



# Proposal of a master plan of green areas, for the mitigation of the effect of the heat island.

## Case study: Southwest District, Febres Cordero Parish - Guayaquil. (December 2022)

Angela Teresa Cruz Barragan<sup>1</sup>.

<sup>1</sup> Decentralized Autonomous Government of the Guayaquil Canton; [ORCID 0000-0003-2107-3981](https://orcid.org/0000-0003-2107-3981); <mailto:angcruth@guayaquil.gov.ec>

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**Abstract**— This work focuses on the reality of one of the densest areas of the city of Guayaquil, the Febres-Cordero Parish, with an approximate population of 344,254 inhabitants. It developed in the middle of the last century, when the need to provide housing to the large number of people who migrated from different parts of the country, in search of a better economy and social development, predominated. The study area has an orderly spatial configuration with a type of orthogonal or checkerboard urban plot, but without the provision of recreational spaces and without the need for care and interaction with nature, these actions affected the population, which was largely evidenced, during the COVID-19 pandemic that hit the world, where people were locked up and with the need to have contact with healthy outdoor areas. The surface temperature of cities has increased in recent years due to factors such as increased population density, use of impermeable materials, degree of reflectance of materials in construction, and elimination of the vegetal layer, all this due to poor urban planning, without future projection and that I do not consider the need to preserve green areas, Permeable soil cover, urban trees and other elements that reduce the incidence of solar radiation. The present proposal seeks to make a change in the urban image where a change of the current situation of the parish is proposed Febres-Cordero in which waterproof materials and concrete predominate. Items to reduce the increase in temperature, improve the situation and quality of life of the inhabitants, proposing a greater number of green spaces, and shaded areas, where leafy and perennial foliage of trees predominates; These actions increase the rate of heat absorption and reduce the incidence of sunlight.

**Keywords:** Territorial planning, heat island, land use, urban fabric, surface temperature.

### I. INTRODUCTION

The present study shows the increase of the effect of the heat island in the city of Guayaquil, where the use of waterproof materials with high reflectance has prevailed, in addition, the study area presents great thermal inertia and a low cooling capacity at night. [1] Therefore, it seeks to present alternatives to try to improve the microclimate of the area, and the urban image and as a primary way, promote a better standard of living for the inhabitants of the area, by increasing the index of green areas, increasing the number of trees in public spaces and reducing the surface temperature of the area.

"He who before his death has planted a tree has not lived uselessly." (Martin Luther King)

### II. MATERIALS AND METHODS

The growth of the city of Guayaquil is due to the migration of people from various sectors of the country, such is the case of the Febres-Cordero Parish, which has its origin around the sixties, is a sector where residential land use predominates, with one of the highest population densities in the city, but where one of the lowest rates of green areas per inhabitant is concentrated. [2] It is in the southwest of the city, bordered by the north, west, and south with the Estero Salado, while to the east is the Letamendi Parish, the extension of the territory is crossed by branches of the Estero Salado, previously it was a swampy forest with the presence of mangrove trees, which were cut down to be implemented in mixed type houses. It has a population of 344,254 inhabitants, middle and popular economic class with a poverty rate of 23.25% according to INEC data in 2014, there are 86672 households within the Parish. [3]

The growth of the city, without prior planning, has led to problems such as the deficit of equipment and services to meet basic needs, it should also be noted that many of these sectors needed settling on unsuitable soils or eliminating natural barriers such as mangroves or forests and increasing the percentage of impermeable soils. One of the problems, which undoubtedly has a greater echo today, is the environmental problem among them, the effect of the heat island, which corresponds to the surface temperature of the areas, especially urban ones. It is extremely well known the effect that pollutants have on the health of people, on the growth and development of animals and plants, on the deterioration of the elements and the acidity of rain. [4] The environmental quality of urban centers depends to a large extent on the state and leafiness of their parks, green areas, squares, recreational areas and streets. Which were diminished due to ignorance of the effects of uncontrolled growth where the environment and its elements are affected to the point of disappearing.

#### *a. Urban Coverage*

According to data provided by ESPOL and the Municipality of Guayaquil, it was shown that the predominant material in the study area is construction debris and garbage. [5] In 2017, the city was under a vulnerability study in the face of growing climate change, in which the respective diagnosis was carried out, where the units of analysis were the urban parishes.

According to this report, Guayaquil is subject to alterations associated with climate change and its effects, which must be overcome to ensure sustainable economic development, following concepts of good living, where sustainable responses are generated, which are also responsible, replicable, and socio-environmentally acceptable. [6] Through visits to the study site, carried out in the months of August and September of the year 2022, it was evidenced that the surface of the study area is waterproofed by 90%, including in the properties destined as parks and squares. The tree cover of the city of Guayaquil is 85.39 square kilometers, that is, 26% of the urban area, which corresponds to 323.49 km<sup>2</sup> [7]



Fig. 1. Urban image showing the low percentage of tree cover of the city of Guayaquil and the study area. Note: Prepared by the author.

### III. METHODOLOGY

The present work has a qualitative–transversal, non-experimental methodology, whose focus emphasizes knowing the customs, needs, and means of interaction of the people who inhabit the study area, based on field visits, conversations with residents, and people linked to the corresponding Municipal Directorates. In addition to being based on documentation regarding issues related to territorial planning, laws, ordinances, urban landscape, and agronomic knowledge. Several indicators were estimated to determine the current situation and problems, where tools such as:

*Table 1 Tools used in research: Prepared by the author.*

TOOLS USED IN THIS RESEARCH	
SURVEYS	The sample size will be a total of 200 people between the ages of 18 and 65.
OBSERVATION	A visual record is established of the behavior of the population (hours of entry, exit, leisure) the daily life is evidenced.
DATA ANALYSIS	The main objective is the mapping and characterization (land uses) of the Febres-Cordero parish.

For the selection of the indicators, the quantity and distribution of the areas according to the extension of the parish and its population were considered.

*a. Indicator 1. Green area per inhabitant.*

The city of Guayaquil according to the index of the Municipality of Guayaquil granted by personnel of the Directorate of Environment and Preservation of Green Areas, has an index of 9 m<sup>2</sup> of green areas per inhabitant, but the study area is the densest area with fewer green areas per inhabitant.

*b. Indicator 2. Location of the public green areas of the study area.*

Natural spaces, tree-lined streets, urban green areas, parks, and trails, among others, are also part of the green infrastructure, which provide a wide range of ecological, economic, and social benefits and services, in addition to environmental value.

According to the information of the Cadastre geoportal, a total of 71 ACM (Areas Ceded to the Municipality) was determined, of which 49 areas are already defined as Public Municipal Parks, as shown in Figure 2.

It was evidenced that 70% of the population interviewed believe that the facilities related to green areas, recreational areas, and parks, do not meet the needs of the people who inhabit the Febres-Cordero Parish.

30% of the population presents a level of dissatisfaction due to a small number of recreational areas since they must mobilize, to find an area of this type, added to the insecurity that the city is going through.

80% of the population that performs exercises comments that there are no spaces for these activities or that they are not in good condition and need maintenance. So, they improvise sports courts on the road of the streets with less traffic.

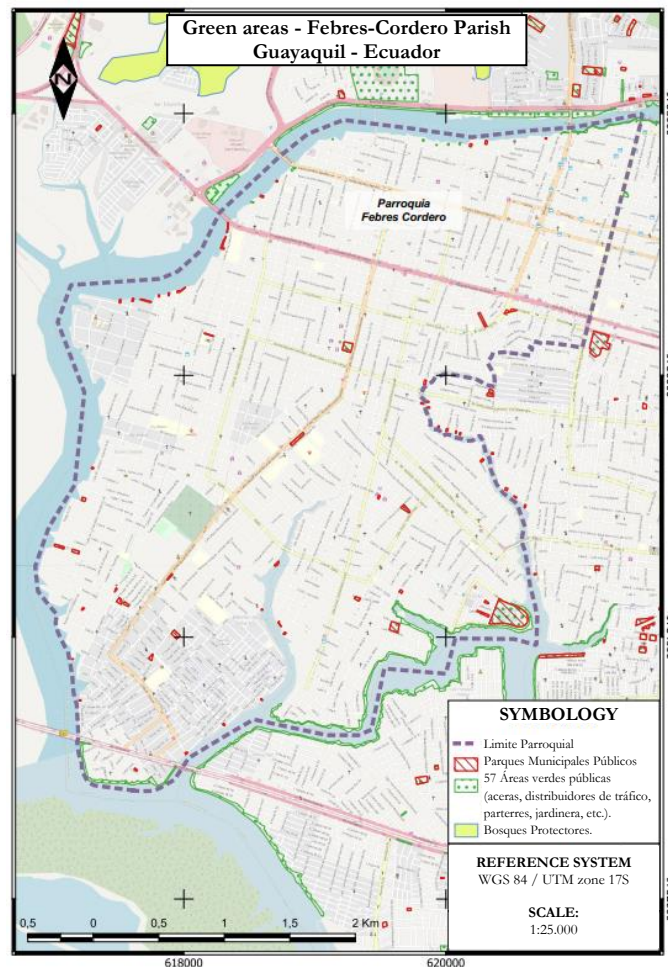


Fig. 2. Green areas of the Febres-Cordero Parish. Note: Prepared by the author.



*c. Indicator 3. Location of the public green areas of the study area.3. Number of tree species per inhabitant.*

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The director of Environment and Preservation of Green Areas, María Fernanda Rumba, clarified that "Guayaquil has registered 116,000 trees."

- 86000 trees
- 30000 palm trees

The study area has a number of 1763 species, including trees and palm trees, it should also be noted that according to a forest inventory carried out by the former Directorate of Green Areas, and based on a criterion handled by the Ministry of Environment the technical regulations of ministerial agreement 059, palm trees are considered as a tree. [8]



Fig. 3. Trees implanted in the Febres-Cordero Parish. Note: Prepared by the author.

*d. Indicator 4. Earth's Surface Temperature and Atmospheric Temperature.*

The thermal increase perceived in a city, with respect to air temperature, is called Urban Heat Island; These temperatures follow patterns sensitive to the orientation of the surface components by the sun during the day and by the wind at night, it tends to be stronger during the day, in clear and clear conditions, as well as in the warm season [9]

The type of cover, humidity, solar radiation, and topography are characteristics of the soil, which are directly related to surface temperature, as well as air temperature, depending on meteorological factors such as air humidity, atmospheric pressure, and radiance changes in long waves. [10]

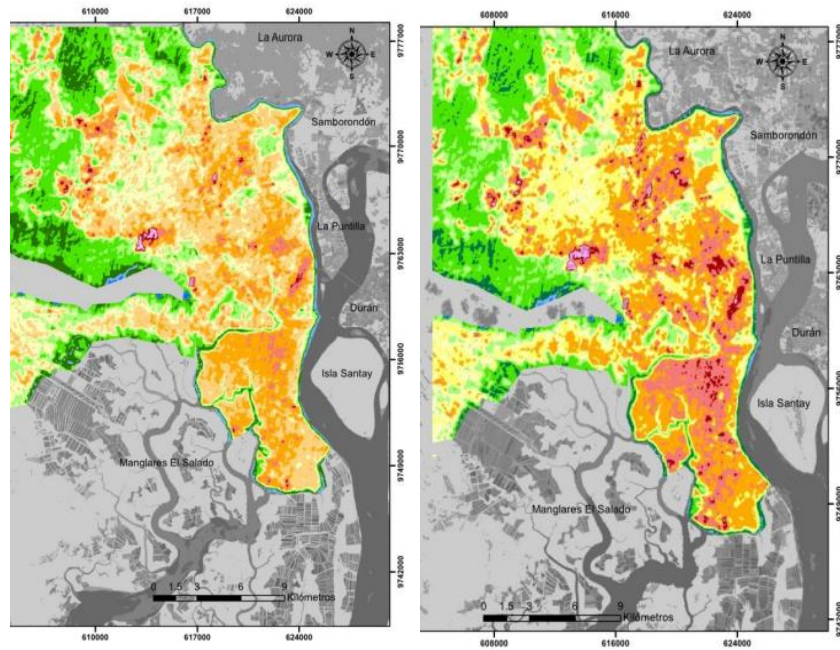


Fig. 4 & 5. Earth Surface Temperature: January 25, 20 November 18 and 9, 2015 Source: Geanella García H. 2018



Fig. 6. Vegetation Index. Source: Geanella García H. 2018

### Formulation of Alternatives.

The formulation of proposals is based on the identification and evaluation of current problems and future prospects, which seek to reduce the effect of the heat island and the risk that this entails in the population; Among the alternatives, it also seeks the integration of public spaces, the improvement of social conditions, the revitalization of local economic activities, social inclusion, community integration, since the increase of green areas in urban areas derive in the benefits that fall on the resident population, since it creates or develops the ecological awareness, the feeling of security, mental and physical health. [11]

Table 2 Actions, advantages and disadvantages of the proposed alternatives. Note: Prepared by the author.

Proposal	Action	Advantages	Disadvantages
Increase of Green Areas, Creation of green corridors and Land use change	Optimize wasted spaces, redistributing areas in sections of tracks larger than 8 m.	Defined circulation areas, both for vehicles and pedestrians.	Lack of habit of the population.
		Improvement in the quality of the urban image	
		Tree-lined sidewalks	
	Land use change in areas where improvised courts are improvised	Through agreements, it can be delivered to the population for management and maintenance.	Little interest in the population, to organize activities in favor of the care of the areas.
		Defined areas for population recreation	Complaints due to accessibility restrictions.
	Creation of planters, prioritizing as far as possible technical tree planting.	Increase in green corridors	Irrigation systems, until the tree, is established.
		Increased wind flow.	
	Creation of new parks.	More recreation areas that cover the various areas of the Parish.	Lack of ACM - Expropriation of residential areas
	Combination of parking spaces and green areas.	Covered parking areas	
		Prolongation in the quality of the paint, by reduction of direct radiation index on the surface of the vehicles	
		Alternate the type of covering material for parking areas, pedestrians, and any space where it does not influence the type of circulation	Increase in the weed index, due to the lack of care or commitment of the population.
	Recovery of the Ribera del Estero and branches.	Opportunity to connect from one area to another, also promoting the use of branches as a means of river transport.	
		Reforestación del Manglar	
		Creation of a linear park for athletes	Wave of insecurity affecting the city
		Local job creation	River traffic in illegal objects or things

The proposal considers the planting of native and introduced species, in order to provoke a careful urban image, satisfying the needs of a city, and the ecosystem balance, in addition, to avoiding monocultures and possible spread of pests, such is the example of the Cochineal (*Dactylopius coccus*) that affected the adult samans, in most of the north of the city of Guayaquil, which caused the death of many specimens.





Fig. 7. Zoning according to proposals. Note: Prepared by the author.

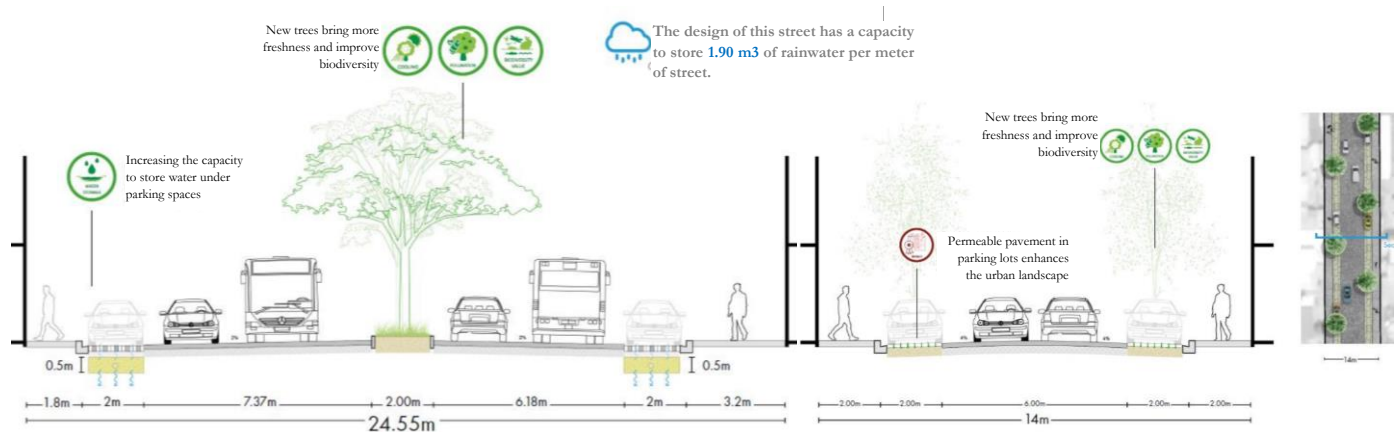


Fig. 8 & 9. Proposal to increase green areas and change of material on roads and sidewalks. Note: Prepared by the author.

#### Cost estimation.

The estimation of pre-referential costs, obedience to the referential budgets of several works executed by the Projects Unit of Parks, Green Areas and Popular Recreational Areas that were executed within the fiscal years of the years 2020 and 2022, which estimates the cost of the m<sup>2</sup> of construction of parks, green areas and recreational areas with a range between USD\$ 75 to USD\$ 105.00, depending on the type of equipment to be implemented.

For the planting of tree species, the referential budget was made based on the values of the construction chamber and through items that must be executed by the soil typology of the study area.

Table 2 Referential budget for planting a tree. Note: Prepared by the author.

ORDER	DESCRIPTION OF THE GOOD OR SERVICE	UNIT	QUANTITY	UNIT COST	COSTO TOTAL
<b>START OF WORK</b>					
1	CUTTING ON FLOORS OF HO. SIMPLE	ML	6	\$ 1,09	\$ 6,54
2	PORTLAND CEMENT CONCRETE REMOVAL	M3	0,03	\$ 22,36	\$ 0,67
3	MATERIAL DE PRESTAMO IMPORTADO MANUAL (INC.TRANSPORTE)	M3	0,14	\$ 13,28	\$ 1,86
4	LAYOUT AND STAKING OUT	M2	2,25	\$ 0,95	\$ 2,14
<b>CIVIL WORKS</b>					
5	HORM. ESTRUCT./CEM.PORTL.CL-B F'C=210 KG/CM2 (INC.ENC.CURAD)	M3	0,05	\$ 208,14	\$ 10,41
6	ENLUCIDO DE FILOS	ML	0,6	\$ 1,17	\$ 0,70
<b>AGRONOMIC WORKS</b>					
7	WEED CLEANING (HASTA 30CMS) INC. EVICTION	M2	2,25	\$ 0,24	\$ 0,54
8	FUMIGATION PHYTOSANITARY CONTROL	M2	2,25	\$ 0,06	\$ 0,14
9	SOIL AND FOLIAR FERTILIZATION	M2	2,25	\$ 0,05	\$ 0,11
10	WOODEN TUTOR L=3M - (5,5x1,5) CM. INC. WINDS	U	2	\$ 3,03	\$ 6,06
11	IRRIGATION WITH TANKER.	M3	2	\$ 4,75	\$ 9,50
12	ROOT DRAINAGE FILTER (TUBO 4" - L=0,60 M)	U	1	\$ 6,88	\$ 6,88
13	EXCAVATION OF TREE-PALM PITS	M3	0,125	\$ 18,89	\$ 2,36
14	PREPARED LAND (PLANTED)	M3	0,061	\$ 28,31	\$ 1,73
15	TREE SPECIES HEIGHT MIN 2.5M FUSTE 0,03 CM	U	1	\$ 50,20	\$ 50,20
<b>SEVERAL:</b>					
16	FINAL CLEANING (INC. DESALOJO)	M2	1,5	\$ 0,25	\$ 0,38
17	WORKER PROTECTION	U	1	\$ 39,90	\$ 39,90
18	PLASTIC SECURITY TAPES (COLOR REFLECTIVO)	ML	2	\$ 0,22	\$ 0,44
19	WOODEN STOP WITH DIE OF H.S.	U	2	\$ 10,98	\$ 21,96
20	EVICTION OF MATERIAL	VIAJE	0,05	\$ 48,81	\$ 2,44
21	TEMPORARY SIGNAGE SIGNS	U	1	\$ 90,02	\$ 90,02
<b>TOTAL COST PER UNIT:</b>					<b>\$ 254,97</b>

#### IV. RESULTS

According to the data analyzed, growth without planning has produced a 2° increase in the surface temperature of the study area, between 2015 and the present.

Among the consequences associated with the increase in temperature is the loss of biodiversity, floods, desert soils, variations in climate, and not to mention the facts that must be emphasized within populated areas is the greater energy expenditure, so energy consumption would increase and therefore the cost that the inhabitants of the study area would have to pay.

The proposed change of the land cover of the study area, the increase of its green areas, a greater tree planting, and any minimal intervention even the most ambitious could generate the following benefits:

- Reduction of CO<sub>2</sub>, by increasing the number of trees that capture this pollutant and contribute to mitigating climate change.
- The increase in the number of trees and green elements, improve air quality, therefore, has a positive effect on the health of the inhabitants.
- Better quality of life, since the shade, a constant airflow, and cooler temperature, cause a greater use of outdoor areas both for transit and to increase the sense of ownership and greater social participation.
- Improvement in the image and greater commercial attractiveness.
- Green and livable environments influence mental health because it reduces stress and anxiety.
- Improvement of the surplus value of the area.
- Environmental or biodiversity benefits, as green soils or permeable surfaces improve environmental conditions and can lead to increased urban flora and fauna, even in highly urbanized areas.
- Protection against flooding and the economic and physical damage that these events entail.



## V. CONCLUSION

Climate change is a current problem, and the increase in temperatures worldwide is a reality, but there are still options to reverse this situation,

The present proposal seeks to make a change not only in the urban image is a change of the current situation of the parish Febres-Cordero where the common gray predominates, the cities.

Items not only to mitigate or reduce the rate of temperature increase but also to improve the situation and quality of life of the inhabitants, proposing green spaces, shaded areas, and green corridors, where leafy and perennial foliage of trees predominates, and these actions increase the rate of heat absorption and reduce the incidence of sunlight.

Granting, to the community, safe and recreational spaces, with universal design criteria, where the feeling of appropriation of them can arise.

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**First A. Author – Angela Teresa Cruz Barragán** born in Guayaquil on August 14, 1990, Architect, with professional experience in Design, Planning and planning of the territory with approaches in landscaping. He has worked in various government institutions. He currently works in the Directorate of Environment and Preservation of Green Areas, of the Municipality of Guayaquil.