; the percentage of the urban population that has this service for the period analyzed almost doubles, reaching a coverage of 58% of the population residing in urban spaces; this service expands in rural areas to 26% of the population, 32% in the concentrated rural population and decreases to 12% in the rural dispersed (Table 32).

Table 32. Eastern Region: percentages of population with access to water by aqueduct, 2002 and 2012 (%)

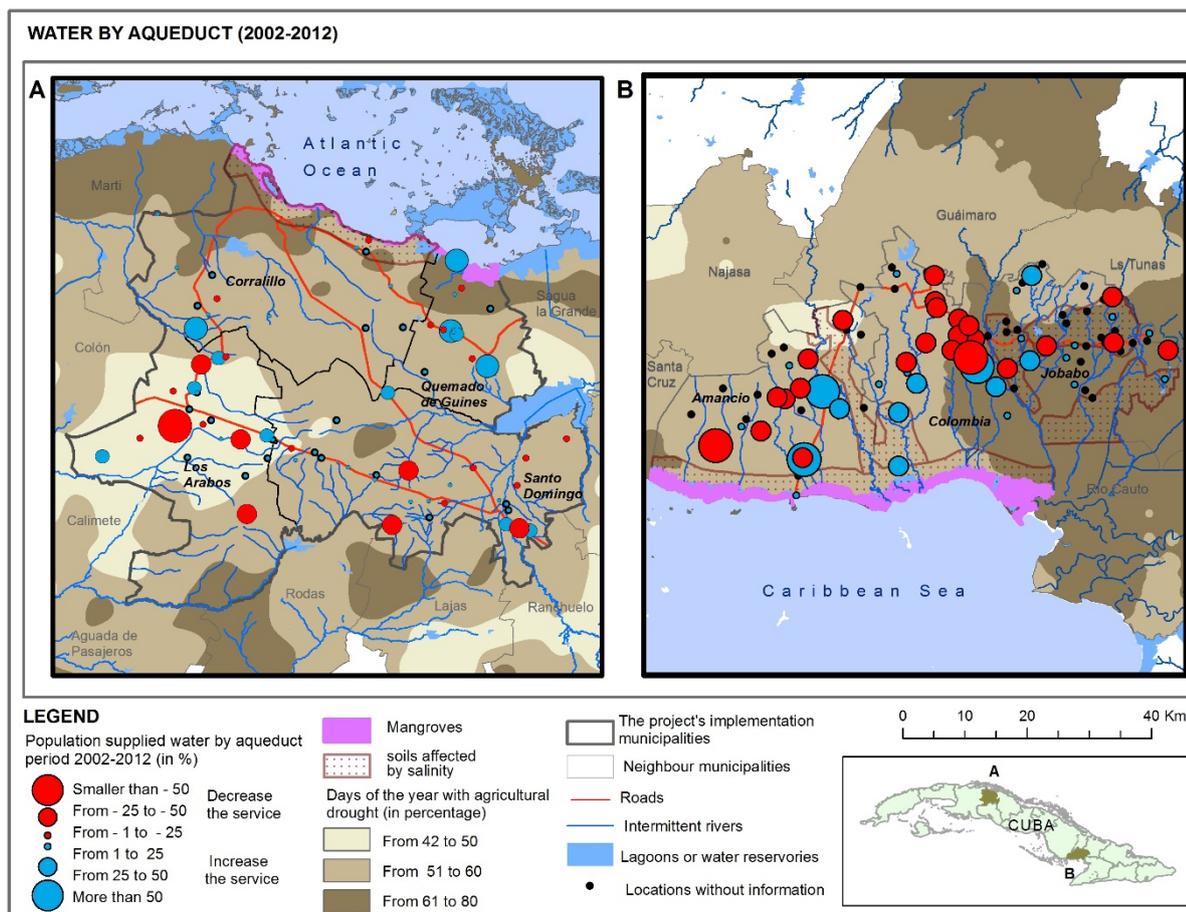
| Municipality | Years | 2002 | 2012 | Variation |
|--------------|--------------------|-------|-------|-----------|
| Jobabo | Total municipal | 22 | 39,56 | 17,56 |
| | Urban area | 25,4 | 58,10 | 32,70 |
| | Rural area | 19,7 | 26,30 | 6,60 |
| | Concentrated | 28,7 | 32,00 | 3,30 |
| | Disperse | 15,3 | 12,15 | -3,15 |
| Colombia | Total municipal | 48,8 | 22,17 | -26,63 |
| | Urban area | 31,8 | 16,66 | -15,14 |
| | Rural area | 37,8 | 12,60 | -25,20 |
| | Concentrated | 50,1 | 18,00 | -32,10 |
| | Disperse | 8,5 | 4,70 | -3,80 |
| Amancio | Total municipal | 62,2 | 67,57 | 5,37 |
| | Amancio (urban) | 72,6 | 76,60 | 4,00 |
| | Guayabal (urban) | 90,9 | 92,97 | 2,07 |
| | Rural concentrated | 49,2 | 64,30 | 15,10 |
| | Disperse | 12,70 | 16,68 | 3,98 |

Source: ONEI. Population and housing censuses, 2002 and 2012

The coverage of this service in the municipality of Colombia decreases sharply in the intercensal period, varying from 48.8% to 22.17%; for the urban area, the percentage of the population served decreases to represent 16% of the total residents in these spaces; the rural population with access varies from 37.8% to 12.6%. While the rural population maintains this same decreasing tendency whereby only 12.6% had this service in 2012; the concentrated rural population and the dispersed one also diminishes the percentage of population with access to aqueduct service.

The population of the Amancio municipality with access to water service by aqueduct increased by 5.37% in the intercensal period, and reaches a coverage of 67.57% of the total municipality; the urban population with access does so by 4% in the municipal capital, by 2% in the second urban settlement of the municipality; the rural population increases and reaches 64% coverage, while the dispersed rural population also increases and comes to represent approximately 17% of the total dispersed population.

Figure 14. Situation of the water supply to the population residing in the localities of the AIP



Source: Prepared by the authors from the image processing Sentinel 2a, Census of population and housing, 2002 and 2012 and information of the agricultural drought in: Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baz, S. Gonzalez, J. Sille, P. Rosario and L. Duarte (2006). The meteorological and agricultural drought in the Republic of Cuba and the Dominican Republic. Volume I, 172 pp.,

The effects of climate change in the AIP, which are evident by the frequency and intensity of the extreme weather events that affect them, the increase of the area affected by agricultural drought, together with the low rates of forest cover reported in the territories, as well as the reduction of rainfall and a more arid climate, threaten the state of surface and underground basins, and the availability of water resources for water supply to communities inhabiting the AIP. As shown in Figure 14, there are a significant number of human settlements whose population aqueduct services decreased.

From the analysis of the territorial statistical yearbooks for 2016 (ONEI) for the province and municipalities of Las Tunas (it is not done for the AIP of the Central region because it does not contain this information in the indicated statistical source), it is evident that half of the population of the municipality of Colombia (71.6%) lacks home connection and public service for water supply, therefore must seek this resource up to distances of 300 meters from their place of residence; in the Jobabo municipality, this percentage is 45.4 and in Amancio it is 11.7%, nevertheless, this figure increases to 66.5% (Table 33) for the rural population of the municipality.

Table 33. Eastern Region: indicators of drinking water coverage, 2016 (%)

| INDICATOR | % Population according to type of potable water coverage | | |
|-------------------|----------------------------------------------------------|----------|---------|
| | Jobabo | Colombia | Amancio |
| Total Population | 100 | 100 | 100 |
| • Home connection | 23,4 | 17,4 | 21,8 |
| • Public service | 31,2 | 11,0 | 66,5 |
| • Easy access | 45,4 | 71,6 | 11,7 |
| Urban Population | 100 | 100 | 100 |
| • Home connection | 31,4 | 11,3 | 47,4 |
| • Public service | 28,4 | 13,4 | 19,9 |
| • Easy access | 40,2 | 75,4 | 32,7 |
| Rural Population | 100 | 99,9 | 100 |
| • Home connection | 17,2 | 31,8 | 21,8 |
| • Public service | 33,4 | 5,4 | 11,7 |
| • Easy access | 49,4 | 62,7 | 66,5 |

Notes: Easy access: it requires searching for water up to distances of 300 meters.

Source: ONEI (2016). Statistical yearbook of Cuba by territories. Havana.

X. CONCLUSIONS

1. Research shows abandonment by the population of the AIP and a significant process of population aging, more noticeable in rural areas, with a percentage growth of the urban population as a result of rural-urban migration. The exodus of the rural population of the AIP reached more than 23 thousand inhabitants between 1995 and 2015.
2. A process of feminization of the rural spaces of the AIPs is also under way, where women present the most unfavorable situation, given the abandonment of a greater number of men in search of better opportunities for work and life.
3. An assessment of the demographic situation of the AIPs and the adjacent municipalities, based on the migratory status that predominates in this group, reveal that regardless of registering positive rates of natural growth, as well as of fertility, which could imply the possibility of replacing the labor force, the reduction of the arable land that influences the lack of employment in agricultural and agro industrial sectors, force the population to leave the AIPs, which leads to negative growth rates and population exodus.
4. The AIPs report a considerable loss of cultivated area, given in a context where processes and physical-geographic phenomena (meteorological and climatic) linked to climate change are added, highlighting the agricultural drought that has been present for several decades in these territories. The loss of agro productivity of soils, the frequency of hurricanes and the expansion of Marabu, the latter favored by the set of factors aforementioned and which influences the decline in numbers of cultivated area.
5. The behavioral study of the area occupied by Marabu shrubs and its dynamics between 2015 and 2019, from the processing of satellite images for 2019, shows that a percentage growth of 31 is reported for the AIP of the Central region. 14% and 22.25% for the AIP of the East region, highlighting the municipalities of Jobabo, Amancio, Corralillo and Los Arabos, with about a third of their area covered by Marabu. The analysis of the distribution of lands covered with natural pastures and other lands that are considered up to 2015, show values close to 55% of the total area in both regions. These high values are a consequence, among other factors, of the increase in the agricultural drought reported for these territories, with a more pronounced growth in the East region.
6. The related analysis for 2012-2015 of the number of landholders, cultivated area and covered area of Marabu, shows a reduction of approximately 3.7 thousand landholders, with a greater reduction in the AIP of the Eastern region.
7. The analysis of the historical trajectories of hurricanes in the last 15 years represented through the density surfaces shows a greater exposure of the AIP to the impact of these tropical organisms that could become more intense and destructive in the context of the change climate.
8. The reduction on the amount of population in more than 85% of the human settlements of the AIP is, to a large extent, a result of what happens in these territories affected by an agricultural drought in ranges that start from 42 to 50 days and reach to between an average

of 61 to 80 days per year, plus the expansion of Marabu in the last four years, with values reaching 662 km² in the AIP of the Central Region and 476 km² in the East region by 2019.

9. The annual percentage of the area affected by agricultural drought as an average in the AIP shows a growing trend, calculated from records that began in 1951 and extended to 2018, a phenomenon that greatly influences the population of the human settlements that have been affected for more than three decades by agricultural droughts and the expansion of Marabu, and where population decline is reported in most of the rural, urban and dispersed populations.
10. The effects of climate change on the studied AIP that are manifested in the frequency and intensity of extreme weather events, the expansion of the area affected by the agricultural drought, together with the low rates of forest cover reported in the territories, the decrease in rainfall and a more arid climate, threaten the state of surface and underground basins, and the availability of water resources for the supply of water to the population of human settlements, with a significant number of these localities where there is a decline of the population benefiting from water by aqueduct.

BIBLIOGRAPHY

- Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baéz, S. González, J. Sille, P. Rosario and L. Duarte (2006). The meteorological and agricultural drought in the Republic of Cuba and the Dominican Republic. Volume I, 172 pp.
- National Center for Land Control (several years). Balance of use and land tenure. MINAG.
- GEOCUBA (1995). National Cadaster use and possession of the land. Annual summary. Havana.
- INSMET (s / f). Monitoring system and early warning of the agricultural drought executed by the Agricultural Meteorology Center of INSMET.
- MINAG (2017). Digital map 1:25 000 of Cuba. Direction of soils and fertilizers. Havana.
- ONE (2012) Demographic series 1982-2002. Magnetic support. ONEI (2007). National Nomenclature of Human Settlements of the Population and Housing Census of 2002. Havana.
- ONEI (2012) Demographic series 2000-2010. Magnetic support.
- ONEI (2012). National Nomenclature of Human Settlements of the Population and Housing Census of 2012. Havana.
- ONEI (2017). Statistical yearbook of Cuba. Edition 2018. Havana.
- ONEI (2017). The aging of the population 2017. Havana
- ONEI (2018). National statistical information system (SIEN), demography 2017. Magnetic support.
- ONEI (several years). Demographic yearbook of Cuba. Havana
- ONHG (2003). National Cadaster Annual summary. Magnetic support.
- ONHG (2005). National Cadaster Annual summary. Magnetic support.
- ONHG (2007). National Cadaster Annual summary. Magnetic support.

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Appendix 2.2.1. Selected indicators of the population of the municipalities of the Central region, years 2009 and 2017

| Municipality | Population | | | | | Masculinity Index (Men per 1000 women) | Percentage | |
|-----------------------|----------------|---------------|---------------|---------------|---------------|----------------------------------------------|--------------|--------------|
| | Total | Male | Female | Urban | Rural | | Urban | Rural |
| YEAR 2009 | | | | | | | | |
| Los Arabos | 24 829 | 12 701 | 12 128 | 13 869 | 10 960 | 1 047 | 55,86 | 44,14 |
| Population ≥60 | 4 665 | 2 410 | 2 255 | 2 629 | 2 036 | 1 069 | 56,36 | 43,64 |
| % | 18,79 | 18,97 | 18,59 | 18,96 | 18,58 | | | |
| Corralillo | 27 554 | 14 043 | 13 511 | 19 441 | 8 113 | 1 039 | 70,56 | 29,44 |
| Population ≥60 | 5 582 | 2 855 | 2 727 | 3 851 | 1 731 | 1 047 | 68,99 | 31,01 |
| % | 20,26 | 20,33 | 20,18 | 19,81 | 21,34 | | | |
| Quemado de Güines | 22 474 | 11 630 | 10 844 | 14 211 | 8 263 | 1 072 | 63,23 | 36,77 |
| Population ≥60 | 4 670 | 2 378 | 2 292 | 2 767 | 1 903 | 1 038 | 59,25 | 40,75 |
| % | 20,78 | 20,45 | 21,14 | 19,47 | 23,03 | | | |
| Santo Domingo | 53 007 | 27 005 | 26 002 | 38 201 | 14 806 | 1 039 | 72,07 | 27,93 |
| Population ≥60 | 10 659 | 5 352 | 5 307 | 7 451 | 3 208 | 1 008 | 69,90 | 30,10 |
| % | 20,11 | 19,82 | 20,41 | 19,50 | 21,67 | | | |
| CENTRAL REGION | 127 864 | 65 379 | 62 485 | 85 722 | 42 142 | 1 046 | 67,04 | 32,96 |
| Population ≥60 | 25 576 | 12 995 | 12 581 | 16 698 | 8 878 | 1 033 | 65,29 | 34,71 |
| % | 20,00 | 19,88 | 20,13 | 19,48 | 21,07 | | | |
| YEAR 2017 | | | | | | | | |
| Los Arabos | 24 119 | 12 257 | 11 862 | 14 650 | 9 469 | 1 033 | 60,74 | 39,26 |
| Population ≥60 | 5 290 | 2 683 | 2 607 | 3 352 | 1 938 | 1 029 | 63,36 | 36,64 |
| % | 21,93 | 21,89 | 21,98 | 22,88 | 20,47 | | | |
| Corralillo | 25 834 | 13 117 | 12 717 | 19 039 | 6 795 | 1 031 | 73,70 | 26,30 |
| Population ≥60 | 6 031 | 2 973 | 3 058 | 4 401 | 1 630 | 972 | 72,97 | 27,03 |
| % | 23,35 | 22,67 | 24,05 | 23,12 | 23,99 | | | |
| Quemado de Güines | 21 359 | 10 942 | 10 417 | 13 906 | 7 453 | 1 050 | 65,11 | 34,89 |
| Population ≥60 | 5 217 | 2 597 | 2 620 | 3 295 | 1 922 | 991 | 63,16 | 36,84 |
| % | 24,43 | 23,73 | 25,15 | 23,69 | 25,79 | | | |
| Santo Domingo | 49 445 | 24 919 | 24 526 | 35 905 | 13 540 | 1 016 | 72,62 | 27,38 |
| Population ≥60 | 11 562 | 5 628 | 5 934 | 8 351 | 3 211 | 948 | 72,23 | 27,77 |
| % | 23,38 | 22,59 | 24,19 | 23,26 | 23,71 | | | |
| CENTRAL REGION | 120 757 | 61 235 | 59 522 | 83 500 | 37 257 | 1 029 | 69,15 | 30,85 |
| Population ≥60 | 28 100 | 13 881 | 14 219 | 19 399 | 8 701 | 976 | 69,04 | 30,96 |
| % | 23,27 | 22,67 | 23,89 | 23,23 | 23,35 | | | |

Source: ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2012) Demographic series 2000-2010. Magnetic support; ONEI (2017). The aging of the population 2017, Havana

Appendix 2.2.2 Selected indicators of the population of the municipalities of the East region, years 2009 and 2017.

| Municipality | Population | | | | | Masculinity Index (Men per 1000 women) | Percentage | |
|-------------------|------------|--------|--------|--------|--------|-------------------------------------------|------------|-------|
| | Total | Male | Female | Urban | Rural | | Urban | Rural |
| YEAR 2009 | | | | | | | | |
| Jobabo | 47 580 | 24 608 | 22 972 | 18 299 | 29 281 | 1 071 | 38,46 | 61,54 |
| Population ≥60 | 7 330 | 3 924 | 3 406 | 2 453 | 4 877 | 1 152 | 33,47 | 66,53 |
| % | 15,41 | 15,95 | 14,83 | 13,41 | 16,66 | | | |
| Colombia | 32 779 | 16 750 | 16 029 | 22 532 | 10 247 | 1 045 | 68,74 | 31,26 |
| Population ≥60 | 5 044 | 2 531 | 2 513 | 3 504 | 1 540 | 1 007 | 69,47 | 30,53 |
| % | 15,39 | 15,11 | 15,68 | 15,55 | 15,03 | | | |
| Amancio Rodríguez | 40 771 | 20 868 | 19 903 | 28 335 | 12 436 | 1 048 | 69,50 | 30,50 |
| Population ≥60 | 6 069 | 3 062 | 3 007 | 4 079 | 1 990 | 1 018 | 67,21 | 32,79 |
| % | 14,89 | 14,67 | 15,11 | 14,40 | 16,00 | | | |
| EAST REGION | 121 130 | 62 226 | 58 904 | 69 166 | 51 964 | 1 056 | 57 | 43 |
| Population ≥60 | 18 443 | 9517 | 8 926 | 10 036 | 8 407 | 1 066 | 54,42 | 45,58 |
| % | 15,23 | 15,29 | 15,15 | 14,51 | 16,18 | | | |
| YEAR 2017 | | | | | | | | |
| Jobabo | 47 350 | 24 503 | 22 847 | 18 012 | 29 338 | 1 072 | 38,04 | 61,96 |
| Population ≥60 | 8 394 | 4 368 | 4 026 | 3 788 | 4 606 | 1 085 | 45,13 | 54,87 |
| % | 17,73 | 17,83 | 17,62 | 21,03 | 15,70 | | | |
| Colombia | 32 185 | 16 747 | 16 068 | 22 564 | 10 251 | 1 042 | 70,11 | 31,85 |
| Population ≥60 | 6 342 | 3 224 | 3 118 | 4 666 | 1 676 | 1 034 | 73,57 | 26,43 |
| % | 19,70 | 19,25 | 19,41 | 20,68 | 16,35 | | | |
| Amancio Rodríguez | 40 647 | 20 832 | 19 815 | 28 360 | 12 287 | 1 051 | 69,77 | 30,23 |
| Population ≥60 | 7 104 | 3 487 | 3 617 | 5 250 | 1 854 | 964 | 73,90 | 26,10 |
| % | 17,48 | 16,74 | 18,25 | 18,51 | 15,09 | | | |
| EAST REGION | 120 182 | 62 082 | 58 730 | 68 936 | 51 876 | 1 057 | 57,36 | 43,16 |
| Population ≥60 | 21 840 | 11 079 | 10 761 | 13 704 | 8 136 | 1 030 | 62,75 | 37,25 |
| % | 18,17 | 17,85 | 18,32 | 19,88 | 15,68 | | | |

Source: ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2012) Demographic series 2000-2010. Magnetic support; ONEI (2017). The aging of the population 2017. Havana

Appendix 2.2.3. Summary of selected indicators of the population of the municipalities of the AIP, years 2009 and 2017

| Municipality | Population | | | | | Masculinity Index (Men per 1000 women) | Percentage | |
|----------------|------------|--------|--------|--------|-------|-------------------------------------------|------------|-------|
| | Total | Male | Female | Urban | Rural | | Urban | Rural |
| YEAR 2009 | | | | | | | | |
| Total | 248994 | 127605 | 121389 | 154888 | 94106 | 1051 | 62,21 | 37,79 |
| Population ≥60 | 44019 | 22512 | 21507 | 26734 | 17285 | 1047 | 60,73 | 39,27 |
| % | 17,68 | 17,64 | 17,72 | 17,26 | 18,37 | | | |
| YEAR 2017 | | | | | | | | |
| Total | 240939 | 123317 | 118252 | 152436 | 89133 | 1043 | 63,27 | 36,73 |
| Population ≥60 | 49940 | 24960 | 24980 | 33103 | 16837 | 999 | 66,29 | 33,71 |
| % | 20,73 | 20,24 | 21,12 | 21,72 | 18,89 | | | |

Source: ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2012) Demographic series 2000-2010. Magnetic support; ONEI (2017). The aging of the population 2017. Havana