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Research article

Los árboles longevos y frondosos en la provisión de servicios ecosistémicos en ambientes urbanos

Old leafy trees in the provision of ecosystem services in urban areas

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Abstract

Mature, leafy trees are characterized by their large size and longevity. They provide many ecosystem services and sometimes are part of the cultural and historical heritage of cities. The objective of this research was to analyze the economic, social, and ecological value of mature, leafy trees in the city of *Durango*, Mexico. Through satellite images and field inventories, 83 trees were identified with the characteristics of size and longevity. Diameter at breast height, height, diameter and crown condition were measured, as well as temperature and solar radiation. A survey was administered to residents and park visitors to learn about their perceptions of the importance of these trees. The inventory data were analyzed in the i-Tree Eco v6 platform to determine the quantity and economic value of the ecosystem services. Mature, leafy trees in this city store about 1.3 CO_2 tons per year, intercept 375 kg of particles smaller than 10 μm, and their substitution value was estimated at MXN $23.6 million. From data taken under and outside the canopy, a difference between 400 and 1 200 Wm^2 of intercepted solar radiation and between 6 and 20 °C of temperature was calculated. Derived from the factor analysis, the questionnaires revealed three latent variables, in this order: "disservices", "benefits" and "existential values". No significant differences in the factor scores were found among these variables. This information will allow city managers to define plans for the management and conservation of these type of trees.

Key words: Leafy trees, green areas, i-Tree Eco, urban planning, economic value, social valuation.

Resumen

Los árboles frondosos se caracterizan por su gran tamaño y longevidad, la cantidad de servicios ecosistémicos que proveen y, en ocasiones, destacan por su contribución al acervo cultural e histórico de las ciudades. El objetivo de este trabajo fue analizar el valor económico, social y ecológico que representan los árboles frondosos en la ciudad de Durango, México. A través de imágenes satelitales e inventarios de campo, se identificaron 83 árboles frondosos. Se midió el diámetro a la altura del pecho, altura, diámetro y estado de la copa, además de la temperatura y la radiación solar. Se aplicó una encuesta para conocer las percepciones sociales de la importancia de estos individuos. Los datos del inventario se analizaron en la plataforma *i-Tree Eco* v6 para determinar la cantidad y valor económico de los servicios ecosistémicos. Los árboles frondosos de esta ciudad secuestran alrededor de 1.3 t de CO_2 por año, interceptan alrededor de 375 kg de partículas menores a 10 μm y su valor de sustitución se estimó en MXN $23.6 millones. A partir de datos tomados bajo y fuera del dosel, se calculó una diferencia de entre 400 y 1 200 Wm^2 de radiación solar interceptada y de 6 a 20 °C de temperatura. Derivado del análisis factorial, las encuestas revelaron tres variables latentes: "perjuicios", "beneficios" y "valores existenciales". No se obtuvieron diferencias significativas en las puntuaciones factoriales de las variables. La información generada permitirá definir planes para el manejo y conservación de este tipo de ejemplares.

Palabras clave: Árboles frondosos, áreas verdes, *i-Tree Eco*, planeación urbana, valor económico, valoración social.

Introduction

In recent decades, industrial and urban development has presented accelerated growth, and with it, alterations in natural landscapes and a negative impact on urban vegetation, and consequently, on human well-being (Pickett *et al.*, 2011). Urban trees play a fundamental role in cities since they contribute to public health and the quality of life of citizens through the many ecosystem services (ES), which are the direct and indirect benefits provided by ecosystems to human beings (Roy *et al.*, 2012). Urban trees are generally located in public spaces and green areas, such as parks, gardens or along the streets and boulevards of cities. They provide oxygen, sequester carbon and improve air quality, reduce noise, support personal or family relaxation, reduce temperature, regulate water runoff and soil erosion and, in their leaves and branches, concentrate air polluting particles (Pickett *et al.*, 2011; Blancarte-Siqueiros *et al.*, 2020).

Some studies even report that the crime rate in certain cities in the United States of America is inverse to the coverage of urban trees (Troy *et al.*, 2012). The ES offered by long-lived and leafy trees (also known as patrimonial trees) in urban environments are similar to those of average trees, but due to their size, ecosystem services are multiplied and furthermore, due to their longevity, they are part of a historical and sociocultural identity of local residents (Jim, 2018; Mejorado *et al.*, 2020; Granados-Espíndola *et al.*, 2022).

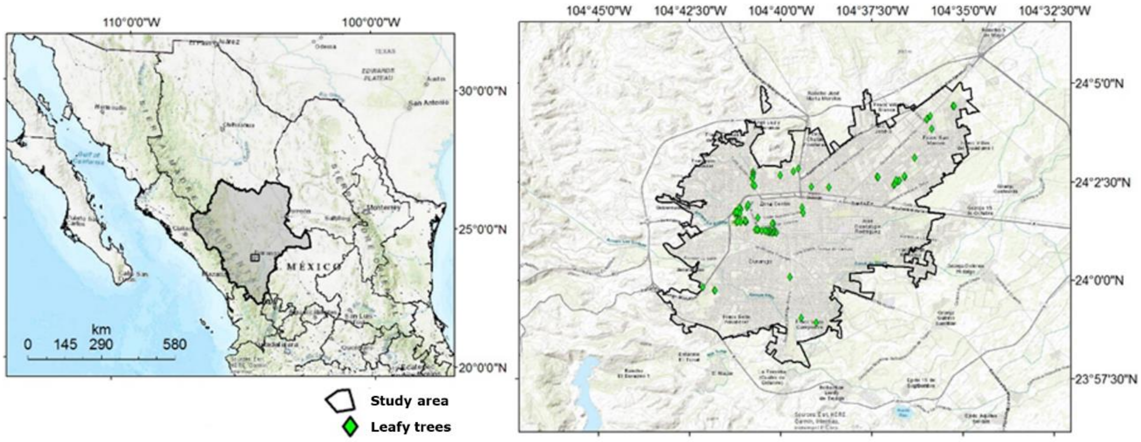
According to Borelli *et al.* (2018), urban trees are immersed in the 2030 Agenda and in the Objectives for Sustainable Development. However, efforts made in the country to promote the conservation of long-lived and leafy trees are sporadic and incipient, although they are based on the importance that these specimens have due to their size or their relationship with some historical, religious or sentimental fact that links them to the establishment of a human settlement. Therefore, it is important to know its location, distribution, structure and dynamics to assess its environmental condition (ecosystem value), in order to determine protection and conservation strategies, given its importance in society. In Mexico, although the benefits of urban trees are appreciated, there are no parameters, derived from research or a consensus about valuation methods, to qualitatively and quantitatively study the ecosystem services of this type of trees (Mejorado *et al.*, 2020; Arango *et al.*, 2023).

With the implementation of evaluation tools such as i-Tree Eco v6 (Nowak, 2021), which simulates environmental and economic benefits, it is possible to analyze the role of these trees in the provision of ES. Specifically, this tool allows us to characterize the structure of the urban forest, quantify the ES that are generated, and economically value the benefits to society (Song *et al.*, 2020). To do this, it is necessary to carry out inventories that describe the general diagnosis of the trees, including their phytosanitary status, distribution, location, and quantity. The i-Tree Eco v6 program facilitates the understanding of its value for the inhabitants, technicians and administrators who are related to its management. The i-Tree Eco application is useful to determine the value of trees, which will eventually serve to manage resources for their protection, conservation, and improvement (Nowak, 2021). In this context, the objective of this work was to analyze the environmental, economic, and social value represented by long-lived and leafy (or patrimonial) trees in *Durango* city, Mexico.

Materials and Methods

Study area

The study area is located in the city of *Victoria de Durango*, capital of the state of *Durango*, Mexico, within the *Guadiana* Valley. It has an altitude of 1 880 m (Figure 1). The city's climate varies from semi-dry temperate to temperate sub-humid, with little rain in semi-cold summer and sub-humid in winter. The average annual temperature is 17.5 °C and the average annual precipitation is 522 mm, with maximum precipitation values and regular rains from June to October (Conagua, 2014). The population is 688 697 inhabitants, which represents 37.6 % of the total population of the State. The total area of the urban area is 9 285 ha (Inegi, 2021). The surface area occupied by public green areas in the *Durango* city corresponds to 2.1 million m^2 (includes parks, gardens, squares and boulevards); in this estimate, a population of 518 709 inhabitants was considered, which is equivalent to a density of 3.7 m^2 of green areas per inhabitant (Blancarte-Siqueiros *et al.*, 2019).



Source: Own information, with support from ESRI public images.

Figure 1. Location of the study area and the trees evaluated.

Identification and characterization of leafy trees

The characterization of the leafy trees was done with the following criteria: trees with a diameter at breast height (*DBH*, 1.30 m above ground level) greater than 80 cm, total height greater than 15 m and a crown diameter greater than 10 m. In order to identify possible areas in the location of said trees in the city, a satellite image from the WorldView-2 sensor from 2015 was used, with a spatial resolution of 0.5 m (Anderson and Marchisio, 2012).

Subsequently, a supervised classification was done to identify the areas with vegetation in the city. The following classes were generated: urban area, vegetation, bare soil, pavement and bodies of water. Classification was performed using the maximum likelihood algorithm, which assumes that the statistics for each class in each band are normally distributed and the probability that a given pixel belongs to a specific class is calculated, that is, the maximum probability (Richards, 2013). This process was executed in ERDAS Imagine software (Nelson and Khorram, 2018). Once the classification was executed, only the vegetation class was selected to identify the green areas of the city and visit the sites to verify the leafy trees. Afterwards, a forest inventory of the identified trees was prepared, for which a brigade was organized with three people trained to collect field information.

Forest inventory of urban trees

In order to obtain the measurements and phytosanitary information of leafy trees, field trips were carried out in the City. Based on the classified image obtained from the vegetation class, the leafy trees were located and the variables described in Table 1 were directly measured for each tree.

Table 1. Parameters applied in the forest inventory of leafy trees in *Durango* city, *Durango*, Mexico.

Variables	Description	Units
Date	Dates in which the data of each tree were taken	
GPS coordinates	Geografic location of each tree	UTM
Species	Identification of tree names at the species or genus level	
DBH	Diameter of the stem at breast height (1.30 m)	Centimeters
Total height	Height measured from the ground up´to the last live branch of the tree	Meters
Crown diameter	Crown width in north-south and east-west direction	Meters
Top height of the cup	Height of the crown from the bottom (first branch) to the living top of the tree	Meters

Height from base to crown	Height from ground to base of living crown (first branch)	Meters
Percentage of dead crown	Percentage of crown volume that is dead	%
Percentage of missing crown	Percentage of crown volume that is absent	%
Light exposure on the crown	Number of sides (maximum 5) that the crown receives sunlight at the zenith, north, south, east and west	Side number
Land use	Type of land use the tree is on (park, commercial, forest, residential, institutional, etc.)	

To capture the data, a field format was designed and used in which each tree was identified by genus and species, and labeled with an identification code to facilitate its geographical location.

To measure the *DBH* of the trees, Forestry Suppliers® diameter tape was used, the total height was measured with a model PM-5 360 PC Suunto® clinometer, plus a 30 m tape measure model Fluor MEDID® for the horizontal distance at which said height would be taken (usually 20 m). The height of the crown was also measured, starting from the first branch of the tree and up to the tip of the crown. In addition, the height of the clean stem (from the base of the tree to the beginning of the crown) was calculated with the difference between the total height and the crown height. Likewise, the average diameter of the crown was calculated using the compass included in the clinometer and the 30 m measuring tape, always at the tangential friction of the tree trunk and in a north-south and then east-west direction; there, the longest branches were measured in both directions. The tree crown was also evaluated at different angles to determine the percentages of the dead crown and missing crown variables (Nowak, 2021).

Ecosystem services and economic valuation

Once the inventory data was obtained, a database was generated that was sent to the i-Tree Eco v6 platform for the analysis of ecosystem services and economic valuation. i-Tree Eco v6 is a digital platform developed by the United States Department of Agriculture Forest Service and is in the public domain (Nowak, 2021). Its configuration is simple and compatible with some cities in the country including *Monterrey*, *Guadalajara*, Mexico City and *Durango* city. The software uses inventory data by species, local weather and air pollution information by hour. After sending the field information, the server returns the diagnostic report containing estimates of carbon dioxide storage and capture, air quality, runoff control, and its economic value.

The calculations are carried out through equations taken from the literature for each species or by genus (Nowak, 2021); due to space limitations, these equations and calculation processes are not described here, but are available in the manual and server page (https://www.itreetools.org/). In the case of economic valuation, the user can add local price data such as m^3 of water, kWh and price per ton of CO_2.

The limitations of the software are that the air pollution data dates back to 2015, and currently there may be variations. Furthermore, there are no economic valuation models for the removal of contaminants; these are calculated with methods used in the United States and the user makes the conversion to national currency, based on the purchasing power parity of each country.

Environmental and social evaluation

For the environmental evaluation, the variables of temperature and solar radiation were taken. Outdoor temperature data were recorded for each tree, taken with a TER-150 Steren® digital thermometer for indoors and outdoors with humidity sensor. In order to observe the temperature change caused by the trees individually. Two measurements were considered for each tree, the first was taken under the shade of the trees and the second directly under the sun at the same time. The measurements were taken between 2:00 p. m. and 5:00 p. m. when the sun radiates with greater intensity (Roque, 2018). The thermometer was placed on the surface and the temperature was waited for to stabilize (approximately 15 minutes) at each point. To determine the solar radiation (Watts m^2) intercepted by the foliage of the trees, an SM206 Walfront® solarimeter was used. Like temperature, two measurements were considered for each tree, radiation was measured under the shade of the tree and directly under the sun at the same time.

In order to know the perception that society has about long-lived and leafy trees, a social evaluation was carried out through the application of personal surveys. Social benefits such as recreation, mental health, provision of shade and historical, educational or landscape relevance were included. Also, environmental benefits were included such as CO_2 capture, soil retention, habitat for wildlife, microclimatic regulation and avoided runoff, in addition to risks and damages such as falling branches, weak trunk, exposed roots, damage to permanent structures, among others. Additionally, sociodemographic variables such as income level, education, age, etc. were captured.

The survey used a five-point Likert scale (Matas, 2018) to identify the degree of agreement on the importance of these trees in the city, where 1 was the minimum value assigned and represents total disagreement and minimum degree of importance, and 5 represents the maximum degree of conformity and greater importance. A random sample of 20 trees was made and 5 people were surveyed in each one, who always had the vision of the tree.

The information derived from the surveys was analyzed using the statistical technique of factor analysis to identify latent or unobservable variables. The number of latent variables or factors is generally less than the number of observed variables, so this technique also helps to reduce the number of correlated variables that are originally observed. Those that are highly correlated (positively or negatively) can be linked by the same factors and those that do not exhibit correlation can be associated by different factors (Méndez and Rondón, 2012). The varimax rotation technique, Bartlett's test of sphericity and the Kaiser-Meyer-Olkin coefficient of sampling adequacy were applied to test the veracity of the factor analysis (Tabachnick and Fidell, 2013).

Results and Discussion

Eighty-three trees belonging to eight different taxa were located, which were: *Eucalyptus* spp. (46.98 %), *Taxodium mucronatum* Ten. (24.09 %), *Populus* spp. (21.68 %), *Schinus molle* L. (2.40 %), *Acer pseudoplatanus* L. (1.20 %), *Casuarina cunninghamiana* Miq. (1.20 %), *Fraxinus uhdei* (Wenz.) Lingelsh. (1.20 %) and *Araucaria heterophylla* (Salisb.) Franco (1.20 %) distributed in parks, squares, boulevards and sidewalks of the city. Most of them show a favorable health condition, without apparent pests or diseases. Only *Taxodium mucronatum* and *Fraxinus uhdei* are native species to the region. The *DBH* of the leafy trees varied from 80.7 to 315.3 cm, in which the highest value came from *Taxodium* *mucronatum*. The total height range was 14.8 and 37.5 m, while the crown diameters ranged from 11 to 31.4 m (Table 2).

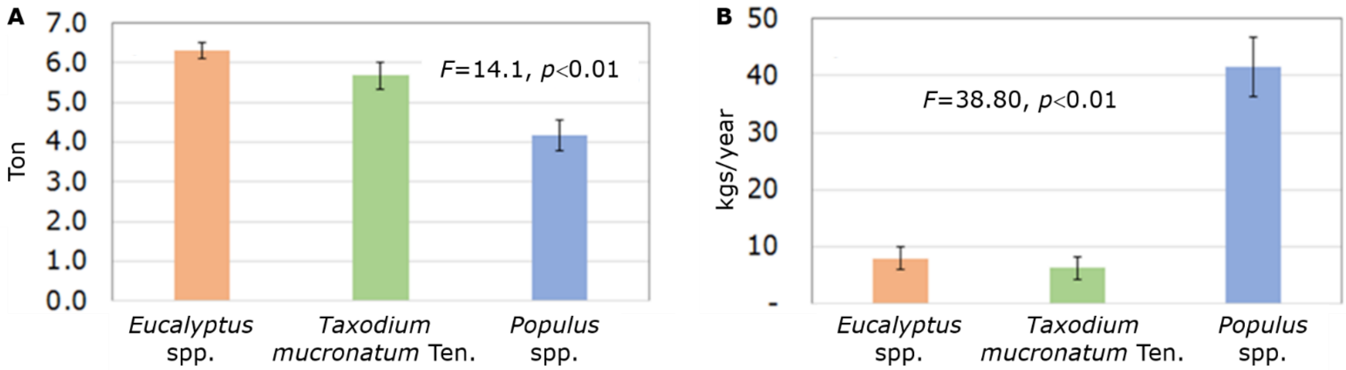
Table 2. Descriptive statistics of the forest inventory of the three most abundant genera of leafy trees in of *Durango* city.

Genus	Average	Minimum	Maximum	Standard deviation
Diameter at breast height (cm)				
Eucalyptus spp.	103.62	80.7	142.7	16.17
Taxodium spp.	173.05	97.8	315.3	52.27
Populus spp.	110.9	81.0	163.6	22.04
Total height (m)				
Eucalyptus spp.	25.64	18.4	37.5	4.66
Taxodium spp.	24.88	18.2	29.8	3.12
Populus spp.	21.32	14.8	31.6	4.9
Crown diameter (m)				
Eucalyptus spp.	17.21	11.0	26.35	3.59
Taxodium spp.	19.98	14.4	31.38	4.03
Populus spp.	16.7	11.54	23.25	3.2

Only genera with more than three individuals are included. The species with one or two individuals were *Schinus molle* L., *Acer pseudoplatanus* L., *Casuarina cunninghamiana* Miq., *Fraxinus uhdei* (Wenz.) Lingelsh. and *Araucaria heterophylla* (Salisb.) Franco.

Evaluation of ecosystem services

According to the results of i-Tree, the leafy trees of *Durango* city store more than 465 tons of CO_2 and annually sequester 1 296.1 kg of CO_2 through the process of photosynthesis. The calculation of gross carbon dioxide sequestration per year was carried out considering the average growth of the *DBH* per year and the leaf index, as well as the general condition of the trees. *Eucalyptus* (6.31 tons), *Taxodium* (5.68 tons) and *Populus* (4.16 ton) showed the greatest CO_2 accumulation, because these three genera were the most abundant in the sample. Figure 2A illustrates the storage averages per tree in each of them.



A = Average CO_2 storage by genus; B = Average annual CO_2 sequestration

Figure 2. Most abundant genera (>3 individuals) in *Durango* city.

Regarding the annual sequestration of CO_2, as shown in Figure 2B, in average values per tree, the *Populus* genus is the one that contributes the most to the removal of carbon dioxide from the environment (41.43 kg yr^{-1}) followed by *Eucalyptus* (7.98 kg yr^{-1}) and *Taxodium mucronatum* (6.27 kg yr^{-1}).

There are significant differences between genders in both the current storage and annual sequestration of CO_2. Individuals of the *Populus* genus have the lowest carbon dioxide storage but their annual sequestration rate is the highest. The differences may be due to the leaf index and photosynthetic capacity that certain individuals have to convert solar energy, water and CO_2 into carbohydrates and, eventually, biomass (Muraoka *et al.*, 2010; Pompa-García *et al.*, 2023).

The price per ton of CO_2 is constantly changing; for this analysis, the price per metric ton of CO_2 was determined at MXN $1 000, based on updated market references in the month of March 2023 (SendeCO2, 2023). Therefore, given that the monetary value of annual carbon storage and sequestration is equal to 1kg=MXN $1.00, this results in MXN $465 204.00 in total and MXN $1 296.00 per year, respectively, for all trees.

The total removal of air pollutants by the 83 trees sampled was estimated to be 588.8 kg annually. The most abundant polluting materials in the air that can harm human health are suspended particles smaller than 10 *µ*m (PM_{10}), and gases such as ozone, carbon monoxide, nitrogen dioxide and sulfur dioxide.

Table 3 shows that PM_{10} removal on average is highest in *Eucalyptus* spp (5 217.4 g), followed by *Taxodium mucronatum* (4 838.9 g). According to the i-Tree report, the 83 trees annually intercept a total of 374 kg of PM_{10}, 85 kg of carbon monoxide (CO), 89 kg of ozone (O_3), 4.8 kg of nitrogen dioxide (NO_2) and 35.4 kg of sulfur dioxide (SO_2). The polluting gases removed by leafy trees in *Durango* city amount to a value of MXN $234 262.

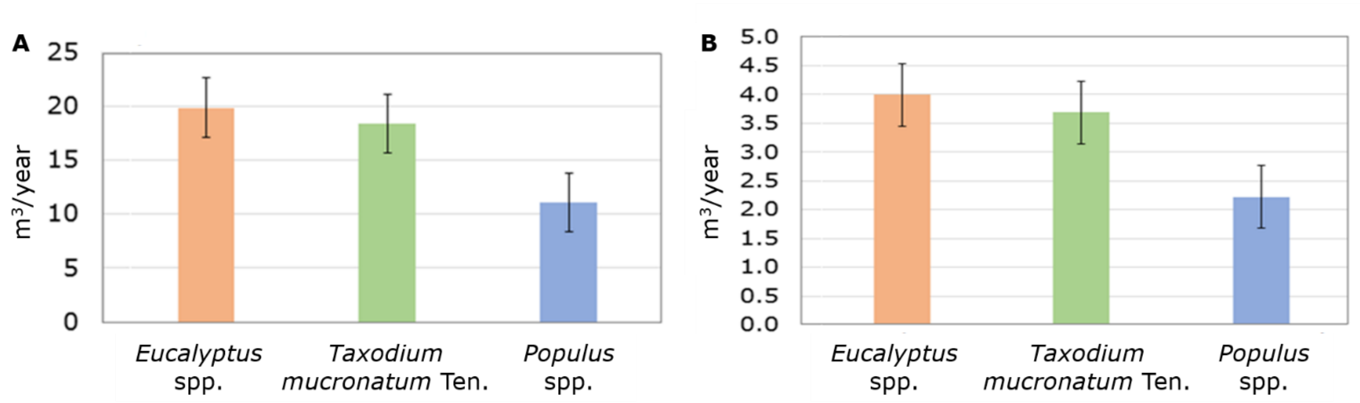
Table 3. Removal of air pollutants by the three most representative genera of the sample of leafy trees in *Durango* city.

Genus	**g yr (average per genus)**					
	NARB	**CO**	**O_3**	**NO_2**	**SO_2**	**PM_{10}**
Eucalyptus L'Hér. spp.	39	1 187.9	1 242.9	67.5	493.1	5 217.4
Taxodium mucronatum Ten.	20	1 101.7	1 152.7	62.6	457.3	4 838.9
Populus L. spp.	18	660.9	691.6	37.6	274.4	2 903.1

NARB = Number of trees; CO = Carbon monoxide; O_3 = Ozone; NO_2 =Nitrogen dioxide; SO_2 = Sulphur dioxide; PM_{10} = Particulate matter. Source: i-Tree Eco (Nowak, 2021).

It was estimated that the replacement value of leafy trees in the city of *Durango* is approximately MXN $23.6 million. This amount, which refers to the intrinsic value of trees (Piccolo, 2017), is composed of the total cumulative value of CO_2 storage (MXN $465 000), annual functional values of ecosystem services such as CO_2 sequestration (MXN $1 300.00), avoided runoff (MXN $5 190) and the removal of polluting gases from the air (MXN $234 000). The relationship that exists between the replacement value of these trees with the *DBH* and total height is positive.

The 83 trees sampled contribute 286 m^3 per year of avoided runoff, that is, the portion of the precipitation that infiltrates into the subsoil. This represents an economic benefit of MXN $5 186 per year. To obtain these values, costs as of January 2023 were used, coming from the fees and rates applied by the municipal office in charge of managing drinking water (Municipal Waters of *Durango*). Precipitation data from meteorological station 10 092 located in of *Durango* city were also used. Figure 3A shows the averages of water intercepted by *Eucalyptus* spp. (19.84 m^3 yr^{-1}) and *Taxodium mucronatum* (18.41 m^3 yr^{-1}); non-significant differences were observed between both genera compared to *Populus* spp. (11.05 m^3 yr^{-1}). Figure 3B illustrates the averages of stormwater runoff avoided by *Eucalyptus* spp. (3.99 m^3 yr^{-1}), *Taxodium mucronatum* (3.69 m^3 yr^{-1}) and *Populus* spp. (2.22 m^3 yr^{-1}). The latter presented significant differences with the other two concurrent genera (F=13.3, p<0.01).



A = Average intercepted water in m^3; B = Average avoided runoff in m^3.

Figure 3. Most abundant genera in the sample in Durango city.

Regarding the effect of tree canopies on radiation and ambient temperature, it was found that there is a large difference between the data taken under the tree canopy and those taken directly under the sun. Regarding radiation, the range extends from 400 Wm^2 to 1 200 Wm^2. While the temperature ranges between 6 and 20 °C; this contrast is reflected in the immediate surroundings of the tree. The more abundant the foliage, the less radiation reaches the ground and therefore the temperature is reduced. The results coincide with other studies that evaluated differences in temperature. Borelli *et al.* (2018) mentions that shaded surfaces can be from 11 to 25 °C cooler than the temperatures of places exposed to the sun.

Survey results

The factor analysis revealed three important factors that together accumulated 83 % of the total variation. The first factor (damages or disservices, by its definition in

English) included variables such as weak branches and trunk, exposed roots and damage to infrastructure, and recorded 42.8 % of the variation; the second (benefits) included variables such as recreation, shade, and mental health, and accumulated 32.1 % of the total variation; and the third (existence value) included variables such as presence, coverage and distribution in the city, with 8.4 %. The scores from each factor suggest that the people surveyed attribute slightly greater importance to the harms than to the benefits that these trees represent. However, the t-student test did not show significant differences between the two factors (t=1.81, p=0.09).

Through one-way analysis of variance, it was evaluated whether the geographical location of the trees is a key indicator to express their perceptions through the factor scores of each block. The analysis showed that only in the case of damages, significant differences were found in terms of individual perception (F=4.07, p=0.023).

The trees in the central area of the city had values close to zero, while those on the periphery gave negative values. That is, the damage caused by the trees was less noticeable on the outskirts of the city than in the central area. This may be because they are more dispersed, in smaller numbers and with less damage to infrastructure.

Comparison with other studies

There are few studies that have described the importance of this type of trees inside and outside Mexico using similar methodologies. Benegas *et al.* (2021) determined that the trees of *Turrialba*, Costa Rica, generate more than US $60 000 per year through their existence value and carbon sequestration. One of the first cases that used i-Tree Eco in Mexico for the evaluation of urban trees was in the city of *Mérida*, *Yucatán* State by de la Concha *et al.* (2017). They concluded that the average diameter of the 2.3 million trees evaluated was 13 cm, which sequester around 16 637 tons per year and their economic value was estimated at US $2.5 million per year. Martínez-Trinidad *et al.* (2021), in their study on the urban trees of the city of *Texcoco*, State of Mexico, and also with the i-Tree platform, reported that of the 391 trees of different sizes that were evaluated, their total economic value was MXN $269 481 or MXN $875 per tree (prices updated as of May 2023). The average data for these trees were *DBH*=25.3 cm, total height=8 m and crown diameter=3.7 m. In the case of *Durango*, a value of approximately MXN $8 505 per tree was obtained. These comparisons indicate that the value of leafy trees is almost 10 times greater than those evaluated in the city of *Texcoc*o.

The results of this research suggest that the density and diversity of leafy tree species in *Durango* city is low, compared to other cities in Mexico. In the *Durango* city, 83 leafy trees belonging to eight different genera were found in about 9 200 ha, which shows a very low density. The most frequent taxa were: *Eucalyptus* spp., *Taxodium mucronatum* and *Populus* spp. Climate and geographical location are factors that not only limit the quantity and diversity of tree species, but also their photosynthetic capacity, carbon accumulation and productivity (Pompa-García *et al.*, 2023). Leal *et al.* (2018) recorded in the city of *Linares*, *Nuevo León* State, a total of 41 species of urban trees, where trees with *DBH* greater than 80 cm had a density of 13 individuals per hectare.

As Jim (2018) mentioned, the study of leafy trees can help raise awareness of the benefits they generate for society and obtain support to increase their number in appropriate places and improve their management. Villanueva *et al.* (2010) estimated that a tree of this type (particularly *Taxodium mucronatum*) takes at least 200 years to reach this classification. During that time, many benefits are obtained, and many times they cannot be replaced by young individuals. Therefore, it is important to identify those trees that can be treated as leafy or heritage and place records that detail their physiognomic characteristics and, where appropriate, the history associated with social events. Its dissemination on social networks or related media can also help in its conservation.

Conclusions

In this work, an evaluation was made of the leafy (or heritage) trees in *Durango* city, *Durango*. The leafy trees of this city sequester around 1.3 tons of CO_2 per year, intercept around 375 kg of PM_{10} and their replacement value was estimated at MXN $23.6 million. There is a very low density of leafy trees, which is why it is important to carry out this type of studies and encourage the presence of these specimens. It is concluded that the care and promotion of these trees is essential, highlighting their benefits and identifying areas that encourage their development without affecting the urban infrastructure and without causing harm to the population. i-Tree Eco is a tool that helps quantify the ecosystem services provided by urban trees and their economic contribution to the well-being of the population.

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Conflict of interests

The authors declare no conflict of interest.

Contribution by author

Martha Gabriela Pérez Martínez: project planning and monitoring, field data collection, data analysis and manuscript review; Gustavo Pérez Verdín: direction and monitoring, data analysis and writing of the manuscript; Pablito Marcelo López Serrano: spatial analysis, data review and writing of the manuscript.

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