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I-TREE
URBAN FOREST ASSESSMENT
IN SANTO DOMINGO's COLONIAL CITY

March 2016

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TECHNICAL REPORT

I-TREE
URBAN FOREST ASSESSMENT IN
SANTO DOMINGO's COLONIAL CITY

February 22-26, 2016

Conservation And Sustainable Management Of Urban Watersheds
Dominican Republic

Prepared by

Jerry Bauer
Director of International Cooperation
US Forest Service, International Institute of Tropical Forestry

Mervin E. Pérez
College of Natural Sciences-ITES, University of Puerto Rico
Consultant, US Forest Service, International Institute of Tropical Forestry

Sofia Olivera Lora
College of Natural Sciences-ITES, University of Puerto Rico
Consultant, US Forest Service, International Institute of Tropical Forestry

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I. INTRODUCCIÓN

The US Forest Service's International Institute of Tropical Forestry and International Programs (USFS), is providing technical assistance through a PAPA Interagency Agreement to USAID/DR Climate Change project in the Dominican Republic. The USFS will provide research, technical assistance, technology transfer and training to USAID/Dominican Republic project partners working to improve citizen security, promote economic growth, and increase the resilience of vulnerable populations to the impact of climate change in urban areas under the Mission's Development Objective #2: Increased Resilience of People to the Impact of Climate Change.

As part of this technical assistance the USFS is helping to survey and determine the value of urban forest and green areas using the i-Tree "Tools for Assessing and Managing Community Forest" methodology (www.itreetools.org). In November of 2015 an i-Tree training was held at the University of Puerto Rico (UPR) and the International Institute of Tropical Forestry (IITF) with participation of eight project partners. This training taught the basics of the i-Tree methodology. However, the i-Tree Eco module is the most suitable application to work internationally, so i-Tree Eco survey plots were established and measured on the UPR campus to give course participants the experience and knowledge needed to apply i-Tree Eco in the Dominican Republic.

To implement the i-Tree methodology in the Dominican Republic UPR and IITF have designed the field survey plots for Wards 1-2-3 in the Santo Domingo's National District (Ayuntamiento Distrito Nacional [ADN]). In February 2016 the first i-Tree field plots were surveyed in the Colonial City. This report documents the work completed and outlines the next steps to implement i-Tree in Santo Domingo.
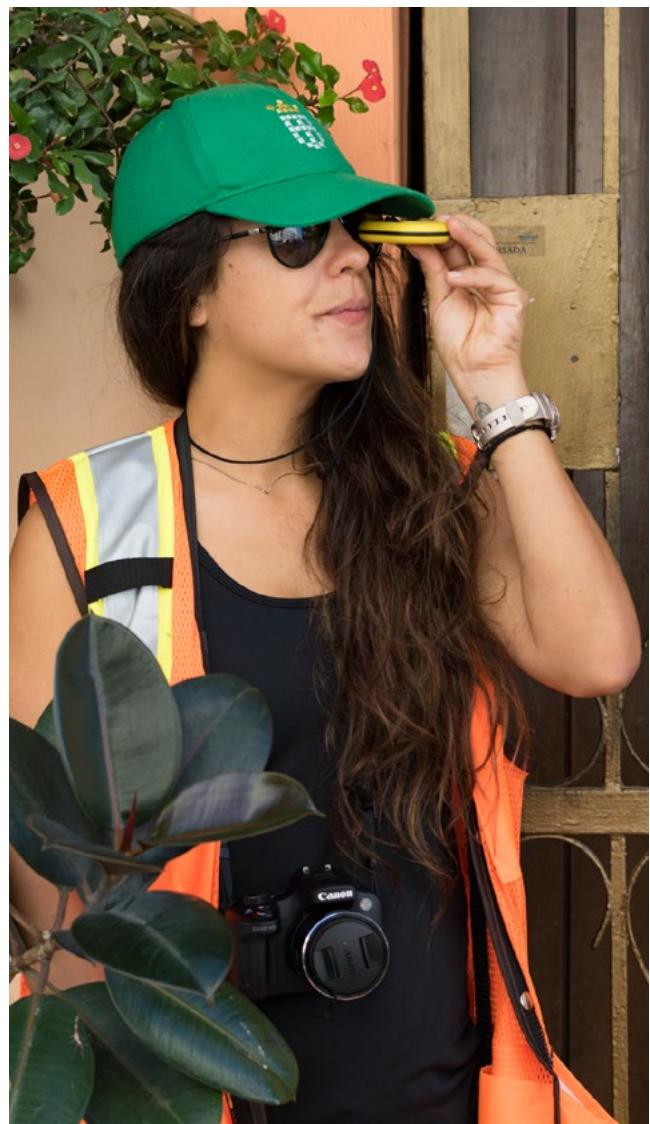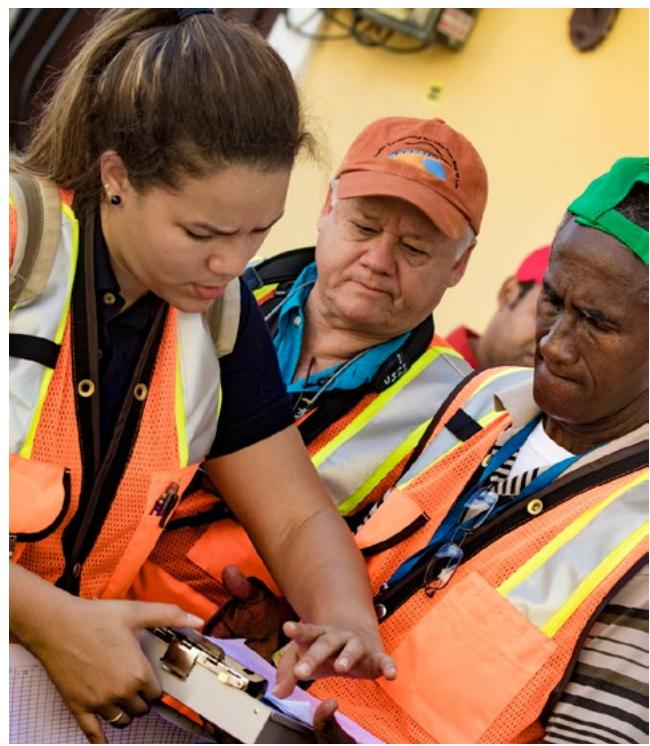
2. WHAT IS I-TREE

Taken from www.itreetools.org

i-Tree is a state-of-the-art, peer-reviewed software suite from the US Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

Since the initial release of the i-Tree Tools in August 2006, numerous communities, non-profit organizations, consultants, volunteers and students have used i-Tree to report on individual trees, parcels, neighborhoods, cities, and even entire states. By understanding the local, tangible ecosystem services that trees provide, i-Tree users can link urban forest management activities with environmental quality and community livability. Whether your interest is a single tree or an entire forest, i-Tree provides baseline data that you can use to demonstrate value and set priorities for more effective decision-making.

The i-Tree suite includes the following urban forest analysis tools and utility programs. Not all of the i-Tree programs are suitable at this time for use outside of the U.S. The entire suite is describe here to give the reader a better understanding of what i-Tree consists of and how it can be used. Some of the i-Tree components are used in many countries around the world and as i-Tree is continually updated more aspects of it are usable on a global scale.

The i-Tree Eco tools is being used for the Santo Domingo urban analysis. In the future we plan to use other parts of the i-Tree tools.
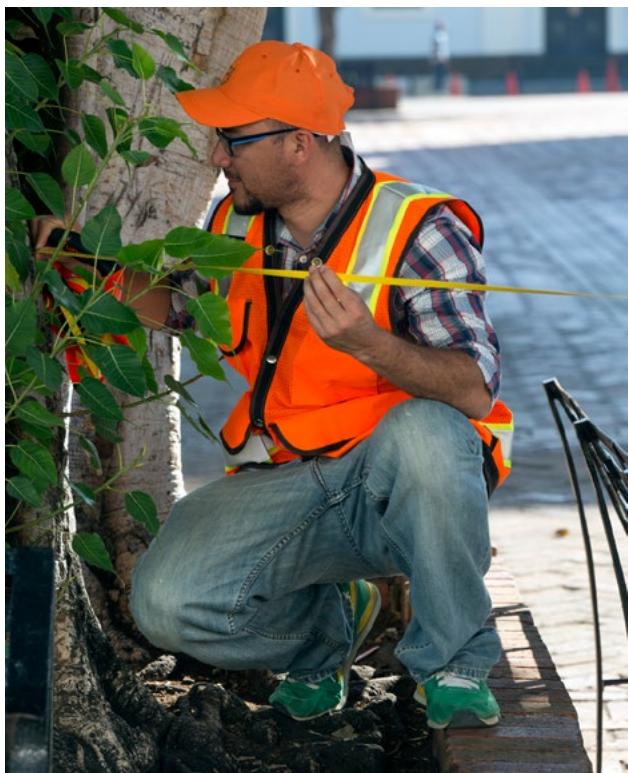
Analysis Tools

i-Tree Eco provides a broad picture of the entire urban forest. It is designed to use field data from complete inventories or randomly located plots throughout a community along with local hourly air pollution and meteorological data to quantify urban forest structure, environmental effects, and values to communities. Note: This tool is the component currently being used for the Santo Domingo metropolitan area.

i-Tree Landscape is an online tool that allows you to explore geospatial data for an area of interest. It makes use of datasets, such as land cover and U.S. Census data, to provide local information, tree benefits, and planting prioritization by designated management boundaries.

i-Tree Hydro is an application designed to simulate the effects of changes in tree and impervious cover characteristics within a watershed on stream flow and water quality.

i-Tree Design is a simple online tool that provides a platform for assessments of individual or multiple trees at the parcel level. This tool links to Google Maps and allows you to see how tree selection, tree size, and placement around your home affects energy use and other benefits.

i-Tree Canopy offers a quick and easy way to produce a statistically valid estimate of land cover types (e.g., tree cover) using aerial images available in Google Maps. The latest version of Canopy also estimates values for air pollution reduction and capturing atmospheric carbon. Canopy can be used by urban forest managers to estimate tree canopy cover, set canopy goals and monitor canopy change over time. Canopy can also be used to estimate inputs for use in i-Tree Hydro and elsewhere where land cover data are needed.

i-Tree Streets focuses on the benefits provided by a municipality's street trees. It makes use of a sample or complete inventory to quantify and put a dollar value on the street trees' annual environmental and aesthetic benefits. Streets also describes urban forest structure and management needs to help managers plan for the future.

i-Tree Vue allows you to make use of the freely available National Land Cover Database (NLCD) satellite-based imagery to assess your community's land cover, including tree canopy, and some of the ecosystem services provided by your current urban forest. The effects of planting scenarios on future benefits can also be modeled.
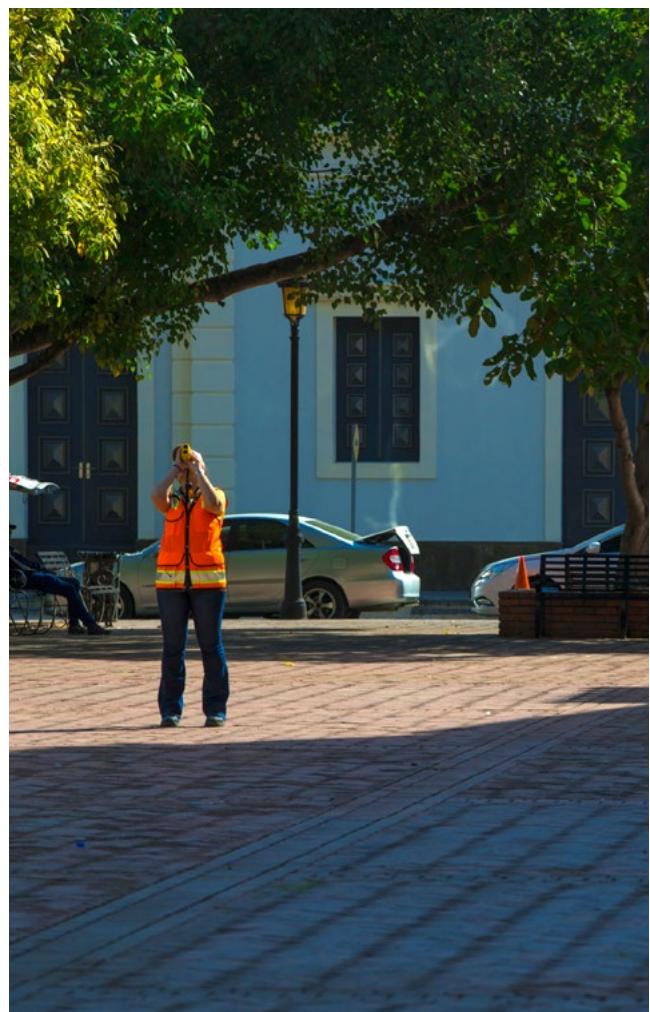
Utility Programs

i-Tree Species is a free-standing utility designed to help urban foresters select the most appropriate tree species based on environmental function and geographic area.

i-Tree Pest Detection Module is a portable, accessible and standardized protocol for observing a tree for possible insect or disease problems. The i-Tree Pest Detection module is currently available within the i-Tree Streets and i-Tree Eco programs. Pest Detection can be adapted to other external tree inventory programs also.

i-Tree Storm provides a method for a community to assess widespread storm damage in a simple, credible, and efficient manner immediately after a severe storm. It is adaptable to various community types and sizes and provides information on the time and funds needed to mitigate storm damage.

The i-Tree Tools are in the public domain and are freely accessible. You can explore this site to learn more about how i-Tree can make a difference in your community, www.itreetools.org.

3. FIELD WORK

Field work was conducted from 22-26 February in the Colonial City. A total of 30 plots were surveyed by three teams of 4-5 persons. Field crew leaders were Mervin Pérez, Sofia Olivero and Anna Poa. Mervin and Sofia are PhD. candidates at the University of Puerto Rico in the College of Natural Sciences and have been conducting i-Tree surveys in the Río Piedras watershed as part of the San Juan ULTRA program. Anna is staff assistant in the ADN Department of Environment and Risk Protection and she was one of the Dominican Republic counterparts trained in i-Tree methodology in Puerto Rico in November 2015.

Appendix A lists all field crew members. Although this work was not specifically designed as training, all field crewmembers were trained in i-Tree field survey methods and several of them have enough skills to be crew leaders on future i-Tree field teams. Part of this training was focused in the use of the equipment listed below. We considered a successful use of the equipment when most of the crewmember read similar measurements (e.g., tree high, DBH, crown base, crown wide), and calculate similar tree parameters (e.g., died back, percentage missing, sun exposure).

Field activities began about 8:30 am each day and continued to 1 PM. Maps of plot location and field protocols where provided to each team and equipment inventory was performed at the beginning and end of each day. A general meeting was held at the end of each day with all field crew members to review work completed and make plans for the next day's activities. A safety briefing was held for all participants on the first day before field work commenced. Bright orange safety vests were provided to each participant as the work required to walk along and take measurements on streets and areas with moving traffic. In addition, contact was made with CESTUR (tourist police) to provide safety for field crews when walking or working along streets.

The ADN provided assistance to inform homeowners of the work being conducted when it was necessary to enter residences or local businesses as some survey plots fell within buildings, both residential and commercial.

4. EQUIPMENT USED

To adequately collect the data needed for i-Tree several technical instruments are needed for each team. The equipment used for the Santo Domingo i-Tree consisted of:

- metal clipboard to hold data sheets and maps
- field data sheets, rite-in-rain paper (to protect field data in case of rain conditions)
- flagging tape
- GPS hand held unit (Garmin Oregon 650)
- rangefinder (Trupulse 200, laser technology)
- clinometer (SUNNTO)
- compass (Ranger Silva)
- measure tape (Lufkin fabric 30 meters)
- diameter tape (Forestry Supplier, meters)
- camera, digital (Canon sx530)
- safety vest, bright orange

Total cost of one set of field equipment is about $2,400.
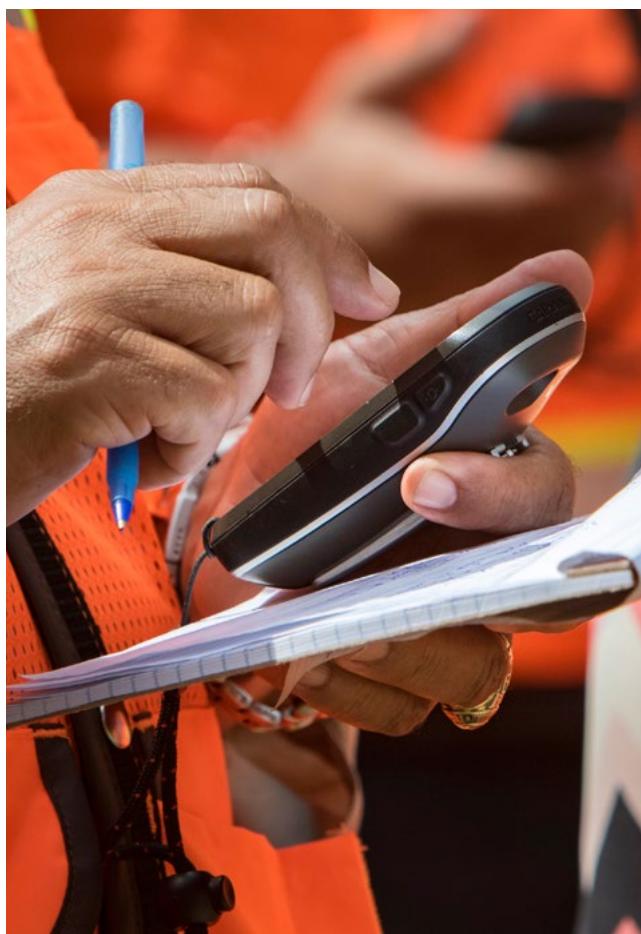
5. METHODOLOGY AND RESULTS

As the entire area of the National District will eventually be surveyed using i-Tree Eco tools, two projects were created: the first one at a national district metropolitan area with a total of 230 i-Tree plots established for Wards 1-2-3 (Figure 1), and the second project within the limits of the colonial city. Thirty plots were identified and surveyed in the Colonial City (two of these plots came from the first i-Tree project in order to be included when surveyed the entire metropolitan area) to initiate i-Tree in Santo Domingo (Figure 2). Plot location was randomly established in the i-Tree program using boundary shapefiles of each study site (i.e., national district and colonial city). Once each survey plot was identified a plot specific map was produced with the open source desktop geographic information system QGIS using satellite images from both Google Map and those provided by the members of the Ayuntamiento del Distrito Nacional (Figure 3). This map was used to help the

field crew to have a visual aid to see the plot area. In addition, coordinates of each plot were imported to the GPS using BaseCamp software to locate each plot with more accuracy. Each plot is 22.6 m in diameter (11.3 m radius), within this area both green (i.e., trees, shrubs) and gray objects (i.e., buildings, roads) were recorded on the i-Tree field data sheet (see Appendix B).

To expedite the search and interpretation of the i-Tree Eco codes that are reported in the manual and data sheets, we create a shorter protocol (and in Spanish language) summarizing the green and gray parameters to be measured within the plot, this protocol also includes images that define characteristics of the tree trunk and canopy to facilitate their interpretation such as: DBH, die back, missing percentage, sun exposure, among others obtained from the i-Tree Eco Manual v5 (Appendix B). Once the plot was located the center was marked so measurements could be taken starting at this point,

**Figure 1.** i-Tree plot for the Wards 1, 2 and 3.
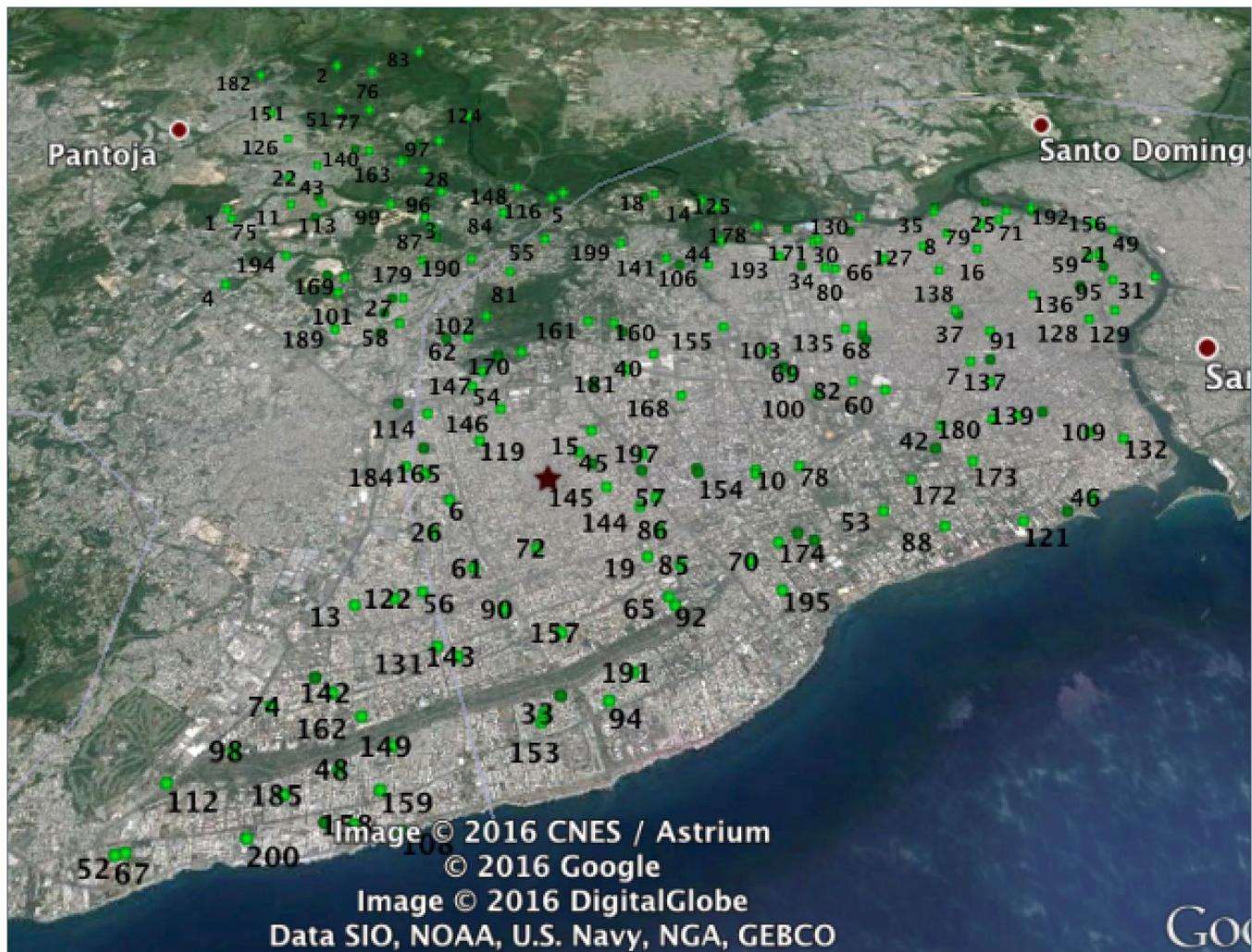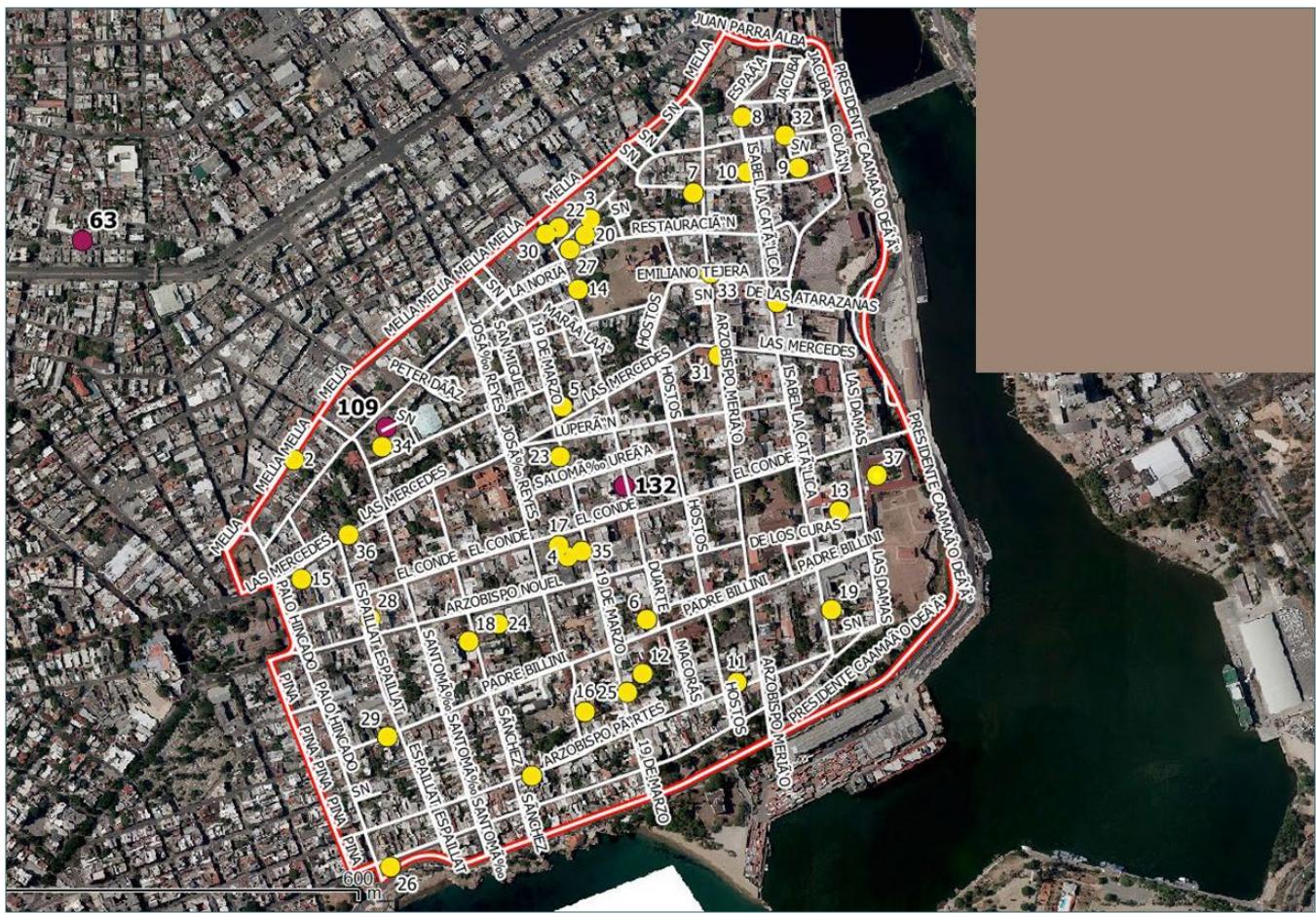
Figure 2. i-Tree plots in the colonial city.

but first we delimited the plot area by measuring a radius of 11.3 m following the North, East, South, and West directions. Data recollection consisted of measuring land use (i.e. residential, institutional) and soil cover (i.e., herbs, soil, maintained grass, buildings); recording species of trees and shrubs; tree location and distance in relation to the center of the plot; height, crown width, and DBH of trees; tree distance and direction to the nearest buildings (if and only if trees were higher than 6 m and that buildings were within the range of 18 m). Additionally, two reference objects were measured (distance and direction from the plot center) in order to find the plot center in case revalidation is needed. Photographs were taken of each plot for future reference and of plant for species identification.

Information of 30 plots was recollected in the Colonial City and field data will be entered in the i-Tree software program and analyzed over the next few weeks. New version of i-Tree Eco will be available soon and this includes climate and pollution data from Puerto Rico; considering that there is no such data for Dominican Republic in the i-Tree database at the moment, and

Figure 3. Individual i-Tree plot.

assuming that climatic and pollution information are similar in both islands, ecosystem services and the associated economical value of green areas in the Colonial City will be analyzed using Puerto Rico information. However, we encourage the monitoring of climatic and air pollution data following i-Tree guidelines and format in order to obtain more accurate results.

APPENDIX A
Field Crew Participants

The following counterparts assisted with the field data collection

Ayuntamiento Distrito Nacional (ADN)		
1	José Miguel Martínez	Secretario de Gestión Ambiental y Riesgos
2	Ana Pou	Encargada del Departamento de Prevención y Reducción de la Vulnerabilidad
3	Amancio Pereyra	Encargado del Centro de Información Ambiental
4	Leonardo Cortés	Técnico Ambiental del Centro de Información Ambiental
5	Heidel Moronta	Técnico Ambiental del Centro de Información Ambiental
6	Claudia Caballero	Técnico en Cambio Climático del Departamento de Prevención y Reducción de Vulnerabilidad
7	Karen Medina	Técnico en Gestión de Riesgos del Departamento de Prevención y Reducción de Vulnerabilidad
8	Juan Camejo	Técnico en SIG para Ciudad Colonial

ICMA, Clima Plan		
1	Andrea Vogel	Coordinadora Técnico Programa de Planificación para la Adaptación Climática, USAID-ICMA
2	Kirsis Roa	Técnico Municipal, FEDOMU Programa de Planificación para la Adaptación Climática, USAID-ICMA

APPENDIX B

i-Tree Field Measurement Protocol

Protocolo Medición de Campo i-Tree Eco
Sofía Olivero – Mervin E. Pérez

The i-Tree Eco manual can be used to interpret the codes and parameters that have to be measured in plots and that appear in data sheets; however, the manual is large and codes are hard to find. Because of this, we create a shorter version of this manual by creating a protocol (in Spanish language) that summarizes and highlights the gray and green parameters that appear in data sheets. This protocol was also a great help for field crews that cannot read English, a common case in countries of Latin America.

Antes de salir:

1. Verificar carga de baterías en el GPS, la cámara e hipsómetro.

2. Verificar mapas de ruta a visitar, hacer llamadas a residentes de ser necesario.

3. Hacer inventario de equipo (antes de salir y al final del día):

Comienzo	Cantidad	Equipo	Final
		Clipboard / Portapapeles	
		Hipsómetro, estuche, cinta de cuello	
		Cámara, estuche, cinta de cuello	
		Baterías AA extra	
		Brújula	
		Cinta diamétrica	
		Cinta métrica	
		Hojas de datos	
		GPS, estuche y cinta de cuello	
		"Sharpie"	
		Lápices	
		"Pin Flags" / "Flagging"	
		Guía de especies	

En campo:

1. **PLOT ID:** Número de parcela; DATE: Fecha; CREW: Nombres de las personas en el equipo de trabajo; GPS COOR: Coordenadas del centro de la parcela; PHOTO ID: Modelo de cámara y código de identificación de fotos.

2. **Fotos de la parcela según coordenada:** Norte (de centro a afuera y de afuera al centro). Repetir para Este, Sur y Oeste. 8 fotos en total.

3. **Buscar dos objetos de referencia** que sean permanentes dentro o cerca de la parcela. Describir el objeto, medir la distancia al centro de la parcela y la dirección en grados (Norte=360°, Este=90°, Sur=180°). Tomarle fotos.

   OJO: Debe tomar los dos objetos de referencia, de lo contrario el programa no deja entrar los datos.

4. **Hacer el diagrama sencillo** ("sketch") de la parcela e identificar el Norte, los dos objetos de referencia y los árboles.

5. **Percent Measured:** Porcentaje que datos que se levantaron de la parcela (100% si se completó toda el área).

6. **Actual Land Use:** Indicar los usos del suelo y su porcentaje:

   a. Residential: Residencial de 1 a 4 familias.

   b. Multi-familiar residential: Residencial de 4 o más familias.

   c. Comercial / Industrial: Áreas comerciales e industriales, incluido estacionamiento o áreas de estacionamiento.

   d. Park: Parque

   e. Cementery: Cementerio

   f. Golf course: Campo de golf

   g. Agriculture: Agricultura, incluye cultivos, pasturas, viñedos, viveros, fincas, plantaciones forestales y edificios asociados.

   h. Vacant: Espacios o terrenos baldíos que no tienen un uso definido. Edificios abandonados y estructuras abandonadas deben ser clasificadas según su uso de suelo original.

   i. Institutional: Institucional, incluye escuelas, hospitales, universidades, edificios religiosos, edificios del gobierno, museos, etc.

   j. Utility: Facilidades de generación de energía eléctrica, tratamiento de desperdicios líquidos, reservas, áreas de retención de escorrentía, canales de control de inundaciones, etc.

   k. Water / Wetland: Agua, incluye ríos, lagos y otros cuerpos de agua naturales o artificiales. Piscinas y fuentes llevan el uso de suelo donde se encuentre localizado.

   l. Transportation: Transporte, incluye carreteras y la vegetación asociada, rampas, estaciones de bus o tren, puerto y aeropuerto.

   m. Otros: Usos de suelos que no caen dentro de las otras categorías.

7. **Obtener la cobertura en PLOT TREE COVER:** % de cobertura por la copa de los árboles, SHRUB COVER: % de cobertura por todos los arbustos, y PLANTABLE SPACE: % de espacio donde se puede sembrar.

8. **GROUND COVER:** % de cobertura del suelo según su tipo (OJO: deben sumar 100 en total):

   • %BLDG: Edificios.

   • %CMNT: Cemento.

   • %TAR: Brea, asfalto.

   • %ROCK: Rocas/Piedras.

   • %SOIL: Suelo expuesto.

   • %DUFF/MULCH: Hojarasca y "mulch" (cuando es mucha la cobertura)

   • %HERB/YVY: Hierbas y hiedras.

   • %MAIN. GRASS: Grama con mantenimiento.

   • %UNMAIN. GRASS: Grama sin mantenimiento.

   • H_2O: Agua

9. **SHRUBS:** Recolectar información de los arbustos leñosos (menos de 2.54 cm de diámetro).

   • SPECIES: Especies (deben ser agrupadas en masas de la misma especie).

      » Si no sabe la especie identificarla como SP1, SP2, SP3, etc.

      » OJO: Tomar fotografías de la planta y anotar el código (#) de las fotos.

   • HEIGHT: Altura del arbusto, si hay varios individuos sacar un promedio de la altura.

- **%AREA:** total del área ocupada por especie (debe sumar 100%, consiste en el total ya reportado de SHRUB COVER)

- **%MISSING:** espacio del área ocupada por arbusto que esta vacío.

10. TREES: Recolectar información de los árboles (más de 2.54cm).

- Tree ID: Identificación del individuo.

  » Si no sabe la especie identificarla como SP1, SP2, SP3, etc.

  » Tomar entre 1-3 fotografías del árbol (fotos de planta completa y partes reproductivas si tiene).

  » OJO: Anotar el código (#) de las fotos.

- DR: Dirección desde centro del patio hacia el árbol en grados.

- DS: Medir distancia del centro en metros.

- STAT: Estado, se determina por consulta al residente o debido a que visualmente es fácil de determinar:

  » Plantado ("P").

  » Dispersión Natural ("I").

  » Desconocido ("U").

- LAND USE: Uso del suelo donde se encuentra el árbol.

- HT-DBH: Altura donde se toma el Diámetro a la altura del pecho (DBH). Anotar en caso que sea diferente a 1.37m.

- Registrar DBH del árbol. (DBH1-DBH6)
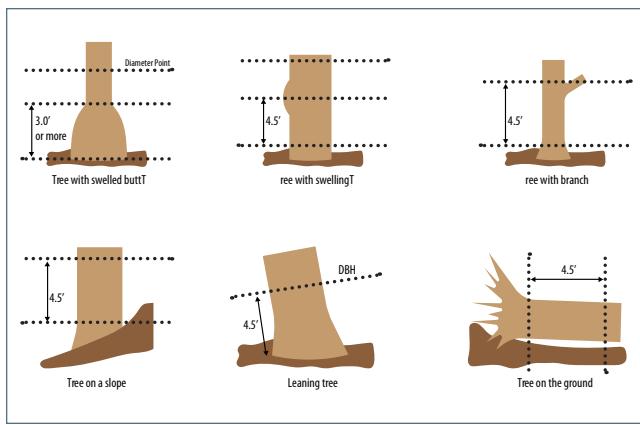
  » Altura de medición de DBH. Si el punto de intersección esta debajo del 1.37m se miden todas las ramas.
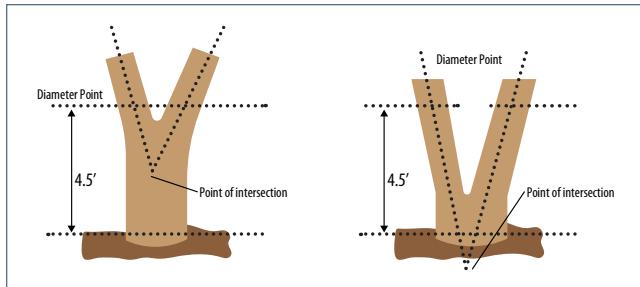
- TOT: Altura total del árbol, el punto mas alto. (Total Height).

  » Altura total del árbol

    Asegurarse que el hipómetro diga HD and HT en la pantalla.

   Apuntar directamente hacia el árbol y tomar distancia.

Apuntar hacia el punto más alto y tomar medida de ángulo.

Apuntar hacia la base del árbol y tomar ángulo.

Reportar la medida de altura final que muestra el hipsómetro en su pantalla.

» Utilizando el clinómetro:

LIVE TOP: Altura donde se encuentra el punto más alto de vegetación viva en la copa.

Percentage 1 (i.e., 80%)

Percentage 2 (i.e., -20%)

Distance (20 m recommended)

H = (Percentage 1 - (-Percentage 2)) * Distance) / 100
H = (80 - (-20)) * 20) / 100 = (100*20) / 100 = 2000 / 100 = 20 meters
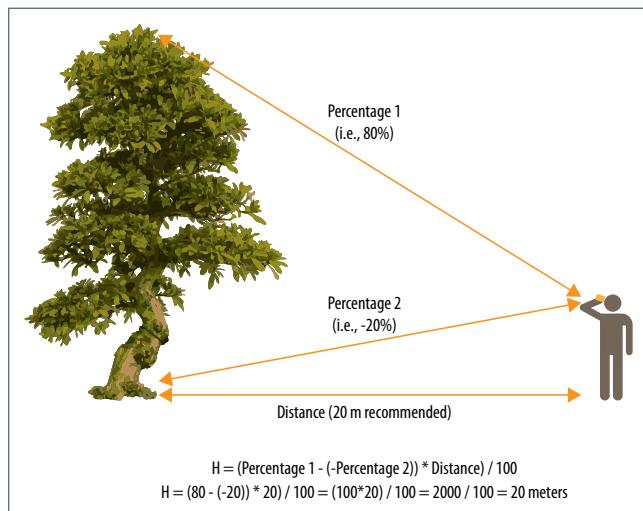
CROWN BASE: Altura hasta la base de la corona.

- CROWN WIDTH: Ancho de la corona, medir de norte a sur y de este a oeste utilizando cinta métrica. (Width N-S, Width E-W)

- %MISS: Medir % espacio ausente de la copa, esta observación debe ser realizada por dos personas colocándose de manera perpendicular al árbol. (% Missing)
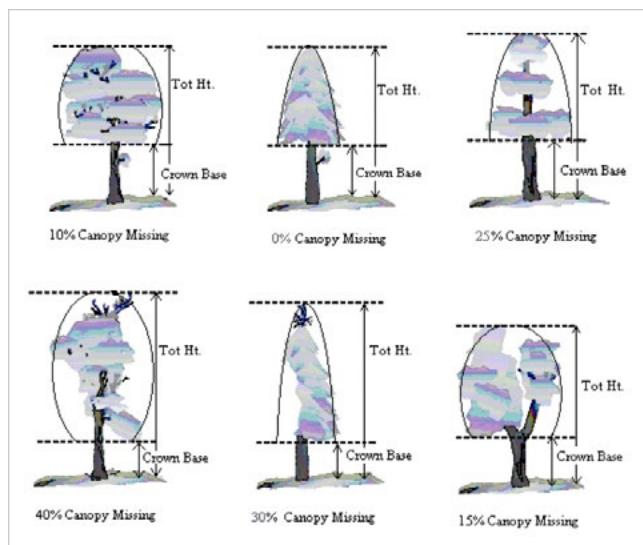
- DB: Medir % de muerte regresiva de la corona, esta observación debe ser realizada por dos personas con binoculares, si no llegan a un acuerdo se seguirán las especificaciones. Esta medida iría en % de 0-100% con intervalos de 5%. (% Die Back).
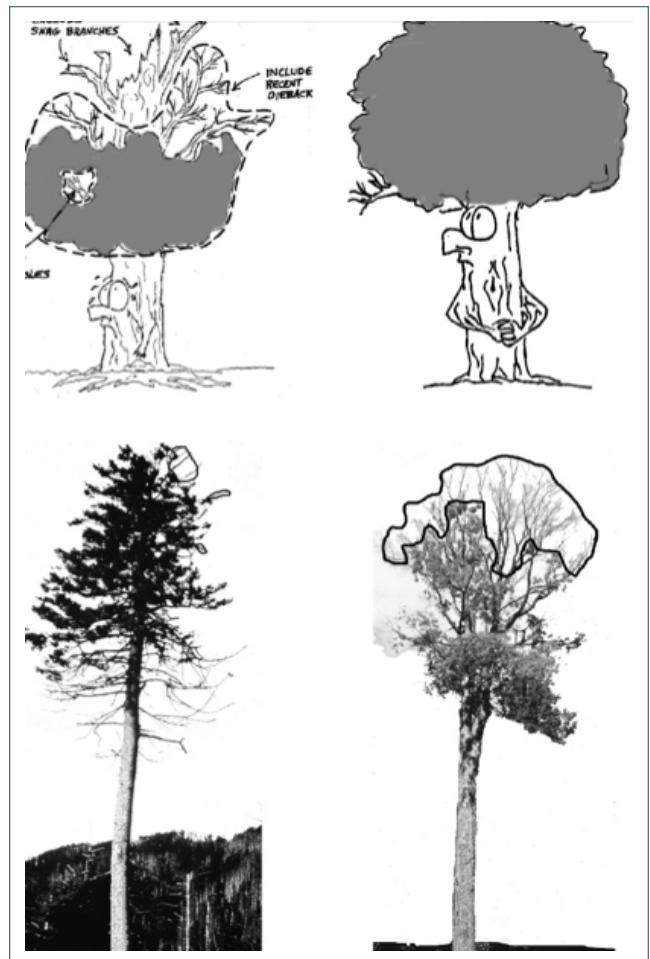
- CLE: Exposición solar de la corona. (CLE)
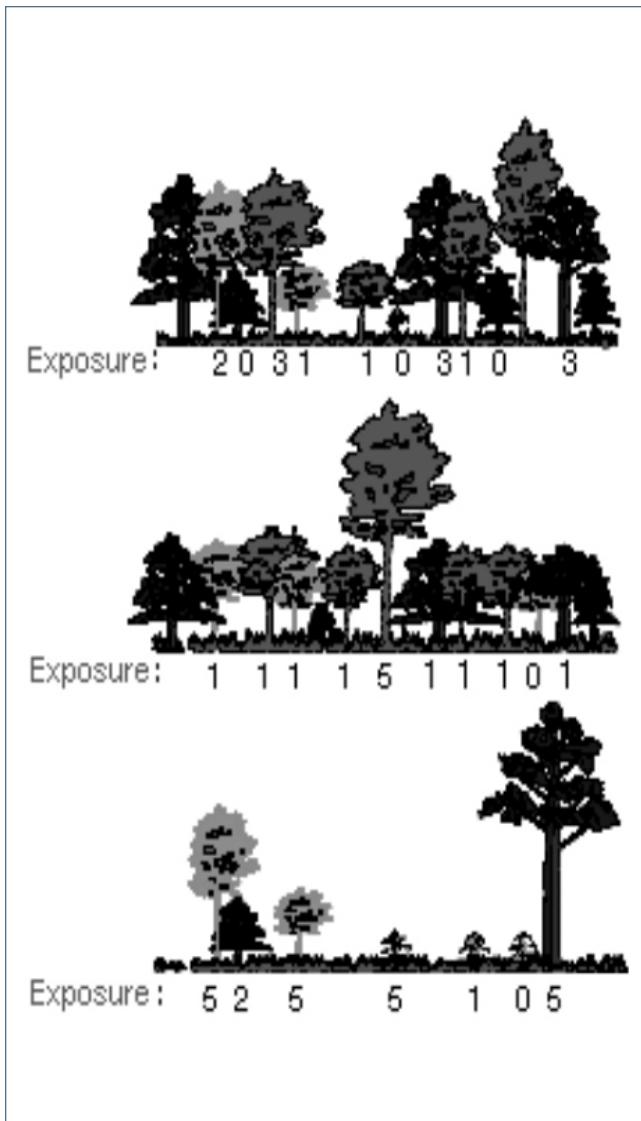
-1	Arboles muertos.
0	Árbol no recibe luz directa porque tiene sombra de arboles, trepadoras o edificios.
1	Árbol recibe luz directa en el tope o por uno de sus lados.
2	Árbol recibe luz directa en 2 lados o el tope y por uno de sus lados.
3	Árbol recibe luz directa en 3 lados o el tope y por dos de sus lados.
4	Árbol recibe luz directa en 5 lados o el tope y por tres de sus lados.
5	Árbol recibe luz directa todos lados.

%IMP: Medir % de superficie impermeable bajo el árbol. Esta medida iría en % de 0-100% con intervalos de 5%.

%SHRUB: Medir % de cobertura de arbustos bajo el árbol. Esta medida iría en % de 0-100% con intervalos de 5%.

- TREES NEAR BUILDING: Interacción entre árboles y energía del edificio. (D1,S1,D2,S2,D3,S3)

Si el árbol es mayor a 6.1m de altura y se encuentra a una distancia menor de 18.3m de una casa.

Añade el ángulo (D1) y la distancia (S1) a los tres edificios más cercanos.

- TREE SITE: Si el árbol se encuentra al norte o al sur de la parcela.

PLOT ID=	DATE=	CREW=	GPS COOR		PHOTO ID=
			X		
			Y		

PLOT SKETCH AND NOTES FOR PLOT RELOCATION

(Note distance and direction from plot center to fixed objects; sketch fixed objects in relation to plot center)

Plot address=   Plot contact info:
Notes: Name and Title:_____
                                                                 Phone #_____

LOCATING REFERENCE OBJECTS/LANDMARKS (Identify at least 1 object)
Measure Reference Object (1) description_____
Distance to Reference Object (1)_____
Direction to Reference Object (1)_____
Measured Reference Object (2) description_____
Distance to Reference Object (2) _____
Direction to Reference Object (2)_____
Tree Measurement Point (TMP): Reference Object (1) used   Y/N
                                                    Reference Object (2) used   Y/N

Measurement Unit: M/E

Percent Measured_____

ACTUAL LAND USE=	PERCENT IN=		PLOT TREE COVER (%)=	SHRUB COVER (%)=	PLANTABLE SPACE (%)=
ACTUAL LAND USE=	PERCENT IN=				
ACTUAL LAND USE=	PERCENT IN=				
ACTUAL LAND USE=	PERCENT IN=				

GROUND COVER	%BLDG	%CMNT	%TAR	%ROCK	%SOIL	%DUFF/ MULCH	%HERB/ IVY	%MAIN. GRASS	%UNMAIN GRASS	%H2O

S H R U B S	SPECIES	HEIGHT	% AREA	% MISSING	SPECIES	HEIGHT	% AREA	% MISSING	SPECIES	HEIGHT	% AREA	% MISSING

PLOT ID=

TREE ID	STAT	DR	DS	TREE SPECIES LAND	USE	HT DBH	DBH 1	2	3	4	5	6	HEIGHT TOT	LIVE TOP	CROWN BASE	CROWN WIDTH N-S	E-W	% MISS	DB	% IMP	% SHRUB	CLE	TREES NEAR BUILDINGS D1	S1	D2	S2	D3	S3	TREE SITE