THE VALUE OF SANTA CRUZ DE TENERIFE´S URBAN FOREST

EFFECTS ON AIR QUALITY, REDUCING CONTAMINATION AND RESIDENT'S HEALTH

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa
Santa Cruz de Tenerife
AYUNTAMIENTO
i-Tree

Santa Cruz de Tenerife's Urban Forest is the ecosystem that inhabits in our city. This complex system is formed by all the nature coexists with us, both living organisms and the physical environment they relate to. So, the thousands of palm trees, trees, shrubs, herbaceous plants, fungi and lichens, animals, soil, freshwater sheets, the marine ecosystem and the air we breathe, all this is part of Santa Cruz de Tenerife's Urban Forest. This study aims to value the Urban Forest of our city as well as to value the ecosystem benefits it brings us.

SANTA CRUZ
El corazón de Tenerife

SANTA CRUZ DE TENERIFE CITY COUNCIL

This study has been able to come to light thanks to its promotion by the Santa Cruz de Tenerife City Council within the framework of the European Funds Development and the active participation of all municipal technicians.

Humberto Gutiérrez García.
General Coordinator of Infrastructure and Equipment Community of Santa Cruz de Tenerife City Council.

Juan Domingo Cabrera Delgado.
Director-General of Community Welfare and Public Services of Santa Cruz de Tenerife City Council.

Javier Fernández Rodríguez.
Head of the Technical Service for Control and Public Services Management of Santa Cruz de Tenerife City Council.

María Flores González Moro.
Head of Maintenance Section of the city of Santa Cruz de Tenerife.

Dolores Peña Hernández.
Head of Parks and Gardens of Santa Cruz de Tenerife City Council.

UNIÓN EUROPEA
Fondo Europeo de Desarollo Regional

Santa Cruz de Tenerife
AYUNTAMIENTO

PEOPLE WHO HAVE BEEN INVOLVED IN PROJECT DEVELOPMENT

Juan Manuel Borrajo Millán.
Forestry Engineer.
Dasotec Technical Director.

Ana Rastrollo Gonzalo.
Forestry Engineer.
Dasotec Senior Consultant.

dasotec

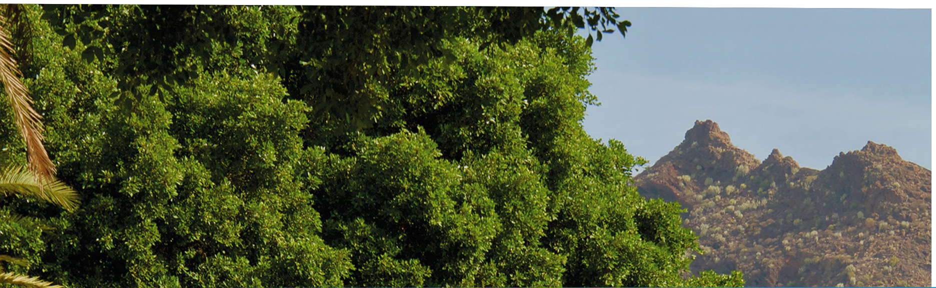
David J. Nowak.
PhD Senior Scientist.
i-Tree Team Leader – USDA Forest Service.

THANKS TO

Juan Agulló Pérez.
Head of Technical Planning and Forestry Projects Service Unit in the Natural Environment Management, and Security Area of Cabildo de Tenerife.

Verónica Clavarana Piñol.
Dasotec Technician.

María Mercedes García Rodríguez.
Forestry Engineer.
Senior Consultant.



Santa Cruz de Tenerife has an Urban Forest with magnificent biodiversity. There are about 500 different tree species in its streets and green areas. Anaga Rural Park, which belongs to the city, is declared a UNESCO Biosphere Reserve, presenting the highest concentration of endemism per km^2 from Europe.

SUMMARY

In the city of Santa Cruz de Tenerife grows and develops a forest formed by thousands of palm trees, shrubs, trees and herbaceous that constitute, together with the animals, the soil, the air, sheets of freshwater, the coast, the sea or the habitats of Macizo de Anaga, a complex natural ecosystem that interacts with the city. It is known as **Santa Cruz de Tenerife's Urban Forest**.

This forest is part of the green infrastructure of the city; includes the green areas, tree-lined streets and biodiversity of the city. Like any natural ecosystem, the environmental benefits it brings to citizens are multiple and of great value. Not only does it care for and improve the health and well-being of Santa Cruz citizens and their many visitors, but it also positively and directly influences air quality, acts as a sink of carbon and polluting particles, collects and retains rainwater, regulates the local climate, mitigates the heat-island effect, reduces city's energy consumption and therefore has an immediate result in the fight against pollution and climate change.

Understanding the structure, function, and value of Santa Cruz Urban Forest is aimed at promoting management decisions that improve human health and environmental quality, as well as reducing the city's economic effort in terms of energy consumption and stormwater drainage infrastructure. The current policies, actions and strategic environmental decisions of cities such as Santa Cruz de Tenerife must include the role of the Urban Forest in the targets of reducing polluting emissions and air quality standards, as well as its associated economic benefits.

The City Council of Santa Cruz de Tenerife has always focussed a great effort on the creation, maintenance, and conservation of its natural heritage, as well as in its protection, knowledge and study.

In 1995, the Declaration of the Right to the Tree was signed in the city. It has a Tree Risk Management Plan, a Tree Communication Plan and, from 2017, the catalogue of Singular Trees of the city, consisting of 70 trees belonging to 46 genera.

In this line of action, it promotes this analysis to advance the knowledge of its Urban Forest, its composition and assessment both quantitative and economic of the benefits or ecosystem services it offers to the city. The i-Tree model developed by the US Forest Service (USDA Forest Service), which is being widely used in major cities around the world, has been applied in this analysis.

This study is the result of an initiative that arises under the Sustainable and Integrated Urban Development Strategy (DUSI), promoted by this local corporation and financed under the European Regional Development Funds. Its goal is to achieve another way of planning the city, in which nature-based urban planning solutions are essential. It is the first informative step to realize, soon, the Green Infrastructure and Biodiversity Plan of Santa Cruz de Tenerife which will be the source of concrete investments to increase the ecosystem services that our infrastructure green provides to citizens.

Santa Cruz de Tenerife has a green heritage highly valued by its citizens and visitors, with a total area of 454 ha of parks and public green areas of municipal conservation. This means that **the City Council manages and conserves an area of 22.2 m^2 of green areas per inhabitant**, far exceeding the value recommended by the World Health Organization (WHO), which establishes as an acceptable value in cities a relationship of 15 m^2 per inhabitant.

Most of this municipal conservation area consists of palm trees, trees, shrubs, seasonal plants, creeping plants and perennial plants. Only 3.4% of it are lawns (15 ha) and is 47 ha the surface of spontaneous or natural vegetation (10% of total). 1% of the area belongs to public schools.

The City Council manages 39 parks in the city, with circular economy criteria. Sustainability and irrigation efficiency plans have been implemented in green areas, plants with low water requirements (which come from the municipal nursery created more than 50 years ago) are selected. 76% of the area has automatic irrigation. It also has a Municipal Composting Plant that in 2018 produced 265 m^3 of compost.

In addition to these public areas preserved by the City Council, the Urban Forest of the city is composed of the private and public natural network of non-municipal conservation. These areas account for 52% of the tree cover of the urban area.

DIFFERENT TREE SPECIES

GREEN AREAS AND TREE-LINED STREETS

488

FOREST ENVIRONMENTS

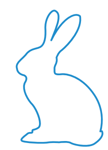
19

DIFFERENT ANIMAL SPECIES

BIRDS

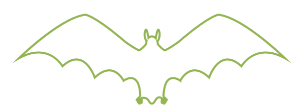
41

MAMMALS



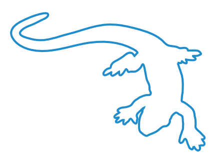
10

BATS



5

REPTILES

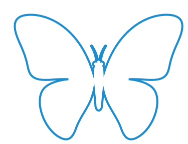


5

AMPHIBIANS

2

INVERTEBRATES



1.900

To this infrastructure of urban environment must be added the forest area that belongs to Santa Cruz de Tenerife and that corresponds for the most part with the **Anaga Rural Park**. This park, transcendental lung of the city, is declared Biosphere Reserve by UNESCO and presents the highest concentration in Europe of endemism per square kilometer.

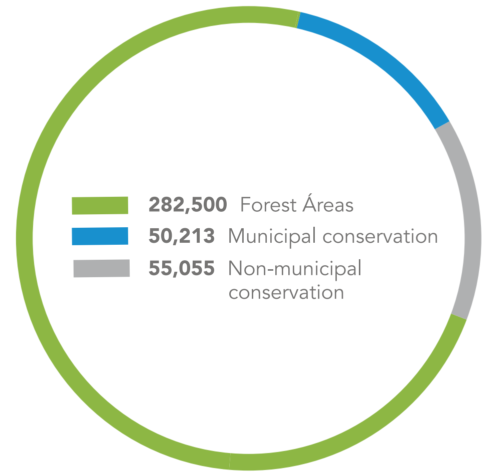
In terms of quality, 488 different tree species are identified in the green areas of municipal conservation, giving an idea of their magnificent biodiversity.

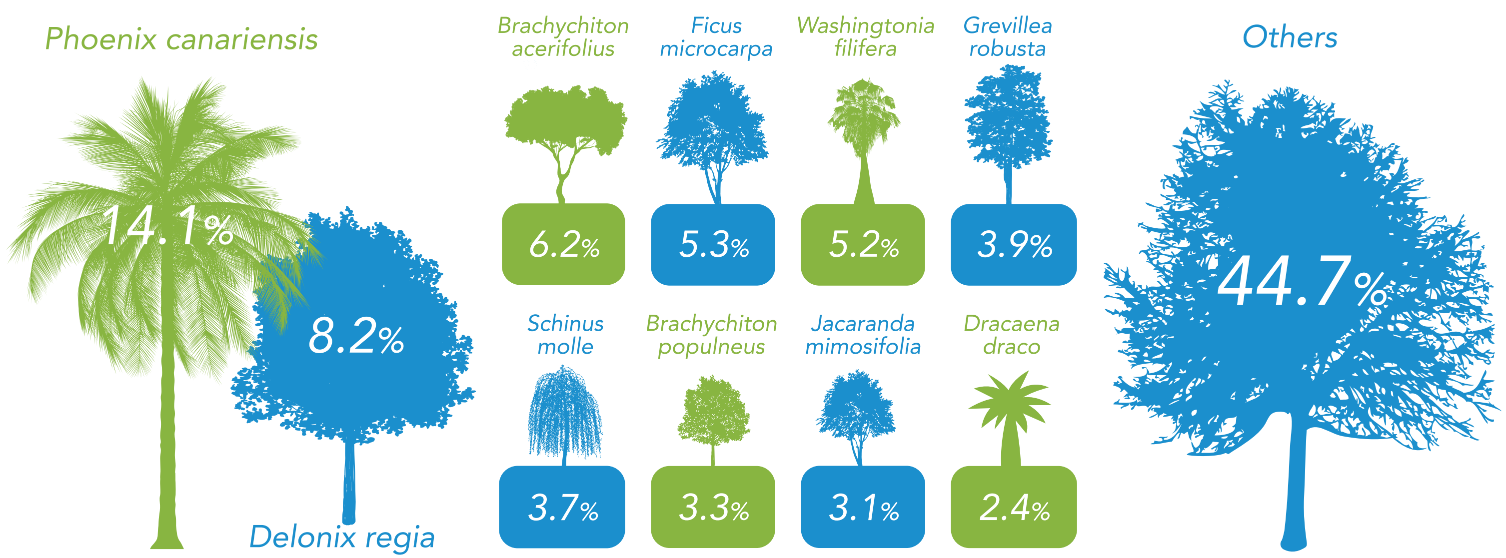
If we add to this tree cover the shrub stratum, herbaceous, the seasonal flowers that adorn and beautify all corners of the city, the fauna (in Anaga there are more than 1,900 invertebrates) and the marine ecosystem for its direct relationship with this biodiversity, we get an idea of the great natural heritage that represents the Urban Forest of the city.

To value the ecosystem benefits of the Santa Cruz de Tenerife's Urban Forest, the number of trees that make up it should be considered and estimated. When we talk about trees in this study, we also include palm trees under this common denomination. Taking into account the municipal conservation trees, those that form the non-municipal green areas and the forest area, **388,000** trees are estimated.

DISTRIBUTION BY SPECIES OF MUNICIPAL CONSERVATION TREES

NUMBER OF TREES	
Green areas and tree-lined streets under Municipal Conservation	50,213
Non-municipal green areas	55,055
Forest areas	282,500
Total number of trees in Santa Cruz de Tenerife	**387,768**





This study is based on the existing data of the municipal management trees of the city, referring to the green zones and tree-lined thoroughfares preserved by the City Council of Santa Cruz de Tenerife and the forest inventory of Anaga Rural Park.

The ratio of trees per capita in the city exceeds the World Health Organization (WHO) recommended value of 1 tree per 3 inhabitants. In Santa Cruz de Tenerife we have **1 tree per 0.5 inhabitants.** If we stick to the strictly urban area, that threshold is also easily exceeded, obtaining a value of 1 tree per 1.9 inhabitants

As a summary, these are the main characteristics of the city's woodland.

CHARACTERISTICS OF MUNICIPAL CONSERVATION URBAN TREES

PARAMETERS		UNITS	%
Number of trees	Municipal maintenance	50,213	
Tree cover	Municipality of Santa Cruz de Tenerife		19.1 %
	Urban area		7.4 %
Most common species	*Phoenix canariensis*	7,070	14.1 %
	Delonix regia	4,093	8.2 %
	Brachychiton acerifolius	3,111	6.2 %
	Ficus microcarpa	2,641	5.3 %
	Washingtonia filifera	2,630	5.2 %
	Grevillea robusta	1,953	3.9 %
	Schinus molle	1,869	3.7 %
	Brachychiton populneus	1,675	3.3 %
	Jacaranda mimosifolia	1,536	3.1 %
	Dracaena draco	1,212	2.4 %
	Others	22,423	44.7 %
Tree species		488	
Most common diameter class		<30	53 %
Most common height		<5	82 %

From the inventory of woodland collected in the **GIS of the Government Area of Territory Planning and Environment of the city**, the i-Tree Eco tool has been used to obtain the value of the municipal conservation trees in the urban centre. This gives us a new vision and perspective in terms of their environmental and economic benefit. It also allows new criteria to be established to set indicators and strategic actions for the management of the city's green infrastructure, oriented towards improving air quality, infrastructure investment, Urban Forest and his biodiversity design and management, citizen health and improving the quality of life of citizens and visitors.

The following table shows the main values obtained in the different chapters that study contains. It gives us an idea of the amount of pollution captured by the trees that live in the streets and public areas managed by the City Council of Santa Cruz de Tenerife, its effect as a carbon sink, savings in infrastructures because the rainwater interception through the vegetation of the city, as well as the production of oxygen that improves the quality of the air we breathe, the cost in medical incidents avoided, and the energy savings in buildings.

If we extrapolate these results to the total Santa Cruz de Tenerife's Urban Forest, we get the ecosystem benefits it brings to the city.

VALUE OF MUNICIPAL CONSERVATION TREES

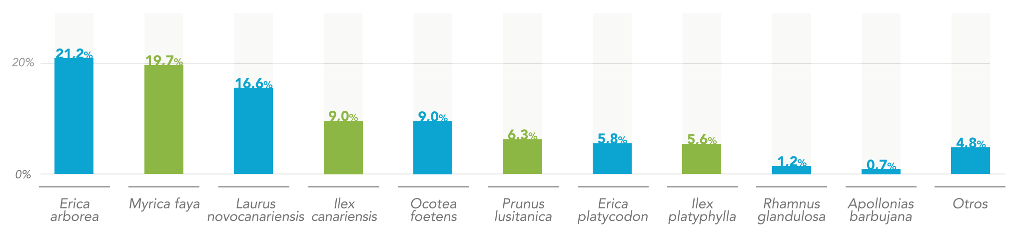
Pollution uptake	11 MT/yr	1,250,000 €
Carbon strorage	22,860 MT	3,670,000 €
Carbon sequestration	875 MT/yr	141,000 €
Oxygen production	2,332 MT/yr	
Avoided runoff	5,782 m^3/year	10,500 €
Energy saving of buildings		12,000 €
Annual benefits		**5,083,500 €**
Structural value		**84,700,000 €**

In the calculation of ecosystem services provided by **Anaga Rural Park**, the woodland data belonging to Brezal, Fayal-Brezal-Acebiñal, Laurisilva and no Monteverde arbolado habitats are considered, according to the studies carried out by Area of Environment of Cabildo de Tenerife. The distribution of species in this natural area is:

SANTA CRUZ DE TENERIFE'S FOREST WOODLAND CHARACERISTICS

PARAMETER		UNITY	%
Number of trees		282,500	
Most common species	*Erica arborea*	59,846	21.2 %
	Myrica faya	55,719	19.7 %
	Laurus novocanariensis	46,777	16.6 %
	Ilex canariensis	25,452	9.0 %
	Ocotea foetens	25,452	9.0 %
	Prunus lusitanica	17,885	6.3 %
	Erica platycodon	16,509	5.8 %
	Ilex platyphylla	15,821	5.6 %
	Rhamnus glandulosa	3,439	1.2 %
	Apollonias barbujana	2,064	0.7 %
	Others	13,536	4.8 %
Number of tree species		19	
Most common diameter class		<30	96 %
Most common height		5-9 m	48 %

DISTRIBUTION BY TREE SPECIES IN ANAGA RURAL PARK



The total results obtained from the value of Santa Cruz de Tenerife's Urban Forest using i-Tree Eco are:

VALUE OF SANTA CRUZ DE TENERIFE'S URBAN FOREST

	URBAN AREA		ANAGA RURAL PARK		TOTAL
POLLUTION UPTAKE (MT/yr)	23	2,628,157 €	39	4,454,023 €	7,082,180 €
CARBON STORAGE (MT)	47,925	7,693,920 €	18,990	3,047,35 €	10,741,272 €
CARBON SEQUESTRATION (MT/yr)	1,834	295,597 €	2.522	405,167 €	700,764 €
OXYGEN PRODUCTION (MT/yr)	4,889*		6,724		
AVOIDED RUNOFF (m³/año)	11,541	22,013 €			22,013 €
ENERGY SAVING OF BUILDINGS		23,323 €			23,323 €
ANNUAL BENEFITS		**10,663,010 €**		**7,906,542 €**	**18,569,55 €**
STRUCTURAL VALUES		**177,568,134 €**			**177,568,134 €**

*The economic valuation has been carried out following the methodology set out in annexe 2. For oxygen, there is no market or price, unlike CO_2, for which there is an international value and trade.


UNITED COLORS OF BENETTON.
UNITED COLORS OF BENETTON.
enic
enic ESCUELA DE NEGOCIOS
RACE

INDEX

INTRODUCTION

Urban forests are the backbone of green infrastructure that connects urban to rural areas and improves the environmental footprint of cities. FAO 2017.

Pollution is now one of the main problems in urban areas, due to the serious health disruptions they can cause to their inhabitants. The city of Santa Cruz de Tenerife is no stranger to this fact. It is therefore considered necessary to study and understand all the tools that can in some way help to control and reduce pollutants.

Among these tools, we must consider the vegetation that grows and develops in its own heart and that is part of its Urban Forest. This vegetation plays a basic and fundamental role in improving the quality of life of citizens. It has been shown in numerous international studies that its presence offers multiple beneficial effects, such as air purification, climate regulation, noise

VEGETATION INFLUENCE ON CITIES

reduction, water retention, and erosion control, among others.

Vegetation has a direct influence on air quality of cities, by exercising as a gas sink and possessing a high capacity for capturing polluting particles. At the same time and due to its properties as a climate regulator, the presence of vegetation decreases energy consumption and therefore the emission of polluting particles, thus playing a crucial role in the fight against air pollution and Climate change.

Therefore, the proper management of the Urban Forest can be a very cost-effective strategy for air pollution control. The analysis of Urban Forest structure, the functions currently developed by it and its equivalent economic value are essential to better know the effects of the Urban Forest on the city and its ecosystem services.

It is very important too to change how the image of green infrastructure has been usually perceived in urban environments. Until relatively recently, exclusively the aesthetic and ornamental value of the woodland, shrubs, and meadows of our green areas was appreciated. In general, the other benefits were unnoticed or undervalued because were not evaluated in economic terms.

Thanks to the international modelling achieved by the i-Tree Project, is obtained a knowledge of the Urban Forest that allows us to interpret and calculate the benefits it quantitatively offers to the public. In this way, it is possible to raise public awareness and the different administrative bodies of the importance of the proper management of this natural heritage in improving the quality of life of the inhabitants and visitors of the city.

BENEFITS OF TREES

STORM WATER REDUCTION

Intercepting rainwater, reducing the volume of run-off and distributing the effects over time.

SHADE AND COOLING

Providing shade, reducing summer temperatures by foliar evapotranspiration, reducing the heat island effects.

SOCIAL HABITS

Providing social benefits, meeting points, recreation and play, improving psychological well-being and reducing rates of violence.

IMPROVING AIR QUALITY

Reducing pollution, capturing pollutant particles, producing oxygen and absorbing CO_2.

AESTHETICS

Objectively increasing the aesthetic value of the cities, both the old trees of Santa Cruz de Tenerife's historic parks and new plantations in modern developments.

BIODIVERSITY AND HABITAT

Increasing the biodiversity of the cities such as habitats for birds, insects, mammals and other types of living beings, lichen, mosses, fungi, etc.

ENERGY SAVING

Reducing the use of heating in autumn and winter and air conditioning in spring-summer.

FOOD AND SHELTER FOR THE BIODIVERSITY

The fruits, leaves, twigs and trunk are food and shelter for the great biodiversity of Santa Cruz.

CARBON STORAGE

They store a great reserve of carbon when forming their tissues, obtained from the absorption of the greenhouse gas CO_2

PROPERTY VALUE

Houses close to green areas or trees, significantly increase their value.

LANDSCAPE SCREEN

Undesirable sights and noises in some points of the city, such as high occupation routes, factories, etc, can be disguised o reduced.

MEDICAL ASSISTANCE

Reduces the harmful effects of pollution on the population as well as the resulting medical incidences, reduces stress and increases physical well-being.

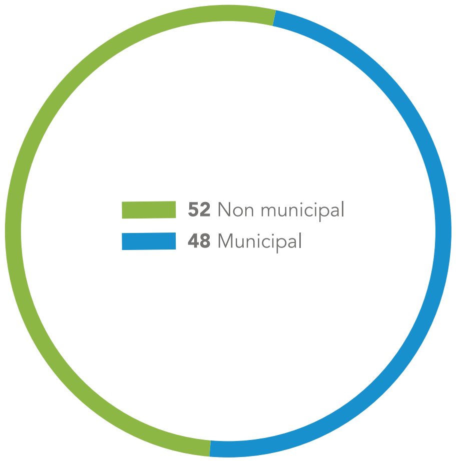
SANTA CRUZ DE TENERIFE'S URBAN FOREST

Mencey Beneharo never imagined that the coexistence of humans with nature would bear fruit the Biosphere Reserve of Macizo de Anaga, icon of the nature of Tenerife, fruit of the coexistence of man with the natural environment in a sustainable way for hundreds of years. Nor did he suspect that one day in the northeast of his domains, at the foothills of his ravines and by the sea would be create a city worldwide recognized for its parks, gardens and ramblas, the city of Santa Cruz de Tenerife.

When we talk about Santa Cruz de Tenerife's Urban Forest, we mean the whole ecosystem that inhabits our city. We consider included in this complex system all the nature that inhabits the city, both living organisms and the physical environment which they are related to. Thus, the thousands of palm trees, trees, shrubs, herbaceous, flowering plants, fungi and lichens, animals, soil, the marine ecosystem and the air we breathe, is all part of Santa Cruz de Tenerife's Urban Forest.

We cannot, therefore, forget its citizens, who are part of the medium and relate directly to it. The care and improvement of the urban ecosystem that shares space with the grey infrastructure is not only a duty to the nature around us but has implicit the improvement of our quality of life. That is why the study, characterization, quantification, and management of the Urban Forest of cities becomes essential since it translates directly into a multitude of ecosystem effects advantageous to its inhabitants and visitors.

URBAN AREA TREE COVER



Santa Cruz de Tenerife has a detailed inventory of its green areas, trees, shrubs and meadows preserved by the City Council. This inventory is collected in a Geographical Information System of the Government Area of Territory Planning and Environment of the city that is constantly updated. It has the complete and individualized data of 50,213 trees, all located in the streets and green areas of the city.

The biodiversity of urban woodland is very significant. With about 500 different species, and a percentage of the 10 most abundant species that does not reach 56% get very positive values, well above average in these urban environments.

Next to these trees, there are many different species of shrubs, herbaceous, and seasonal flowers that adorn our entire city. All this is distributed in the streets and the nearly **500 hectares of parks and public green areas** maintained by the corporation.

This **natural heritage is managed by the City Council of Santa Cruz de Tenerife**, which has direct competences over its maintenance and conservation. However, **this is only a part of its Urban Forest**.

To get an idea of the magnitude of Santa Cruz de Tenerife's Urban Forest, to all this vegetation we must add the parks and non-municipal green areas of the interior of the urban area, whether public or private, and the forest areas, represented mainly by Anaga Rural Park. **Non-municipal green areas** account for just over half **(52%)** of the tree cover of the urban area. For the total Urban Forest, the **forest areas represent 80%** of the area of the municipality, giving an idea of the ecological importance of these spaces for the city, taking into account its valuable state of conservation.

To complete the Santa Cruz's Urban Forest, we cannot forget the **marine ecosystem** and the very direct relationships it has with the biodiversity of the city. 197 marine species of flora have been identified and numerous birds are part of the Anaga Marine Space Z.E.P.A. (bird protection special zone).

This Urban Forest is not an isolated ecosystem but is interrelated with its direct environment. There is permeability with the forest areas of the island of Tenerife, which affect the urban core in different ways. This interrelationship takes place through canals or green corridors that exchange their species and individuals with the city.

SANTA CRUZ DE TENERIFE´S URBAN FOREST

In Santa Cruz de Tenerife it grows and develops a natural ecosystem formed by thousands of palm trees, trees, shrubs, herbaceous and flowering plants, mushroom and lichens, animals, soil, air, freshwater sheets, the coast and forest habitats of Macizo de Anaga. All together is known as Santa Cruz de Tenerife's Urban Forest.

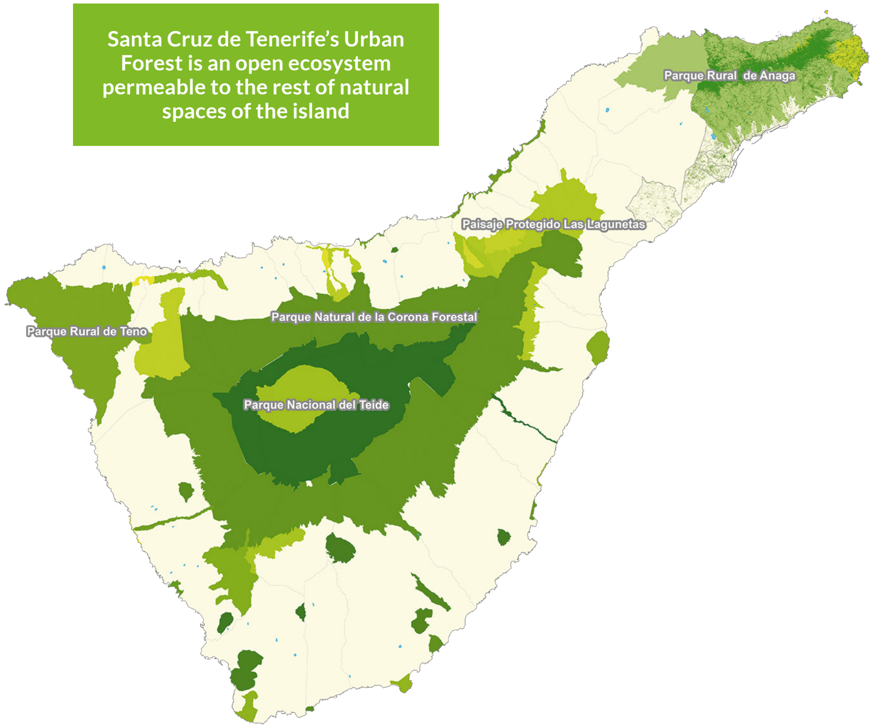
Santa Cruz de Tenerife's Urban Forest is not complete without its forest environment, which occupies almost entirely the 12,000 ha of the **Anaga District**, one of the five districts in which the municipality is divided. The **Anaga Rural Park**, declared a Biosphere Reserve by UNESCO, has three **Integral Natural Reserves** (Ijuana, El Pijaral, and Los Roques de Anaga), spaces of the **Canarian Network of Natural Spaces** and spaces of **Natura 2000 Network of the European Union** (it has two **Special Bird Protection Zones**; Anaga and The Anaga Marine Space). It is a magnificent space for the city, municipal public management, accessible to the public and that provides great environmental value as a reserve of an indigenous biodiversity, in many cases endemic, institutionally protected and of singular ecological and environmental value. It is a space where, traditionally, there has been a harmony between man and nature that has allowed to preserve the environment and forge a cultural and environmental heritage necessary to obtain the different international recognitions of protection of his environment.

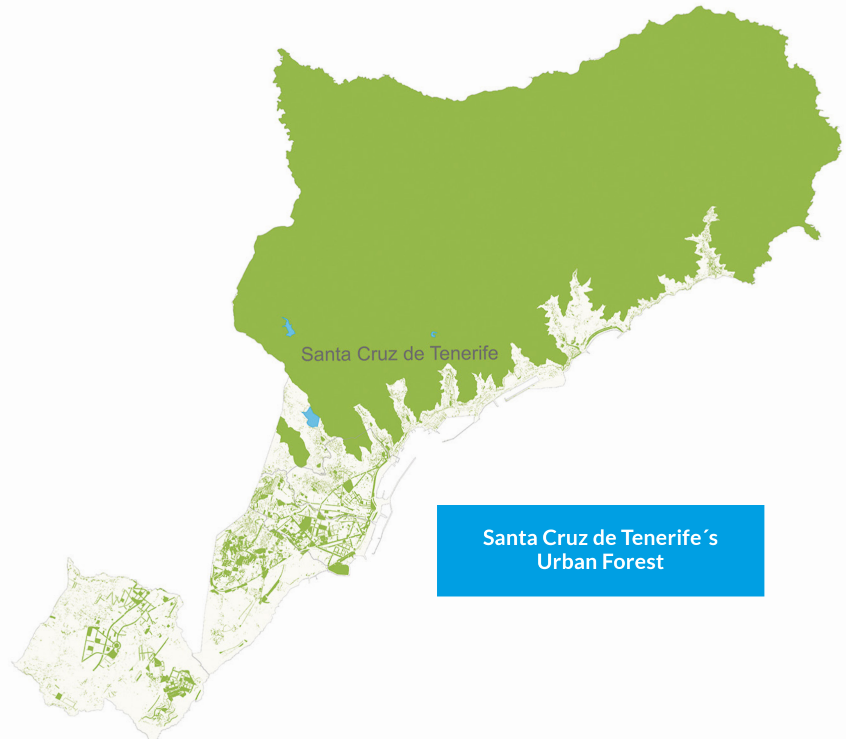
Not for nothing, the Sustainable and Integrated Urban Development Strategy (DUSI) "Anaga en el Corazón" is part of the Europe 2020 Strategy. This study of the City's Urban Forest is part of its line of action 5. "Anaga paisaje urbano".

To give us an idea of what Anaga represents for the city and its biodiversity, 19 trees of its laurisilva and 196 wild plant species are identified, 39 of them Macaronesian endemisms, 102 canaries, 26 of Tenerife, and 21 locals. It has the highest concentration of endemism per square kilometer in Europe.

Talking about fauna, the *Calonectris diomedea*, the kestrel, the owl and the endemic pigeons of the Canary Islands (Rabiche - *Columba junoniae*) and Turqué - *Columba bollii*) are part of the 41 species of birds listed in Santa Cruz. There are also 5 species of bats, 10 species of terrestrial mammals, 5 reptiles (lizards, *Tarentola delalandii*, and *Chalcides sexlineatus*), 2 amphibians and more than 1,900 invertebrates.

Santa Cruz de Tenerife's Urban Forest is an open ecosystem permeable to the rest of natural spaces of the island





Santa Cruz de Tenerife´s Urban Forest

SANTA CRUZ DE TENERIFE´S URBAN FOREST

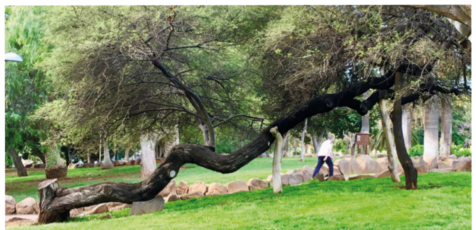
In Santa Cruz de Tenerife there are many green enclaves of different dimensions, which are part of the green infrastructure of the city. They are connected by other elements of this infrastructure, forming a complex network of public and private property. These elements can be of different typology, both parks and gardens and streets, sports facilities, spontaneous vegetation, green buildings, cemeteries, urban vegetable gardens or garden centres, among others. Among the municipal conservation parks, we highlight the following:

ALAMEDA DEL DUQUE DE SANTA ELENA

Known in a time as "Los Paragüitas", it was built in 1787 as a public garden where you can walk in the shade of plane trees, some tamarinds and decorated with some statues and a marble fountain brought from Genoa.
With the expansion of the land area that the city snatched from the sea this space was recovered. When Plaza del Príncipe was built in the following century, Alameda del Duque de Santa Elena became obsolete, being today annexed to Plaza de España. The gateway arches of the 18th century are preserved.

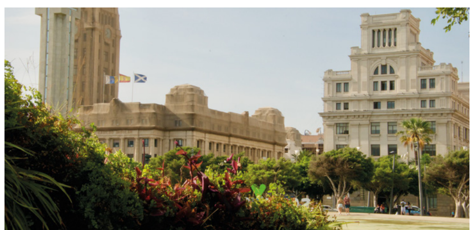
GARCÍA SANABRIA PARK

With an area of 55,000 m², it has more than 200 plant species arrived from all countries, as well as walks, fountains, ponds, children's areas, monuments and sculptures of great interest. There are two routes: a botanical route, where there are 78 plant species indicated and another sculptural route for leisure and the diffusion of values of this magical place of the city.



PARQUE DE LA GRANJA

It's a bit larger than García Sanabria Park and inside stand out the groups of royal palm trees and bamboo cane fields, large areas of grass, a playground and several sculptures; one of them erected by Belén Morales in honour of Félix Rodríguez de la Fuente. 71 different species have been inventoried.



PLAZA DE ESPAÑA

It requires a green mention after its remodelling and the increase of its vegetation. it has 300 specimens of various species and green walls or vertical gardens.

LAS RAMBLAS

La Rambla de Santa Cruz or La Rambla is the central artery of the city. Strictly it starts at Plaza de la Paz and ends at Avenida de Anaga, but we can say that it begins with the entrance to the city from the north in Avenida Reyes Católicos. Other green lines of the city are Avenida Benito Pérez Armas, Avenida Francisco la Roche, Avenida Tres de Mayo, Avenida Manuel Hermoso Rojas...

"EL PALMETUM" BOTANICAL GARDEN

It's a global example of converting a landfill into a space for recreation and botanical culture specialised in palm family. There are 1698 palm trees in 12 hectares. It's the best botanical collection of tropical island palms in the world.
We must also highlight its faunal aspect, being a multitude of species of native birds that have found here a favourable environment to live or visit, and it is thanks to the lakes, lagoons and artificial waterfalls of freshwater and the absence of pesticides.
We can find moorhens (*Gallinula chloropus*), canarian grey wagtails (*Motacilla cinerea canariensis*), hoopes (*Upupa epops*), white egrets (*Ardea alba*) and purple heron (*Ardea purpurea*). We can see easily also kestrels (*Falco tinnunculus*), canaries (*Serinus canaria*), blackbirds (*Turdus merula*), blue tits (*Cyanistes caeruleus*), swifts (*Apus apus*), curlews (*Numenius*), little owls and a lot more of species, including migratory birds that are very difficult to see in Canary Islands. Watercourses have also led to the existence of colourful dragonflies, sound frogs and beautiful monarch butterflies.

PLAZA DEL PRÍNCIPE

Its complete name is "Plaza del Príncipe de Asturias por Alfonso XII". It was built on the orchard of the convent of San Pedro de Alcántara and now is in the historic centre of the city. In addition to the central shrine and various sculptures, there are numerous laurels of Indians, some of them sent from Cuba and planted on October 29, 1860.

OTHER GREEN AREAS

Other charming green corners are:

- Parque Viera y Clavijo
- Plaza de San Francisco
- Plaza de Isla de la Madeira
- Plaza de Santo Domingo
- Plaza de 25 de Julio - Plaza de Los Patos
- Plaza de Valeriano Weyler
- Plaza de La Candelaria
- Parque El Quijote

Among the green areas of the suburbs are Parque de Las Indias in the neighborhood of El Perú, Yumbo Park, Miramar Park and the Cuchillitos de Tristán dog park in Ofra, Leoncio Oramas Park in Los Gladiolos, Tincer Park and La Estrella Park in Santa Maria del Mar, Santa Catalina Park and La Era Park in La Gallega.

Santa Cruz de Tenerife's Urban Forest has a large environmental value and is a reserve for a great deal of native biodiversity and numerous Macaronesian endemisms, canarian, from Tenerife and locals, protected by international organisms and of unique ecological and environmental value.

SANTA CRUZ DE TENERIFE´S URBAN FOREST

TREES IN NON-MUNICIPAL GREEN AREAS

55.000 non-municipal conservation public trees and private trees

TREES IN PARKS, MUNICIPAL GREEN AREAS AND STREETS

50.000 trees
488 different species
454 ha

MARINE HABITAT

197 marine species of flora
400 species of fishes
Sea turtles and cetaceans
Numerous seabirds

BIODIVERSITY

41 species of birds
10 species of terrestrial mamals
5 species of bats
5 species of reptils
2 species of anphibians
1.900 invertebrate species

TREES IN FOREST ENVIRONMENTS

282.500 trees.
Erica arborea y Myrica faya are the most common species, **19** trees and **196** species of native flora, a lot of them endemic species

GREEN BUILDINGS

Facades
Balconies
Vegetable plots
Atriums

METHODOLOGY

To evaluate the services provided by the forest of Santa Cruz de Tenerife, both in quantitative and economic terms, the **i-Tree Eco** model, designed by the **USDA Forest Service**, has been used. This model combines data on the composition and structure of the city's vegetation, air pollution and weather data (Nowak & Crane 2000).

The information relating to the woodland analysed in this Study is part of that collected in the GIS of the **Government Area of Territory Planning and Environment of the city**, a georeferenced database of all the trees and green areas of Municipal Conservation. **The number of trees evaluated**, of which we have complete data because they **are the trees managed by the City Council**, are **50,000**.

The Geographic Information System of the Government Area of Planning of the Territory and Environment of the City Council is constantly updated by **specialized technicians in arboriculture**. The data used in this study belongs to those from the last inventory update of 2018. There is information about species, treetop diameter, height, and trunk perimeter for each municipal conservation tree.

The starting data of Anaga Rural Park trees have been obtained from the existing forest inventory, where species, height, and normal diameter data are collected.

This information has been processed to adapt the starting data to the standardized format required by the i-Tree model, and stratified to classify it according to land use, which in this case is determined by Santa Cruz de Tenerife General Urban Planning Plan.

Weather data has been obtained from the State Bureau of Meteorology (AEMET) for several stations in the city of Santa Cruz de Tenerife. Specifically, data from the Zonal Meteorological Center of Santa Cruz de Tenerife have been used for having the oldest and most complete series of the city's environment. For the pollution data, those collected at the Automatic Measurement Station of Tomé Cano, belonging to the Canary Islands Air Quality Surveillance Network, that depends on the Vice-Ministry of the Environment of the Ministry of Politics Sustainability and Security of the Government of the Canary Islands, have been used. It has been selected for its central location, as well as for providing the most complete series of stations scattered throughout the city and the time determination of a considerable number of pollutants.

The USDA Forest Service's i-Tree Eco model calculates the structure of age and species classes of Urban Forest, with other parameters such as biomass and leaf area index. Once these parameters are calculated, the model uses different mathematical algorithms to combine this information with weather and pollution data. So, the ecosystem services provided by vegetation are estimated, and the economic value of these services is assessed. This model associates the value obtained with the total cost of removing this contamination by using another type of technology.

In this way the following parameters have been estimated in Santa Cruz de Tenerife:

STRUCTURE OF SANTA CRUZ DE TENERIFE´S URBAN FOREST:

The composition of species of the forest of the city that is the object of municipal conservation has been analysed, as well as the number of trees, density, and diameter distribution. Existing foliar biomass has also been analysed.

INFLUENCE OF WOODLAND ON AIR QUALITY:

The model determines the amount of pollution eliminated every hour by the Urban Forest, and its economic value. The improvement in air quality is evaluated by the percentage of each pollutant captured by the Urban Forest in a year. It also calculates the volume of oxygen provided by the vegetation studied to the air of Santa Cruz de Tenerife.

The elimination of air pollution has been calculated for ozone (O_3), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particles less than 2.5 microns ($PM_{2.5}$). Information on pollutant particles of less than 10 microns is also available, although as in this case $PM_{2.5}$ is a subset of PM_{10}, the latter has not been taken into account in the analysis of the City's pollutants. Generally, $PM_{2.5}$ is a more relevant value in discussions on the effects of air pollution on human health.

EFFECTS ON CARBON DIOXIDE EMISSIONS:

Santa Cruz de Tenerife's Urban Forest is a large sink of polluting greenhouse gases, such as CO_2, of which the amount and value of net annual storage and sequestration are analysed. Carbon storage is the amount of carbon that is part of the structure of woody plants, both in their aerial and root parts. Carbon sequestration is the capture of carbon dioxide (CO_2) from the air by plants, in their photosynthetic processes.

EMISSION OF BIOGENIC VOLATILE ORGANIC COMPOUNDS (VOCS):

The model estimates the emissions of this type by vegetation, and the formation of ozone and carbon monoxide associated, classifying the species according to the degree of emissions made.

EFFECTS ON THE ENERGY USE OF BUILDINGS:

The energy savings associated with the presence of urban vegetation near the buildings of Santa Cruz de Tenerife and their economic value have been quantified.

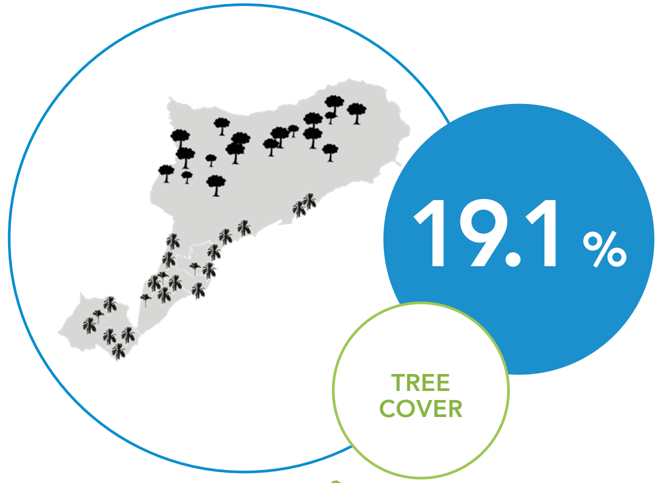
RAINWATER INTERCEPTION:

Rainwater collection by the city's woodland and the volume of runoff avoided are analysed.

PUBLIC HEALTH:

Air pollution has a direct influence on the health of Santa Cruz de Tenerife citizens. This model estimates the incidences avoided by the capture of pollution by the city's woodland and its economic value.

RESULTS/ANALYSIS



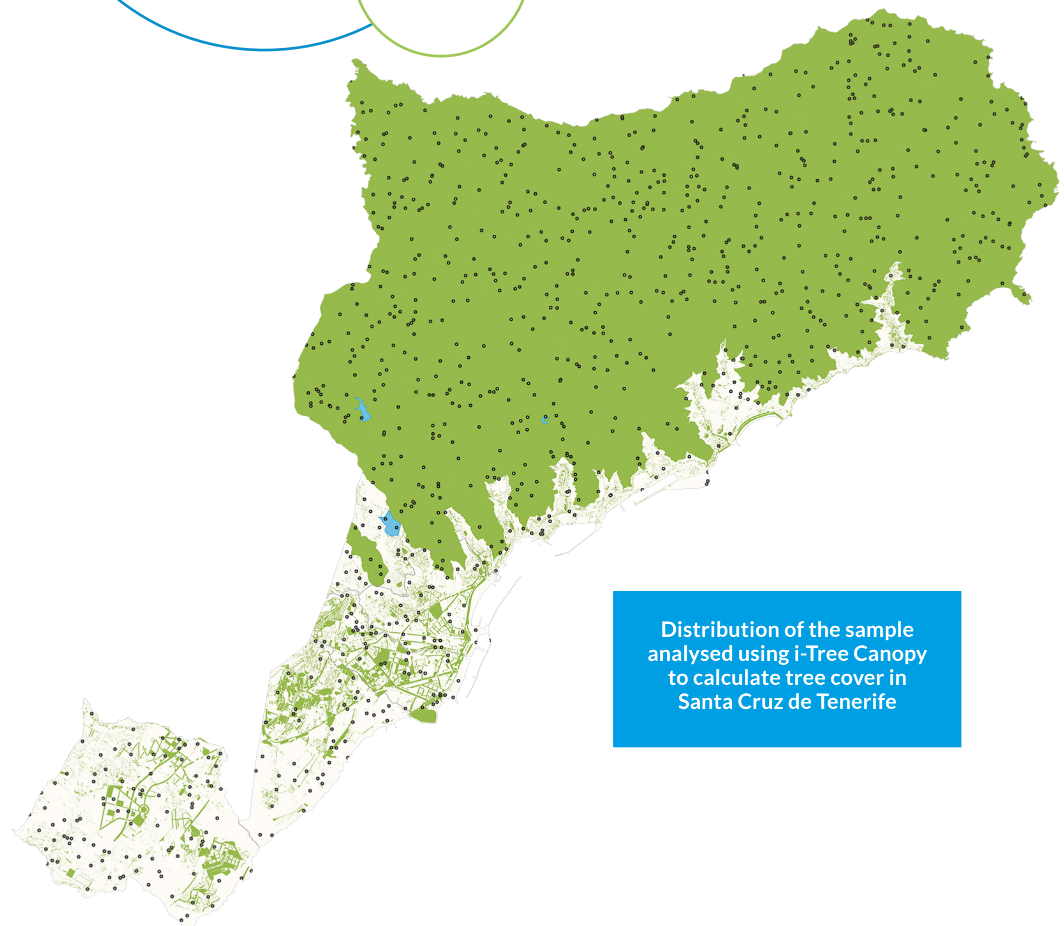
01 URBAN FOREST STRUCTURE. TREE COVER

Tree cover is one of the most interesting parameters for urban forest's management. There are numerous methods of calculating tree cover, which provide results in some very different cases. Also, results vary markedly if forest areas are included, which is common in most studies in large cities. It is therefore appropriate to indicate the methodology used, to be able to compare correctly between different cities and agree on objectives when applying this value as an indicator of the city.

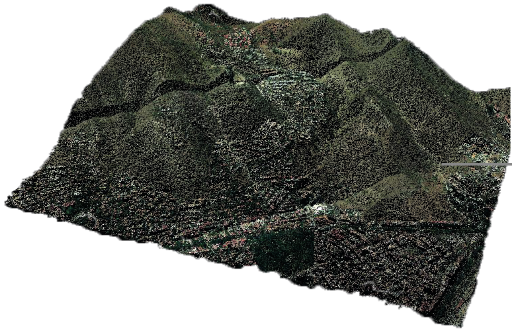
In this case two calculation methods have been used. The first is the one developed by the U.S. Forestry Department, i-Tree Canopy, exclusively selecting trees. The forest area belonging to the city has been included, as seen in the methodology used in other cities that have carried out similar studies.

With a sample of 1,000 points, the tree cover of Santa Cruz de Tenerife obtained results of **19.1%**.

The other method of calculation is based on digital files with altimetric information from the point cloud of the PNOA LiDAR project managed by the Government of Spain. These are LAS files of 2x2 Km extension. Point clouds were captured by airborne LiDAR sensors, with a density of 0.5 points/m^2 and subsequently classified and coloured from the orthophotos of National Air Orthophotography Plan (PNOA) with a pixel size of 25 and 50 cm.



Distribution of the sample analysed using i-Tree Canopy to calculate tree cover in Santa Cruz de Tenerife



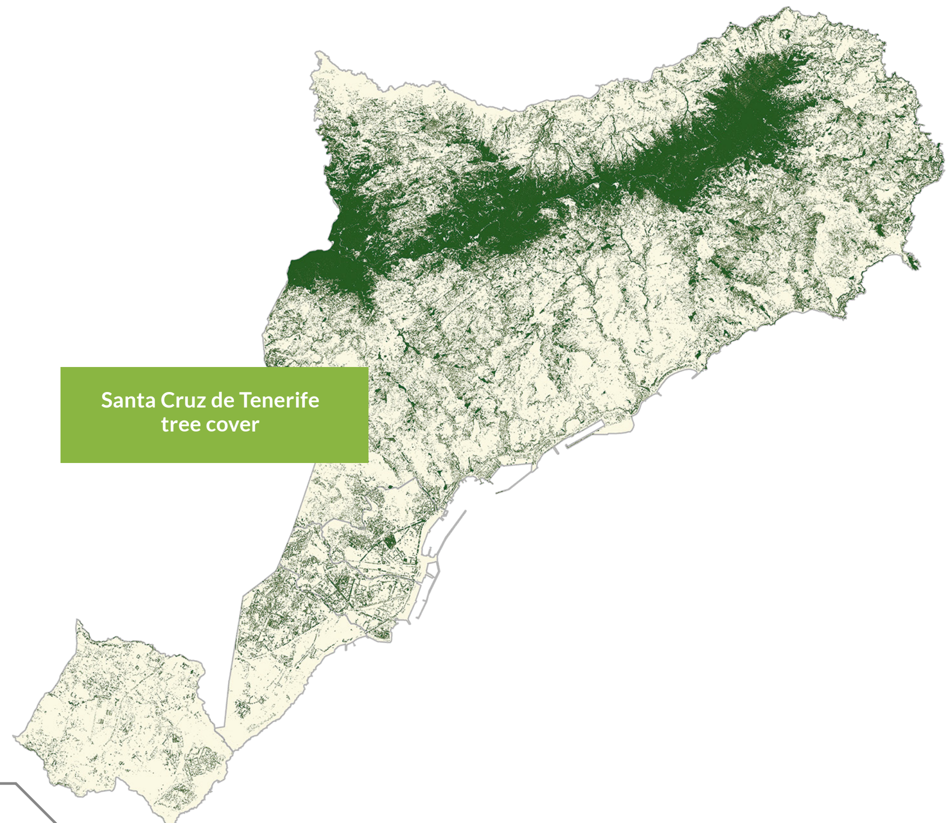
PNOA LiDAR cloud points for Santa Cruz de Tenerife

In this way, this tree cover plot is obtained. Coverage is reduced to **18.6%**, indicating that when setting city-level targets or comparing between other cities in the world, it is necessary to identify the calculation method that allows to correctly interpret its results. This value includes the woodland of Anaga Rural Park

By pre-treatment and filtering of the point cloud according to typology, and then purified with the support of orthophotos and digital mapping, the tree cover of Santa Cruz de Tenerife has been determined. However, very high-resolution satellite images are not currently available. These images would give us a closer approximation to tree cover, so the results should be considered estimated. However, applying this LiDAR technology system, we can calibrate the result obtained with ITree Canopy model.

We can see an example of the result of applying this evaluation method in the following figure of García Sanabria Park:

García Sanabria Park in Santa Cruz de Tenerife



Santa Cruz de Tenerife tree cover

02 URBAN FOREST STRUCTURE. TREES

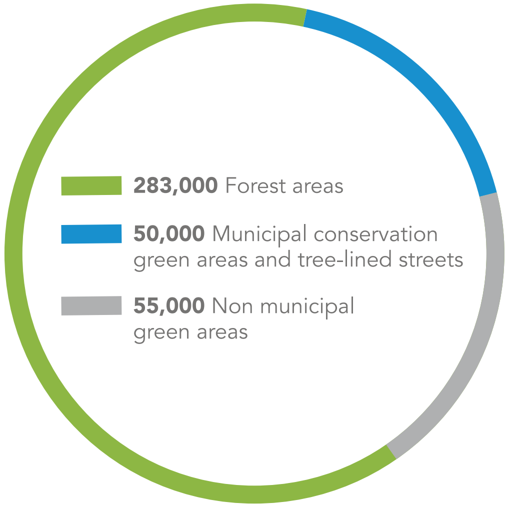
Santa Cruz de Tenerife has a population of approximately **388,000 trees**.
In the urban environment, 50,000 are public and maintained by the City Council, estimating 55,000 those of non-municipal public ownership and those located on private properties. A total of 105,000 trees are therefore estimated to live in the strictly urban area. The remaining 283,000 are part of the forest spaces that depend on and are part of the city, most of its area located in Anaga Rural Park and therefore municipal conservation. All these areas are administratively part of the City and are bordering the urban area.

The ratio of trees per capita in the city exceeds the World Health Organization (WHO) recommended value of **1 tree per 3 inhabitants**. In Santa Cruz de Tenerife we have **1 tree per 0.5 inhabitants**. If we stick to the strictly urban area, that threshold is also easily exceeded, obtaining a value of 1 tree per 1.9 inhabitants.

Tree cover, calculated using **i-Tree canopy** software, it reaches **19.1%, value on average with the rest of international values**.

The density of the woodland results in **26 trees per hectare**, less than the average of those calculated for other cities of the world, according to data obtained from other studies conducted with i-Tree Eco. This result is influenced because the forest area is mainly composed of the shrub and herbaceous stratum, so the density of the woodland is logical that it is not very high.

TREES IN SANTA CRUZ DE TENERIFE



COMPARATIVE CHART WITH OTHER CITIES

		Number of trees	Area (ha)	Density (Trees/ha)	Tree cover (%)
Atlanta	United States	9,415,000	34,710	275.8	36.7
Halifax	Canada	7,400,000	23,472	315	34.3
Oakville	Canada	1,908,000	9,891	192.9	29.1
Washington	United States	1,928,000	17,700	121.1	28.6
Syracus	United States	1,088,000	6,499	167.4	26.9
Toronto	Canada	10,220,000	66,140	160.0	26.6
Minneapolis	United States	979,000	15,108	64.8	26.4
Madrid	Spain	5,700,000	60,430	65.2	26.0
Hartford	United States	568,000	4,559	124.6	25.9
Barcelona	Spain	1,419,823	10,190	139.0	24.0
Birmingham	United Kingdom	6,000,000	26,780	224.0	23.0
Boston	United States	1,183,000	12,540	82.9	22.3
Baltimore	United States	2,479,000	20,920	118.5	21.0
New York	United States	5,212,000	78,900	65.2	20.9
Santa Cruz de Tenerife	Spain	**388,000**	**15,060**	**25.7**	**19.1**
Chicago	United States	3,585,000	60,610	59.9	17.2
Edinburgh	United Kingdom	600,000	26,400	23.0	17.0
Wrexham	United Kingdom	364,000	1,177	309	17.0
Philadelphia	United States	2,113,000	36,700	61.9	15.7
Glasgow	United Kingdom	2,000,000	17,643	113.0	15.0
London	United Kingdom	8,421,000	159,470	53.0	14.0
Olham	United Kingdom	466,800	14,007	33	12.0
San Francisco	United States	668,000	12,140	55.7	11.9
Torbay	United Kingdom	818,000	6,288	130	11.8
Jersey City	United States	136,000	3,831	35.5	11.5
Los Angeles	United States	5,993,000	123,822	48.4	11.1
Casper	United States	123,000	5,467	22.5	8.9

The analysis of the composition of Santa Cruz de Tenerife's Urban Forest has been carried out by evaluating the complete data of the municipal conservation trees and the forest inventory of Anaga Rural Park. The municipal conservation trees are 50,000 specimens distributed by public green areas and tree-lined streets of the capital.

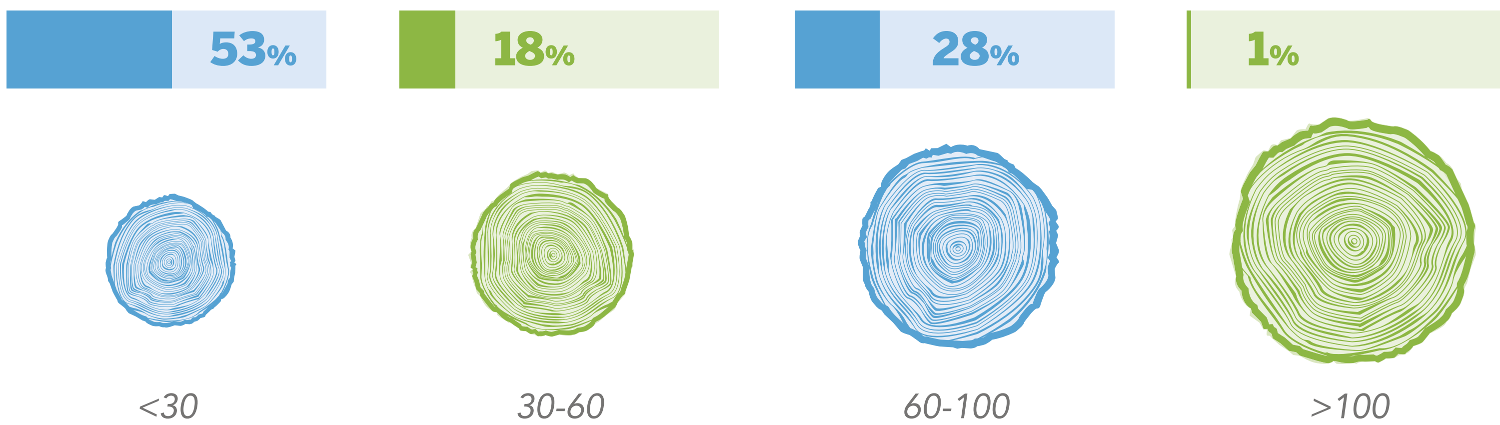
The normal diameter (DBH) is calculated at a height of approximately 1.3 meters or chest height.

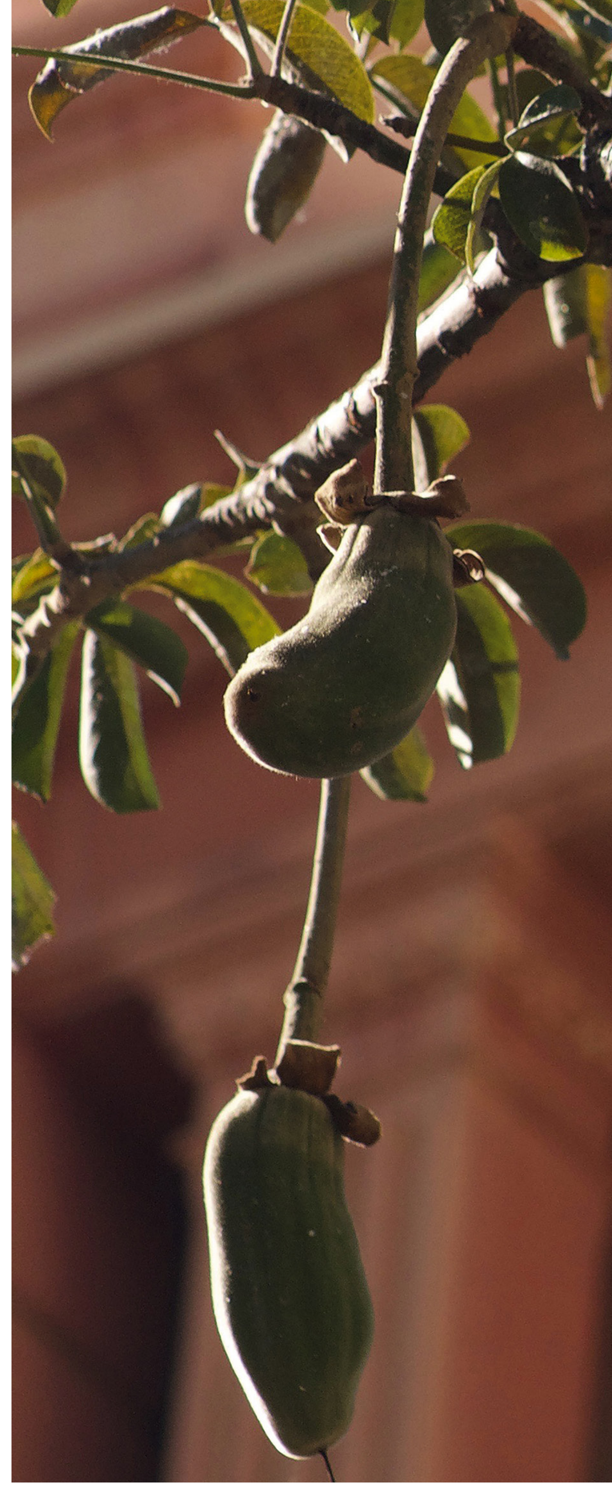
In municipal urban trees, 53% have diameters less than 30 cm.

The diameter class distribution of trees is shown in the following graphic, which shows that most municipal trees (53%) have diameters less than 30 cm. As the diameter increases its proportion is reduced, with less than 1% those exceeding 100 cm in diameter. However, there is a very adequate proportion of trees between the diameter classes 60 and 100 cm (28%).

Distribution in diameter classes is important for determining the resilience of the urban forest. The lower classes are necessary as a future for the renewal of the woodland, although an adequate percentage of large-diameter trees is necessary, as they provide ecosystem benefits and an ecological value far greater than that of young trees.

DISTRIBUTION BY DIAMETER CLASSES OF MUNICIPAL MAINTENANCE TREES



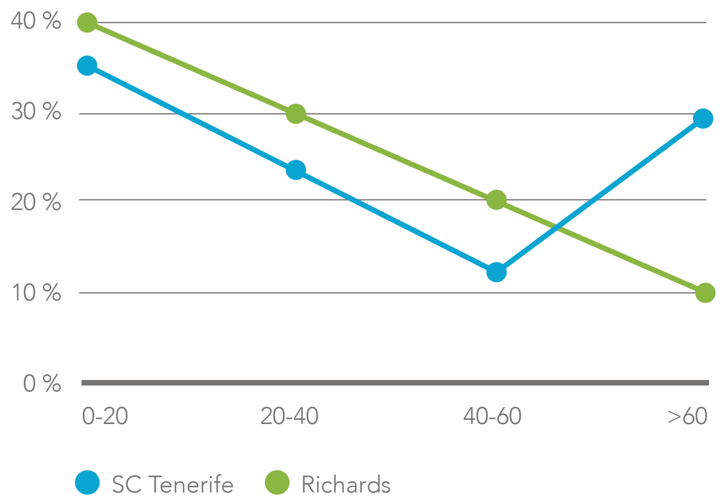


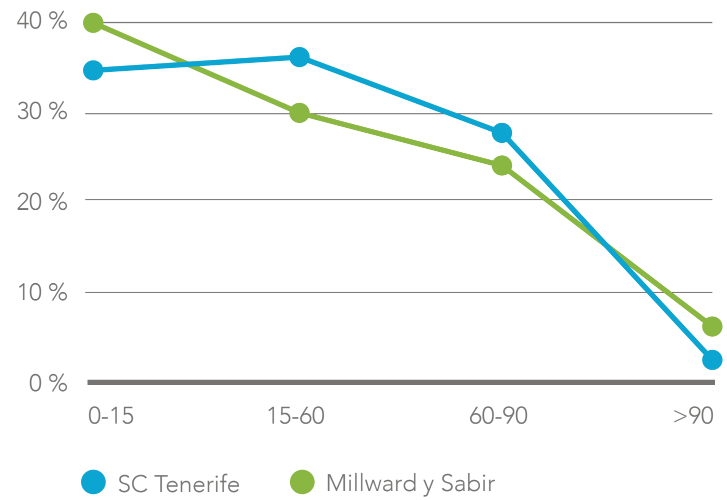
Some studies identify the ideal curves or percentages of each of the diameter classes of the urban forest. Among them are Richards (1983) and subsequent modifications to his approaches, including the ideal distribution of Millward and Sabir (2010). This work has been adopted in cities such as Toronto as indicators for making decisions about tree management.

In Santa Cruz de Tenerife, the city has a correct percentage of lower diameter classes, indicating a good level of woodland resilience and future replacement of older trees. There is also a high proportion of trees larger than 60 cm (Richards curve) and adequate proportion of trees larger than 90 cm (Millward and Sabir curve), adult trees that bring great ecosystem benefits to the city. Therefore, there is a balance in the urban forest of the city, with a proportionate distribution of diameter classes of its woodland.

The composition of the urban forest has also been evaluated. In this case, focusing on urban trees of municipal conservation, the most abundant species is the Canarian palm (*Phoenix canariensis*), with 14.1% of the trees, followed by the flamboyant (*Delonix regia*), the fire tree (*Brachychiton acerifolius*), the laurel (*Ficus microcarpa*) and the Washingtonia

Canarian palm tree (Phoenix canariensis) is the dominant species of Santa Cruz de Tenerife's Urban Forest.It's a native palm tree and endemic to the Canary Islands.

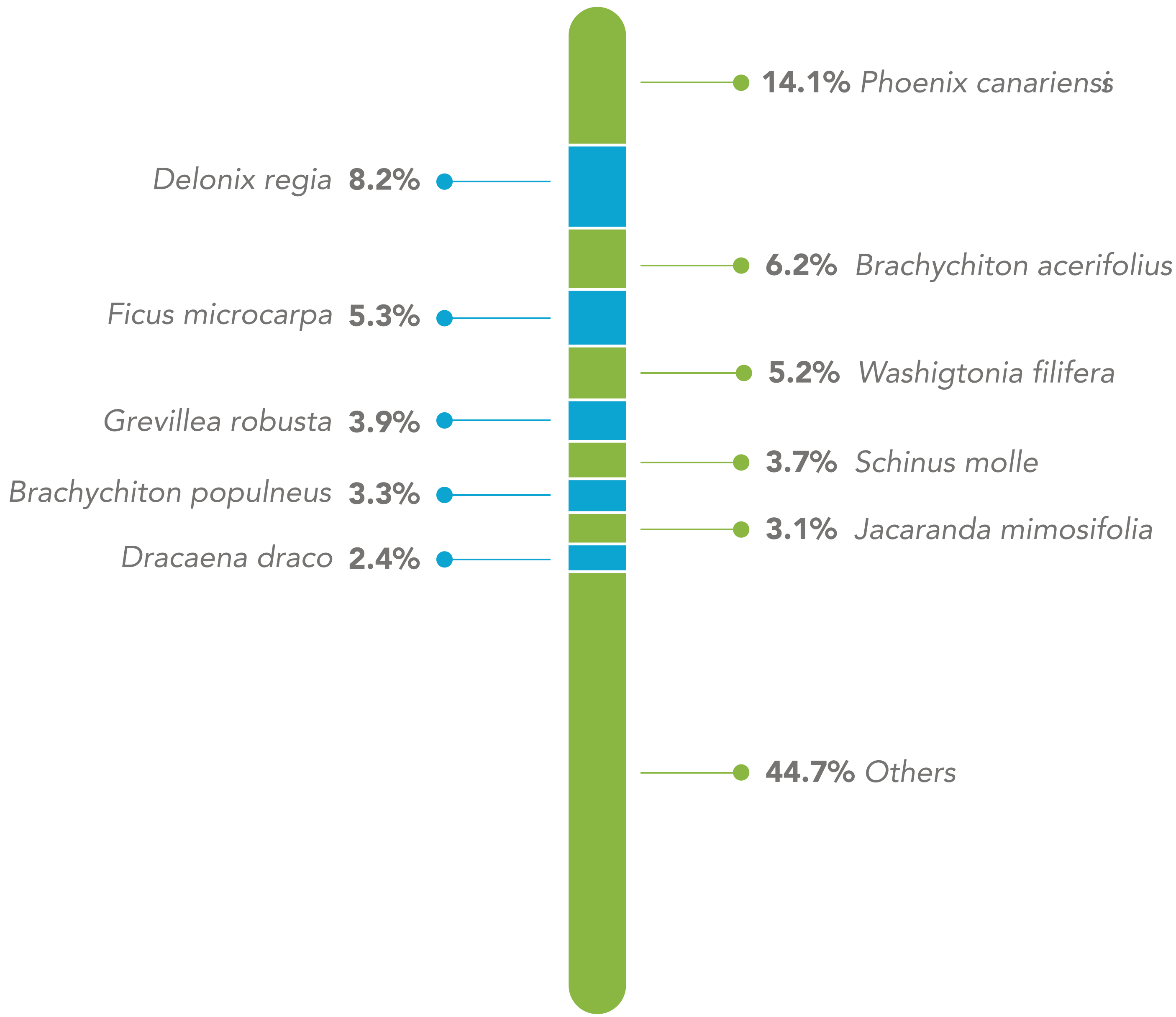




palm of California (*Washingtonia filifera*). Of these, the first is an indigenous and endemic species of the Canary Islands and the drago (*Dracaena draco*), which occupies the tenth place, is the next species native to the Canary Islands and endemic to the Macaronesian ecosystem. The rest are introduced species, perfectly acclimatized and adapted to the urban environment of Santa Cruz de Tenerife. **The 10 most abundant species represent 55.3%**, that is a very balanced population.

The list of current species under municipal maintenance can be found in the appendices. The data from the GIS of the Government Area of Territory Planning and Environment of the city have determined **488 different species of trees**, which gives an idea of the great biodiversity of its Urban Forest. In the list of species adapted to i-Tree Eco that are collected in the appendices, this number decreases to 339, because it has adapted to the species pre-established in the program. Therefore, in many cases, only the name of the genus appears and not the species, encompassing all those species that belonged to that genus and that were not found as a species in the list of the software.

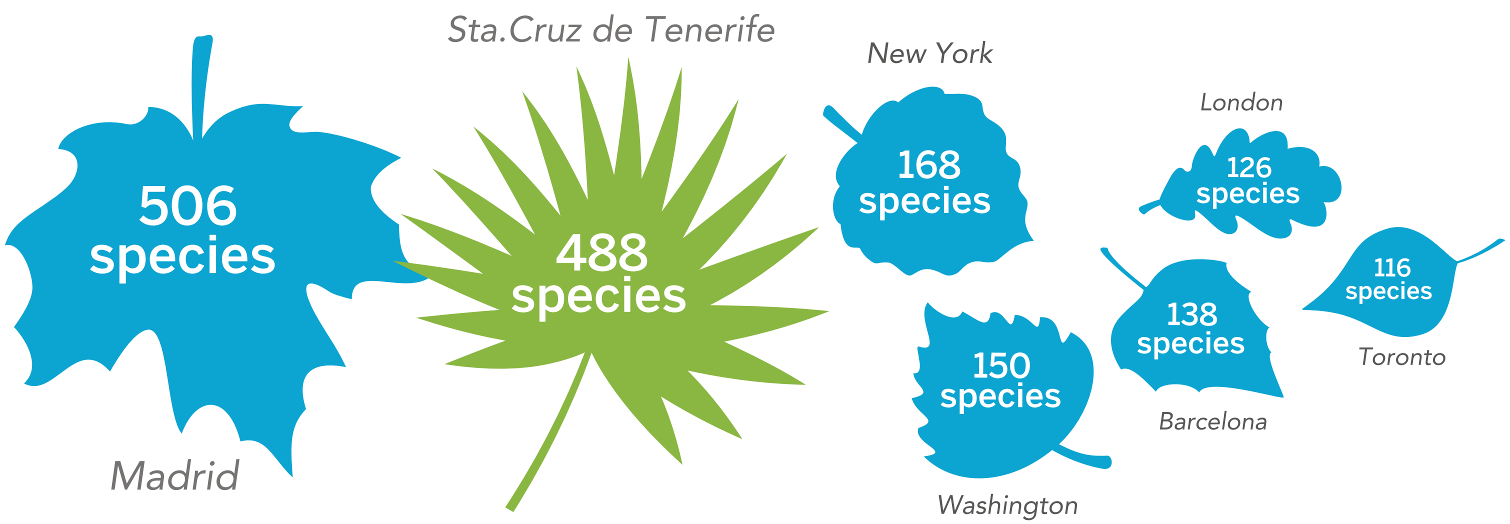
10 MOST COMMON SPECIES PROPORTION OF THEM UNDER MUNICIPAL CONSERVATION



Comparing with other cities that have performed the same analysis using i-Tree Eco, London has a result of 126 different species, being the most biodiversity of the cities of the United Kingdom, 168 in New York, 506 in Madrid, more than 150 in Washington, Toronto 116 or Barcelona 138.

This data does not include the species of botanical parks or private collections that have all the major cities, but the trees present in green areas and tree-lined streets of the urban environment in which these studies are carried out. This data corresponds to the biodiversity references and the climate so benign that the Canary Islands have in general and the city of Santa Cruz de Tenerife in particular, due to its special location.

DIVERSITY OF SPECIES IN SANTA CRUZ DE TENERIFE'S URBAN FOREST



03 URBAN FOREST STRUCTURE. LEAF AREA AND SPECIES DOMINANCE

The number of trees of Urban Forest is an important data to give us an idea of the number of trees that live in the city. However, coverage, diversity and quality are more relevant in determining the ecosystem services they provide. Thus, the benefits calculated in the next chapters are linked to the size of the trees, species and healthy foliar surface they have. The bigger trees are (diameters, heights and cup size), the higher coverage is, and therefore greater healthy foliar surface and the greater benefits add to the whole. In many cases, these benefits are exponential, so the trend of urban forests would be to obtain the most large trees and with adequate structural quality.

From the data obtained from abundance and leaf area by species, the dominance value (DV) is determined for each species, which marks the relative importance of each in terms of benefits or ecosystem services that it brings to the city.

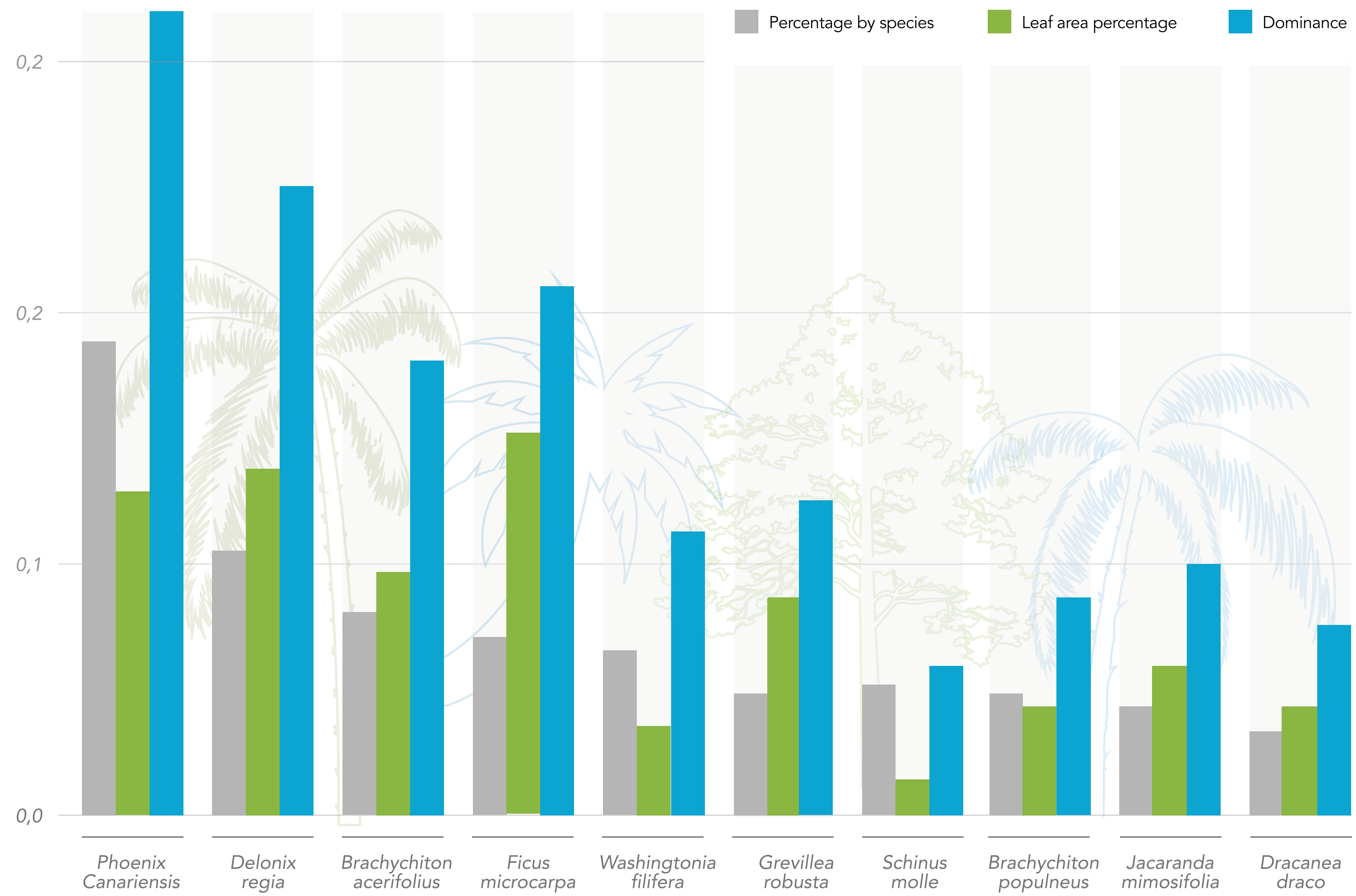
The species of greatest dominance and, therefore, the ones that bring the greatest benefits, are the Canarian palm tree (*Phoenix canariensis*) and the flamboyant (*Delonix regia*) because they are the most numerous species, representing 22.3% of population and 20.6% of the area foliar of the city's trees. It should be noted that both species are evergreen or semi-perennial, providing ecosystem services throughout the year, both in terms of pollutants uptake and rainwater retention.

On the other hand, species with a lower percentage of the population than these two, such as the Laurel of India (*Ficus microcarpa*), has the highest percentage of leaf area of the municipality, with 11.2% of the total, despite constituting only 5.3% of the trees of Santa Cruz. This is why it represents the third dominant species of the city.

The following graphic depicts the dominance of 10 most abundant species of Santa Cruz de Tenerife's Urban Forest under municipal maintenance. After the first two species, are particularly important for their relevance in terms of the benefits the fire tree (*Brachychiton acerifolius*), the laurel of the Indies (*Ficus microcarpa*) and the silky oak or gold pine (*Grevillea robusta*).

When managing the urban forest of cities, these results should be considered, taking into account those species that currently bring greater benefits to the community. However, it does not mean that they become the only reference when determining strategies for the introduction of species in the green areas and tree-lined thoroughfares.

DOMINANCE OF MOST COMMON SPECIES OF URBAN FOREST UNDER MUNICIPAL CONSERVATION



Considering that the greatest benefits are those obtained by those trees of greater size and leaf area, **the management or cultural treatments of the trees should be oriented towards the achievement of a greater dimension of each specimen and increase the volume of its crown**. This will bring greater services to the city. All this, of course, considering the special conditions of urban trees, both in terms of risk and interference with other elements of the city.

Larger trees with a larger leaf area report greater ecosystem services. It is estimated that a 75 cm diameter tree can intercept up to 10 times more air pollution, store more than 90 times more carbon and contribute more than 100 times to the leaf area of tree cover than a 15 cm diameter tree (Valuing London Urban Forest, 2015).

The **total leaf area** calculated for Santa Cruz de Tenerife's Urban Forest under municipal maintenance is **640 ha**. Using this value to estimate the total leaf area of urban forest of the urban area of the city, we get an area of **1,341 ha**. If we compare that area with the total of the city, assuming that the foliar is two dimensional, this would represent **44% of the urban area of Santa Cruz de Tenerife**.

01 ECOSYSTEM SERVICES. REDUCING POLLUTION

The steady increase in the population and industrialization of cities, together with the increasingly growing demand of energy and the numerous activities that require the use of fossil fuels, especially vehicle traffic, has led to an important increase in air pollution in urban centres. Today, it has become one of the main problems in the management of municipal corporations. The negative effects caused by low-quality air directly affect human health.

It should be noted that in Santa Cruz de Tenerife there are no measurements of pollutant concentration above the values recommended by the World Health Organization (WHO), as shown in the city's 2017 Air Quality Report. Despite not exceeding the healthy limits under any circumstances, and its concentration is decreasing compared to previous years (mainly due to the suspension of CEPSA refinery activity in 2014), it is very necessary to study the pollution uptake by the vegetation, since it brings a great value to the health of the citizens and visitors.

There are only episodes of PM_{10} particle concentration higher than recommended when there are intrusions of Saharan dust in suspension, due to the situation of the island from the African continent. This is harmful to health, although it comes from natural and exogenous causes to the city and the island. Therefore, it is not possible to act at its origin, but yes in the reduction of its effect by its capture by the vegetation of the city.

The increase in pollution levels in cities has numerous direct and indirect effects on the citizens and infrastructures of the city (buildings, monuments, ...), while significantly increasing the costs derived from its mitigation and remedy.

Urban trees contribute in a very important way to reduce air pollution, influencing the maintenance and improvement of air quality. The direct influence that vegetation has on air quality is due to oxygen production, temperature reduction, which results in a decrease of ozone levels, the decrease in air pollution absorbing polluting gases through of leaf stomata and the capture of suspended particles (Nowak et al., 2006).

All this implies the reduction of health problems directly or indirectly resulting from pollution and therefore health-care costs (Lovasi et al. 2008, Donovan et al., 2013).

Also, and indirectly, the efficient distribution of vegetation around buildings results in a lower need for energy consumption and, therefore, a decrease in the amount of emissions and in energy demand.

To estimate the capacity of the Santa Cruz de Tenerife woodland to remove or absorb contaminants from the atmosphere and improve air quality, the i-Tree model has been used. Specifically, the filtered volume of carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3) and sulphur dioxide (SO_2) has been quantified. The capacity to uptake different $PM_{2.5}$ pollutant particles (particles less than 2.5 microns) has also been estimated.

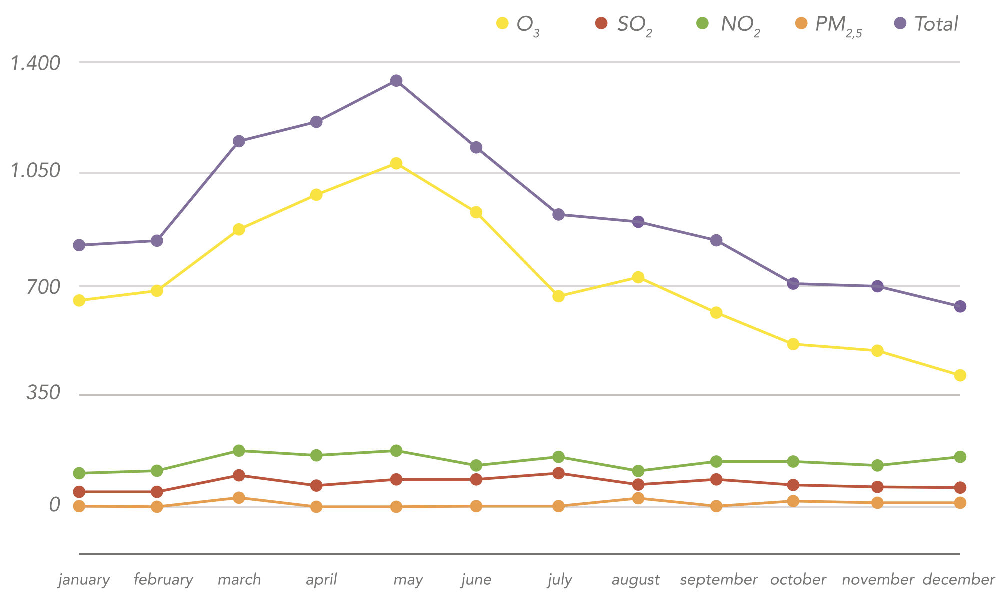
The estimation has been carried out by the program both in quantitative terms and in economic terms.

The pollution uptake by the Santa Cruz's urban forest was calculated from the data of the complete inventory of the municipal maintenance trees collected in the GIS of the Government Area of Land Planning and Environment of the City Council. With this data was estimated for the rest of the city's woodland. For the estimation of the forest area, data were taken from the Forest Inventory of Anaga Rural Park.

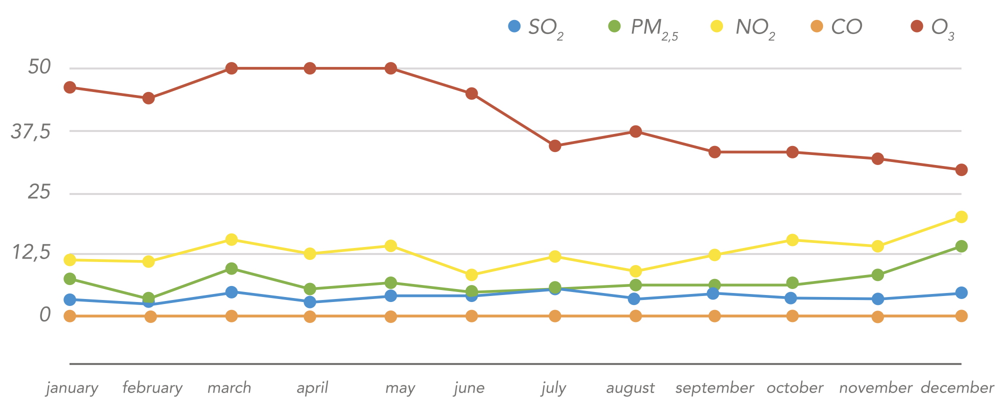
POLLUTION UPTAKE BY TREES OF SANTA CRUZ DE TENERIFE

	Urban area		Anaga Rural Park		Total	
	MT/yr	value	MT/yr	value	MT/yr	value
Carbon monoxide (CO)	-	-	-	-	-	-
Ozone (O_3)	18.0	1,983,421€	29.8	3,351,474€	47.8	5,334,895€
Nitrogen dioxide (NO_2)	3.4	56,182€	5.7	95,252€	9.1	151,434€
Sulphur dioxide (SO_2)	1.8	10,609€	2.9	17,82€	4.7	28,432€
Particulate matter less than 2.5 microns ($PM_{2.5}$)	0.2	577,946€	0.3	989,474€	0.4	1,567,420€
POLLUTION UPTAKE	**23.3**	**2,628,157€**	**38.7**	**4,454,023€**	**62.0**	**7,082,180€**

POLLUTION UPTAKE BY THE TREES OF SANTA CRUZ DE TENERIFE BY POLLUTANT



POLLUTANT CONCENTRATIONS IN THE AIR OF SANTA CRUZ DE TENERIFE

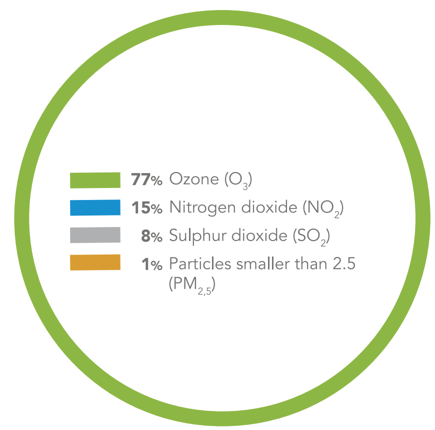


The pollution captured in a year by the Santa Cruz de Tenerife trees is 0.004 MT/ha, lower than values obtained in Madrid (0.011) or London (0.014) as the pollution values collected in these cities are not reached in Santa Cruz. It should be considered, when comparing with other cities such as Glasgow (0.050 MT/ha year) or Barcelona (0.030 MT/ha year), that in the first versions of i-Tree the value of PM_{10} was incorporated, substantially increasing the values of pollution captured against to current estimates where the $PM_{2.5}$ value is used.

Factors influencing pollution capture are tree cover, leaf area, and atmospheric pollution concentrations. Proper management of these parameters contributes to improve air quality in cities. About woodland, increases in the leaf area results in a greater benefit and yield of pollution absorption, so we should tend to improve the structure and volume of treetops and the selection of species with a larger potential foliar surface area.

The pollution captured in Santa Cruz de Tenerife is greater in the spring months, gradually decreasing the rest of the seasons. It has a maximum in May, coinciding with the month of highest concentration of ozone.

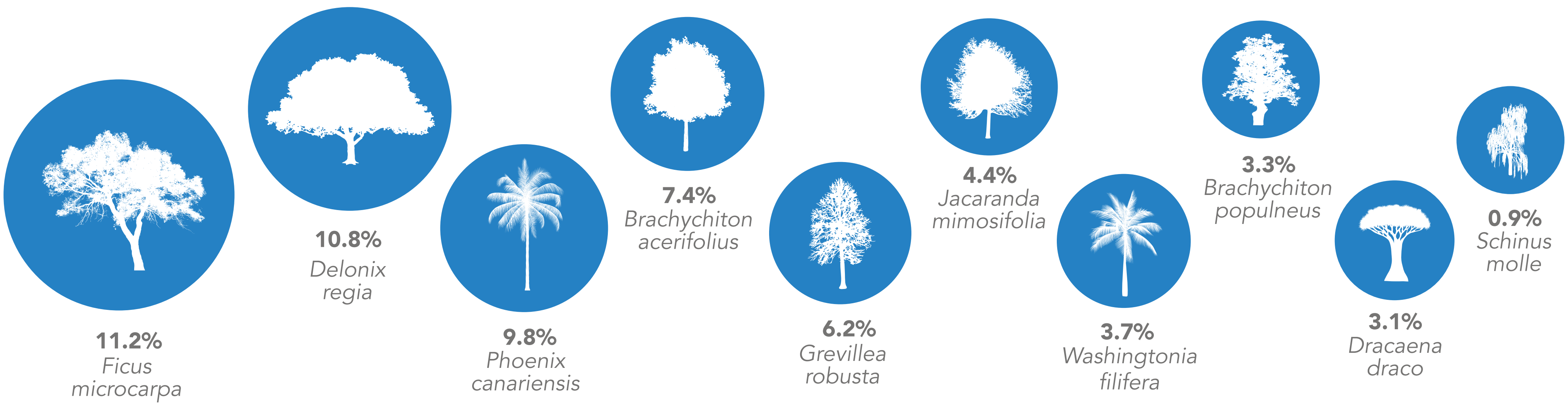
PERCENT OF EACH POLLUTANT CAPTURED BY SANTA CRUZ DE TENERIFE'S URBAN FOREST



The pollutant most captured by Santa Cruz de Tenerife's vegetation is Ozone (O_3), with 77.2% of the total, followed by NO_2 with 14.6% of the pollutants absorbed. Based on the data of the complete inventory of the municipal conservation vegetation and the forest inventory of Anaga Rural Park, the total pollution captured by Santa Cruz de Tenerife's trees has been estimated. Thus, an estimated 47.8 metric tons of O_3, 9.1 metric tons of NO_2, 4.7 metric tons of SO_2 and 0.4 metric tons per year of particles less than 2.5 microns are removed. In economic terms, Santa Cruz de Tenerife's Urban Forest brings benefits to the city of € 7,082,180 due to catchment of pollutants.

As for the species, the ten species that capture the most pollution in Santa Cruz de Tenerife are the ones listed in the graph below. The laurel of Indians (*Ficus microcarpa*) surpasses the rest, with 1,241 kg/year, followed by flamboyant (*Delonix regia*) with 1,198 kg/year. Both species exceed the others, although they are not the most numerous. The Canarian palm tree (*Phoenix canariensis*) catches about 1 metric ton of contaminants a year.

POLLUTION UPTAKE BY MOST COMMON SPECIES IN SANTA CRUZ DE TENERIFE



02 ECOSYSTEM SERVICES. BIOGENIC VOLATILE ORGANIC COMPOUNDS

As we can see, the vegetation of the cities can capture O_3 through its stomata, which has a beneficial effect on air quality. However, some species emit isoprenes and monoterpenes, known as biogenic volatile organic compounds (VOCs). These natural chemical compounds can react with nitrogen oxides (NOx) and generate ozone (O_3) and carbon monoxide (CO) (Nowak et al., 2000; Nowak et al. 2002; Nowak et al., 2007), which have a negative effect on the global pollutant capture balance. This can be considered a detrimental effect of trees, but its impact is very small against the benefits.

VOC's emission varies mainly depending on trees species and temperature. Consequently, actions aimed at increasing tree cover will help to a decrease in temperature, while the choice of species with less capacity to emit VOCs will reduce locally the production of ozone (Nowak et al., 2000; Nowak et al. 2002; Nowak et al., 2007).

For quantification, the model used includes an algorithm through which both the production of VOCs and the reduction experienced in their emission can be quantified, depending on the type of species, structure, degree of cover, etc.

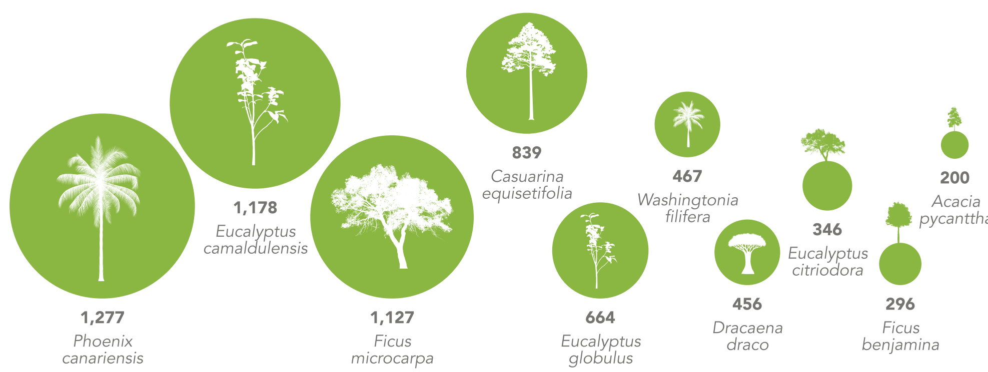
A total of 9,258 kg of VOCs emitted by the municipal conservation trees of Santa Cruz de Tenerife (7,854 kg of Isoprenes and 1,405 kg of Monoterpenes) has been calculated. The estimate for the total Urban Forest of Santa Cruz is 19 metric tons of VOCs (16 metric tons of Isoprenes and 3 metric tons of Monoterpenes).

The highest amounts of biogenic volatile organic compounds were emitted were by species like the Canarian palm tree (*Phoenix canariensis*) (13.8%), followed by the red eucalyptus ( ) (12.7%) and the laurel of Indians (F*icus microcarpa*) (12.2%). The 10 species that most VOCs emit (74% of annual emissions), are represented in the following graphic:

VOC'S EMISSIONS FROM MUNICIPAL CONSERVATION TREES

	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (kg/yr)	Percent (g/yr)
Phoenix canariensis	1,277,198	0	1,277	13.8 %
Eucalyptus camaldulensis	946,936	231,483	1,178	12.7 %
Ficus microcarpa	1,073,422	53,486	1,127	12.2 %
Casuarina equisetifolia	832,023	6,776	839	9.1 %
Eucalyptus globulus	533,300	130,370	664	7.2 %
Washingtonia filifera	448,493	18,350	467	5.0 %
Dracaena draco	444,680	11,386	456	4.9 %
Eucalyptus citriodora	277,936	67,943	346	3.7 %
Ficus benjamina	281,778	14,048	296	3.2 %
Acacia pycanttha	1,182	198,641	200	2.2 %
Others	1,737,055	672,256	2,409	26.0 %
	7,854,001	**1,404,739**	**9,259**	**100.0 %**

VOCS EMISSIONS FROM MUNICIPAL CONSERVATION TREES



03 ECOSYSTEM SERVICES. CARBON SEQUESTRATION AND STORAGE

CO_2 is the main greenhouse gas responsible for climate change on earth. According to the United Nations (UN), there has been a 50% increase in this gas emissions since 1990, and only in the first decade of the 21st century there was an increase larger than in the previous three decades.

Cities are sources of CO2, so actions aimed at reducing its production are being developed and implemented, mitigating, as far as possible, this global problem of the planet.

The Urban Forest greatly helps its reduction, being a **natural CO_2 sink**. Plants, in their photosynthetic processes, absorb this gas and release oxygen, incorporating carbon into its leaves, branches, twigs, trunks and roots. All tissues in a plant are formed from the carbon they absorb from the air. In trees, this carbon becomes part of its structure and because they are usually long-lived, they become a magnificent long-term storehouse of this compound.

It is necessary to differentiate between the **carbon stored** in their aerial and underground biomass from the CO_2 that trees **sequester** annually, calculated as the gas removed or absorbed by the trees. This absorption capacity varies by species and increases with the size and vitality of the tree (Nowak et al., 2002; Nowak, 2006; Nowak et al., 2013).

We should also keep in mind that stored carbon can be returned to the atmosphere after the death of the tree and its subsequent decomposition, so the survival of the trees is important when managing the green heritage of a city (Heisler, G. M., 1986; Nowak et al., 2002; Nowak, 2006; Nowak et al., 2013).

Carbon stored annually in the trees of Santa Cruz de Tenerife has been estimated at **66,915** metric tons. CO_2 sequestration is estimated at **4,356** metric tons/year. In economic terms, this represents values of **€10,741,272**/ year of stored carbon and **€700,764**/ year of net CO_2 sequestration.

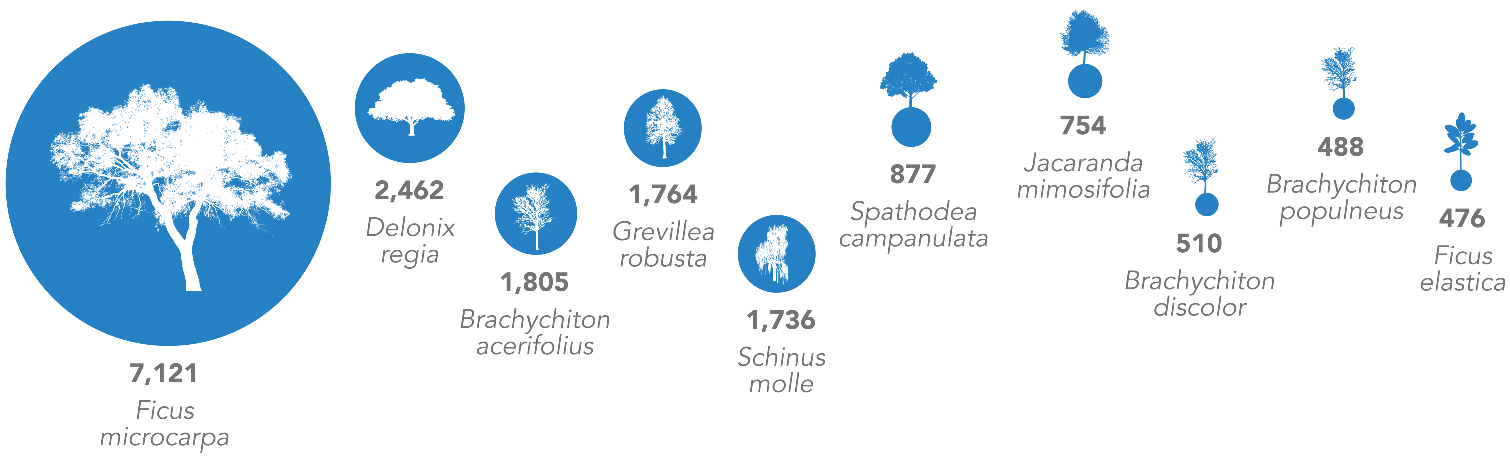
The ten municipal maintenance tree species that stores the most carbon are those represented in the graph. *Ficus microcarpa* tops this list, with **7,121** metric tons, followed by *Delonix regia*, *Brachychiton acerifolius* and *Grevillea robusta*. In total, these 10 species account for **80%** of city's total stored carbon.

Of these, the two species of genus Ficus (*Ficus microcarpa* and *Ficus elastica*) has the largest average storage per tree. It is followed by the African tulip (*Spathodea campanulata*), with an average of 1,145 kg per tree.

CARBON STORAGE AND SEQUESTRATION

	Amount (MT/yr)		Value (€)		Total	
	Urban Area	Anaga Rural Park	Urban area	Anaga Rural Park	Amount (MT/yr)	Value (€)
Carbon storage (MT)	47,925	18,990	7,693,920 €	3,047,352 €	66,915	10,741,272 €
Carbon sequestration (MT/yr)	1,834	2,522	295,597 €	405,167 €	4,356	700,764 €
TOTAL	**49,759**	**21,512**	**7,989,518 €**	**3,452,519 €**	**71,271**	**11,442,037 €**

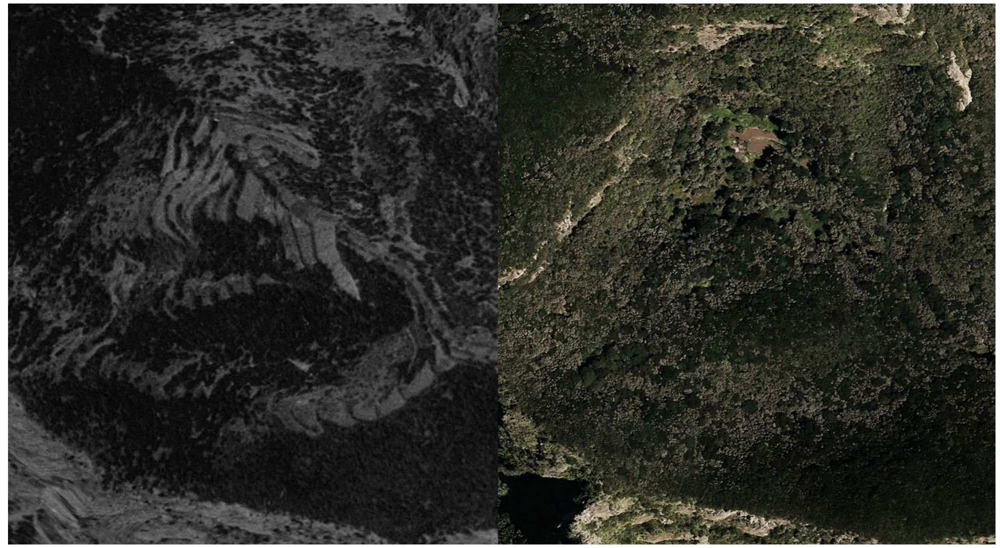
MUNICIPAL CONSERVATION SPECIES THAT MORE CARBON STORAGE



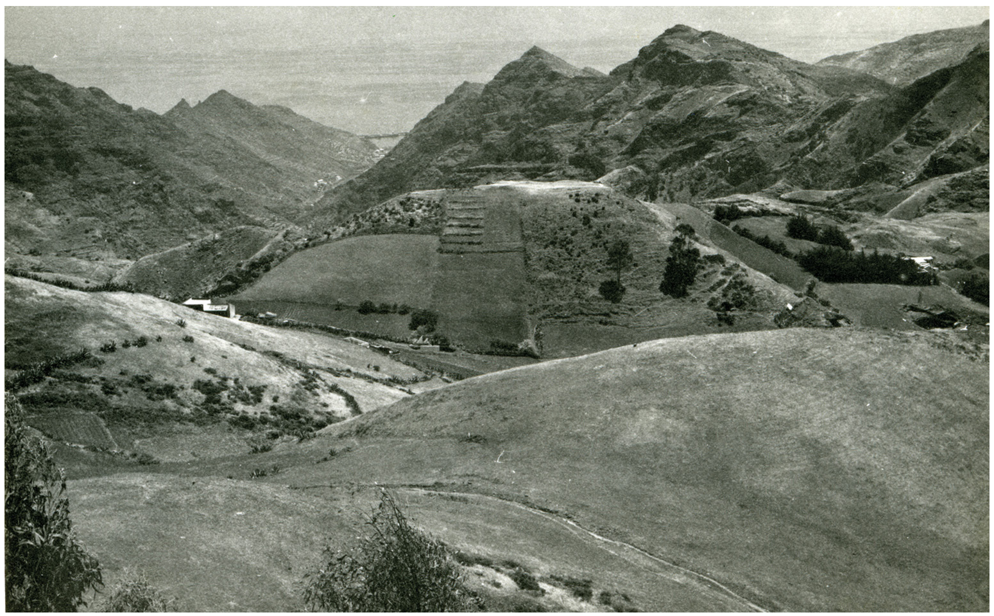
Carbon storage of trees belonging to Anaga District is lower in absolute terms than those of the urban environment, despite being higher in number. Analysis of data tells us that these are trees of smaller sizes, where 96% of trees do not exceed 30 cm in trunk diameter, compared to 53% of urban trees.

In this sense, it should be remembered that the woodland of Anaga is relatively young since only after its protection as a Natural Park in 1987 the formations of laurisilva, brezal, fayal-brezal-acebiñal and no monteverde arbolado have progressively increasing in size and surface. Anaga is and has always been a space where man and nature have coexisted in perfect harmony, and where the abandonment of some ancient cultural practices has led to the progressive expansion of wooded habitats.

CO_2 storage in Anaga will increase as its forest mass increases towards larger diameter trees. It's only a matter of time. Indeed, stored carbon values depend greatly on the trunk diameter, as reflected in the values of this table, in which we can see the average carbon storage of the trees in the urban environment of Santa Cruz de Tenerife in front of the average carbon storage of the Anaga District, depending on the diameter of its trunk.



Anaga Forest is in the process of advancing in extension and development. Photograph from 1964 and current photograph indicating this increase.



Anaga´s view in 1963

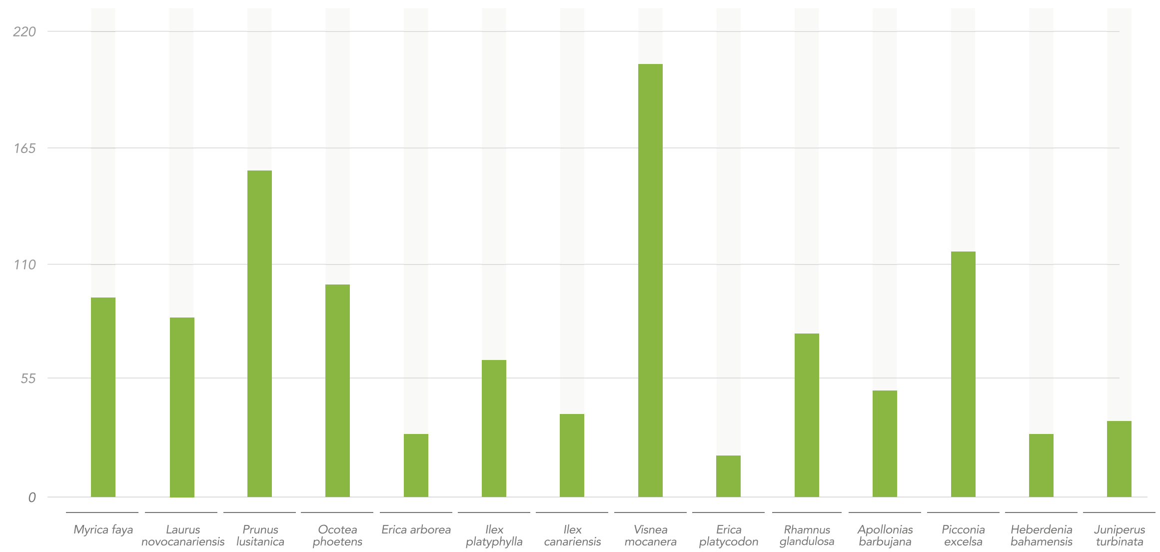
Diameter class	Average carbon storage per tree (kg/tree)	
	Forest environment (Anaga)	Urban environment
<=30	52	56
30-60	482	413
60-100	0	940
>100	0	6.208

As tree diameters increase, carbon storage grows exponentially, from about 50 kg per tree in diameters less than 30 cm to more than 6 tons per tree when the diameters are greater than 100 cm.

The following graphic shows the average carbon storage of the most represented tree species in Anaga Rural Park. It illustrates the difference in medium storage by tree with the previous graphs, which contains the average store by tree of the environments Urban.

Specie	Carbon storage (MT)	Number	Average carbon storage per tree (kg/tree)
Myrica faya	4,896	55,719	88
Laurus novocanariensis	3,795	46,777	81
Prunus lusitanica	2,634	17,885	147
Ocotea phoetens	2,592	25,452	102
Erica arborea	1,833	59,846	31
Ilex platyphylla	1,033	15,821	65
Ilex canariensis	937	25,452	37
Visnea mocanera	414	2,064	201
Erica platycodon	350	16,509	21
Rhamnus glandulosa	269	3,439	78
Apollonias barbujana	97	2,064	47
Picconia excelsa	79	688	115
Heberdenia bahamensis	33	1,376	24
Juniperus turbinata	21	688	31

SPECIES WITH HIGHER CARBON STORED IN ANAGA RURAL PARK

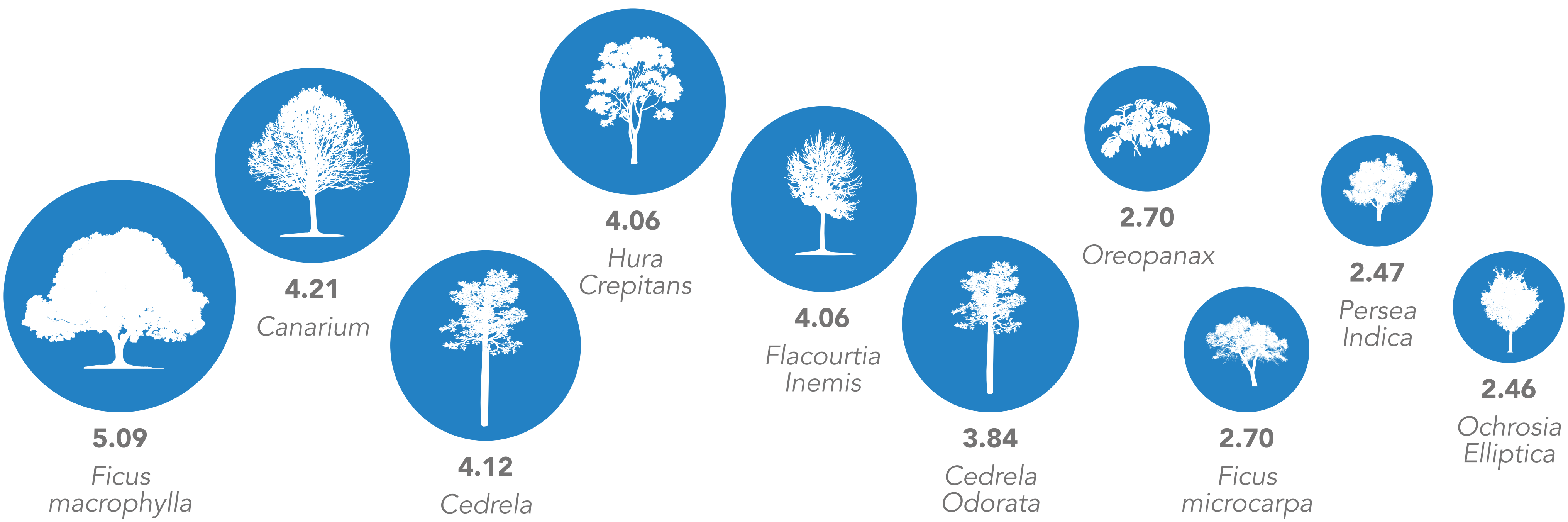


MUNICIPAL CONSERVATION SPECIES THAT MORE CARBON STORE			
Specie	**Carbon storage (ton)**	**Number**	**Average storage (kg/tree)**
Ficus microcarpa	7,121	2,641	2,696
Delonix regia	2,462	4,093	602
Brachychiton acerifolius	1,805	3,111	580
Grevillea robusta	1,764	1,953	903
Schinus molle	1,736	1,869	929
Spathodea campanulata	877	766	1,145
Jacaranda mimosifolia	754	1,536	491
Brachychiton discolor	510	794	642
Brachychiton populneus	488	1,675	291
Ficus elastica	476	276	1,725

It should be remembered that the study refers exclusively to the tree stratum, so the carbon storage of the shrubs and subarbustive strata, which are the most common in **Anaga Rural Park**, has not been contemplated.

If we analyse the average storage per tree of those of municipal conservation, we get the results shown in the following graphic. Of these, the species of the genus Ficus (*Ficus macrophylla* with 5.1 kg/tree and *Ficus microcarpa* with 2.7) are those with largest average storage of the most common trees in the city. The rest are generally not very abundant.

MUNICIPAL CONSERVATION SPECIES WITH LARGEST AVERAGE CARBON STORAGE PER TREE



In terms of carbon sequestration, the graph identifies the ten species with the highest annual carbon sequestration from municipal conservation trees. The species that contributes the most in global terms is *Ficus microcarpa*, with 149 metric tons/year, followed by Delonix regia (120) and *Brachychiton acerifolius* (84).

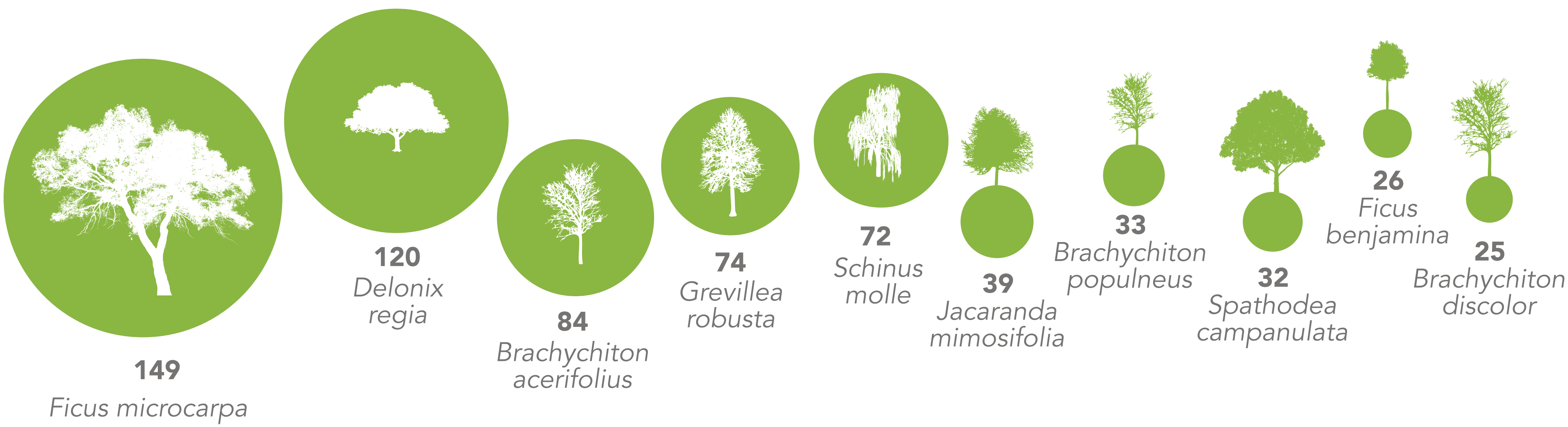
Annual net sequestration values per tree indicate that *Ficus microcarpa* and *Spathodea campanulata* are the species that bring the most benefit per tree, with an average of 56 and 42 kg/tree and year respectively. It is followed by *Grevillea robusta* and *Schinus molle*, with 38 and 39 kg per tree and year.

In absolute terms, the annual net carbon sequestration is higher in Anaga District than in the urban environment, being 1,834 MT/year in the urban area and 2,522 MT/year in the forestry area of Anaga.

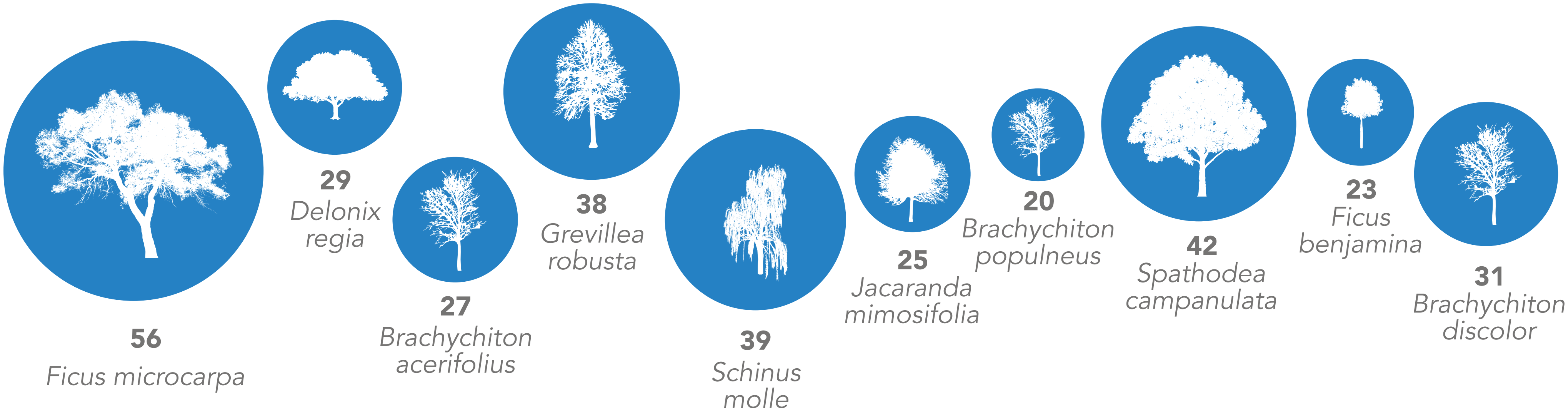
MUNICIPAL CONSERVATION SPECIES THAT MORE CARBON STORE

Specie	Carbon sequestration (MT/yr)	Númber	Average carbon sequestration per tree (kg/yr/tree)
Ficus microcarpa	149	2,641	56
Delonix regia	120	4,093	29
Brachychiton acerifolius	84	3,111	27
Grevillea robusta	74	1,953	38
Schinus molle	72	1,869	39
Jacaranda mimosifolia	39	1,536	25
Brachychiton populneus	33	1,675	20
Spathodea campanulata	32	766	42
Ficus elastica	26	1,148	23
Brachychiton discolor	25	794	31

MUNICIPAL CONSERVATION SPECIES THAT MORE CARBON STORE



SPECIES WITH LARGEST AVERAGE CARBON SEQUESTRATION PER TREE (AVERAGE PER TREE).



04 ECOSYSTEM SERVICES. TREES AND BUILDING ENERGY USE

The presence of urban trees has a direct effect on city's buildings energy use. In warmer times such as the spring or summer in Santa Cruz de Tenerife, the presence of trees in the vicinity of buildings provides them with shade, reducing the influence of solar irradiation. Also, because of evapotranspiration effects, the local temperature is regulated, reducing the use of air conditioning. In colder seasons, the proper location of trees near the buildings will act as a barrier to protect against cold winds, reducing heat loss and therefore reducing heating consumption. In both cases, the presence of trees results in lower energy consumption by buildings and lower emissions of pollutants into the atmosphere and reducing energy demand to production plants too (Heisler, G. M., 1986, Nowak, 2002; Nowak et al, 2007).

But trees can also have the opposite effect and increase the energy consumption of nearby buildings, by decreasing with their presence the temperature in winter or blocking the cool summer breezes, which results in higher consumption. Despite these negative effects, savings of 20-25% of energy have been recorded in some residential buildings with well-located trees in their proximity, compared to other unprotected constructions. Therefore, an adequate design of urban trees location is essential for the achievement of optimal consumption and energy savings (Heisler, G.M., 1986, Nowak, 2002; Nowak et al, 2007).

To estimate the effects of woodland on buildings energy consumption, the model uses the position of trees, their orientation and the distance to buildings. It should be noted that the model used is designed for the climate, standard constructions and energy efficiency of the United States. However, this program is also able to estimate the energy effects of vegetation for other locations, equating them with the original model, although with some limitations by the differences between the styles of construction of different study sites.

In Santa Cruz de Tenerife, municipal maintenance trees higher than 6 meters and situated less than 18 m away from any building have been selected for this analysis. Of the trees whose data are collected in the GIS of the Government Area of Planning of the Territory and Environment, a total of **5,455 trees** satisfy these conditions.

By applying the model to these trees, estimates of the energy savings linked to nearby to them buildings are obtained. In this way, it is also possible to estimate the benefit provided to the entire city. The estimates obtained by i-Tree Eco model are based on the following effects:

- **Effects on building energy use.** The increases or decreases in the BTU (British Thermal Unit) and kWh required to heat or cool buildings directly influenced by vegetation have been analysed.

Regarding electricity, the total reduction in MWh due to the presence of trees is **220 MWh**. This data results from the sum of the reduced energy due to the shade produced in the hot months, the reduction of the effects of the wind, the cooling of the local climate due to evapotranspiration and the warming of the climate. To these costs, kWh should be deducted for the negative effect caused by shadow in the colder months. As we can see, the general calculation is positive.

In terms of the influence on the BTU (British thermal unit) variation equivalent to natural gas in Spain (1 m3 of natural gas = 36,374 BTU), the results obtained are negative, with a total value of **-1,291 MBTU**. The result comes from the sum of the reduced BTUs by the effect of the weather and wind and BTUs increased by the shade effect produced by trees on buildings in cold times.

ANNUAL ENERGY SAVIGNS BY CLOSE TREES TO BUILDINGS IN SANTA CRUZ DE TENERIFE

	heating	cooling	total
MBTU	-1,291	N/A	-1,291
MWH	-67	287	220
Carbon avoided	-34	23	-10

- **Effects on carbon emissions.** We assess the increase or decrease in carbon emissions from energy sources as a result of changes in energy consumption. In this case, a total negative amount of **-10 metric tons of carbon avoided** is estimated in Santa Cruz de Tenerife.

- **Evaluation of the effects.** For the total estimation of the effects on energy use of buildings, the economic values associated with changes in the building's energy consumption and with changes on carbon emissions are summed.

The prices of electricity and natural gas used to estimate the economic value are 230€/MWh and 19.64 €/MBTU. The avoided carbon cost was calculated based on the unit values used in the other chapters of this study.

The economic results obtained for each of the effects are:

ANNUAL SAVINGS IN RESIDENTIAL ENERGY EXPENSES DURING HEATING AND AIR CONDITIONING SEASONS IN SANTA CRUZ DE TENERIFE

	heating	cooling	total
MBTU	-25,350 €	N/A	-25,350 €
MWH	-15,484 €	65,990 €	50,505 €
Carbon avoided	-5,451 €	3,618 €	-1,832 €
TOTAL	**-46,285 €**	**69,608 €**	**23,323 €**

In the general calculation, the effects of the woodland in the city on the amount of energy used to heat or cool nearby homes brings an overall benefit of **€23,323 per year**.

Despite using the real trees and distances of Santa Cruz de Tenerife, it should be noted that this component of i-Tree Eco model is developed for US climate types, its type of buildings and its conditions regarding energy use, so the results obtained for Santa Cruz should be considered as an estimate.

05 ECOSYSTEM SERVICES. RAINWATER INTERCEPTION

The continuous growth of cities is followed by an increment in paved areas, sidewalks and buildings, which increases the waterproofness of the land. This means greater difficulty to infiltration of rainwater into the soil, facilitates runoff and collapses sanitation and rain evacuation infrastructures.

In addition, the resulting water-flows quickly wash the streets, dragging in their path numerous pollutants, harmful particles such as hydrocarbons, metals, dust, garbage and organic substances, being one of the main causes of water masses contamination, both ground and surface water in which they eventually flow (Xiao et al. 1998; Seitz et al., 2008, Livesley et al. 2015).

Trees, shrubs, lawns, and meadows intercept and temporarily store rainwater on their leaf surfaces, branches, and trunk. This water is incorporated back into the soil gradually and moderately or is directly incorporated into the atmosphere by evaporation (Korhnak, 2000; Seitz et al., 2008). This reduces runoff, improves the quality of the evacuated water, and reduces the costs and size of the necessary infrastructures for flash floods control and rainwater evacuation.

At the same time, vegetation improves soil structure with the growth of its radicular system and the decomposition of its organic matter. It increases the infiltration and water retention capacity of the soil and reduces runoff. Vegetation also reduces the speed of raindrops and their inertia when falling to the ground, decreasing erosion.

The water interception capacity depends on the species, the foliar surface, density, time of year and the type of precipitation. i-Tree Eco allows us to estimate the annual volume intercepted by city's vegetation and the annual volume of runoff avoided.

The total leaf area calculated in Santa Cruz de Tenerife for municipal maintenance trees is 640 ha, so it is estimated at **1,342 ha the leaf area of Santa Cruz de Tenerife's Urban Forest**. The runoff avoided by this area is **12,121 m³/year**, which represents an economic benefit of €22,013/year.

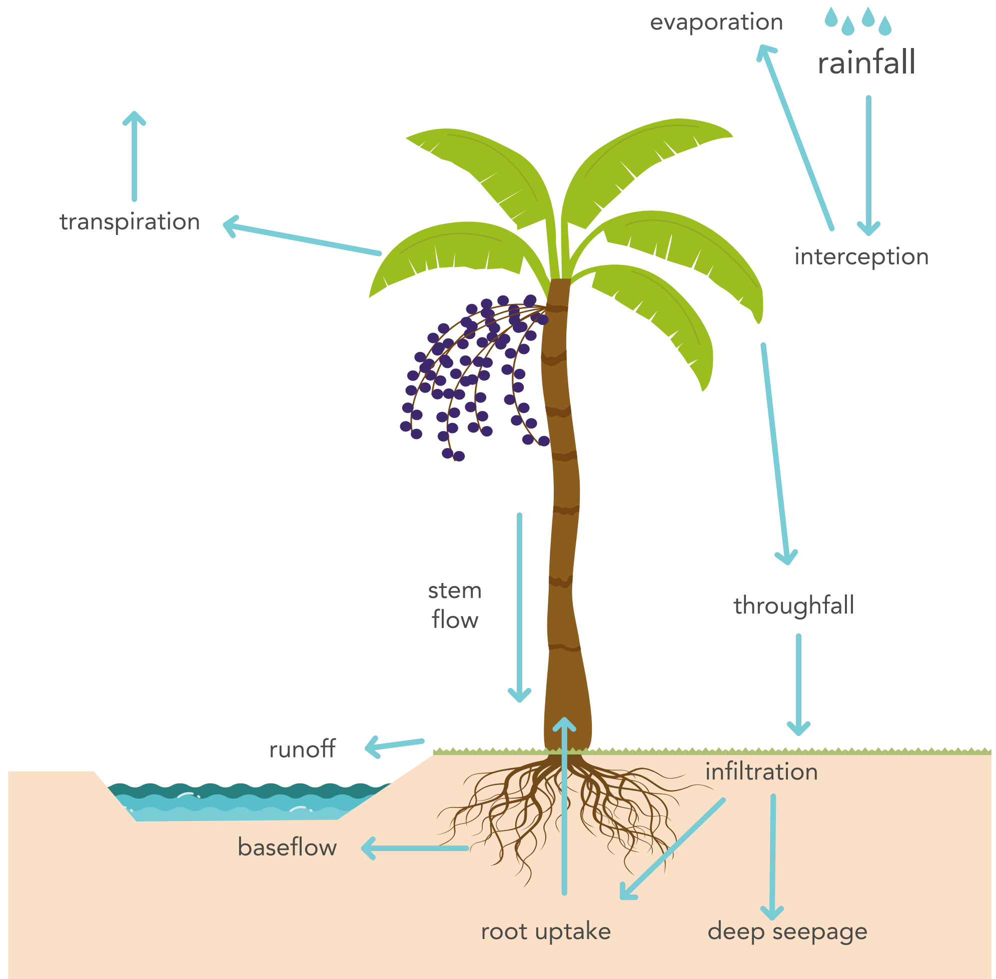
The volume of **water intercepted** by vegetation, it is estimated at **11,541 m³/year** for the trees included in the urban area of Santa Cruz de Tenerife.

The ten species that intercept the most water in municipal maintenance trees are those listed in the following table:

Ficus microcarpa represents 11.3% of water intercepted by municipal conservation trees, followed by *Delonix regia* with 10.9%, *Phoenix canariensis* (9.4%) and *Brachychiton acerifolius* (8.97%). In total, the 10 species that intercept the most water represent 62.5% of water captured by the municipal conservation trees of Santa Cruz de Tenerife.

RAINWATER INTERCEPTION BY TREE SPECIES UNDER MUNICIPAL CONSERVATION IN SANTA CRUZ DE TENERIFE

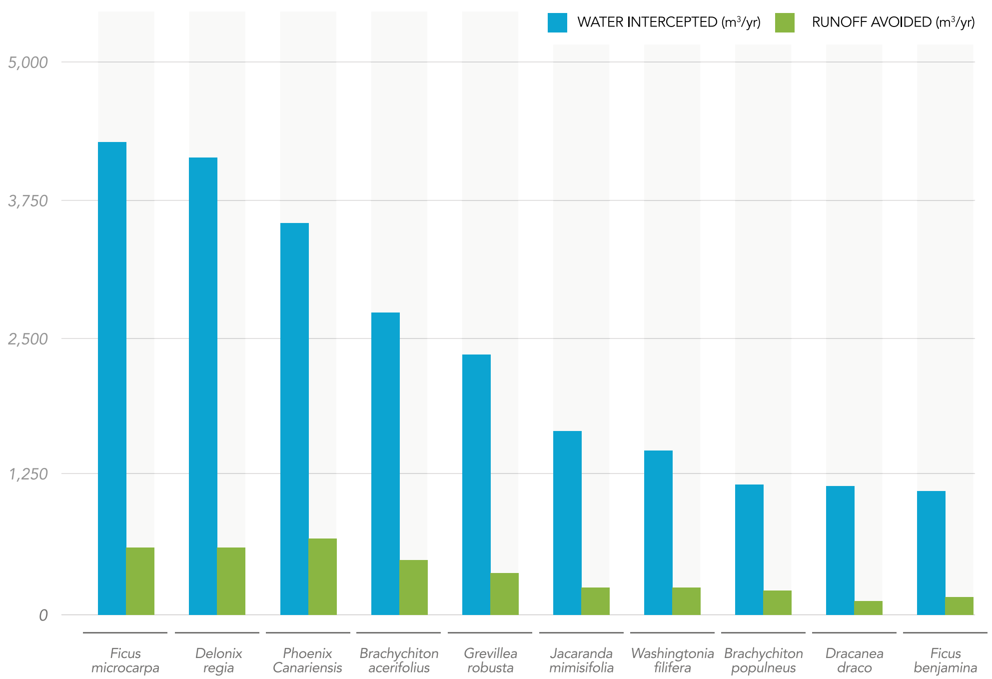
	potential evaporation (m³)	evaporation (m³)	transpiration (m³)	water intercepted (m³/yr)	runoff avoided (m³/yr)
Ficus microcarpa	96,756	4,279	51,861	4,279	621
Delonix regia	93,353	4,132	50,061	4,132	615
Phoenix canariensis	84,622	3,545	45,555	3,545	704
Brachychiton acerifolius	63,937	2,727	34,200	2,727	484
Grevillea robusta	53,869	2,366	28,880	2,366	361
Jacaranda mimosifolia	38,277	1,680	20,466	1,680	245
Washingtonia filifera	32,084	1,479	17,134	1,479	259
Brachychiton populneus	28,235	1,191	15,082	1,191	231
Dracaena draco	27,012	1,154	14,467	1,154	131
Ficus benjamina	25,423	1,120	13,597	1,120	160



Vegetation plays an active role in water cycle

There are about 488 species of trees in the city. Of these, the species of the genus *Eucalyptus* stand out as the species with the highest yield of intercepted water and runoff avoided by tree, with values reaching 5 m^3/tree in a year for *Eucalyptus globulus*. It is followed by trees belonging to the species of the genus *Canarium, Eucalyptus citriodora, Casuarina equisetifolia* and *Cedrela sp*, all with intercepted water values greater than 3 m^3 per tree in a year.

Of the 10 most common species in Santa Cruz de Tenerife, the highest ratio of water intercepted per tree is for the species *Ficus microcarpa*, with average values close to 1.62 m^3 per year and *Grevillea robusta* with 1.21 m^3/tree and year. *Delonix regia* and *Jacaranda mimosifolia* also exceed the average of cubic meter per tree per year.



06 ECOSYSTEM SERVICES. PUBLIC HEALTH

Air pollution has a direct influence on the health of citizens and visitors. High levels of air pollution are proven to result in the appearance of different pathologies and diseases, especially cardiovascular and pulmonary.

Besides, some studies link the loss of trees with the increase in mortality due to this type of pathologies. These effects have a sliding scale, both in terms of the severity of their consequences and the population at risk (Ballester et al., 1999, Ballester, 2005; Ballester et al., 2010, Donovan et al., 2013).

A correlation between the increase in mortality rates and continued exposure to high levels of contamination has also been shown. For the World Health Organization (WHO), air pollution is one of the main causes of health problems in the world. According to WHO, the number of premature deaths related to air pollution is close to two million, of which 300,000 occur in Europe.

The Sustainability observatory in Spain, in its 2007 Report Air Quality in Cities, lists the following health effects of some pollutants:

PM PARTICLES

Enter de lungs and the circulatory system. Aggravate respiratory diseases such as asthma and increase the number of cardiovascular diseases. Increase the number of premature deaths.

OZONE

O_3

Produces inflammation of the respiratory tract and irritation of eyes; reduces defences and damages the lungs, causing changes of different types in the respiratory system.

NITROGEN DIOXIDE

NO_2

Affect the respiratory system causing irritation and aggravating respiratory diseases (asthma). Results in reduced lung capacity, increasing the number of health care appointments and premature deaths.

SULPHUR DIOXIDE

SO_2

Cause diseases of the respiratory system such as bronchitis and other diseases.

CARBON MONOXIDE

CO

A highly toxic pollutant that reduces the ability of blood to transport oxygen from the lungs to other tissues.

The i-Tree model allows to estimate the number of medical incidents avoided by Santa Cruz de Tenerife trees. These calculations are based on the U.S. population and its health data, so we need to be cautious when interpreting the results obtained for our city.

This study is based on Santa Cruz de Tenerife population, 205,000 people, with a density of 1,467 inhabitants per km2. From this data, regression equations are used to estimate the value (in dollars) of each of the pollutants, obtaining economic benefits whose quantification is provided in the benefits of pollution capture collected in corresponding chapter of this study of Santa Cruz's Urban Forest.

Based on the average medical incidences per pollutant in urban areas of different cities in the United States, the results of medical incidents avoided due to the capture of pollutants by trees of the city can be obtained.

In Santa Cruz de Tenerife it has special relevance in terms of economic benefit for the Health System the capture, by the trees of the city, of ozone, followed by particles less than 2.5 microns.

Asthma and acute respiratory problems are the most numerous medical pathologies of those avoided due to the capture of contaminants by the Santa Cruz's Urban Forest. It has been estimated 13 cases of asthma exacerbation and 34 acute respiratory symptoms avoided annually by Santa Cruz trees.

MEDICAL INCIDENTS AVOIDED BY SANTA CRUZ DE TENERIFE'S URBAN FOREST

Pollutant	Medical incident	Incidents avoided
NO_2	Acute respiratory Medical incident	1.23
	Exacerbation of asthma	11.67
O_3	Acute respiratory symptoms	28.60
	Hospital admissions	0.29
	Number of college days lost	7.10
$PM_{2,5}$	Acute respiratory symptoms	4.13
	Exacerbation of asthma	0.80
	Symptoms of lower respiratory system	0.02
	Number of work days lost	0.15
SO_2	Exacerbation of asthma	0.47

01 RELATIVE TREE EFFECTS. COMPARATIVE ESTIMATE OF EMISSIONS

Santa Cruz de Tenerife's Urban Forest provides benefits like carbon storage and sequestration and air pollutant removal. To compare and get an idea of their relative value, the trees benefits were compared with estimates of municipal average carbon emissions, average car emissions, and average household emissions.

CARBON (C) STORAGE IS EQUIVALENT TO:

Annual carbon (C) emissions from **37,317** automobiles

Annual C emissions from **15,325** single-family houses

ELIMINATION OF NITROGEN DIOXIDE (NO_2) IS EQUIVALENT TO:

Annual nitrogen dioxide emissions from **537** automobiles

Annual nitrogen dioxide emissions from **243** single-family houses

ELIMINATION OF SULPHUR DIOXIDE (SO_2) IS EQUIVALENT TO:

Annual sulphur dioxide emissions from **20,839** automobiles

Annual sulphur dioxide emissions from **55** single-family houses

ANNUAL CARBON SEQUESTRATION IS EQUIVALENT TO:

Annual C emissions from **1,468** automobiles

Annual C emissions from **629** single-family houses

APPENDIX 1

COMPARISON OF URBAN FORESTS

The i-Tree model, being a single method of analysis, allows to compare the urban forests of different cities. However, the data should be treated with caution, as there are several variable attributes of each city that affect the structure of the Urban Forest and its functions.

In the following tables, we compare the results obtained in Santa Cruz de Tenerife with those of other cities in the world that have used the same method.

The number of Santa Cruz trees has been calculated, as in the rest of the cities of these comparative tables, including the trees in the green areas, parks and gardens (public and private), in streets and in the forest areas of the city. With **388,000 trees, Santa Cruz de Tenerife far exceeds the WHO-recommended value** of 1 tree per 3 inhabitants, with a ratio of **1 tree per 0.5 inhabitants**. If we limit to the strictly urban area, that threshold is also easily exceeded, obtaining a value of 1 tree per 1.9 inhabitants. Therefore, we can conclude that Santa Cruz is a city with an adequate number of trees. As for its tree cover, calculated using the **i-Tree canopy** software, it reaches **19.1%, being on the average with the rest of international values**.

Carbon storage and sequestration values are on average for other cities. With an average carbon storage value of 172 kg per tree, it's near the average value of 179. For carbon sequestration, the average unit value (11 kg/year) is twice the average value of other cities.

For the removal of contamination, the value obtained is less than the average. The difference with other cities may be due to because the amounts of PM_{10} captured are contemplated or not in the calculation of this parameter. In Santa Cruz de Tenerife, only the removal values of $PM_{2.5}$ have been obtained, as set by i-Tree in its new versions. Therefore, the values are comparatively lower than other cities in which the amounts of PM_{10} are also added, as contemplated in the analysis of the i-Tree software in previous versions.

City	Country	Number of trees	Tree cover	Carbon storage (MT)	Carbon sequestration (MT/yr)	Contamination removal (MT/yr)
Toronto	Canada	10,220,000	26.6	1,108,000	46,700	1,905
Atlanta	United States	9,415,000	36.7	1,220,000	42,100	1,509
Morgantown	United States	658,000	35.5	84,000	2,600	65
Freehold	United States	48,000	34.4	18,000	500	20
Halifax	Canada	7,400,000	34.3	380,000	20,392	547
Woodbridge	United States	986,000	29.5	145,000	5,000	191
Oakville	Canada	1,908,000	29.1	133,000	6,000	172
Washington DC	United States	1,928,000	28.6	477,000	14,700	379
Syracuse	United States	1,088,000	26.9	166,000	5,300	99
Minneapolis	United States	979,000	26.4	227,000	8,100	277
Madrid	Spain	5,700,000	26.0	470,789	29,176	673
Hartford	United States	568,000	25.9	130,000	3,900	52
Barcelona	Spain	1,419,823	24.0	113,437	5,422	305
Boston	United States	1,183,000	22.3	290,000	9,500	257
Baltimore	United States	2,479,000	21.0	517,000	16,700	390
New York	United States	5,212,000	20.9	1,225,000	38,400	1,521
Sta. Cruz de Tenerife	**Spain**	**388,000**	**19.1**	**66,915**	**4,356**	**62**
Chicago	United States	3,585,000	17.2	649,000	22,800	806
Edimburgo	United Kingdom	600,000	17.0	145,611	4,721	100
Wrexham	United Kingdom	364,000	17.0	66,000	1,300	60
Philadelphia	United States	2,113,000	15.7	481,000	14,600	522
Glasgow	United Kingdom	2,000,000	15.0	183,000	9,000	283
London	United Kingdom	8,421,000	14.0	2,367,000	77,200	2,241
Olham	United Kingdom	466,800	12.0	66,508	3,168	65
San Francisco	United States	668,000	11.9	176,000	4,600	128
Torbay	United Kingdom	818,000	11.8	98,100	3,310	50
Jersey City	United States	136,000	11.5	19,000	800	37
Los Angeles	United States	5,993,000	11.1	1,151,000	69,800	1,792
Casper	United States	123,000	8.9	34,000	1,100	34
Strasbourg	France	588,000		128,000	4,060	88

Also, Santa Cruz de Tenerife has an air quality that rarely exceeds the values recommended by WHO, except in episodes of suspended Saharan dust from the African continent. Less pollution than in other larger or more polluted cities may also be the reason of this variation.

APPENDIX 2

LIST OF SPECIES

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Acacia	16	0,032%	2.945,20	0,046%	712,20	0,078%	8,02	0,47	5,11	1,25	17,70	2,50	397,90	17,70	213,20	62,80	10.664,50	10.726,40
Acacia baileyana	11	0,022%	2.547,10	0,040%	616,00	0,062%	16,63	0,61	4,42	1,63	15,50	2,10	344,20	15,50	184,50	54,20	9.223,30	9.276,80
Acacia caven	24	0,048%	2.832,60	0,044%	685,20	0,092%	3,48	0,35	4,92	0,95	16,80	2,70	382,80	16,80	205,20	60,90	10.254,90	10.315,50
Acacia cyclops	226	0,454%	44.934,20	0,702%	10.865,20	1,156%	195,79	8,51	78,01	22,71	269,00	39,20	6.074,30	269,00	3.257,20	956,60	162.695,90	163.646,40
Acacia dealbata	9	0,018%	918,90	0,014%	222,30	0,032%	0,85	0,11	1,59	0,28	5,40	0,90	124,20	5,40	66,60	19,80	3.326,40	3.346,20
Acacia koa	4	0,008%	918,00	0,014%	222,00	0,022%	2,33	0,15	1,59	0,39	5,60	0,80	124,00	5,60	66,40	19,60	3.324,40	3.343,60
Acacia melanoxylon	1	0,002%	305,60	0,005%	49,50	0,007%	0,62	0,04	0,53	0,10	1,80	0,30	41,30	1,80	22,20	4,30	741,40	745,70
Acacia pycnantha	530	1,064%	54.873,20	0,858%	13.274,60	1,922%	57,17	6,42	95,24	17,11	322,50	53,60	7.416,90	322,50	3.977,20	1.181,90	198.640,80	199.822,70
Acacia retinodes	30	0,060%	4.837,00	0,076%	1.170,00	0,136%	42,78	1,38	8,40	3,67	29,00	4,00	654,00	29,00	351,00	103,00	17.512,00	17.615,00
Acoelorrhaphe wrightii	8	0,016%	241,60	0,004%	40,80	0,020%	0,03	0,00	0,42	0,00	1,60	0,00	32,80	1,60	17,60	644,00	16,00	660,00
Adansonia	8	0,016%	1.087,20	0,017%	81,60	0,033%	1,75	0,16	1,89	0,44	6,40	0,80	147,20	6,40	79,20	0,00	0,00	0,00
Adansonia digitata	12	0,024%	2.255,60	0,035%	169,20	0,059%	8,38	0,31	3,92	0,83	13,30	1,80	305,30	13,30	164,10	0,00	0,00	0,00
Adonidia merrilli	21	0,042%	634,20	0,010%	107,10	0,052%	0,08	0,00	1,10	0,01	4,20	0,00	86,10	4,20	46,20	1.690,50	42,00	1.732,50
Agathis	1	0,002%	9,80	0,000%	0,70	0,002%	0,01	0,00	0,02	0,01	0,10	0,00	1,30	0,10	0,70	0,10	5,50	5,50
Albizia julibrissin	16	0,032%	2.279,60	0,036%	99,40	0,068%	3,84	0,31	3,96	0,83	13,30	2,20	308,50	13,30	165,80	9,10	99,30	107,50
Aleurites moluccanus	21	0,042%	4.059,30	0,063%	304,50	0,106%	12,38	0,76	7,05	2,04	23,10	4,20	548,10	23,10	294,00	0,00	0,00	0,00
Allamanda blanchetii	1	0,002%	12,70	0,000%	1,00	0,002%	0,00	0,00	0,02	0,00	0,10	0,00	1,70	0,10	0,90	0,10	1,00	1,00
Aloe	1	0,002%	156,20	0,002%	26,20	0,004%	0,01	0,00	0,27	0,00	0,90	0,10	21,10	0,90	11,30	347,40	8,90	356,30
Araucaria	1	0,002%	21,40	0,000%	3,30	0,002%	0,01	0,00	0,04	0,01	0,10	0,00	2,90	0,10	1,50	0,30	25,00	25,30
Araucaria bidwillii	3	0,006%	233,70	0,004%	36,60	0,010%	0,14	0,02	0,41	0,04	1,50	0,30	31,50	1,50	16,80	3,30	273,90	277,20
Araucaria columnaris	31	0,062%	415,40	0,006%	31,00	0,069%	0,30	0,11	0,72	0,28	3,10	0,00	55,80	3,10	31,00	3,10	232,50	235,60
Araucaria excelsa	10	0,020%	2.422,10	0,038%	379,40	0,058%	3,10	0,13	4,21	0,36	14,60	2,10	327,30	14,60	175,40	33,20	2.841,00	2.874,30
Araucaria heterophylla	152	0,305%	36.416,60	0,569%	5.703,60	0,874%	50,30	2,09	63,23	5,57	219,70	33,70	4.921,10	219,70	2.637,20	499,80	42.713,80	43.213,70
Arbutus canariensis	20	0,040%	1.896,00	0,030%	142,00	0,070%	12,02	0,74	3,29	1,98	12,00	2,00	256,00	12,00	138,00	12,00	70,00	84,00
Archontophoenix	54	0,108%	2.075,00	0,032%	346,90	0,141%	0,24	0,01	3,60	0,02	11,20	0,30	280,70	11,20	150,70	5.535,20	139,50	5.675,10
Archontophoenix alexandrae	36	0,072%	1.875,40	0,029%	312,80	0,102%	0,32	0,01	3,25	0,02	10,00	1,40	253,40	10,00	136,00	5.002,00	126,00	5.128,00

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Archontophoenix cunninghamiana	19	0,038%	651,20	0,010%	108,60	0,048%	0,09	0,00	1,13	0,01	3,90	0,00	87,40	3,90	46,70	1.736,90	42,90	1.779,60
Areca	17	0,034%	468,10	0,007%	78,80	0,041%	0,06	0,00	0,81	0,01	3,00	0,00	63,40	3,00	34,20	1.092,90	27,90	1.120,70
Areca catechu	17	0,034%	778,60	0,012%	130,90	0,046%	0,09	0,00	1,35	0,01	5,10	0,00	105,40	5,10	56,10	1.819,00	45,90	1.864,90
Arenga	22	0,044%	672,70	0,011%	113,40	0,055%	0,08	0,00	1,17	0,01	4,50	0,00	91,30	4,50	49,00	1.570,90	40,00	1.610,90
Arenga pinnata	6	0,012%	368,40	0,006%	61,80	0,018%	0,04	0,00	0,64	0,00	2,40	0,60	49,80	2,40	27,00	861,00	21,60	882,60
Artocarpus	2	0,004%	97,20	0,002%	7,20	0,006%	0,02	0,01	0,17	0,02	0,60	0,00	13,20	0,60	7,00	55,00	4,80	59,80
Artocarpus altilis	6	0,012%	291,60	0,005%	21,60	0,017%	0,06	0,02	0,51	0,05	1,80	0,00	39,60	1,80	21,00	165,00	14,40	179,40
Artocarpus mariannensis	1	0,002%	48,60	0,001%	3,60	0,003%	0,01	0,00	0,08	0,01	0,30	0,00	6,60	0,30	3,50	27,50	2,40	29,90
Attalea	12	0,024%	829,30	0,013%	138,80	0,037%	0,13	0,00	1,44	0,01	4,90	0,50	112,10	4,90	60,20	2.213,50	55,80	2.268,60
Attalea dubia	1	0,002%	82,50	0,001%	13,80	0,003%	0,02	0,00	0,14	0,00	0,50	0,10	11,20	0,50	6,00	220,10	5,50	225,60
Azadirachta indica	2	0,004%	225,60	0,004%	16,80	0,008%	0,17	0,02	0,39	0,06	1,40	0,20	30,60	1,40	16,40	1,40	8,40	10,00
Bactris	2	0,004%	27,10	0,000%	4,50	0,004%	0,00	0,00	0,05	0,00	0,20	0,00	3,70	0,20	2,00	72,40	1,80	74,20
Bactris gasipaes	5	0,010%	214,00	0,003%	36,00	0,013%	0,07	0,00	0,37	0,01	1,50	0,00	29,00	1,50	15,50	571,50	14,50	586,00
Barringtonia	2	0,004%	159,00	0,002%	12,00	0,007%	0,17	0,02	0,28	0,06	1,00	0,20	21,60	1,00	11,60	69,40	6,80	76,20
Bauhinia	2	0,004%	611,20	0,010%	45,80	0,014%	1,19	0,07	1,06	0,20	3,60	0,60	82,60	3,60	44,40	373,00	74,60	447,80
Bauhinia purpurea	3	0,006%	561,10	0,009%	42,00	0,015%	1,25	0,08	0,97	0,23	3,40	0,50	75,80	3,40	40,60	342,50	68,50	411,20
Bauhinia variegata	854	1,715%	100.617,10	1,573%	7.502,00	3,287%	147,88	12,86	174,65	34,30	596,40	93,50	13.601,80	596,40	7.291,50	61.402,90	12.306,80	73.717,90
Beaucarnea recurvata	7	0,014%	1.654,80	0,026%	123,90	0,040%	4,14	0,25	2,87	0,68	9,80	1,40	224,00	9,80	119,70	1.643,60	42,00	1.685,60
Bismarckia nobilis	93	0,187%	5.488,90	0,086%	919,50	0,273%	0,59	0,01	9,53	0,03	28,20	9,30	741,30	28,20	394,20	14.665,00	366,00	15.031,00
Bolusanthus speciosus	23	0,046%	2.348,30	0,037%	174,80	0,083%	1,98	0,27	4,08	0,72	13,80	2,30	317,40	13,80	170,20	1.432,90	287,50	1.720,40
Borassus aethiopium	3	0,006%	1.258,50	0,020%	211,20	0,026%	0,11	0,00	2,18	0,00	7,50	1,20	170,10	7,50	91,20	936,60	474,60	1.411,50
Bougainvillea glabra	1	0,002%	82,60	0,001%	6,20	0,003%	0,09	0,01	0,14	0,03	0,50	0,10	11,20	0,50	6,00	0,50	3,10	3,60
Brachychiton	7	0,014%	515,90	0,008%	45,50	0,022%	0,58	0,08	0,90	0,22	2,80	0,70	70,00	2,80	37,10	0,00	0,00	0,00
Brachychiton acerifolius	3.111	6,247%	472.310,00	7,382%	41.428,70	13,629%	1.805,57	84,94	820,20	226,54	2.727,00	483,80	63.936,80	2.727,00	34.199,70	0,00	0,00	0,00
Brachychiton discolor	794	1,594%	149.145,90	2,331%	13.066,10	3,925%	510,31	25,71	258,99	68,59	868,70	142,80	20.178,40	868,70	10.817,20	0,00	0,00	0,00
Brachychiton populneus	1.675	3,364%	208.519,00	3,259%	18.307,70	6,623%	488,40	33,00	362,12	88,02	1.190,70	230,80	28.235,40	1.190,70	15.082,40	0,00	0,00	0,00
Brachychiton rupestris	23	0,046%	1.695,10	0,026%	149,50	0,073%	1,89	0,27	2,94	0,72	9,20	2,30	230,00	9,20	121,90	0,00	0,00	0,00
Brahea	6	0,012%	111,60	0,002%	18,60	0,014%	0,02	0,00	0,19	0,00	0,60	0,00	15,00	0,60	8,40	298,20	7,20	306,00
Brahea armata	2	0,004%	135,00	0,002%	22,60	0,006%	0,01	0,00	0,23	0,00	0,80	0,20	18,20	0,80	9,80	360,20	9,00	369,20
Brahea brandegeei	4	0,008%	202,40	0,003%	34,00	0,011%	0,02	0,00	0,35	0,00	1,20	0,00	27,20	1,20	14,80	540,00	13,60	553,60
Brahea edulis	4	0,008%	245,60	0,004%	41,20	0,012%	0,03	0,00	0,43	0,00	1,60	0,40	33,20	1,60	18,00	655,60	16,40	672,00
Brosimum	3	0,006%	98,70	0,002%	7,50	0,008%	0,02	0,01	0,17	0,02	0,60	0,00	13,20	0,60	7,20	55,80	4,80	60,60
Bursera simaruba	2	0,004%	77,00	0,001%	5,80	0,005%	0,02	0,01	0,13	0,02	0,40	0,00	10,40	0,40	5,60	42,60	31,60	74,20
Butia	3	0,006%	106,20	0,002%	17,70	0,008%	0,01	0,00	0,18	0,00	0,60	0,00	14,40	0,60	7,80	283,50	7,20	290,40
Butia capitata	8	0,016%	331,20	0,005%	55,20	0,021%	0,04	0,00	0,57	0,00	1,60	0,00	44,80	1,60	24,00	883,20	22,40	905,60

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Buxus sempervirens	2	0,004%	141,80	0,002%	10,60	0,006%	0,17	0,02	0,25	0,06	0,80	0,20	19,20	0,80	10,20	1,00	10,60	11,60
Caesalpinia	5	0,010%	510,50	0,008%	45,50	0,018%	0,43	0,06	0,89	0,16	3,00	0,50	69,00	3,00	37,00	371,50	74,50	446,00
Caesalpinia cacalaco	1	0,002%	102,10	0,002%	9,10	0,004%	0,09	0,01	0,18	0,03	0,60	0,10	13,80	0,60	7,40	74,30	14,90	89,20
Caesalpinia spinosa	35	0,070%	3.431,50	0,054%	306,00	0,124%	2,83	0,39	5,96	1,04	20,00	3,50	464,00	20,00	248,50	2.497,50	500,50	2.998,00
Canarium	3	0,006%	1.914,60	0,030%	143,40	0,036%	12,62	0,35	3,32	0,94	11,40	1,50	258,90	11,40	138,90	1.061,10	787,50	1.848,60
Caryota	22	0,044%	1.346,40	0,021%	225,40	0,065%	0,45	0,01	2,34	0,03	7,20	0,80	182,40	7,20	97,60	3.593,60	90,40	3.684,80
Caryota mitis	143	0,287%	4.360,20	0,068%	735,70	0,355%	0,55	0,01	7,57	0,04	28,60	0,00	591,90	28,60	317,80	11.623,50	289,20	11.911,90
Caryota urens	71	0,143%	3.880,80	0,061%	650,50	0,203%	0,45	0,01	6,74	0,02	21,90	0,30	526,20	21,90	284,70	10.363,30	262,80	10.626,40
Casimiroa edulis	22	0,044%	3.975,40	0,062%	297,00	0,106%	14,73	0,85	6,90	2,26	24,20	4,40	536,80	24,20	288,20	26,40	2.156,00	2.182,40
Cassia fistula	6	0,012%	1.350,50	0,021%	350,80	0,033%	2,54	0,17	2,34	0,46	8,00	1,30	182,50	8,00	98,00	2.859,80	572,40	3.432,00
Cassia javanica	3	0,006%	185,90	0,003%	48,30	0,009%	0,10	0,02	0,32	0,04	1,20	0,10	25,20	1,20	13,50	393,70	78,80	472,40
Cassia nodosa	1	0,002%	229,50	0,004%	59,60	0,006%	0,58	0,04	0,40	0,10	1,40	0,20	31,00	1,40	16,60	486,10	97,30	583,40
Cassia spectabilis	284	0,570%	36.663,80	0,573%	9.518,10	1,143%	69,08	4,91	63,64	13,11	217,00	34,80	4.955,70	217,00	2.656,80	77.640,40	15.546,20	93.163,80
Castanea sativa	2	0,004%	211,20	0,003%	14,80	0,007%	0,16	0,02	0,37	0,06	1,20	0,20	28,60	1,20	15,40	0,00	0,00	0,00
Casuarina cunninghamiana	10	0,020%	987,00	0,015%	74,00	0,036%	0,86	0,12	1,71	0,31	6,00	1,00	133,00	6,00	72,00	4.527,00	37,00	4.564,00
Casuarina equisetifolia	300	0,602%	177.779,20	2,778%	13.582,60	3,381%	160,33	5,87	308,67	15,64	1.056,20	153,80	24.046,10	1.056,20	12.895,50	832.022,50	6.776,30	838.803,10
Cecropia	1	0,002%	109,10	0,002%	8,20	0,004%	0,09	0,01	0,19	0,03	0,60	0,10	14,80	0,60	7,90	35,60	6,10	41,70
Cedrela	1	0,002%	503,50	0,008%	37,70	0,010%	4,12	0,12	0,87	0,31	3,00	0,40	68,10	3,00	36,50	3,30	18,80	22,10
Cedrela odorata	18	0,036%	7.128,80	0,111%	533,80	0,148%	69,14	1,96	12,38	5,21	42,70	5,40	964,50	42,70	517,70	46,30	266,80	313,20
Ceiba	3	0,006%	1.163,70	0,018%	87,00	0,024%	7,07	0,25	2,02	0,66	6,90	0,90	157,50	6,90	84,30	0,00	0,00	0,00
Ceiba pentandra	16	0,032%	4.589,20	0,072%	343,50	0,104%	20,87	0,72	7,97	1,93	27,10	4,40	620,80	27,10	332,70	0,00	0,00	0,00
Ceratonia siliqua	168	0,337%	23.245,30	0,363%	1.733,80	0,701%	102,73	4,44	40,35	11,85	138,00	21,00	3.142,60	138,00	1.685,70	14.186,00	2.844,10	17.031,20
Chamaedorea	3	0,006%	39,60	0,001%	6,60	0,007%	0,01	0,00	0,07	0,00	0,30	0,00	5,40	0,30	3,00	105,90	2,70	108,30
Chamaedorea seifrizii	5	0,010%	66,00	0,001%	11,00	0,011%	0,01	0,00	0,11	0,00	0,50	0,00	9,00	0,50	5,00	176,50	4,50	180,50
Chamaerops	4	0,008%	69,80	0,001%	11,60	0,009%	0,01	0,00	0,12	0,00	0,40	0,00	9,40	0,40	5,20	186,20	4,60	191,00
Chamaerops humilis	641	1,287%	48.042,00	0,751%	8.065,10	2,038%	5,14	0,07	83,42	0,21	307,40	62,50	6.512,30	307,40	3.482,00	128.282,70	3.224,00	131.505,20
Chorisia speciosa	82	0,165%	15.521,90	0,243%	1.162,30	0,407%	44,57	2,43	26,95	6,47	91,00	15,30	2.099,70	91,00	1.125,70	0,00	0,00	0,00
Cinnamomum camphora	13	0,026%	295,10	0,005%	19,50	0,031%	0,07	0,03	0,51	0,08	1,30	0,00	40,30	1,30	20,80	0,00	0,00	0,00
Citharexylum	350	0,703%	36.895,00	0,577%	2.761,10	1,279%	138,83	8,31	64,05	22,15	221,90	40,90	4.996,40	221,90	2.678,60	239,10	1.377,60	1.628,60
Citrus	26	0,052%	2.699,40	0,042%	364,50	0,094%	3,09	0,33	4,69	0,88	16,10	2,80	365,20	16,10	195,60	31,50	2.364,20	2.395,70
Citrus aurantium	15	0,030%	1.610,10	0,025%	217,60	0,055%	1,84	0,20	2,79	0,53	9,50	1,60	217,60	9,50	116,70	18,90	1.409,90	1.428,80
Citrus limon	12	0,024%	1.281,90	0,020%	188,40	0,044%	5,01	0,24	2,23	0,64	7,60	1,30	173,30	7,60	92,90	16,30	1.224,10	1.240,40
Clusia rosea	5	0,010%	91,50	0,001%	7,00	0,011%	0,03	0,01	0,16	0,03	0,50	0,00	12,50	0,50	6,50	0,00	0,00	0,00
Coccoloba uvifera	693	1,392%	74.506,30	1,164%	5.585,10	2,556%	148,44	11,38	129,30	30,34	442,80	75,60	10.087,40	442,80	5.407,50	468,00	2.792,40	3.255,30
Coccothrinax	84	0,169%	2.557,40	0,040%	429,20	0,209%	0,32	0,01	4,44	0,03	16,90	0,00	347,60	16,90	186,10	6.822,30	171,10	6.994,30
Coccothrinax argentata	1	0,002%	25,70	0,000%	4,30	0,002%	0,00	0,00	0,04	0,00	0,20	0,00	3,50	0,20	1,90	68,60	1,70	70,40

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Coccothrinax barbadensis	9	0,018%	302,40	0,005%	50,40	0,023%	0,04	0,00	0,52	0,00	1,80	0,00	40,50	1,80	21,60	806,40	19,80	826,20
Cocos	4	0,008%	202,40	0,003%	34,00	0,011%	0,02	0,00	0,35	0,00	1,20	0,00	27,20	1,20	14,80	540,00	13,60	553,60
Cocos nucifera	152	0,305%	10.997,40	0,172%	1.844,40	0,477%	1,46	0,03	19,09	0,08	69,50	14,70	1.486,10	69,50	802,00	29.354,70	735,70	30.090,20
Coffea arabica	3	0,006%	196,50	0,003%	14,70	0,009%	0,25	0,04	0,34	0,09	1,20	0,30	26,70	1,20	14,40	0,00	0,00	0,00
Colvillea racemosa	1	0,002%	102,10	0,002%	7,60	0,004%	0,09	0,01	0,18	0,03	0,60	0,10	13,80	0,60	7,40	62,30	12,50	74,80
Copernicia	7	0,014%	371,70	0,006%	62,30	0,020%	0,04	0,00	0,65	0,00	2,10	0,00	50,40	2,10	27,30	992,60	25,20	1.017,80
Copernicia prunifera	3	0,006%	124,20	0,002%	20,70	0,008%	0,01	0,00	0,22	0,00	0,60	0,00	16,80	0,60	9,00	331,20	8,40	339,60
Cordia sebestena	8	0,016%	190,40	0,003%	14,40	0,019%	0,04	0,02	0,33	0,05	0,80	0,00	25,60	0,80	13,60	0,00	0,00	0,00
Cordyline	1	0,002%	26,80	0,000%	4,50	0,002%	0,00	0,00	0,05	0,00	0,20	0,00	3,60	0,20	1,90	59,60	1,50	61,10
Cordyline australis	13	0,026%	588,90	0,009%	98,80	0,035%	0,07	0,00	1,02	0,00	3,90	0,00	79,30	3,90	42,90	1.309,10	33,80	1.341,60
Corymbia ficifolia	9	0,018%	3.368,00	0,053%	252,40	0,071%	10,81	0,46	5,85	1,22	19,70	3,00	455,30	19,70	244,30	6.200,30	630,10	6.830,40
Corynocarpus laevigatus	3	0,006%	628,20	0,010%	47,10	0,016%	1,77	0,11	1,09	0,29	3,60	0,60	84,90	3,60	45,60	4,20	47,10	51,00
Corypha	17	0,034%	741,80	0,012%	124,10	0,046%	0,08	0,00	1,29	0,01	4,20	0,60	100,80	4,20	53,80	1.979,30	49,60	2.028,60
Corypha utan	3	0,006%	232,20	0,004%	39,00	0,010%	0,02	0,00	0,40	0,00	1,50	0,30	31,50	1,50	16,80	620,10	15,60	635,70
Crescentia cujete	6	0,012%	1.356,60	0,021%	101,40	0,033%	3,54	0,22	2,36	0,58	7,80	1,20	183,60	7,80	98,40	24,60	37,80	62,40
Cupressus sempervirens	1.087	2,183%	44.426,00	0,694%	6.964,40	2,877%	75,82	7,01	77,15	18,61	269,20	10,60	5.999,00	269,20	3.210,10	0,00	27.841,20	27.841,20
Cycas	115	0,231%	13.006,30	0,203%	2.178,80	0,434%	1,24	0,01	22,57	0,03	74,40	11,50	1.757,20	74,40	940,60	12.264,10	742,20	13.006,30
Cycas circinalis	175	0,351%	11.812,50	0,185%	1.977,50	0,536%	0,21	0,02	20,49	0,05	70,00	17,50	1.592,50	70,00	857,50	11.130,00	665,00	11.812,50
Cycas revoluta	481	0,966%	50.553,10	0,790%	8.465,60	1,756%	4,86	0,05	87,73	0,14	288,60	48,10	6.830,20	288,60	3.655,60	47.667,10	2.886,00	50.553,10
Delonix	3	0,006%	306,30	0,005%	22,80	0,011%	0,25	0,04	0,53	0,09	1,80	0,30	41,40	1,80	22,20	2,10	22,80	24,90
Delonix regia	4.093	8,219%	690.619,70	10,794%	51.604,20	19,013%	2.462,82	120,92	1.198,94	322,58	4.131,90	614,80	93.353,20	4.131,90	50.061,20	4.574,70	51.604,20	56.178,40
Dombeya	2	0,004%	445,40	0,007%	33,40	0,011%	1,16	0,07	0,77	0,19	2,60	0,40	60,20	2,60	32,40	0,00	0,00	0,00
Dovyalis	18	0,036%	2.010,60	0,031%	151,30	0,068%	8,30	0,41	3,49	1,09	12,30	2,20	272,60	12,30	146,30	12,90	75,50	88,40
Dracaena	47	0,094%	7.902,00	0,123%	591,30	0,218%	17,97	1,20	13,72	3,19	47,20	6,40	1.069,60	47,20	571,50	7.849,00	200,40	8.048,80
Dracaena draco	1.212	2,434%	199.935,90	3,125%	33.534,40	5,559%	18,92	0,14	347,14	0,41	1.154,10	131,00	27.012,10	1.154,10	14.467,40	444.679,60	11.386,40	456.065,90
Dypsis	22	0,044%	470,10	0,007%	78,60	0,052%	0,07	0,00	0,82	0,01	2,80	0,00	64,00	2,80	34,30	1.254,00	31,10	1.285,70
Dypsis decaryi	331	0,665%	13.589,20	0,212%	2.266,60	0,877%	1,61	0,04	23,57	0,10	66,90	0,00	1.838,20	66,90	984,70	36.237,90	917,80	37.156,20
Dypsis leptocheilos	9	0,018%	372,60	0,006%	62,10	0,024%	0,04	0,00	0,65	0,00	1,80	0,00	50,40	1,80	27,00	993,60	25,20	1.018,80
Dypsis lutescens	528	1,060%	16.276,60	0,254%	2.745,80	1,315%	2,13	0,06	28,24	0,17	106,50	0,30	2.209,50	106,50	1.186,10	43.391,20	1.079,60	44.468,70
Dypsis madagascariensis	15	0,030%	531,00	0,008%	88,50	0,038%	0,06	0,00	0,92	0,00	3,00	0,00	72,00	3,00	39,00	1.417,50	36,00	1.452,00
Elaeis guineensis	8	0,016%	424,80	0,007%	71,20	0,023%	0,05	0,00	0,74	0,00	2,40	0,00	57,60	2,40	31,20	1.134,40	28,80	1.163,20
Enterolobium contortisiliquum	107	0,215%	19.171,40	0,300%	1.432,00	0,515%	104,27	4,09	33,28	10,91	114,20	16,70	2.592,20	114,20	1.390,40	11.700,90	2.343,80	14.047,30
Eriobotrya japonica	56	0,112%	6.006,20	0,094%	447,70	0,206%	12,18	0,92	10,43	2,44	34,30	6,20	811,80	34,30	433,90	0,00	0,00	0,00
Erythrina caffra	30	0,060%	6.054,00	0,095%	452,30	0,155%	59,13	1,82	10,51	4,84	36,20	5,00	818,70	36,20	439,30	3.695,00	740,30	4.435,90
Erythrina crista-galli	11	0,022%	1.395,30	0,022%	104,30	0,044%	12,53	0,40	2,42	1,07	8,30	1,00	188,60	8,30	101,30	851,40	170,60	1.022,40

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Erythrina sandwicensis	3	0,006%	86,40	0,001%	6,60	0,007%	0,01	0,01	0,15	0,02	0,60	0,00	11,70	0,60	6,30	52,80	10,50	63,30
Erythrina variegata	1	0,002%	102,10	0,002%	7,60	0,004%	0,08	0,01	0,18	0,03	0,60	0,10	13,80	0,60	7,40	62,30	12,50	74,80
Eucalyptus camaldulensis	268	0,538%	111.640,00	1,745%	15.450,40	2,283%	287,53	12,03	193,84	32,07	662,70	89,80	15.103,90	662,70	8.094,60	946.935,50	231.482,90	1.178.411,10
Eucalyptus citriodora	58	0,116%	35.035,80	0,548%	4.536,30	0,664%	101,82	3,57	60,83	9,53	207,30	29,70	4.738,70	207,30	2.540,50	277.936,30	67.943,00	345.878,90
Eucalyptus globulus	79	0,159%	67.225,70	1,051%	8.702,30	1,209%	186,77	5,34	116,73	14,23	397,40	57,20	9.092,40	397,40	4.877,30	533.299,90	130.370,20	663.670,30
Eucalyptus robusta	11	0,022%	3.411,40	0,053%	441,70	0,075%	9,83	0,47	5,92	1,26	20,40	2,80	461,40	20,40	247,50	27.064,60	6.616,10	33.680,70
Eugenia uniflora	4	0,008%	139,20	0,002%	10,40	0,010%	0,33	0,05	0,24	0,12	0,80	0,00	18,80	0,80	10,00	93,20	0,00	93,20
Euphorbia	2	0,004%	141,80	0,002%	10,60	0,006%	0,16	0,02	0,25	0,06	0,80	0,20	19,20	0,80	10,20	0,60	7,00	7,60
Euphorbia cotinifolia	10	0,020%	156,00	0,002%	12,00	0,023%	0,05	0,02	0,27	0,06	1,00	0,00	21,00	1,00	11,00	1,00	8,00	8,00
Euphorbia pulcherrima	2	0,004%	141,80	0,002%	10,60	0,006%	0,16	0,02	0,25	0,06	0,80	0,20	19,20	0,80	10,20	0,60	7,00	7,60
Euphorbia tirucalli	6	0,012%	179,40	0,003%	13,20	0,015%	0,10	0,03	0,31	0,07	1,20	0,00	24,00	1,20	13,20	0,60	9,00	9,60
Euterpe	1	0,002%	42,80	0,001%	7,20	0,003%	0,01	0,00	0,07	0,00	0,30	0,00	5,80	0,30	3,10	114,30	2,90	117,20
Ficus	14	0,028%	2.459,40	0,038%	184,00	0,067%	20,30	0,68	4,27	1,81	14,70	2,00	332,90	14,70	178,20	3.692,50	184,00	3.875,90
Ficus aurea	1	0,002%	324,90	0,005%	24,30	0,007%	2,40	0,08	0,56	0,22	1,90	0,30	44,00	1,90	23,60	487,80	24,30	512,10
Ficus auriculata	1	0,002%	48,60	0,001%	3,60	0,003%	0,01	0,00	0,08	0,01	0,30	0,00	6,60	0,30	3,50	73,00	3,60	76,60
Ficus benghalensis	22	0,044%	3.768,00	0,059%	282,00	0,103%	13,21	0,64	6,54	1,72	22,20	3,40	510,60	22,20	273,00	5.657,80	282,00	5.938,40
Ficus benjamina	1.148	2,305%	187.675,30	2,933%	14.049,40	5,239%	457,61	26,90	325,88	71,75	1.119,90	160,30	25.423,00	1.119,90	13.597,20	281.777,70	14.048,30	295.760,60
Ficus binnendijkii	34	0,068%	4.791,90	0,075%	358,90	0,143%	23,50	0,73	8,32	1,95	27,90	3,90	649,40	27,90	347,00	7.195,20	358,60	7.550,80
Ficus carica	76	0,153%	13.834,00	0,216%	1.035,50	0,369%	36,62	2,35	24,02	6,27	83,80	13,40	1.873,90	83,80	1.000,80	20.771,90	1.035,50	21.805,60
Ficus elastica	276	0,554%	69.373,60	1,084%	5.194,60	1,638%	476,20	16,67	120,46	44,46	412,30	61,00	9.388,40	412,30	5.031,60	104.150,10	5.188,30	109.332,70
Ficus lyrata	46	0,092%	11.288,40	0,176%	845,50	0,269%	85,90	2,90	19,60	7,73	66,60	9,80	1.527,60	66,60	819,20	16.946,80	844,30	17.789,70
Ficus macrophylla	75	0,151%	24.644,70	0,385%	1.846,00	0,536%	382,00	2,33	42,80	6,21	146,30	20,50	3.336,10	146,30	1.787,00	36.997,30	1.841,40	38.842,80
Ficus microcarpa v. hillii	2.641	5,304%	715.031,80	11,175%	53.533,40	16,479%	7.121,21	149,43	1.241,56	398,45	4.278,80	620,50	96.755,70	4.278,80	51.861,20	1.073.421,60	53.485,70	1.126.853,60
Ficus religiosa	3	0,006%	569,70	0,009%	42,70	0,015%	4,24	0,14	0,99	0,36	3,30	0,50	77,00	3,30	41,30	855,20	42,60	897,70
Ficus rubiginosa	26	0,052%	6.014,40	0,094%	450,30	0,146%	36,33	1,31	10,44	3,49	35,30	5,30	814,40	35,30	436,40	9.030,00	449,70	9.478,70
Ficus superba	1	0,002%	48,60	0,001%	3,60	0,003%	0,01	0,00	0,08	0,01	0,30	0,00	6,60	0,30	3,50	73,00	3,60	76,60
Ficus sur	1	0,002%	120,20	0,002%	9,00	0,004%	0,08	0,01	0,21	0,03	0,70	0,10	16,30	0,70	8,70	180,50	9,00	189,40
Ficus sycomorus	2	0,004%	240,40	0,004%	18,00	0,008%	0,17	0,02	0,42	0,06	1,40	0,20	32,60	1,40	17,40	361,00	18,00	378,80
Ficus virens	1	0,002%	65,50	0,001%	4,90	0,003%	0,02	0,00	0,11	0,01	0,40	0,10	8,90	0,40	4,80	98,30	4,90	103,20
Flacourtia inermis	1	0,002%	337,80	0,005%	25,30	0,007%	4,06	0,11	0,59	0,30	2,00	0,30	45,70	2,00	24,50	2,20	12,60	14,80
Gaussia	17	0,034%	705,10	0,011%	118,30	0,045%	0,11	0,00	1,22	0,01	4,50	0,00	95,50	4,50	51,00	1.881,20	47,60	1.928,80
Gaussia attenuata	4	0,008%	165,60	0,003%	27,60	0,011%	0,02	0,00	0,29	0,00	0,80	0,00	22,40	0,80	12,00	441,60	11,20	452,80
Ginkgo biloba	1	0,002%	357,50	0,006%	15,80	0,008%	2,36	0,08	0,62	0,22	2,10	0,30	48,40	2,10	25,90	0,00	236,20	236,20
Gleditsia triacanthos	1	0,002%	154,80	0,002%	16,20	0,004%	0,60	0,04	0,27	0,10	0,90	0,10	20,90	0,90	11,20	0,00	0,00	0,00
Grevillea banksii	12	0,024%	2.241,60	0,035%	272,40	0,059%	16,31	0,54	3,89	1,44	13,50	1,80	303,30	13,50	162,60	24,00	272,10	296,10
Grevillea robusta	1.953	3,922%	398.186,10	6,223%	48.380,60	10,145%	1.764,41	74,43	691,27	198,49	2.365,50	361,10	53.868,50	2.365,50	28.880,40	4.256,40	48.335,10	52.585,30

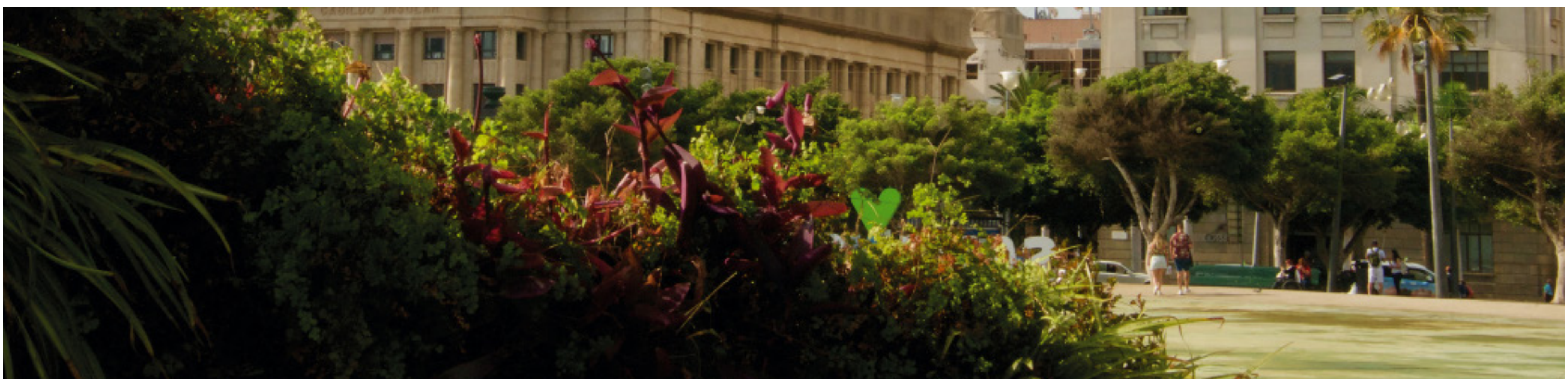
Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Harpephyllum caffrum	8	0,016%	251,10	0,004%	18,80	0,020%	3,24	0,22	0,44	0,59	1,60	0,00	33,60	1,60	18,00	0,00	212,20	212,20
Harpullia pendula	2	0,004%	77,00	0,001%	5,80	0,005%	0,02	0,01	0,13	0,02	0,40	0,00	10,40	0,40	5,60	226,40	0,00	226,40
Hernandia nymphaeifolia	1	0,002%	92,00	0,001%	6,90	0,003%	0,09	0,01	0,16	0,03	0,50	0,10	12,40	0,50	6,70	0,50	5,70	6,20
Heterospathe	3	0,006%	41,70	0,001%	6,90	0,007%	0,01	0,00	0,07	0,00	0,30	0,00	5,70	0,30	3,00	97,50	2,40	99,90
Heterospathe elata	1	0,002%	33,60	0,001%	5,60	0,003%	0,00	0,00	0,06	0,00	0,20	0,00	4,50	0,20	2,40	78,40	2,00	80,40
Hibiscus	9	0,018%	663,30	0,010%	40,50	0,028%	0,76	0,11	1,15	0,28	3,60	0,90	90,00	3,60	47,70	0,00	0,00	0,00
Hibiscus elatus	22	0,044%	1.621,40	0,025%	99,00	0,070%	1,86	0,26	2,82	0,69	8,80	2,20	220,00	8,80	116,60	0,00	0,00	0,00
Hibiscus kokio	1	0,002%	73,70	0,001%	4,50	0,003%	0,08	0,01	0,13	0,03	0,40	0,10	10,00	0,40	5,30	0,00	0,00	0,00
Howea belmoreana	1	0,002%	31,80	0,000%	5,30	0,003%	0,00	0,00	0,06	0,00	0,20	0,00	4,30	0,20	2,30	84,90	2,10	87,10
Howea forsteriana	211	0,424%	5.481,60	0,086%	917,10	0,509%	0,77	0,02	9,53	0,07	42,30	0,00	746,40	42,30	405,10	14.631,80	362,90	15.014,90
Hura crepitans	6	0,012%	1.790,40	0,028%	133,80	0,040%	24,33	0,69	3,11	1,83	10,80	1,80	242,40	10,80	129,60	7,80	89,40	97,20
Hydriastele	2	0,004%	101,20	0,002%	17,00	0,006%	0,01	0,00	0,18	0,00	0,60	0,00	13,60	0,60	7,40	270,00	6,80	276,80
Hyophorbe	6	0,012%	154,20	0,002%	25,80	0,014%	0,02	0,00	0,27	0,00	1,20	0,00	21,00	1,20	11,40	411,60	10,20	422,40
Hyophorbe lagenicaulis	168	0,337%	5.086,80	0,080%	858,00	0,417%	0,70	0,02	8,83	0,05	33,10	0,30	690,50	33,10	370,60	13.561,60	336,80	13.899,40
Hyophorbe verschaffeltii	47	0,094%	1.671,20	0,026%	278,60	0,121%	0,21	0,01	2,90	0,01	9,50	0,00	226,60	9,50	122,70	4.461,30	113,30	4.570,00
Intsia bijuga	2	0,004%	57,60	0,001%	4,40	0,005%	0,01	0,00	0,10	0,01	0,40	0,00	7,80	0,40	4,20	19,20	9,60	28,80
Jacaranda	1	0,002%	226,10	0,004%	16,90	0,006%	0,58	0,04	0,39	0,10	1,30	0,20	30,60	1,30	16,40	0,00	0,00	0,00
Jacaranda mimosifolia	1.536	3,085%	282.678,70	4,418%	21.147,50	7,502%	754,07	39,69	490,77	105,84	1.680,20	244,50	38.276,90	1.680,20	20.466,20	0,00	0,00	0,00
Jacquinia	2	0,004%	386,60	0,006%	29,00	0,010%	1,18	0,07	0,67	0,19	2,20	0,40	52,20	2,20	28,00	168,40	16,60	185,00
Jubaea	1	0,002%	58,50	0,001%	9,80	0,003%	0,01	0,00	0,10	0,00	0,30	0,10	7,90	0,30	4,20	156,30	3,90	160,20
Juniperus	19	0,038%	1.546,60	0,024%	429,40	0,062%	0,99	0,10	2,69	0,27	9,50	1,90	209,00	9,50	112,10	38,00	1.288,20	1.324,30
Lagunaria patersonii	37	0,074%	12.082,10	0,189%	903,80	0,263%	56,91	2,11	20,98	5,62	71,60	11,00	1.634,30	71,60	876,30	0,00	0,00	0,00
Latania	46	0,092%	2.327,60	0,036%	391,00	0,129%	0,25	0,00	4,04	0,01	13,80	0,00	312,80	13,80	170,20	5.437,20	138,00	5.575,20
Latania loddigesii	23	0,046%	1.001,40	0,016%	168,10	0,062%	0,11	0,00	1,74	0,01	6,40	0,00	135,60	6,40	72,40	2.339,50	59,10	2.398,60
Laurus	5	0,010%	1.147,50	0,018%	86,00	0,028%	2,96	0,18	1,99	0,49	7,00	1,00	155,00	7,00	83,00	7,50	43,00	50,50
Laurus nobilis	8	0,016%	736,00	0,012%	55,20	0,028%	0,69	0,09	1,28	0,25	4,00	0,80	99,20	4,00	53,60	4,80	27,20	32,00
Lecythis	1	0,002%	361,40	0,006%	27,10	0,008%	2,41	0,08	0,63	0,22	2,10	0,30	48,90	2,10	26,20	157,50	15,40	172,90
Leucaena	1	0,002%	102,10	0,002%	7,60	0,004%	0,09	0,01	0,18	0,03	0,60	0,10	13,80	0,60	7,40	62,30	12,50	74,80
Leucaena leucocephala	1	0,002%	37,10	0,001%	2,80	0,003%	0,01	0,00	0,06	0,01	0,20	0,00	5,00	0,20	2,70	22,60	4,50	27,20
Ligustrum japonicum	84	0,169%	3.427,10	0,054%	311,60	0,222%	1,68	0,40	5,95	1,07	18,00	0,20	462,90	18,00	249,20	0,00	0,00	0,00
Ligustrum lucidum	23	0,046%	2.729,90	0,043%	248,80	0,089%	3,05	0,32	4,74	0,85	16,60	2,70	368,10	16,60	198,80	0,00	0,00	0,00
Liquidambar styraciflua	2	0,004%	38,20	0,001%	1,80	0,005%	0,01	0,00	0,07	0,01	0,20	0,00	5,20	0,20	2,80	108,80	26,20	135,20
Livistona	40	0,080%	1.995,10	0,031%	334,20	0,112%	0,22	0,00	3,46	0,01	11,40	1,20	270,10	11,40	145,00	5.323,50	134,10	5.457,10
Livistona chinensis	49	0,098%	2.433,60	0,038%	408,10	0,136%	0,35	0,01	4,22	0,02	15,30	1,00	329,20	15,30	175,90	6.493,00	164,10	6.656,70
Macadamia ternifolia	2	0,004%	37,80	0,001%	2,80	0,005%	0,01	0,00	0,07	0,01	0,20	0,00	5,20	0,20	2,80	0,20	2,80	3,00

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Macrozamia	17	0,034%	7.338,90	0,115%	1.230,80	0,149%	0,64	0,00	12,74	0,01	44,20	6,80	992,80	44,20	532,10	6.922,40	416,50	7.338,90
Magnolia grandiflora	7	0,014%	791,40	0,012%	106,90	0,026%	1,14	0,11	1,37	0,29	4,50	0,80	107,00	4,50	57,20	9,10	1.600,80	1.610,50
Malpighia emarginata	1	0,002%	27,30	0,000%	2,00	0,002%	0,01	0,00	0,05	0,01	0,20	0,00	3,70	0,20	2,00	0,00	0,10	0,10
Mangifera	2	0,004%	28,20	0,000%	2,20	0,004%	0,02	0,01	0,05	0,02	0,20	0,00	3,80	0,20	2,00	0,00	23,80	23,80
Mangifera indica	21	0,042%	449,80	0,007%	34,30	0,049%	2,49	0,23	0,78	0,62	3,10	0,00	60,30	3,10	32,20	0,00	379,90	379,90
Markhamia lutea	33	0,066%	3.730,90	0,058%	278,70	0,125%	2,72	0,37	6,48	0,99	22,50	3,30	506,00	22,50	269,00	67,30	105,70	173,00
Maytenus	3	0,006%	247,80	0,004%	18,60	0,010%	0,26	0,04	0,43	0,09	1,50	0,30	33,60	1,50	18,00	1,50	18,60	20,10
Melia azedarach	114	0,229%	27.822,40	0,435%	2.081,60	0,664%	82,75	3,96	48,31	10,57	166,60	22,70	3.765,50	166,60	2.018,90	182,60	1.038,30	1.224,10
Meryta	22	0,044%	1.944,00	0,030%	145,90	0,075%	2,38	0,28	3,37	0,75	11,70	2,30	263,50	11,70	141,20	11,90	145,90	157,70
Mespilus germanica	1	0,002%	30,40	0,000%	2,30	0,002%	0,01	0,00	0,05	0,01	0,20	0,00	4,10	0,20	2,20	0,10	0,30	0,40
Metrosideros	1	0,002%	5,00	0,000%	0,40	0,002%	0,01	0,00	0,01	0,01	0,00	0,00	0,70	0,00	0,40	9,20	0,90	10,20
Metroxylon	9	0,018%	466,20	0,007%	78,30	0,025%	0,07	0,00	0,81	0,00	2,90	0,20	63,00	2,90	33,70	1.089,20	27,50	1.116,70
Mimosa	2	0,004%	97,20	0,002%	7,20	0,006%	0,03	0,01	0,17	0,02	0,60	0,00	13,20	0,60	7,00	59,40	11,80	71,20
Morinda citrifolia	8	0,016%	524,00	0,008%	39,20	0,024%	0,68	0,09	0,91	0,25	3,20	0,80	71,20	3,20	38,40	0,00	0,00	0,00
Morus alba	4	0,008%	967,60	0,015%	70,70	0,023%	3,67	0,17	1,68	0,45	5,80	0,80	130,90	5,80	70,20	6,30	70,70	76,90
Musa	3	0,006%	468,60	0,007%	78,60	0,013%	0,04	0,00	0,81	0,00	2,70	0,30	63,30	2,70	33,90	1.042,20	26,70	1.068,90
Musa acuminata	19	0,038%	2.790,40	0,044%	468,00	0,082%	0,26	0,00	4,84	0,01	16,10	1,90	376,90	16,10	201,90	6.206,00	158,90	6.364,90
Musa ensete	11	0,022%	1.041,40	0,016%	174,80	0,038%	0,10	0,00	1,81	0,00	6,30	1,10	141,20	6,30	75,70	2.316,60	59,20	2.375,80
Musa textilis	1	0,002%	85,60	0,001%	6,40	0,003%	0,09	0,01	0,15	0,03	0,50	0,10	11,60	0,50	6,20	85,10	2,20	87,20
Myoporum	1	0,002%	98,70	0,002%	7,40	0,004%	0,09	0,01	0,17	0,03	0,60	0,10	13,30	0,60	7,20	0,80	3,40	4,10
Myrica	56	0,112%	5.527,20	0,086%	414,40	0,199%	4,61	0,66	9,59	1,75	33,60	5,60	744,80	33,60	403,20	33,60	4.956,00	4.995,20
Myroxylon	2	0,004%	204,20	0,003%	15,20	0,007%	0,17	0,02	0,35	0,06	1,20	0,20	27,60	1,20	14,80	124,60	25,00	149,60
Ochrosia elliptica	3	0,006%	596,10	0,009%	44,70	0,015%	7,39	0,26	1,04	0,68	3,60	0,60	80,70	3,60	43,20	3,90	44,70	48,60
Ocotea	10	0,020%	443,00	0,007%	33,00	0,027%	0,25	0,05	0,77	0,15	2,30	0,10	60,10	2,30	31,90	2,30	27,30	29,60
Olea	294	0,590%	29.017,80	0,454%	2.175,60	1,044%	25,28	3,44	50,36	9,17	176,40	29,40	3.910,20	176,40	2.116,80	176,40	3.263,40	3.439,80
Olea europaea	53	0,106%	14.012,00	0,219%	1.049,30	0,325%	92,49	3,17	24,33	8,46	83,30	12,00	1.895,30	83,30	1.017,50	90,00	1.572,40	1.662,00
Oreopanax	3	0,006%	613,10	0,010%	45,90	0,016%	8,11	0,23	1,06	0,61	3,70	0,60	83,00	3,70	44,40	203,70	103,30	307,00
Pachira aquatica	1	0,002%	25,00	0,000%	1,90	0,002%	0,01	0,00	0,04	0,01	0,10	0,00	3,40	0,10	1,80	0,00	0,00	0,00
Pandanus	18	0,036%	955,80	0,015%	72,00	0,051%	0,67	0,13	1,66	0,35	5,40	0,00	129,60	5,40	70,20	1.139,40	28,80	1.168,20
Pandanus dubius	7	0,014%	371,70	0,006%	28,00	0,020%	0,26	0,05	0,65	0,13	2,10	0,00	50,40	2,10	27,30	443,10	11,20	454,30
Pandanus tectorius	1	0,002%	403,20	0,006%	67,60	0,008%	0,04	0,00	0,70	0,00	2,40	0,30	54,50	2,40	29,20	1.076,20	27,00	1.103,20
Pandanus utilis	38	0,076%	6.551,60	0,102%	1.097,30	0,179%	0,61	0,00	11,37	0,01	39,50	5,20	884,50	39,50	475,30	17.483,90	437,60	17.924,00
Pandanus veitchii	29	0,058%	5.045,80	0,079%	844,90	0,137%	0,46	0,00	8,76	0,01	30,50	4,10	681,20	30,50	366,10	13.465,30	336,80	13.804,40
Parkia	3	0,006%	713,30	0,011%	53,40	0,017%	1,30	0,09	1,24	0,23	4,20	0,70	96,40	4,20	51,80	435,30	87,10	522,60
Parkinsonia aculeata	53	0,106%	9.610,40	0,150%	721,00	0,257%	36,16	1,67	16,69	4,45	58,90	8,40	1.298,50	58,90	697,00	5.866,80	1.174,10	7.041,30
Persea	68	0,137%	7.928,60	0,124%	594,40	0,260%	10,49	1,03	13,77	2,73	44,50	8,10	1.069,70	44,50	576,50	51,90	1.776,70	1.828,60
Persea indica	1	0,002%	453,70	0,007%	34,00	0,009%	2,47	0,09	0,79	0,23	2,70	0,40	61,40	2,70	32,90	3,00	101,80	104,80
Philodendron	9	0,018%	1.405,80	0,022%	235,80	0,040%	0,13	0,00	2,44	0,00	8,10	0,90	189,90	8,10	101,70	3.285,00	83,70	3.368,70
Phoenix canariensis	7.070	14,198%	625.852,40	9,781%	104.916,90	23,979%	73,78	1,11	1.086,83	3,18	3.544,60	703,90	84.622,30	3.544,60	45.555,20	1.277.198,30	0,00	1.277.198,30
Phoenix dactylifera	378	0,759%	26.237,50	0,410%	4.399,40	1,169%	4,49	0,08	45,55	0,23	165,70	35,30	3.547,10	165,70	1.914,40	53.541,80	0,00	53.541,80

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Phoenix reclinata	6	0,012%	274,80	0,004%	46,20	0,016%	0,03	0,00	0,48	0,00	1,80	0,00	37,20	1,80	19,80	560,40	0,00	560,40
Phoenix roebelenii	442	0,888%	13.348,40	0,209%	2.254,20	1,096%	1,68	0,04	23,16	0,13	88,40	0,00	1.812,20	88,40	972,40	27.183,00	0,00	27.183,00
Phytolacca dioica	78	0,157%	16.919,90	0,264%	1.268,50	0,421%	137,01	4,33	29,37	11,55	100,10	14,60	2.288,50	100,10	1.226,40	109,90	633,90	741,20
Pimenta dioica	4	0,008%	837,60	0,013%	62,80	0,021%	2,36	0,15	1,45	0,39	4,80	0,80	113,20	4,80	60,80	1.542,00	156,80	1.698,80
Pinanga	2	0,004%	32,60	0,001%	5,40	0,005%	0,01	0,00	0,06	0,00	0,20	0,00	4,40	0,20	2,40	76,00	2,00	77,80
Pinus canariensis	410	0,823%	35.830,40	0,560%	3.452,20	1,383%	32,31	2,42	62,20	6,47	227,30	47,40	4.832,60	227,30	2.609,40	300,40	51.727,10	52.023,50
Pinus halepensis	13	0,026%	2.432,90	0,038%	234,30	0,064%	4,00	0,17	4,22	0,44	14,80	2,50	328,90	14,80	176,60	20,50	3.512,50	3.532,70
Pinus pinea	5	0,010%	1.017,30	0,016%	98,10	0,026%	2,20	0,08	1,77	0,20	6,10	1,00	137,40	6,10	73,90	8,50	1.468,70	1.477,30
Pithecellobium	11	0,022%	1.123,10	0,018%	83,60	0,040%	0,91	0,13	1,95	0,34	6,60	1,10	151,80	6,60	81,40	685,30	137,50	822,80
Pithecellobium dulce	5	0,010%	763,90	0,012%	57,00	0,022%	4,45	0,16	1,33	0,43	4,50	0,70	103,30	4,50	55,40	466,20	93,40	559,70
Pittosporum	1	0,002%	88,80	0,001%	6,60	0,003%	0,09	0,01	0,15	0,03	0,50	0,10	12,00	0,50	6,40	0,00	0,00	0,00
Pittosporum undulatum	1	0,002%	88,80	0,001%	6,60	0,003%	0,09	0,01	0,15	0,03	0,50	0,10	12,00	0,50	6,40	0,00	0,00	0,00
Plumeria	3	0,006%	266,40	0,004%	19,80	0,010%	7,07	0,25	0,46	0,66	1,50	0,30	36,00	1,50	19,20	1,80	19,80	21,60
Plumeria alba	48	0,096%	3.584,10	0,056%	267,40	0,152%	45,04	1,97	6,22	5,27	20,20	2,90	484,80	20,20	259,70	23,10	267,40	290,50
Podocarpus	1	0,002%	77,90	0,001%	12,20	0,003%	0,05	0,01	0,14	0,01	0,50	0,10	10,50	0,50	5,60	0,00	0,00	0,00
Podocarpus neriifolius	3	0,006%	233,70	0,004%	36,60	0,010%	0,14	0,02	0,41	0,04	1,50	0,30	31,50	1,50	16,80	0,00	0,00	0,00
Populus alba	1	0,002%	9,20	0,000%	0,80	0,002%	0,00	0,00	0,02	0,00	0,10	0,00	1,20	0,10	0,70	49,00	0,40	49,40
Pritchardia	43	0,086%	1.576,70	0,025%	263,00	0,111%	0,19	0,00	2,73	0,01	8,80	0,00	213,70	8,80	115,30	4.207,90	106,80	4.311,50
Pritchardia affinis	4	0,008%	183,20	0,003%	30,80	0,011%	0,02	0,00	0,32	0,00	1,20	0,00	24,80	1,20	13,20	488,80	12,40	501,20
Pritchardia hillebrandii	19	0,038%	786,60	0,012%	131,10	0,050%	0,09	0,00	1,36	0,01	3,80	0,00	106,40	3,80	57,00	2.097,60	53,20	2.150,80
Pritchardia lanaiensis	1	0,002%	41,40	0,001%	6,90	0,003%	0,00	0,00	0,07	0,00	0,20	0,00	5,60	0,20	3,00	110,40	2,80	113,20
Pritchardia lowreyana	2	0,004%	91,60	0,001%	15,40	0,005%	0,01	0,00	0,16	0,00	0,60	0,00	12,40	0,60	6,60	244,40	6,20	250,60
Pritchardia minor	4	0,008%	165,60	0,003%	27,60	0,011%	0,02	0,00	0,29	0,00	0,80	0,00	22,40	0,80	12,00	441,60	11,20	452,80
Pritchardia munroi	7	0,014%	247,80	0,004%	41,30	0,018%	0,03	0,00	0,43	0,00	1,40	0,00	33,60	1,40	18,20	661,50	16,80	677,60
Pritchardia pacifica	112	0,225%	4.636,80	0,072%	772,80	0,297%	0,53	0,01	8,04	0,03	22,40	0,00	627,20	22,40	336,00	12.364,80	313,60	12.678,40
Pritchardia remota	3	0,006%	100,80	0,002%	16,80	0,008%	0,01	0,00	0,17	0,00	0,60	0,00	13,50	0,60	7,20	268,80	6,60	275,40
Prunus amygdalus	1	0,002%	216,00	0,003%	16,70	0,005%	0,72	0,05	0,38	0,12	1,30	0,20	29,20	1,30	15,70	1,50	8,30	9,80
Prunus dulcis	26	0,052%	1.141,80	0,018%	115,10	0,070%	1,03	0,15	1,98	0,41	6,90	0,30	153,60	6,90	83,40	10,40	58,70	66,70
Prunus persica	5	0,010%	460,00	0,007%	35,50	0,017%	0,50	0,07	0,80	0,19	2,50	0,50	62,00	2,50	33,50	3,00	18,00	21,00
Pseudophoenix	8	0,016%	386,20	0,006%	64,40	0,022%	0,06	0,00	0,67	0,00	2,00	0,20	52,20	2,00	28,00	1.030,00	26,00	1.056,00
Pseudophoenix sargentii	9	0,018%	412,20	0,006%	69,30	0,025%	0,05	0,00	0,72	0,00	2,70	0,00	55,80	2,70	29,70	1.099,80	27,90	1.127,70
Psidium guajava	21	0,042%	905,40	0,014%	67,70	0,056%	2,26	0,27	1,57	0,72	5,20	0,20	122,30	5,20	65,20	1.667,50	169,20	1.836,70
Ptychosperma	21	0,042%	362,20	0,006%	60,60	0,048%	0,06	0,00	0,63	0,01	2,20	0,00	49,60	2,20	26,20	965,00	24,00	989,00
Ptychosperma elegans	107	0,215%	3.231,40	0,051%	545,70	0,265%	0,41	0,01	5,61	0,03	21,40	0,00	438,70	21,40	235,40	8.613,50	214,00	8.827,50
Ptychosperma macarthurii	8	0,016%	133,60	0,002%	22,40	0,018%	0,02	0,00	0,23	0,00	0,80	0,00	18,40	0,80	9,60	356,00	8,80	364,80
Punica granatum	10	0,020%	1.333,50	0,021%	100,10	0,041%	7,48	0,32	2,32	0,84	8,30	0,90	180,30	8,30	96,70	961,60	0,00	961,60

Specie	Number	Population Percentage	Leaf Area (m^2)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m^3/yr)	Avoided Runoff (m^3/yr)	Potential Evaporation (m^3/yr)	Evaporation (m^3)	Transpiration (m^3)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Ravenea	11	0,022%	419,00	0,007%	70,30	0,029%	0,05	0,00	0,73	0,00	2,80	0,00	56,80	2,80	30,40	1.118,00	28,20	1.146,60
Ravenea rivularis	5	0,010%	307,00	0,005%	51,50	0,015%	0,03	0,00	0,53	0,00	2,00	0,50	41,50	2,00	22,50	819,50	20,50	840,00
Rhapidophyllum hystrix	2	0,004%	91,60	0,001%	15,40	0,005%	0,01	0,00	0,16	0,00	0,60	0,00	12,40	0,60	6,60	244,40	6,20	250,60
Rhapis	6	0,012%	116,20	0,002%	19,40	0,014%	0,03	0,00	0,20	0,00	0,80	0,00	15,80	0,80	8,60	310,20	7,80	317,80
Rhapis excelsa	36	0,072%	625,80	0,010%	104,40	0,082%	0,10	0,00	1,09	0,01	4,40	0,20	85,20	4,40	46,80	1.672,60	42,40	1.711,60
Rhizophora mangle	6	0,012%	635,70	0,010%	47,70	0,022%	1,19	0,10	1,10	0,27	3,80	0,70	86,10	3,80	46,20	4,00	23,80	27,80
Robinia pseudoacacia	6	0,012%	867,10	0,014%	46,70	0,026%	4,62	0,18	1,51	0,47	5,10	0,80	117,20	5,10	62,90	572,30	46,70	618,50
Rosa	9	0,018%	799,20	0,012%	59,40	0,031%	0,74	0,11	1,39	0,28	4,50	0,90	108,00	4,50	57,60	0,00	0,00	0,00
Roystonea	6	0,012%	368,40	0,006%	61,80	0,018%	0,04	0,00	0,64	0,00	2,40	0,60	49,80	2,40	27,00	983,40	24,60	1.008,00
Roystonea regia	921	1,850%	34.179,60	0,534%	5.710,80	2,384%	6,53	0,17	59,30	0,48	205,50	0,00	4.633,80	205,50	2.501,10	91.251,90	2.316,90	93.498,00
Sabal	3	0,006%	78,60	0,001%	13,10	0,007%	0,01	0,00	0,14	0,00	0,40	0,00	10,60	0,40	5,80	161,60	6,70	168,10
Sabal mauritiiformis	2	0,004%	82,80	0,001%	13,80	0,005%	0,01	0,00	0,14	0,00	0,40	0,00	11,20	0,40	6,00	170,00	7,00	177,00
Sabal mexicana	5	0,010%	229,00	0,004%	38,50	0,014%	0,03	0,00	0,40	0,00	1,50	0,00	31,00	1,50	16,50	470,50	19,00	489,50
Sabal minor	4	0,008%	183,20	0,003%	30,80	0,011%	0,02	0,00	0,32	0,00	1,20	0,00	24,80	1,20	13,20	376,40	15,20	391,60
Sabal palmetto	16	0,032%	983,70	0,015%	164,60	0,048%	0,10	0,00	1,71	0,00	5,80	1,30	132,70	5,80	71,50	2.021,20	83,10	2.103,00
Salix	10	0,020%	2.373,20	0,037%	146,30	0,057%	5,44	0,34	4,12	0,92	14,40	1,90	320,70	14,40	172,50	7.015,60	585,40	7.600,90
Schefflera actinophylla	240	0,482%	18.941,40	0,296%	1.422,30	0,778%	25,22	2,77	32,87	7,37	113,30	20,10	2.565,50	113,30	1.376,10	115,60	1.422,30	1.537,20
Schefflera elegantissima	1	0,002%	22,20	0,000%	1,70	0,002%	0,01	0,00	0,04	0,01	0,10	0,00	3,00	0,10	1,60	0,10	1,70	1,80
Schinus molle	1.869	3,753%	57.506,10	0,899%	4.311,00	4,652%	1.736,37	72,90	99,91	194,46	371,10	0,00	7.695,60	371,10	4.126,80	0,00	73.078,80	73.078,80
Schinus terebinthifolia	397	0,797%	11.057,30	0,173%	834,60	0,970%	260,06	10,93	19,21	29,15	75,30	0,00	1.478,90	75,30	794,90	0,00	14.054,70	14.054,70
Serenoa repens	15	0,030%	531,00	0,008%	88,50	0,038%	0,06	0,00	0,92	0,00	3,00	0,00	72,00	3,00	39,00	2.727,00	45,00	2.772,00
Spathodea campanulata	766	1,538%	168.234,00	2,629%	12.583,50	4,168%	877,46	32,44	292,09	86,51	1.005,50	144,20	22.770,70	1.005,50	12.185,40	3.026,30	4.735,10	7.765,20
Stenocarpus sinuatus	15	0,030%	1.635,00	0,026%	122,60	0,056%	2,33	0,23	2,84	0,60	9,90	1,70	221,40	9,90	118,60	10,10	122,60	132,70
Sterculia foetida	20	0,040%	1.474,00	0,023%	110,00	0,063%	1,65	0,23	2,56	0,62	8,00	2,00	200,00	8,00	106,00	0,00	0,00	0,00
Strelitzia	122	0,245%	27.984,70	0,437%	4.692,80	0,682%	2,55	0,01	48,58	0,04	167,70	19,10	3.781,60	167,70	2.027,70	62.245,80	1.586,40	63.827,30
Swietenia macrophylla	12	0,024%	1.353,60	0,021%	100,80	0,045%	0,99	0,14	2,35	0,37	8,40	1,20	183,60	8,40	98,40	8,40	50,40	60,00
Swietenia mahogani	5	0,010%	564,00	0,009%	42,00	0,019%	0,41	0,06	0,98	0,16	3,50	0,50	76,50	3,50	41,00	3,50	21,00	25,00
Syagrus	38	0,076%	1.575,70	0,025%	264,00	0,101%	0,18	0,00	2,73	0,01	9,40	0,10	213,10	9,40	113,90	4.203,20	106,10	4.309,00
Syagrus coronata	1	0,002%	41,40	0,001%	6,90	0,003%	0,00	0,00	0,07	0,00	0,20	0,00	5,60	0,20	3,00	110,40	2,80	113,20
Syagrus romanzoffiana	978	1,964%	60.428,60	0,944%	10.122,20	2,908%	7,00	0,12	104,94	0,35	313,80	97,00	8.165,10	313,80	4.347,60	161.436,50	4.034,00	165.469,70
Syzygium	36	0,072%	1.252,80	0,020%	93,60	0,092%	3,01	0,42	2,18	1,12	7,20	0,00	169,20	7,20	90,00	1.818,00	0,00	1.818,00
Syzygium jambos	1	0,002%	34,80	0,001%	2,60	0,003%	0,08	0,01	0,06	0,03	0,20	0,00	4,70	0,20	2,50	50,50	0,00	50,50
Syzygium paniculatum	1	0,002%	34,80	0,001%	2,60	0,003%	0,08	0,01	0,06	0,03	0,20	0,00	4,70	0,20	2,50	50,50	0,00	50,50
Tabebuia	6	0,012%	2.036,30	0,032%	152,40	0,044%	14,14	0,48	3,54	1,29	12,10	1,70	275,40	12,10	147,70	0,00	0,00	0,00

Specie	Number	Population Percentage	Leaf Area (m²)	Leaf Area (%)	Foliar Biomass (kg)	Dominance	Carbon Storage (MT)	Carbon Sequestration (MT/year)	Pollution Uptake (kg/yr)	Oxygen Production (MT/yr)	Intercepted Water (m³/yr)	Avoided Runoff (m³/yr)	Potential Evaporation (m³/yr)	Evaporation (m³)	Transpiration (m³)	Isoprenes (g/yr)	Monoterpenes (g/yr)	VOCs (g/yr)
Tabebuia aurea	1	0,002%	226,10	0,004%	16,90	0,006%	0,59	0,04	0,39	0,10	1,30	0,20	30,60	1,30	16,40	0,00	0,00	0,00
Tabebuia rosea	11	0,022%	2.267,90	0,035%	169,50	0,058%	5,41	0,35	3,94	0,94	13,10	2,00	307,00	13,10	164,40	0,00	0,00	0,00
Tamarindus indica	21	0,042%	4.911,80	0,077%	367,20	0,119%	30,35	1,14	8,53	3,04	29,40	4,10	664,20	29,40	356,60	2.997,90	600,60	3.598,90
Tamarix canariensis	65	0,131%	5.167,50	0,081%	390,00	0,211%	5,35	0,76	8,98	2,03	32,50	6,50	702,00	32,50	377,00	32,50	195,00	227,50
Tamarix gallica	4	0,008%	318,00	0,005%	24,00	0,013%	0,33	0,05	0,55	0,12	2,00	0,40	43,20	2,00	23,20	2,00	12,00	14,00
Tecoma stans	9	0,018%	462,80	0,007%	34,60	0,025%	0,12	0,04	0,80	0,09	3,00	0,10	63,00	3,00	33,60	8,20	13,20	21,40
Terminalia catappa	4	0,008%	169,20	0,003%	12,80	0,011%	0,34	0,05	0,29	0,12	1,20	0,00	22,80	1,20	12,40	61,60	3,20	64,80
Terminalia mantaly	2	0,004%	349,20	0,005%	26,20	0,009%	1,16	0,07	0,61	0,19	2,00	0,40	47,20	2,00	25,40	127,00	6,60	133,60
Thespesia populnea	2	0,004%	296,40	0,005%	22,20	0,009%	0,68	0,05	0,51	0,13	1,70	0,30	40,10	1,70	21,50	0,00	0,00	0,00
Thevetia peruviana	103	0,207%	5.505,00	0,086%	414,60	0,293%	9,18	1,23	9,56	3,28	31,10	0,10	746,40	31,10	404,20	31,20	414,60	445,80
Thrinax	6	0,012%	156,40	0,002%	26,30	0,014%	0,02	0,00	0,27	0,00	1,00	0,00	21,20	1,00	11,50	417,10	10,30	427,60
Thrinax radiata	1	0,002%	30,20	0,000%	5,10	0,002%	0,00	0,00	0,05	0,00	0,20	0,00	4,10	0,20	2,20	80,50	2,00	82,50
Tipuana tipu	341	0,685%	69.956,70	1,093%	5.232,80	1,778%	274,50	12,35	121,46	32,94	418,20	62,60	9.457,20	418,20	5.072,80	42.698,70	8.546,70	51.259,90
Trachycarpus	13	0,026%	452,20	0,007%	75,70	0,033%	0,05	0,00	0,78	0,00	2,60	0,00	61,30	2,60	33,00	928,50	38,00	966,50
Trachycarpus fortunei	13	0,026%	460,20	0,007%	76,70	0,033%	0,05	0,00	0,80	0,00	2,60	0,00	62,40	2,60	33,80	945,10	39,00	984,10
Trithrinax	14	0,028%	589,60	0,009%	98,60	0,037%	0,07	0,00	1,02	0,00	3,30	0,00	79,80	3,30	42,70	1.572,80	39,90	1.612,50
Ulmus	1	0,002%	39,10	0,001%	2,70	0,003%	0,01	0,00	0,07	0,01	0,20	0,00	5,30	0,20	2,80	0,20	1,30	1,60
Ulmus pumila	4	0,008%	100,50	0,002%	6,90	0,010%	0,06	0,02	0,17	0,04	0,60	0,00	13,50	0,60	7,20	0,60	3,40	4,00
Veitchia	360	0,723%	12.983,70	0,203%	2.165,60	0,926%	1,60	0,04	22,52	0,11	75,00	0,00	1.760,50	75,00	953,30	34.661,80	879,20	35.508,00
Veitchia merrillii	251	0,504%	9.077,80	0,142%	1.514,70	0,646%	1,29	0,03	15,75	0,10	52,80	0,00	1.230,80	52,80	665,60	24.234,30	615,40	24.827,20
Washingtonia filifera	2.630	5,281%	236.824,10	3,701%	36.640,90	8,983%	34,80	0,59	411,22	1,67	1.479,40	258,50	32.084,30	1.479,40	17.134,00	448.493,30	18.350,20	466.600,20
Washingtonia robusta	853	1,713%	43.749,20	0,684%	6.754,20	2,397%	22,21	0,44	75,94	1,18	255,30	0,00	5.904,50	255,30	3.143,50	82.784,20	3.355,40	86.139,60
Wodyetia bifurcata	395	0,793%	11.941,00	0,187%	2.016,10	0,980%	1,57	0,04	20,72	0,12	79,00	0,00	1.621,10	79,00	869,80	31.829,50	790,80	32.621,10
Yucca	131	0,263%	9.916,60	0,155%	1.659,70	0,418%	0,99	0,01	17,21	0,04	59,30	13,10	1.337,00	59,30	720,10	22.050,50	559,90	22.610,40
Yucca aloifolia	367	0,737%	31.321,80	0,490%	5.258,40	1,227%	3,29	0,08	54,37	0,16	193,10	37,70	4.251,80	193,10	2.280,70	69.680,00	1.778,80	71.458,60
TOTAL	**49.797**	**100,00%**	**6.398.403,60**	**100,00%**	**701.729,50**		**22.859,24**	**874,35**	**11.109,17**	**2.332,38**	**37.866,40**	**5.781,90**	**865.506,40**	**37.866,40**	**463.930,50**	**7854001,30**	**1.404.739,30**	**9.258,00**



APPENDIX 3

NOTES ON METHODOLOGY

i-Tree Eco is designed to use standardized field data and local hourly air pollution and meteorological data to quantify urban forest structure and its numerous effects.

The version used in this study has been the **V6 (Eco 6.0.15; i-Tree 6.1.27)**. The methodology used is developed by the U.S. Forest Service (Nowak et al, 2010) and is based on the following processes:

Tree characteristics

Leaf area of trees used in this study was assessed using measurements of crown dimensions and percentage of crown canopy missing of each specimen since the tree-to-tree information of the municipal maintenance trees of Santa Cruz de Tenerife. If these data variables were not collected, they are estimated by the model.

Air pollution removal

Air pollution removal estimates are derived from calculated hourly tree-canopy resistances for ozone (O_3), and sulphur and nitrogen dioxides (SO_2 and NO_2) based on a hybrid of big-leaf and multi-layer canopy deposition models (Baldocchi et al, 1987). As the removal of carbon monoxide (CO) and particulate matter (PM) by vegetation is not directly related to transpiration, removal rates (deposition velocities) for these pollutants were based on average measured values from the literature (Bidwell y Fraser, 1972; Lovett, 1994) that were adjusted depending on leaf phenology and leaf area. Particulate removal incorporated a 50 percent resuspension rates back to the atmosphere (Zinke 1967).

Recent updates (2011 onwards) to air quality modelling are based on improved leaf area index simulations, weather and pollution processing and interpolation, and updated pollutant monetary values (Hirabayashi et al 2012; Hirabayashi 2011).

Trees remove $PM_{2.5}$ when particulate matter is deposited on leaf surfaces (Nowak et al 2013). This deposited PM2.5 can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors. Generally, $PM_{2.5}$ removal is positive with positive benefits. However, there are some cases when net removal is negative or resuspended particles lead to increased pollution concentrations and negative values. During some months (e.g., with no rain), trees resuspend more particles than they remove.

Resuspension can also lead to increased overall $PM_{2.5}$ concentrations if the boundary layer conditions are lower during net resuspension periods than during net removal periods. Since the pollution removal value is based on the change in pollution concentration, it is possible to have situations when trees remove $PM_{2.5}$ but increase concentrations and thus have negative values during periods of positive overall removal. These events are not common, but can happen.

For i-Tree Eco reports, default air pollution removal value is calculated based on USA local incidence of adverse health effects and national median externality costs. The number of adverse health effects and associated economic value is calculated for ozone, sulphur dioxide, nitrogen dioxide, and particulate matter less than 2.5 microns using data from the U.S. Environmental Protection Agency's Environmental Benefits Mapping and Analysis Program (BenMAP) (Nowak et al 2014). United States median externality costs were used to calculate the value of carbon monoxide removal (Murray et al 1994).

For the analysis in Santa Cruz de Tenerife, pollution removal value is calculated based on the prices of €1,095 per metric ton (carbon monoxide CO), €110,347 per metric ton (ozone O_3), €16,484 per metric ton (nitrogen dioxide NO_2), €6,006 per metric ton (sulphur dioxide SO_2) and €3,829,993 per metric ton (particulate matter less than 2.5 microns $PM_{2.5}$).

Carbon storage and sequestration

Carbon storage is the amount of carbon bound up in the above-ground and below-ground parts of woody vegetation. To calculate current carbon storage, biomass for each tree was calculated using equations from the literature and from measured tree data from the complete inventory of the municipal maintenance trees of Santa Cruz de Tenerife City Council. Open-grown, maintained trees tend to have les biomass than predicted by forest-derived biomass equations (Nowak 1994).

To adjust for this difference, biomass results for open-grown urban trees were multiplied by 0.8. No adjustment was made for trees found in natural stand conditions in the city. Tree dry-weight biomass was converted to stored carbon by multiplying by 0.5.

Carbon sequestration is the removal of carbon dioxide (CO_2) from the air by plants. To estimate the gross amount of carbon sequestered annually, average diameter growth from the appropriate genera and diameter class and tree condition was added to the existing tree diameter (year x) to estimate tree diameter and carbon storage in year x+1.

Carbon storage and carbon sequestration values are based on United States estimated or customized carbon values (US Environmental Protection Agency 2015, Interagency Working Group on Social Cost of Carbon, 2015).

For this analysis, carbon storage and carbon sequestration values are calculated based on €161 per metric ton.

Oxygen production

The amount of oxygen produced is estimated from carbon sequestration based on atomic weights: net O_2 release (kg/yr) = net C sequestration (kg/yr) × 32/12. To estimate the net carbon sequestration rate, the amount of carbon sequestered as a result of tree growth is reduced by the amount lost resulting from tree mortality. Thus, net carbon sequestration and net annual oxygen production of the urban forest account for decomposition (Nowak et al 2007).

However, for projects that have complete tree-to-tree inventory, such as that of Santa Cruz de Tenerife, oxygen production is calculated from gross carbon sequestration and, therefore, mortality of trees has not been considered.

Avoided Runoff

Annual avoided surfaces runoff is calculated based on rainfall interception by vegetation, specifically the difference between annual runoff with and without vegetation. Although tree leaves, branches, and bark may intercept precipitation and thus mitigate surface runoff, only the precipitation intercepted by leaves is accounted for in this analysis.

The value of avoided runoff has been based on average values of U.S. Forest Service's Community Tree Guide Series (McPherson et al., 1999; 2000; 2001; 2002; 2003; 2004; 2006a; 2006b; 2006c; 2007; 2010; Peper et al 2009); For this analysis, avoided runoff value is calculated based on the price of €1,90 per m^3.

Building energy use

Seasonal effects of trees on residential building energy use were calculated based on procedures described in the literature (McPherson y Simpson 1999) using distance and direction of trees from residential structures, tree height and tree condition data. To calculate the monetary value of energy savings, current U.S. prices for kWh and MBTU have been used.

Energy saving value has been calculated based on prices of €230 per kWh y €19,64 per MBTU

Structural values

Structural value is the value of a tree based on the physical resource itself (e.g., the cost of having to replace a tree with a similar tree). Structural values were based on valuation procedures of the Council of Tree and Landscape Appraisers, which uses tree species, diameter, condition, and location information (Nowak et al 2002ª, 2002b).

Relative tree effects

The relative value of tree benefits is calculated to show what carbon storage and sequestration, and air pollutant removal equate to in amounts of municipal carbon emissions, passenger automobile emissions, and house emissions.

Municipal carbon emissions are based on 2010 U.S. per capita carbon emissions (Carbon Dioxide Information Analysis Center 2010). Per capita emission was multiplied by city population to estimate total carbon emissions in Santa Cruz de Tenerife.

Light duty vehicle emissions rates (g/ml) for CO, NO_x, VOCs, PM_{10} and SO_2 for 2010 (Bureau of Transportation Statistics 2010, Heirigs et al 2004) $PM_{2.5}$ for 2011-2015 (California Air Resources Board 2013) and CO_2 for 2011 (U.S. Environmental Protection Agency, 2010) were multiplied by average miles driven per vehicle in 2011 (Federal Highway Administration, 2013) to determine average emissions per vehicle.

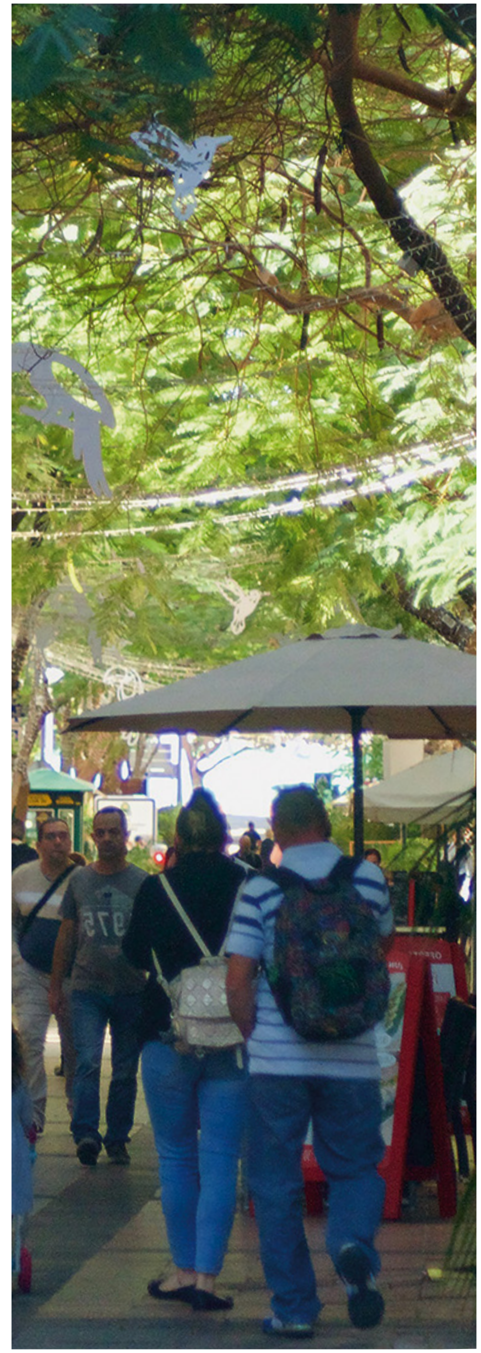
Household emissions are based on average electricity kWh usage, natural gas Btu usage, fuel oil Btu usage, kerosene Btu usage, and LPG Btu usage per household in 2009 (Energy Information Administration, 2013 y 2014).

CO_2, SO_2 and NO_x power plant emission per KWh are from Leonardo Academy 2011. CO emission per kWh assumes 1/3 of one percent of C emissions in CO, based on Energy Information Administration 1994. PM_{10} emission per kWh from Layton 2004.

CO_2, NO_x, SO_2 and CO emission per Btu for natural gas, propane and butane (average used to represent LPG), fuel #4 and #6 (average used to represent fuel oil and kerosene) from Leonardo Academy 2011.

CO_2 per Btu of Wood from Energy Information Administration 2014.

CO, NO_x and SO_2 emission per Btu based on total emissions and wood burning (tons) from British Columbia Ministry 2005 and Georgia Forestry Commission 2009.



REFERENCES

Abdollahi, K.K.; Ning, Z.H.; Appeaning, A.,eds. 2000. Global climate change and the urban forest. Baton Rouge, LA: GCRCC and Franklin Press. 77 p.

Animal and Plant Health Inspection Service. 2010. Plant Health – Asian longhorned beetle. Washington, DC: U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

Baldocchi, D. 1988. A multi-layer model for estimating sulfur dioxide deposition to a deciduous oak forest canopy. Atmospheric Environment. 22: 869-884.

Baldocchi, D.D.; Hicks, B.B.; Camara, P. 1987. A canopy stomatal resistance model for gaseous deposition to vegetated surfaces. Atmospheric Environment. 21: 91-101.

Ballester, F. 2005. Contaminación atmosférica, cambio climático y salud. Rev. Esp. Salud Pública 79, 159-175.

Ballester Díez, F., Tenías, J.M. y Pérez-Hoyos, S. 1999. Efectos de la contaminación atmosférica sobre la salud: Una introducción. Rev.Esp. Salud Pública, 73, 109-121.

Ballester Díez, F., Boldo Pascua, E., Díaz Jiménez, J., Linares Gil, C., y Querol Carceller, X. 2010. Observatorio DKV de Salud y Medio Ambiente en España. Contaminación Atmosférica y Salud. DKV Seguros.

Bidwell, R.G.S.; Fraser, D.E. 1972. Carbon monoxide uptake and metabolism by leaves. Canadian Journal of Botany. 50: 1435-1439.

British Columbia Ministry of Water, Land, and Air Protection. 2005. Residential wood burning emissions in British Columbia. British Columbia.

Broecker, W.S. 1970. Man's oxygen reserve. Science 168(3939): 1537-1538.

Bureau of Transportation Statistics. 2010. Estimated National Average Vehicle Emissions Rates per Vehicle by Vehicle Type using Gasoline and Diesel. Washington, DC: Burea of Transportation Statistics, U.S. Department of Transportation. Table 4-43.

Burnside, R.E.; Holsten, E. H.; Fettig, C.J.; Kruse, J. J.; Schultz, M.E.; Hayes, C.J.; Graves, A.D.; Seybold, S.J. 2011. Northern Spruce Engraver. Forest Insect & Disease Leaflet 180. Washington, DC: U. S. Department of Agriculture, Forest Service. 12 p.

California Air Resources Board. 2013. Methods to Find the Cost-Effectiveness of Funding Air Quality Projects. Table 3 Average Auto Emission Factors. CA: California Environmental Protection Agency, Air Resources Board.

Carbon Dioxide Information Analysis Center. 2010. CO2 Emissions (metric tons per capita). Washington, DC: The World Bank.

Cardelino, C.A.; Chameides, W.L. 1990. Natural hydrocarbons, urbanization, and urban ozone. Journal of Geophysical Research. 95(D9): 13,971-13,979.

Childs, R. 2011. Winter Moth Identification and Management. Amherst, MA: University of Massachusetts Amherst, Landscape, Nursery & Urban Forestry Program.

Ciesla, W. M. 2001. Tomicus piniperda. North American Forest Commission. Exotic Forest Pest Information System for North America (EXFOR).

Ciesla, W. M.; Kruse, J. J. 2009. Large Aspen Tortrix. Forest Insect & Disease Leaflet 139. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Clarke, S. R.; Nowak, J.T. 2009. Southern Pine Beetle. Forest Insect & Disease Leaflet 49. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.

Cranshaw, W.; Tisserat, N. 2009. Walnut twig beetle and the thousand cankers disease of black walnut. Pest Alert. Ft. Collins, CO: Colorado State University.

DeMars, C. J., Jr.; Roettgering, B. H. 1982. Western Pine Beetle. Forest Insect & Disease Leaflet 1. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.

Diller, J. D. 1965. Chestnut Blight. Forest Pest Leaflet 94. Washington, DC: U. S. Department of Agriculture, Forest Service. 7 p.

Donovan, G.H., Butry, D.T., Michael, Y.L., Prestemon, J.P., Liebhold, A.M., Gatziolis, D. and Mao M.Y. 2013. The Relationship between trees and Human Health: Evidence from the spread of the emerald ash borer.Journal of Preventive Medicine 44(2): 139-145.

Eastern Forest Environmental Threat Assessment Center. Dutch Elm Disease. http:// threatsummary.forestthreats.org/threats/threatSummaryViewer.cfm?threatID=43

Energy Information Administration. 1994. Energy Use and Carbon Emissions: Non-OECD Countries. Washington, DC: Energy Information Administration, U.S. Department of Energy.

Energy Information Administration. 2013. CE2.1 Fuel consumption totals and averages, U.S. homes. Washington, DC: Energy Information Administration, U.S. Department of Energy.

Energy Information Administration. 2014. CE5.2 Household wood consumption. Washington, DC: Energy Information Administration, U.S. Department of Energy.

FAO. 2016. Directrices para la silvicultura urbana y periurbana, por Salbitano, F., Borelli, S., Conigliaro, M. y Chen, Y. 2017. Directrices para la silvicultura urbana y periurbana, Estudio FAO: Montes No 178, Roma, FAO.

Federal Highway Administration. 2013. Highway Statistics 2011. Washington, DC: Federal Highway Administration, U.S. Department of Transportation. Table VM-1.

Fellin, D. G.; Dewey, J. E. 1986. Western Spruce Budworm. Forest Insect & Disease Leaflet 53. Washington, DC: U.S. Department of Agriculture, Forest Service. 10 p.

Ferrell, G. T. 1986. Fir Engraver. Forest Insect & Disease Leaflet 13. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Georgia Forestry Commission. 2009. Biomass Energy Conversion for Electricity and Pellets Worksheet. Dry Branch, GA: Georgia Forestry Commission.

Gibson, K.; Kegley, S.; Bentz, B. 2009. Mountain Pine Beetle. Forest Insect & Disease Leaflet 2. Washington, DC: U. S. Department of Agriculture, Forest Service. 12 p.

Haugen, D. A.; Hoebeke, R. E. 2005. Sirex woodwasp - Sirex noctilio F. (Hymenoptera: Siricidae). Pest Alert. NA- PR-07-05. Newtown Square, PA: Department of Agriculture, Forest Service, Northern Area State and Private Forestry.

Heirigs, P.L.; Delaney, S.S.; Dulla, R.G. 2004. Evaluation of MOBILE Models: MOBILE6.1 (PM), MOBILE6.2 (Toxics), and MOBILE6/CNG. Sacramento, CA: National Cooperative Highway Research Program, Transportation Research Board.

Heisler, G.M. 1986. Energy savings with trees. Journal of Arboriculture 12, Nº5, 113-125.

Hessburg, P. F.; Goheen, D. J.; Bega, R.V. 1995. Black Stain Root Disease of Conifers. Forest Insect & Disease Leaflet 145. Washington, DC: U.S. Department of Agriculture, Forest Service.

Hessburg, P. F.; Goheen, D. J.; Bega, R.V. 1995. Black Stain Root Disease of Conifers. Forest Insect & Disease Leaflet 145. Washington, DC: U.S. Department of Agriculture, Forest Service.

Hirabayashi, S. 2011. Urban Forest Effects-Dry Deposition (UFORE-D) Model Enhancements, http:// www.itreetools.org/eco/resources/UFORE-D enhancements.pdf

Hirabayashi, S. 2012. i-Tree Eco Precipitation Interception Model Descriptions, http://www.itreetools.org/eco/resources/iTree_Eco_Precipitation_Interception_Model_Descriptions_V1_2.pdf

Hirabayashi, S.; Kroll, C.; Nowak, D. 2011. Component-based development and sensitivity analyses of an air pollutant dry deposition model. Environmental Modeling and Software. 26(6): 804-816.

Hirabayashi, S.; Kroll, C.; Nowak, D. 2012. i-Tree Eco Dry Deposition Model Descriptions V 1.0

Holsten, E.H.; Thier, R.W.; Munson, A.S.; Gibson, K.E. 1999. The Spruce Beetle. Forest Insect & Disease Leaflet 127. Washington, DC: U.S. Department of Agriculture, Forest Service. 12 p.

Houston, D. R.; O'Brien, J. T. 1983. Beech Bark Disease. Forest Insect & Disease Leaflet 75. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Interagency Working Group on Social Cost of Carbon, United States Government. 2015. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. http://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf

Kliejunas, J. 2005. Phytophthora ramorum. North American Forest Commission. Exotic Forest Pest Information System for North America (EXFOR).

Korhnak, L.V. and S.W. Vince. 2005. Managing hydrological impacts of urbanization. In Forests at the Wildland-Urban Interface: Conservation and Management, eds. Susan W. Vince, Mary L. Duryea, Edward A. Macie, and L. Annie Hermansen, 175–200. New York: CRC Press.

Kruse, J.; Ambourn, A.; Zogas, K. 2007. Aspen Leaf Miner. Forest Health Protection leaflet. R10-PR-14. Juneau, AK: U. S. Department of Agriculture, Forest Service, Alaska Region.

Kucera, D. R.; Orr, P. W. 1981. Spruce Budworm in the Eastern United States. Forest Pest Leaflet 160. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.

Layton, M. 2004. 2005 Electricity Environmental Performance Report: Electricity Generation and Air Emissions. CA: California Energy Commission.

Leonardo Academy. 2011. Leonardo Academy's Guide to Calculating Emissions Including Emission Factors and Energy Prices. Madison, WI: Leonardo Academy Inc.

Liebhold, A. 2010 draft. Personal communication on the geographic distribution of forest pest species.

Livesley, S.J., McPherson, E.G. and Calfapiedra, C. 2015. The Urban Forest and Ecosystem Services:Impacts on Urban Water, Heat, and Pollution Cycles at the Tree, Street, and City Scale. Journal of Environmental Quality 45, 119-124.

Lovasi, G.G., Quinn, J.W., Neckerman, K.M, Perzanowski, M.S. and Rundle, A. 2008. Children living in areas with more street trees have lower prevalence of asthma. Journal of Epidemiology and Community Health 62, 647-649.

Lovett, G.M. 1994. Atmospheric deposition of nutrients and pollutants in North America: an ecological perspective. Ecological Applications. 4: 629-650.

McPherson, E.G.; Maco, S.E.; Simpson, J.R.; Peper, P.J.; Xiao, Q.; VanDerZanden, A.M.; Bell, N. 2002. Western Washington and Oregon Community Tree Guide: Benefits, Costs, and Strategic Planting. International Society of Arboriculture, Pacific Northwest, Silverton, OR.

McPherson, E.G.; Simpson, J.R. 1999. Carbon dioxide reduction through urban forestry: guidelines for professional and volunteer tree planters. Gen. Tech. Rep. PSW-171. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 237 p.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Crowell, A.M.N.; Xiao, Q. 2010. Northern California coast community tree guide: benefits, costs, and strategic planting. PSW-GTR-228. Gen. Tech. Rep. PSW-GTR-228. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Vargas, K.E.; Maco, S.E.; Xiao, Q. 2006a. Coastal Plain Community Tree Guide: Benefits, Costs, and Strategic Planting PSW-GTR-201. USDA Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Vargas, K.E.; Xiao, Q. 2007. Northeast community tree guide: benefits, costs, and strategic planting.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Gardner, S.L.; Cozad, S.K.; Xiao, Q. 2006b. Midwest Community Tree Guide: Benefits, Costs and Strategic Planting PSW-GTR-199. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Gardner, S.L.; Vargas, K.E.; Xiao, Q. 2006c. Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting PSW-GTR 200. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Xiao Q.; Mulrean, E. 2004. Desert Southwest Community Tree Guide: Benefits, Costs and Strategic Planting. Phoenix, AZ: Arizona Community Tree Council, Inc. 81 :81.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Scott, K.I.; Xiao, Q. 2000. Tree Guidelines for Coastal Southern California Communities. Local Government Commission, Sacramento, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Xiao, Q. 1999. Tree Guidelines for San Joaquin Valley Communities. Local Government Commission, Sacramento, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Xiao, Q.; Maco, S.E.; Hoefer, P.J. 2003. Northern Mountain and Prairie Community Tree Guide: Benefits, Costs and Strategic Planting. Center for Urban Forest Research, USDA Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Xiao, Q.; Pittenger, D.R.; Hodel, D.R. 2001. Tree Guidelines for Inland Empire Communities. Local Government Commission, Sacramento, CA.

Michigan State University. 2010. Emerald ash borer. East Lansing, MI: Michigan State University [and others].

Mielke, M. E.; Daughtrey, M. L. How to Identify and Control Dogwood Anthracnose. NA-GR-18. Broomall, PA: U. S. Department of Agriculture, Forest Service, Northeastern Area and Private Forestry.

Murray, F.J.; Marsh L.; Bradford, P.A. 1994. New York State Energy Plan, vol. II: issue reports. Albany, NY: New York State Energy Office.

Nicholls, T. H.; Anderson, R. L. 1977. How to Identify White Pine Blister Rust and Remove Cankers. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry

Northeastern Area State and Private Forestry. 1998. How to identify and manage Dutch Elm Disease. NA- PR-07-98. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry.

Northeastern Area State and Private Forestry. 2005. Gypsy moth digest. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry.

Nowak, D.J. 1994. Atmospheric carbon dioxide reduction by Chicago's urban forest. In: McPherson, E.G.; Nowak, D.J.; Rowntree, R.A., eds. Chicago's urban forest ecosystem: results of the Chicago Urban Forest Climate Project. Gen. Tech. Rep. NE-186. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 83-94.

Nowak, D.J. 1995. Trees pollute? A "TREE" explains it all. In: Proceedings of the 7th National Urban Forestry Conference. Washington, DC: American Forests: 28-30.

Nowak, D.J. 2000. The interactions between urban forests and global climate change. In: Abdollahi, K.K.; Ning, Z.H.; Appeaning, A., eds. Global Climate Change and the Urban Forest. Baton Rouge, LA: GCRCC and Franklin Press: 31-44.

Nowak, D.J., Hirabayashi, S., Bodine, A., Greenfield, E. 2014. Tree and forest effects on air quality and human health in the United States. Environmental Pollution. 193:119-129.

Nowak, D.J., Hirabayashi, S., Bodine, A., Hoehn, R. 2013. Modeled PM2.5 removal by trees in ten U.S. cities and associated health effects. Environmental Pollution. 178: 395-402.

Nowak, D.J.; Civerolo, K.L.; Rao, S.T.; Sistla, S.; Luley, C.J.; Crane, D.E. 2000. A modeling study of the impact of urban trees on ozone. Atmospheric Environment. 34: 1601-1613.

Nowak, D.J.; Crane, D.E. 2000. The Urban Forest Effects (UFORE) Model: quantifying urban forest structure and functions. In: Hansen, M.; Burk, T., eds. Integrated tools for natural resources inventories in the 21st century. Proceedings of IUFRO conference. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 714-720.

Nowak, D.J.; Crane, D.E.; Dwyer, J.F. 2002a. Compensatory value of urban trees in the United States. Journal of Arboriculture. 28(4): 194 - 199.

Nowak, D.J.; Crane, D.E.; Stevens, J.C.; Hoehn, R.E. 2005. The urban forest effects (UFORE) model: field data collection manual. V1b. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station, 34 p. http://www.fs.fed.us/ne/syracuse/Tools/downloads/UFORE_Manual.pdf

Nowak, D.J.; Crane, D.E.; Stevens, J.C.; Ibarra, M. 2002b. Brooklyn's urban forest. Gen. Tech. Rep. NE-290. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 107 p.

Nowak, D.J.; Dwyer, J.F. 2000. Understanding the benefits and costs of urban forest ecosystems. In: Kuser, John, ed. Handbook of urban and community forestry in the northeast. New York, NY: Kluwer Academics/ Plenum: 11-22.

Nowak, D.J.; Hoehn, R.; Crane, D. 2007. Oxygen production by urban trees in the United States. Arboriculture & Urban Forestry. 33(3):220-226.

Nowak, D.J.; Hoehn, R.E.; Crane, D.E.; Stevens, J.C.; Walton, J.T; Bond, J. 2008. A ground-based method of assessing urban forest structure and ecosystem services. Arboriculture and Urban Forestry. 34(6): 347-358.

Nowak, D.J.; Stevens, J.C.; Sisinni, S.M.; Luley, C.J. 2002c. Effects of urban tree management and species selection on atmospheric carbon dioxide. Journal of Arboriculture. 28(3): 113-122.

Observatorio de la Sostenibilidad en España. 2007. Calidad del aire en las ciudades: Clave de sostenibilidad urbana. 382 pp.

Ostry, M.E.; Mielke, M.E.; Anderson, R.L. 1996. How to Identify Butternut Canker and Manage Butternut Trees. U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.

Peper, P.J.; McPherson, E.G.; Simpson, J.R.; Albers, S.N.; Xiao, Q. 2010. Central Florida community tree guide: benefits, costs, and strategic planting. Gen. Tech. Rep. PSW-GTR-230. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Peper, P.J.; McPherson, E.G.; Simpson, J.R.; Vargas, K.E.; Xiao Q. 2009. Lower Midwest community tree guide: benefits, costs, and strategic planting. PSW-GTR-219. Gen. Tech. Rep. PSW-GTR-219. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Phelps, W.R.; Czabator, F.L. 1978. Fusiform Rust of Southern Pines. Forest Insect & Disease Leaflet 26. Washington, DC: U. S. Department of Agriculture, Forest Service. 7 p.

Rexrode, C. O.; Brown, H. D. 1983. Oak Wilt. Forest Insect & Disease Leaflet 29. Washington, DC: U.S. Department of Agriculture, Forest Service. 6 p.

Schmitz, R. F.; Gibson, K. E. 1996. Douglas-fir Beetle. Forest Insect & Disease Leaflet 5. R1-96-87. Washington,DC: U. S. Department of Agriculture, Forest Service. 8 p.

Seitz,J. and Escobedo, F. 2008. Urban Forests in Florida: Trees Control Stormwater runoff and Improve Water Quality. School of Forest Resources and Conservation Department, UF/IFAS Extension.

Seybold, S.; Haugen, D.; Graves, A. 2010. Thousand Cankers Disease. Pest Alert. NA-PR-02-10. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry.

Smith, S. L.; Borys, R. R.; Shea, P. J. 2009. Jeffrey Pine Beetle. Forest Insect & Disease Leaflet 11. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Society of American Foresters. 2011. Gold Spotted Oak Borer Hitches Ride in Firewood, Kills California Oaks. Forestry Source 16(10): 20.

U.S. Environmental Protection Agency. 2010. Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards. Washington, DC: U.S. Environmental Protection Agency. EPA-420- R-10-012a

U.S. Environmental Protection Agency. 2015. The social cost of carbon. http://www.epa.gov/climatechange/ EPAactivities/economics/scc.html

U.S. Forest Service. 2005. Hemlock Woolly Adelgid. Pest Alert. NA-PR-09-05. Newtown Square, PA: U. S. Department of Agriculture, Forest Service, Northern Area State and Private Forestry.

U.S. Forest Service. 2011. Laurel Wilt. Atlanta, GA: U. S. Department of Agriculture, Forest Service, Forest Health Protection, Southern Region.

University of California. 2014. Polphagous Shot Hole Borer. Sacramento, CA: University of California, Division of Agriculture and Natural Resources.

van Essen, H.; Schroten, A.; Otten, M.; Sutter, D.; Schreyer, C.; Zandonella, R.; Maibach, M.; Doll, C. 2011. External Costs of Transport in Europe. Netherlands: CE Delft. 161 p.

Vargas, K.E.; McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Xiao, Q. 2007a. Interior West Tree Guide.

Vargas, K.E.; McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Xiao, Q. 2007b. Temperate Interior West Community Tree Guide: Benefits, Costs, and Strategic Planting.

Vargas, K.E.; McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Xiao, Q. 2008. Tropical community tree guide: benefits, costs, and strategic planting. PSW-GTR-216. Gen. Tech. Rep. PSW-GTR-216. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Worrall, J.J. 2007. Chestnut Blight. Forest and Shade Tree Pathology. http://www.forestpathology.org/dis_chestnut.html

Zinke, P.J. 1967. Forest interception studies in the United States. In: Sopper, W.E.; Lull, H.W., eds. Forest Hydrology. Oxford, UK: Pergamon Press: 137-161.

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Santa Cruz de Tenerife
AYUNTAMIENTO

i-Tree