i-Tree Eco Plot Projects

i-Tree Academy Session 6

What is a sample and why would you do it?

- A small subset of the items you are interested in
- Easier than measuring the whole thing
- For statistical reasons must be random
- We can estimate how well our sample represents the whole population

What is a sample and why would you do it?

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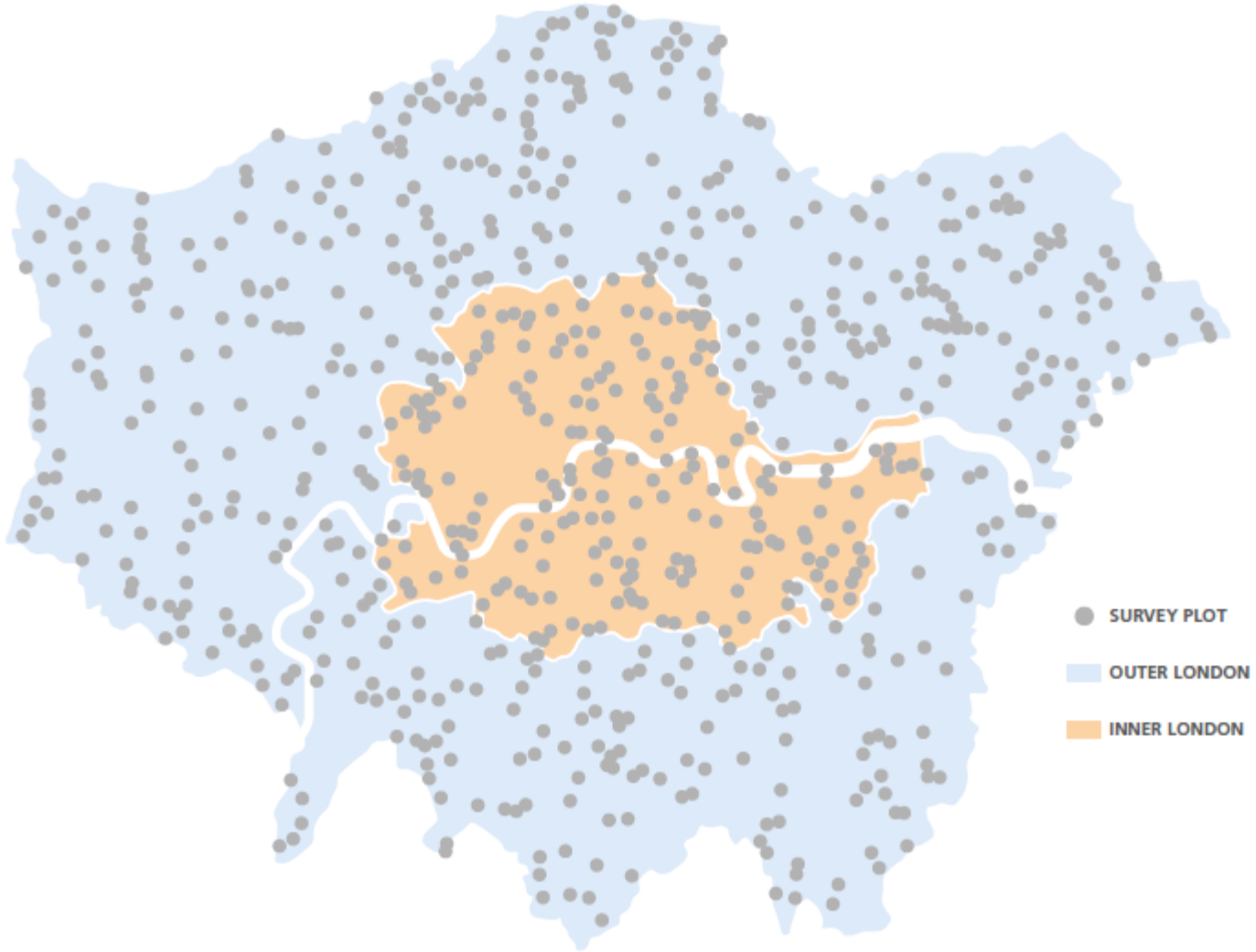
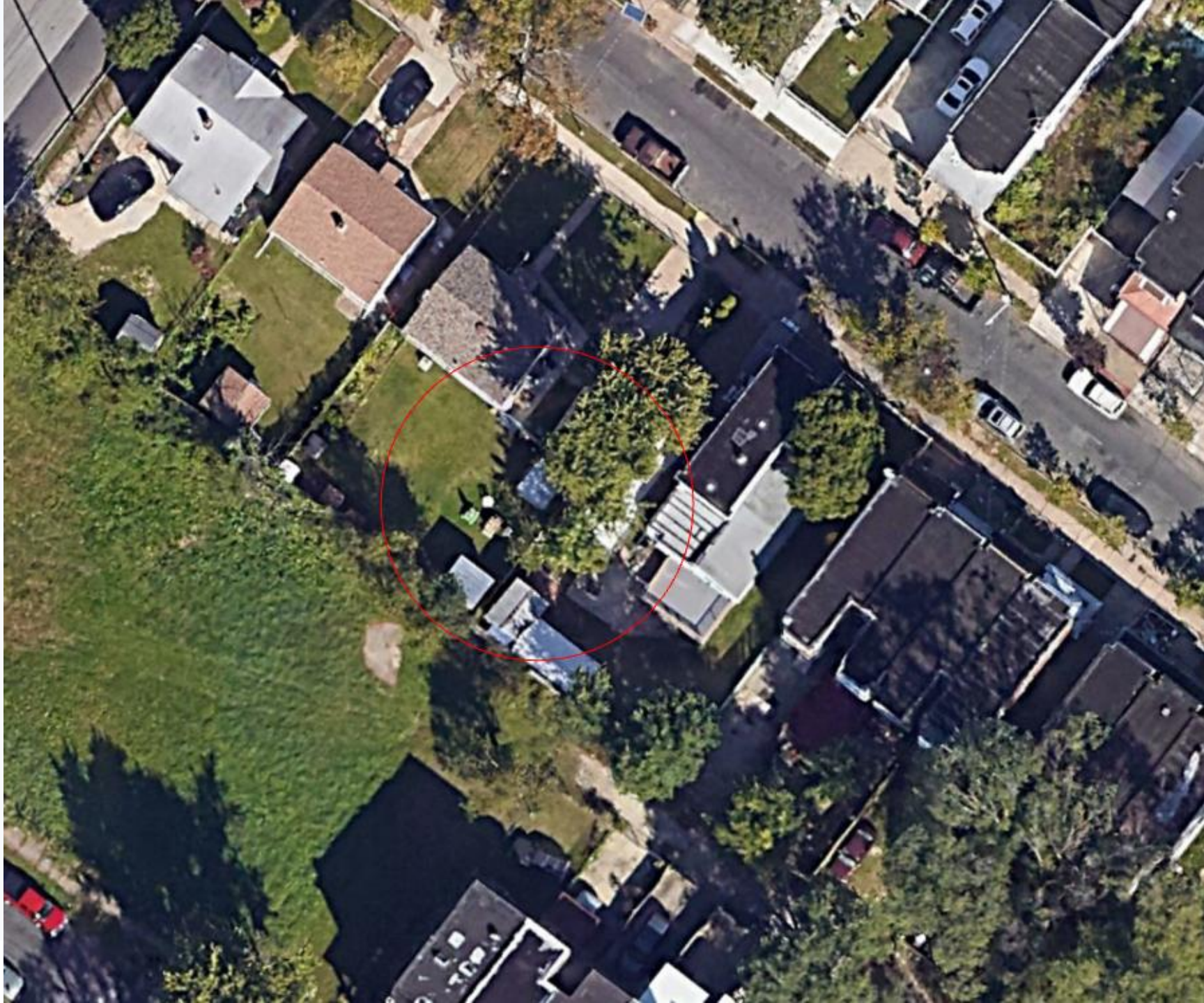
- Easier than measuring the whole thing
- For statistical reasons must be random
- We can estimate how well our sample represents the whole population
- This is how London measures 8.5 million trees



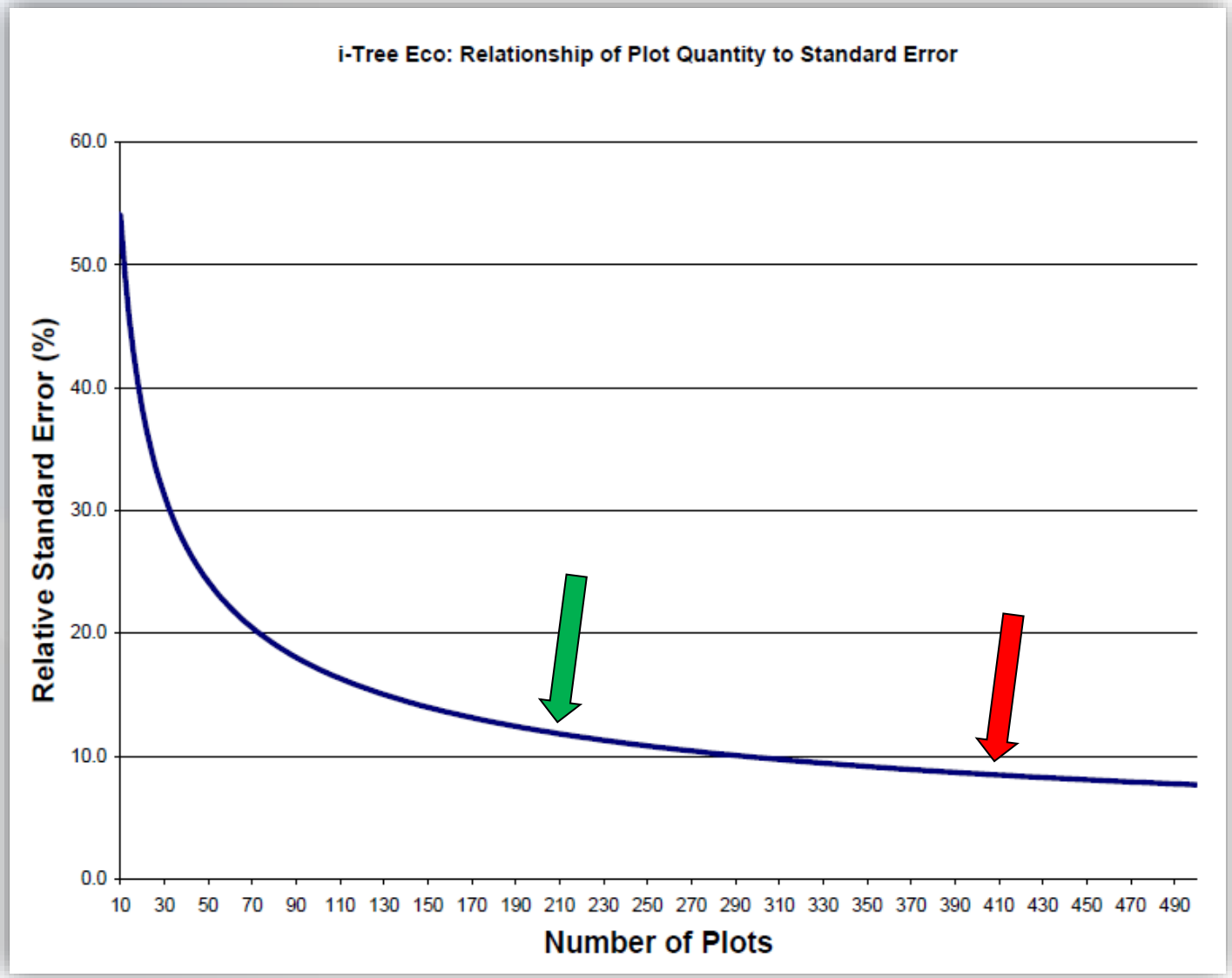
What is a plot?

- By default 11.3m in radius (37.2 ft). 1/10 acre or 405 square meters in area.
- Plot size can be changed
- Tradeoffs between plot size and the number you can measure



How many plots do I need?

General recommendation of 200 plots for a standard error of 12% for the total project estimate of numbers of trees in a typical city



Effect of Plot and Sample Size on Timing and Precision of Urban Forest Assessments
https://www.itreetools.org/eco/resources/08%20plot%20size.pdf

How many plots do I need?

$$n_{opt} = (se_{exp} / se_{des})^2 * n_{exp}$$

The real optimal number of plots will be dependent on

1. The results you are most interested in
2. How much error you can tolerate
3. The inherent variability in your study area

Where:

n_{opt} = optimal sample size (the smallest number of plots to use to achieve your desired standard error)

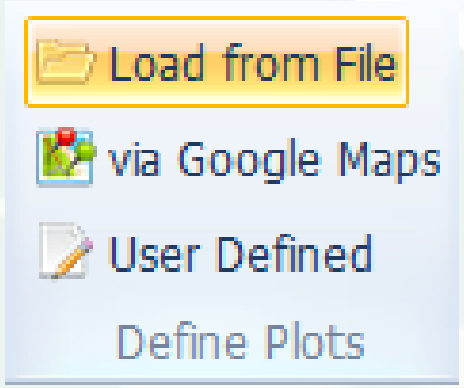
se_{exp} = expected standard error, estimated from pilot study or other method

se_{des} = desired standard error, the standard error you would like to achieve in your results

n_{exp} = the number of plots used to determine your expected standard error (se_{exp}), e.g. the number of plots in you pilot study

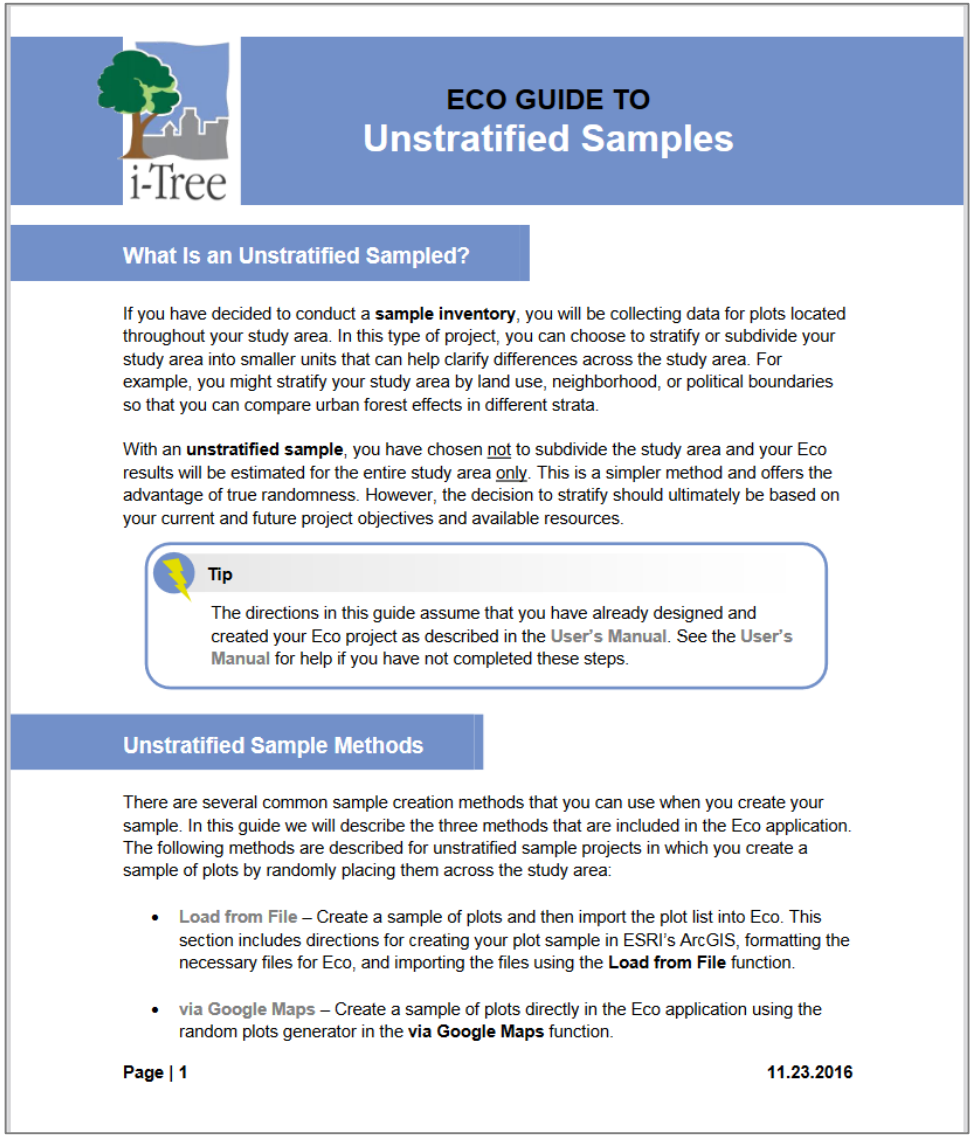
https://forums.itreetools.org/viewtopic.php?f=19&t=1210

How do you generate plot locations?



ArcGIS

QGIS



i-Tree

ECO GUIDE TO
Unstratified Samples

What Is an Unstratified Sampled?

If you have decided to conduct a **sample inventory**, you will be collecting data for plots located throughout your study area. In this type of project, you can choose to stratify or subdivide your study area into smaller units that can help clarify differences across the study area. For example, you might stratify your study area by land use, neighborhood, or political boundaries so that you can compare urban forest effects in different strata.

With an **unstratified sample**, you have chosen not to subdivide the study area and your Eco results will be estimated for the entire study area only. This is a simpler method and offers the advantage of true randomness. However, the decision to stratify should ultimately be based on your current and future project objectives and available resources.

Tip

The directions in this guide assume that you have already designed and created your Eco project as described in the User's Manual. See the User's Manual for help if you have not completed these steps.

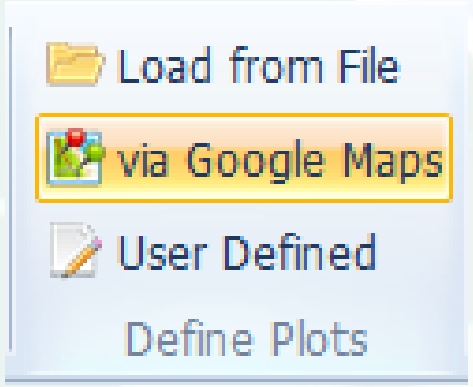
Unstratified Sample Methods

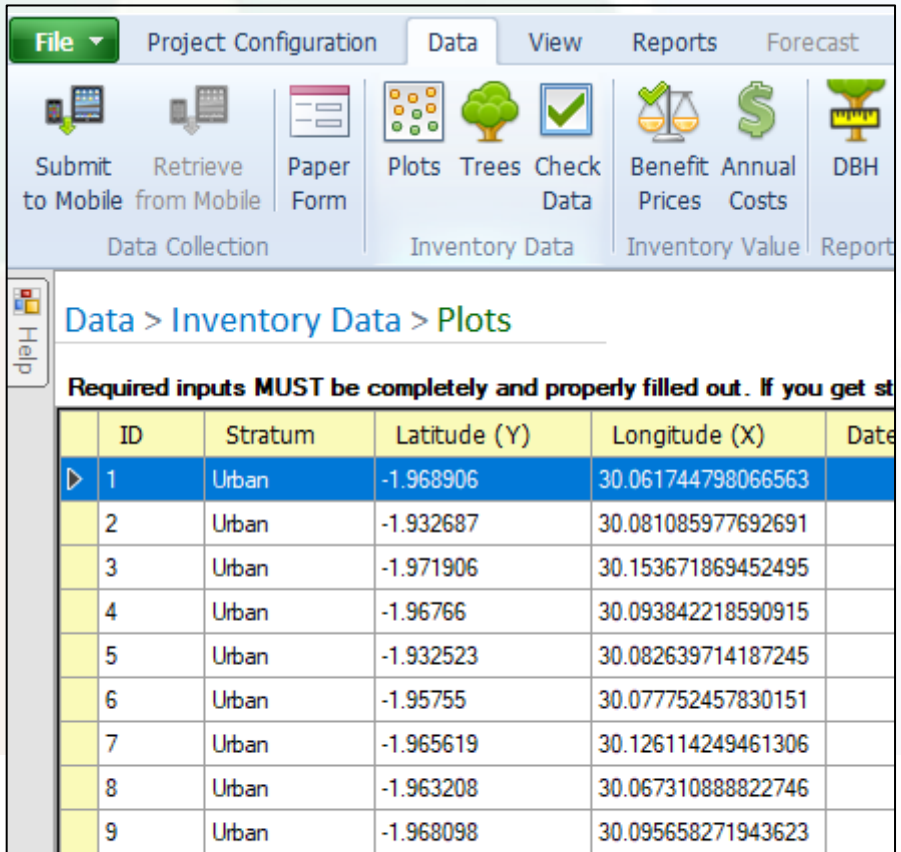
There are several common sample creation methods that you can use when you create your sample. In this guide we will describe the three methods that are included in the Eco application. The following methods are described for unstratified sample projects in which you create a sample of plots by randomly placing them across the study area:

- Load from File – Create a sample of plots and then import the plot list into Eco. This section includes directions for creating your plot sample in ESRI's ArcGIS, formatting the necessary files for Eco, and importing the files using the **Load from File** function.
- via Google Maps – Create a sample of plots directly in the Eco application using the random plots generator in the **via Google Maps** function.

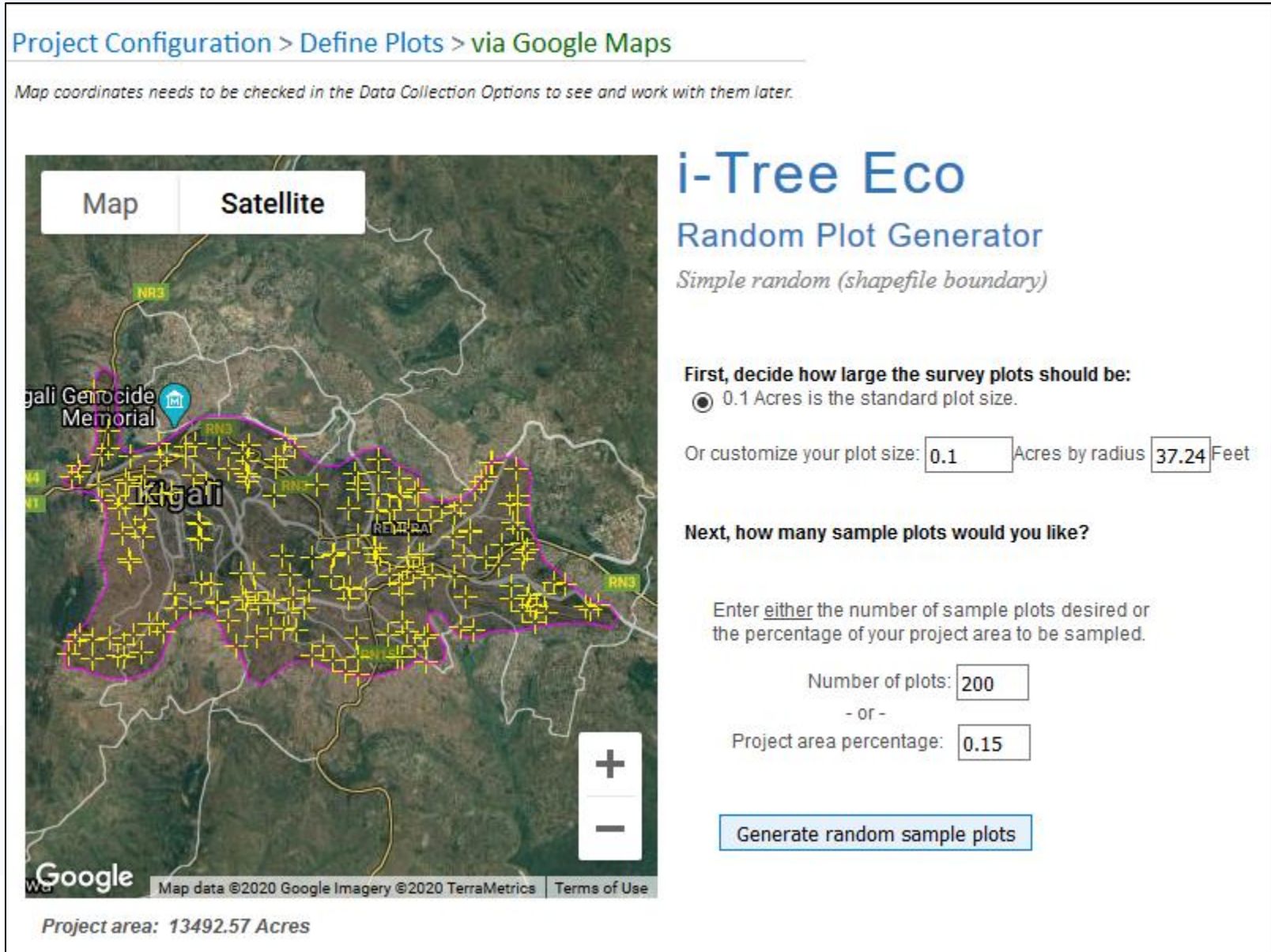
https://www.itreetools.org/documents/272/Ecov6Guide_UnstratifiedSamples.pdf

How do you generate plot locations

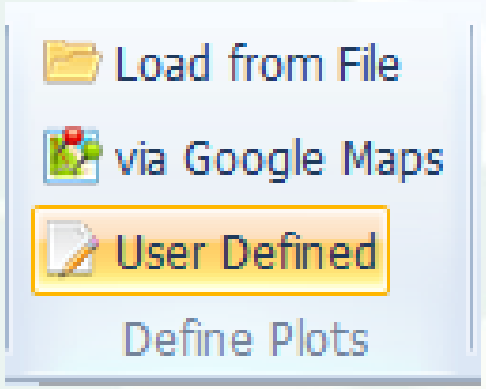




ID	Stratum	Latitude (Y)	Longitude (X)	Date
1	Urban	-1.968906	30.061744798066563	
2	Urban	-1.932687	30.081085977692691	
3	Urban	-1.971906	30.153671869452495	
4	Urban	-1.96766	30.093842218590915	
5	Urban	-1.932523	30.082639714187245	
6	Urban	-1.95755	30.077752457830151	
7	Urban	-1.965619	30.126114249461306	
8	Urban	-1.963208	30.067310888822746	
9	Urban	-1.968098	30.095658271943623	



How do you generate plot locations



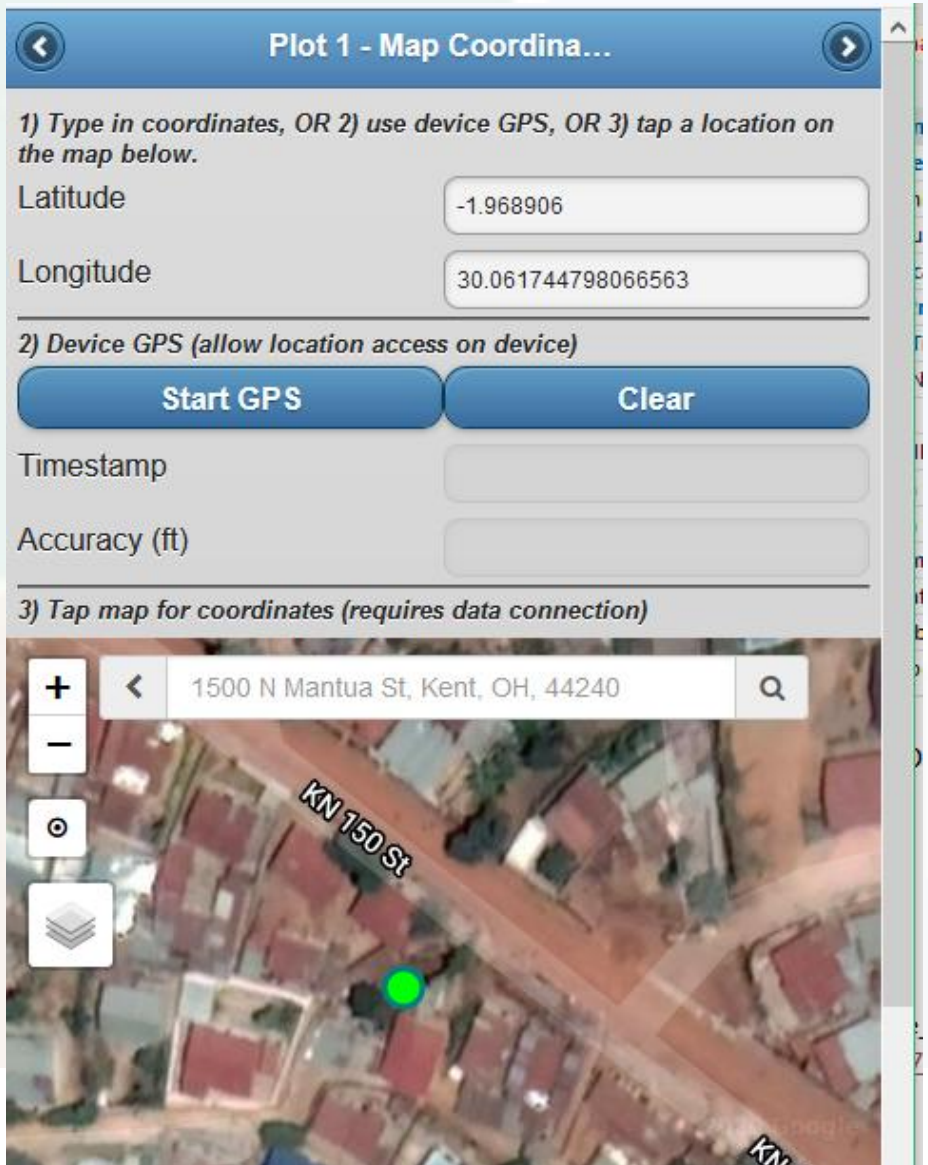
Project Configuration > Define Plots > User Defined

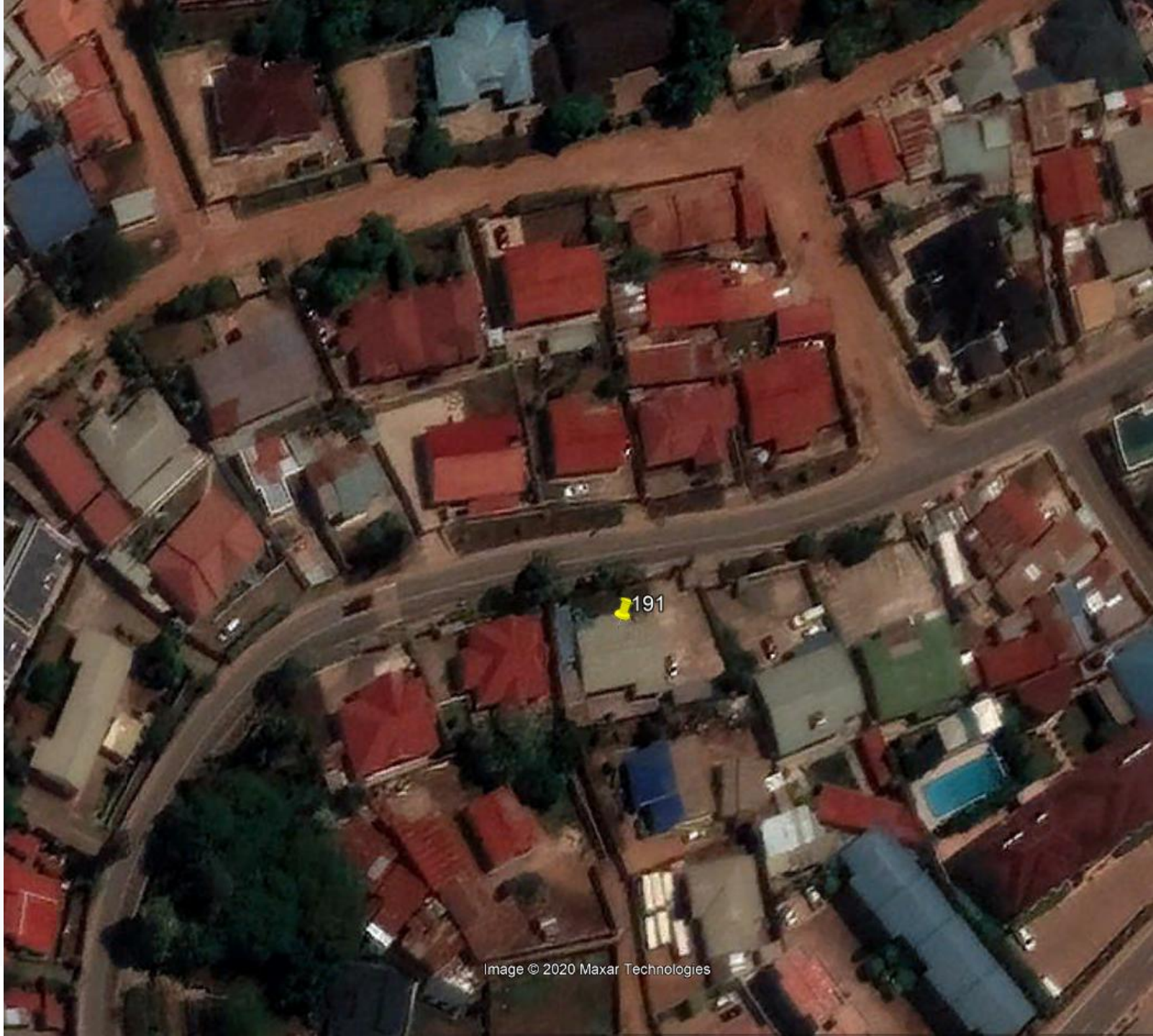
Map coordinates needs to be checked in the Data Collection Options to see and work with them later.

New Plot Area (ac): 0.1 Total Plots: 263 Total Area (ac): 1,854.00

	ID	Strata Description	Strata Abbreviation	Area (ac)	Existing Plots	Plots To Add
	1	Northeast	NE	1,214.00	200	
▶	2	Northwest	NW	512.00	0	42
	3	Center City	Center	128.00	0	21
*						

How do you find plot locations?

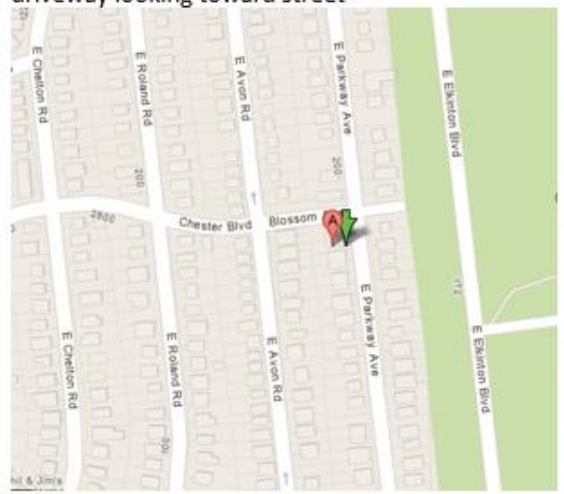




How do you find plot locations?

Eco Plot 1121

location object 1: 294.82° for 28.68 feet from light post on E. parkway ave. on right side at end of driveway looking toward street



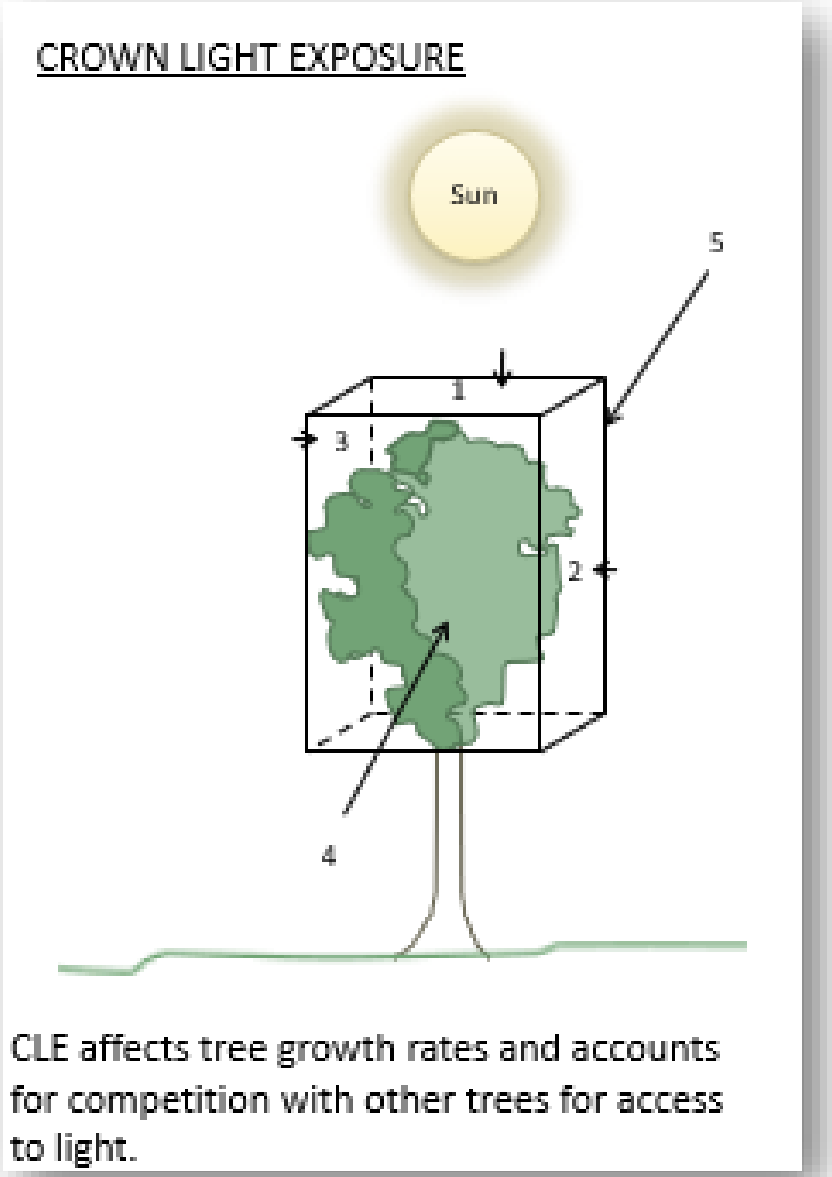
Eco tree data variables

Minimum Required Tree Data

1. Tree species
2. Diameter at breast height (DBH)

Optional but Recommended Tree Data

3. Total tree height
4. Height to live top
5. Height to crown base
6. Crown width (N-S & E-W)
7. % Crown missing
8. % dieback (condition)
9. Crown light exposure (CLE)
10. Direction to building (Energy effect)
11. Distance to building (Energy effect)
12. Land use



File > New Project

Enter project overview information and click OK to save it or Cancel to quit this process.

OK

Project Settings | Location | Data Collection Options

What units will you be using during your data collection?

- (•) English
- ( ) Metric

This option cannot be changed once a project has been created.

- These fields MUST be collected!
- These fields are optional and HIGHLY RECOMMENDED to improve model estima
- These fields are optional.

PLOT INFORMATION

Minimum Required Fields

- [x] Percent measured
- [x] Percent tree cover

General Fields

- [ ] Land Use
  (also requires tree land use)
  - Actual land use
  - Percent of plot
- [ ] Percent plantable space
- [ ] Plot address
- [ ] Map coordinates
  - Latitude
  - Longitude

  (required for GPS location capture and GIS mapping)
- [ ] Reference objects
  - Object type
  - Direction
  - Distance
  - DBH
- [ ] Ground cover
  - Ground cover
  - Percent of plot

  (required to calculate Grass/Herbaceous benefits)
- [ ] Percent shrub cover
- [ ] Shrub details
  (also requires percent shrub cover)
  - Species
  - Height
  - Percent of area
  - Percent missing

TREE INFORMATION

Minimum Requirements

- [x] Species
- [x] DBH

  Measured

General Site Fields

- [ ] Land Use
  (also requires plot land use)
- [ ] Status
- [ ] Distance and direction to plot center
- [ ] Street tree/non-street tree

  Default non-street tree
- [ ] Map (GPS) coordinates
- [ ] Public/private

Tree Detail Fields

- [ ] Total tree height
- [ ] Crown size
  - Height to live top
  - Height to crown base
  - Crown width
  - Percent crown missing
- [ ] Crown Health
  - (•) Dieback
  - ( ) Condition

Management Fields

- [ ] Maintenance recommended
- [ ] Maintenance task
- [ ] Sidewalk conflict
- [ ] Utility conflict
- [ ] Pests (IPED)
  (requires 5 fields for each of the following)
  - Sign & symptoms of tree stress
  - Sign & symptoms of foliage/twigs
  - Sign & symptoms of branches/bole

Eco data variable relationships

D	Directly used
I	Indirectly used
C	Conditionally used

	DERIVED VARIABLES		ECOSYSTEM SERVICES										
DIRECT MEASURES	Leaf Area	Leaf Biomass	Carbon Storage	Gross Carbon Sequestration	Net Carbon Sequestration	Energy Effects	Air Pollution Removal	Avoided Runoff	Transpiration	VOC Emissions	Compensatory Value	Wildlife Suitability	UV Effects
Species	D	D	D	D	D	D	I	I	I	D	D		
Diameter at breast height (d.b.h.)			D	D	D						D	D	
Total height	D	D	C	C	C	D	I	I	I	I		D	
Crown base height	D	D	C				I	I	I	I			
Crown width	D	D	C				I	I	I	I			
Crown light exposure			C	D	D								
Percent crown missing	D	D	C	C	C	D	I	I	I	I			
Crown health (condition/ dieback)				D	D						D	D	
Field land use				D							D	D	
Distance to building						D							
Direction to building						D							
Percent tree cover						D	D	D				D	D
Percent shrub cover							D					D	
Percent building cover						D							
Ground cover composition							I					D	

Tree Variables

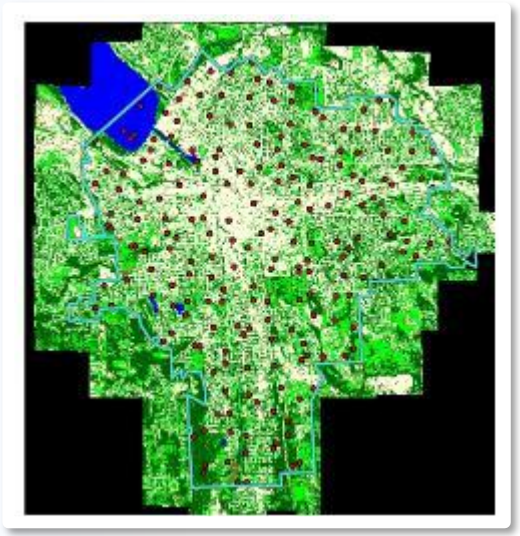
Plot Variables

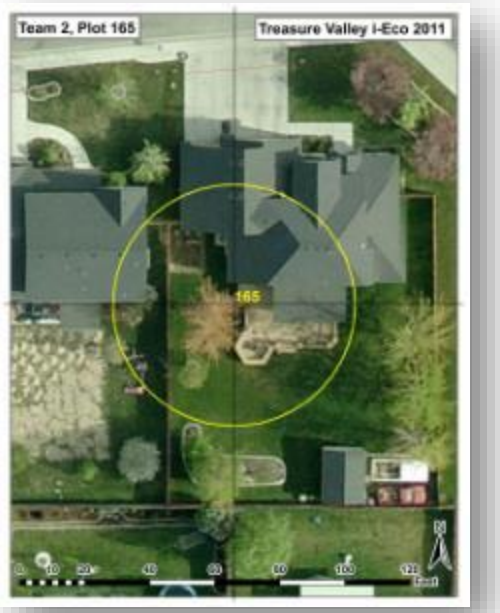
[Understanding i-Tree]

Project options: sample or complete inventory

Sample plots (0.0404ha or 11.3m radius)

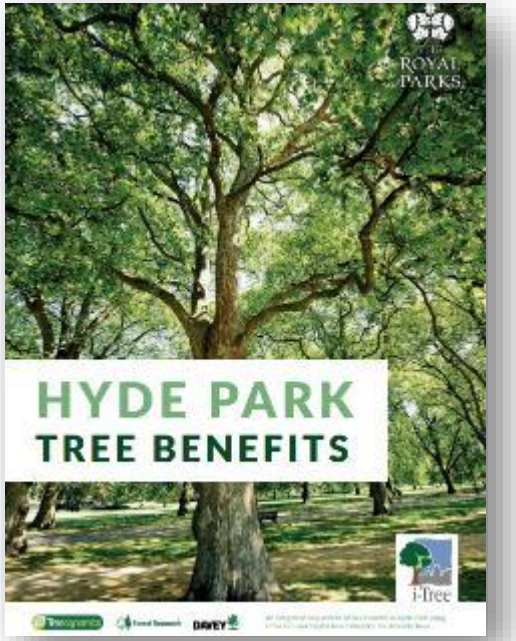
- City
- County
- Regional or watershed
- Large scale





Complete inventory

- Parks
- Campuses
- Residential properties
- Specimen or single trees
- Can import other tree data into Eco for analysis



Sample Plots vs. Complete Inventory

Characteristic	Sample	Complete
Recommended area	City or larger	Any
Number of plots	200 or more	None
Typical number of trees	>500	Any
Access	Numerous permissions usually required	Often no permission required
Accuracy	Some loss of accuracy due to sampling error	No sampling error, all trees of interest measured
Results	Estimates expanded to whole area of interest	Estimates associated with each tree

Additional sample plot considerations

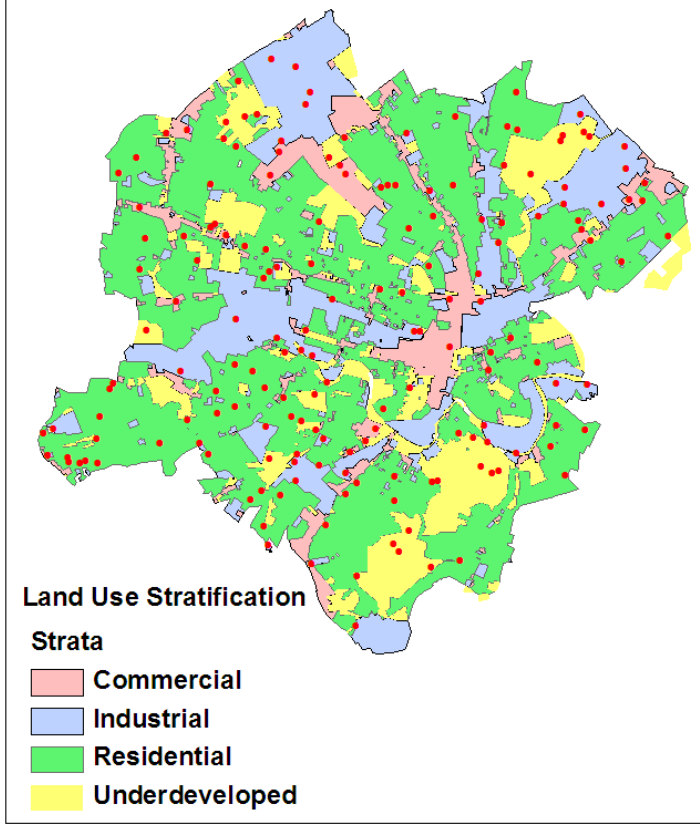
- Need permission to get on private property
- Difficult in more forested or natural areas (> 1 day per plot)
- Travel between plots and locating plots can be time consuming
- Need a dedicated project manager
- Need trained data collectors

  (*Typical time: summer for a field crew of 2 or 3*)

Stratification for Sample or Complete Inventory

Dividing area of interest into categories

- Can be performed by any categories of interest (land use, ownership, political, watershed, etc.)
- Summaries generated by categories of interest
- Perform pre- or post- measurement (sample must be random)
- Can improve statistical accuracy



Additional resources – project planning

Project Management

Idaho Treasure Valley i-Tree Eco Project Management Report - This document developed by David Stephenson, Idaho Department of Lands Community Forestry Program, provides suggestions, methods, tips and tools to help future Eco project managers.

Eco Project Cost Estimation - This document, developed by Eric Kuehler from Urban Forestry South, offers a cost estimate for an Eco project. Note - Numerous factors can affect project cost and this is provided only as a general guideline.

Eco Project Time Estimation - This document, developed by Eric Kuehler from Urban Forestry South, provides time estimations for planning and conducting an Eco project.

Eco Project Timeline - This document, developed by Eric Kuehler from Urban Forestry South, is an example of a Eco project time line for a county assessment.

Eco Project Equipment List - This is an example of equipment options for a typical i-Tree Eco project.

Eco Report Explanation Brief - This document, developed by Eric Kuehler, USFS Urban Forestry South, and Francisco Escobedo, University of Florida, provides a brief explanation of and uses for the i-Tree Eco reports.

City of Milwaukee - Notification Letter - This is an example on an access notification letter sent to residents provided courtesy of the City of Milwaukee.

City of Milwaukee - Access Response Card - This is an example on an Eco plot access response card sent to residents provided courtesy of the City of Milwaukee.

Data Collection Guides

Eco Field Data Cheat Sheet (1 page field resource) *updated 03.28.2021* - (*16MB pdf*) This two-page guide is great to have in the field for inexperienced crews or when you need a reminder of how to collect Eco data and measurements for a given tree. This document was developed by Naomi Zurcher of Arbor Aegis in support of the Swiss i-Tree Eco project.

Casey Trees UFORE Management Guide - This guide, which was developed by Casey Trees in Washington D.C., provides detailed guidelines for planning, managing and executing an i-Tree Eco project.

Cascade Land Conservany (CLC) Integrated Forest Assessment Report - This document was developed by CLC in Seattle, WA, and describes outreach efforts and guidelines for planning and managing Eco plot access issues.

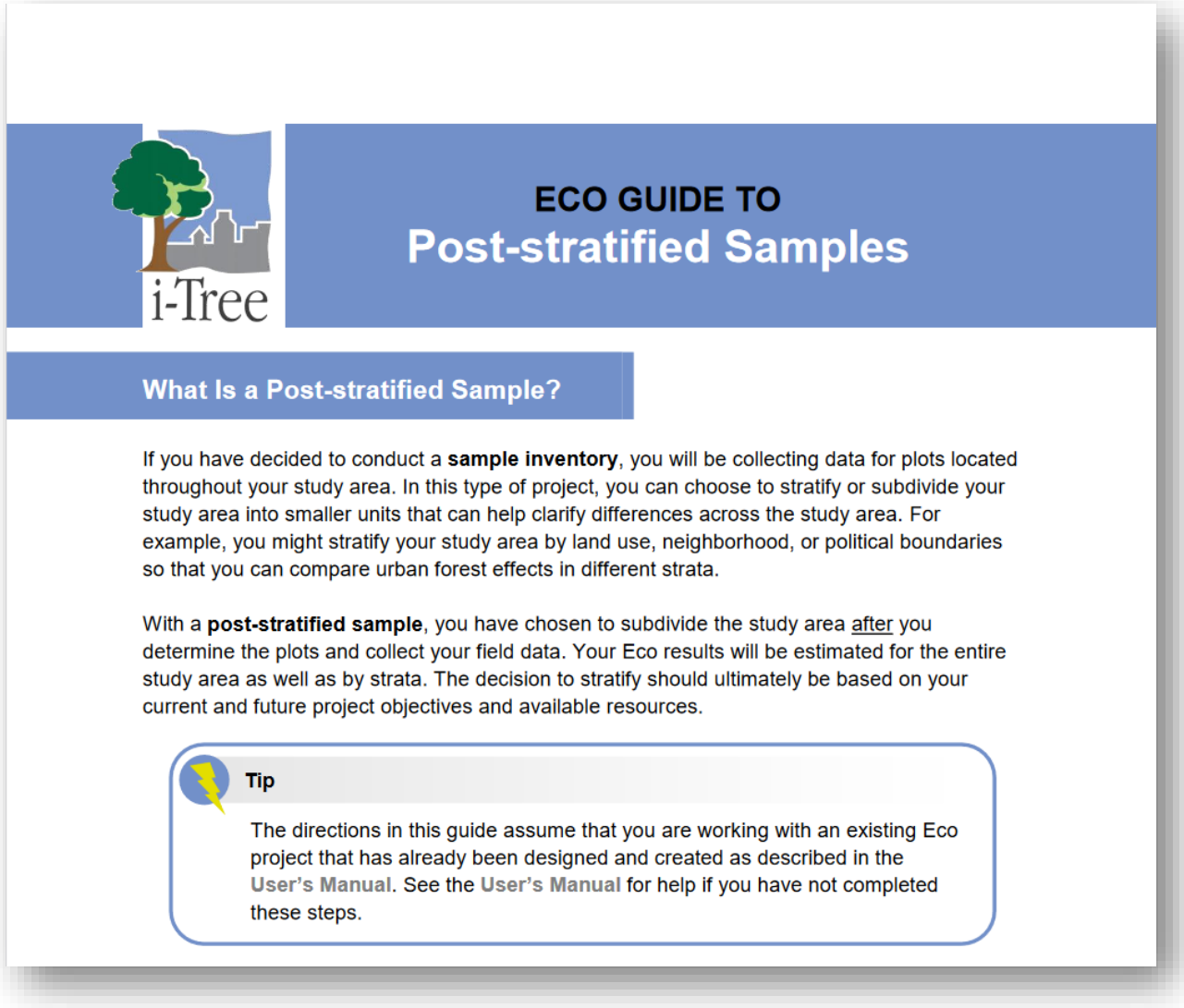
Eco plot descriptions Powerpoint (PDF) - This is a PDF file of a PowerPoint used for Eco plot training developed courtesy of Keith Sacre from Treeconomics

Eco Data Explanation Sheet - Brief description of Eco sample project plot & tree data collection options.

Questions and additional resources

Official i-Tree Manuals, Guides & Workbooks

- Eco v6.0 Guide - Unstratified Sample Project
- Eco v6.0 Guide - Pre-stratified Sample Project
- Eco v6.0 Guide - Post-stratified Sample Project
- Eco v6.0 Guide - Stratifying a Complete Inventory
- Eco v6.0 Guide - Importing an Existing Inventory



i-Tree

ECO GUIDE TO
Post-stratified Samples

What Is a Post-stratified Sample?

If you have decided to conduct a **sample inventory**, you will be collecting data for plots located throughout your study area. In this type of project, you can choose to stratify or subdivide your study area into smaller units that can help clarify differences across the study area. For example, you might stratify your study area by land use, neighborhood, or political boundaries so that you can compare urban forest effects in different strata.

With a **post-stratified sample**, you have chosen to subdivide the study area after you determine the plots and collect your field data. Your Eco results will be estimated for the entire study area as well as by strata. The decision to stratify should ultimately be based on your current and future project objectives and available resources.

Tip

The directions in this guide assume that you are working with an existing Eco project that has already been designed and created as described in the User's Manual. See the User's Manual for help if you have not completed these steps.

i-Tree New Delhi

Give Me Trees Trust
New Delhi, India

Akshat Tyagi

Headlines…..

FEDERAL BUDGET Follow our live blog as the federal government prepares to unveil its election-y

Doctors say breathing toxic air in Delhi is like smoking 10 cigarettes a day and urgent solutions are needed

By Charmaine Manuel

Posted Mon 3 Jan 2022 at 12:27am, updated Mon 3 Jan 2022 at 2:11am

HT Hindustan Times

0°C

World Cities Entertainment Cricket Lifestyle Astrology

ckreads NEW | Web Stories | Omicron | Following NEW | Photos | Educatio

DELHI NEWS

Delhi world's most polluted capital for fourth year in row

Among the most polluted cities, Rajasthan's Bhiwadi fared the worst followed by Uttar Pradesh's Ghaziabad, on the outskirts of Delhi.

Annual average PM2.5 levels in Delhi increased by almost 15% in 2021 compared to the previous year.(HT Photo)

Updated on Mar 23, 2022 12:32 PM IST

Air Quality Index Scale

- Scale for measuring air pollution
- The city's AQI (air quality index) is usually in the range of **250-300**
- It can even cross **999** in months from October- December

Numerical Value	Color	Air Quality Index Levels of Health Concern	Meaning
0 - 50	Green	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.
51 - 100	Yellow	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
101 - 150	Orange	Unhealty for sensitive groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
151 - 200	Red	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
201 -300	Purple	Very unhealthy	Health alert: everyone may experience more serious health effects.
301 - 500	Maroon	Hazardous	Health warnings of emergency conditions. The entire population is more likely to be affected.

Air Quality Index : 50

Air Quality Index : 350

The important questions to ask..

Even though there is 23% green cover in Delhi, the area still suffers from **extreme** air pollution.

It is important to understand:

(i) WHAT does the green cover in Delhi consist of?

(ii) How effective are the trees in removing air pollution?

For this, we have used i-Tree

Doesn’t this data inventory already exist?

Delhi has no data on number of trees, no census conducted in the last two decades: RTI reply

Jasjeev Gandhiok | TNN | Updated: Jul 24, 2020, 23:23 IST

Image used for representational purpose only

NEW DELHI: No tree census has been conducted in Delhi in the past decade and no data is available on the number of trees in the New Delhi Municipal Council area for the past two decades. This has been revealed in an RTI reply to a Delhi-based researcher.

Kohli filed an RTI on the tree census carried out from 2010-2020, along with data on tree count conducted in the NDMC area between 2000 and 2020. According to the records maintained by the Delhi forest and wildlife department, no tree census had been conducted during the period.

The researcher, who works with Centre for Policy Research (CPR), said, Delhi Tree Authority — a statutory body set up under Delhi Preservation of Trees Act, 1992

Adaption of i-Tree Eco in New Delhi (India)

- Using i-Tree Eco to calculate Ecosystem-services of trees in Delhi.
- For this, we :
  - Did a plot based i-Tree study
  - Measured trees and collectd data

WHY IS THIS IMPORTANT?

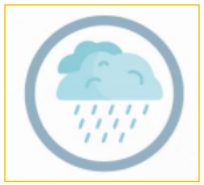
Determine the Ecosystem services of trees

Proper decision making and policy advocation

Calculate the amount of air pollution removal by trees

Create awareness

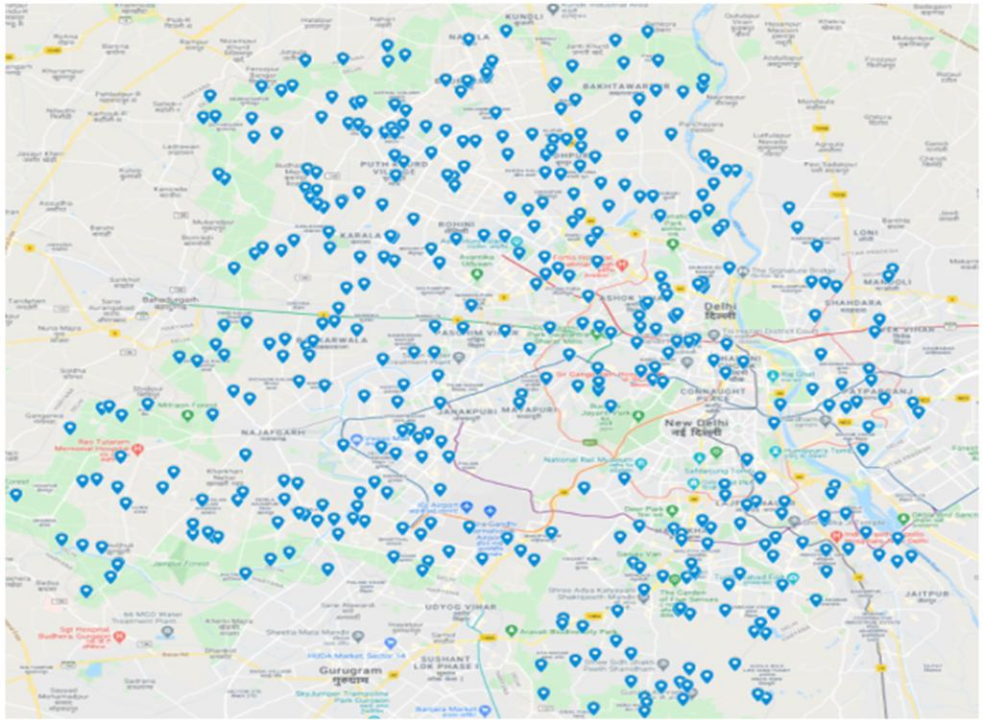
Amount of carbon absorbed by trees annually



Calculate evapo-transpiration by trees

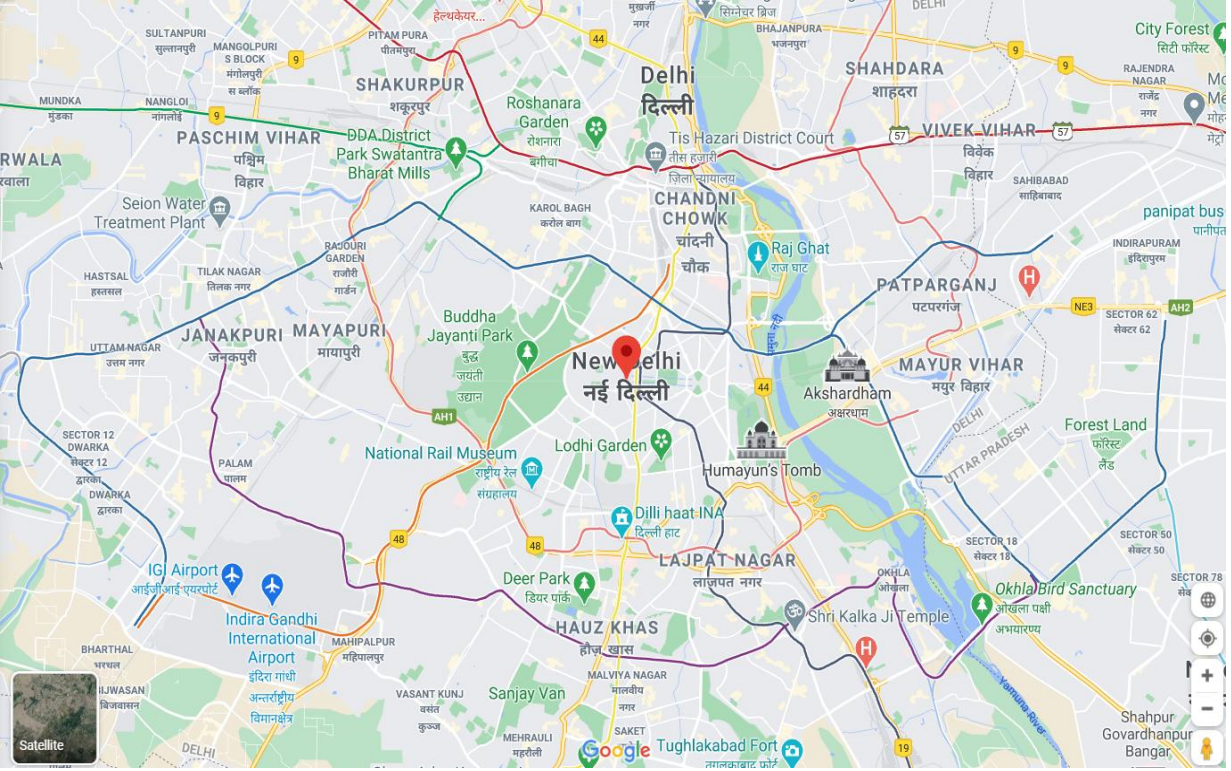
HOW DID WE DO THIS?

- Randomized 400 points (plots) in Delhi to collect trees data
- A Plot is basically a a circular area with 20 meters radius. We measure all the trees in the circular area



HOW DID WE DO THIS?

- ❑ Collecting trees & shrubs data
- ❑ Collecting photos & videos as proof



PROCESS THAT WE FOLLOWED

To use i-Tree locally in New Delhi, we collected and submitted:

- ❑ Rainfall data
- ❑ Air pollution data
- ❑ Location data

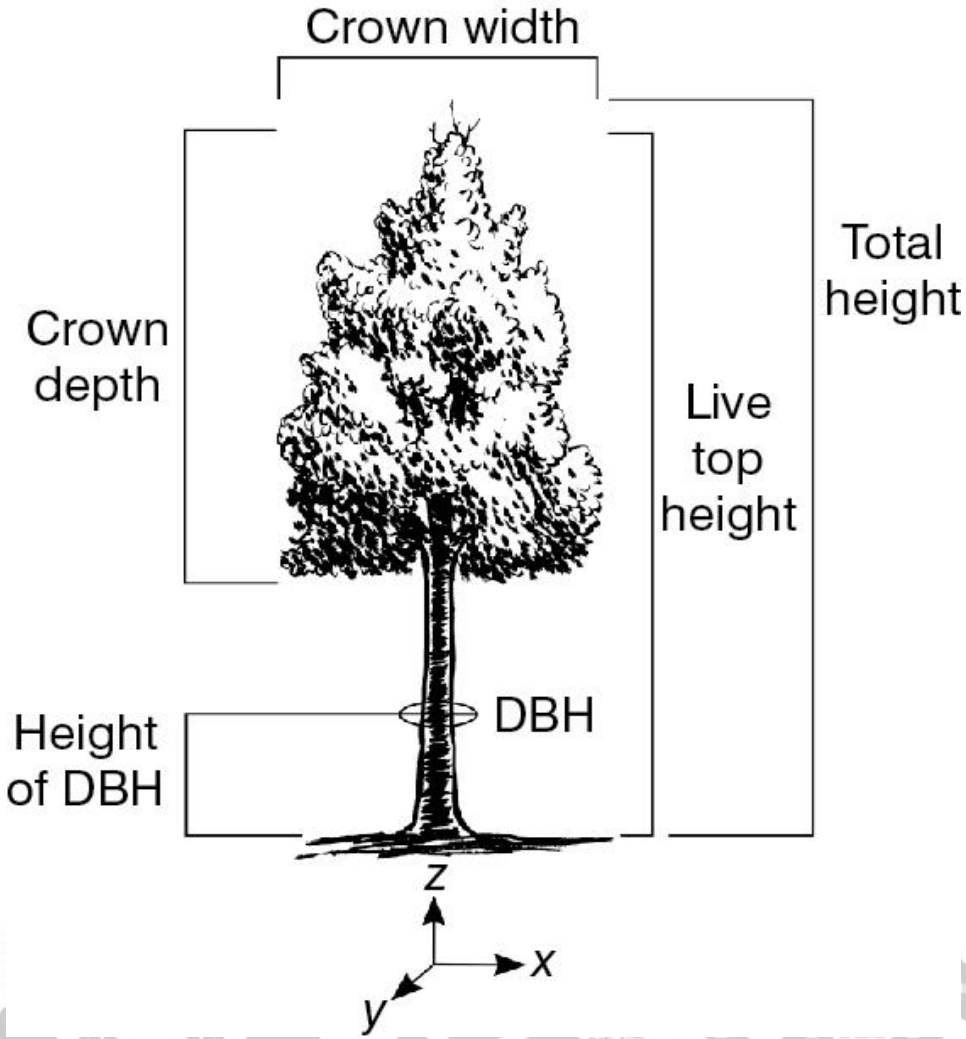
Category	Recommended	Our Project
Number of Plots	220	400
Plot Radius	11 meters	20 meters

Why did we choose more plots with greater area?

- ❑ To reduce the error in our study
- ❑ To have better results

Tree Variables in our study

1. Tree species
2. Diameter at breast height (DBH)
3. Total height
4. Crown live top height
5. Crown base height
6. Crown width (both sides)
7. Sunlight Exposure of crown
8. Gaps in crown (crown missing)
9. Crown Health
10. Dieback (measure of health of the tree)
11. GPS Coordinates



HOW DID WE COLLECT DATA IN THE FIELD?

Step-1 Find plot-center with the help of Google maps

Step-2 Use measuring tape & chalk to mark 20 meters periphery from the center of the plot

Step-3 Number the trees with chalk

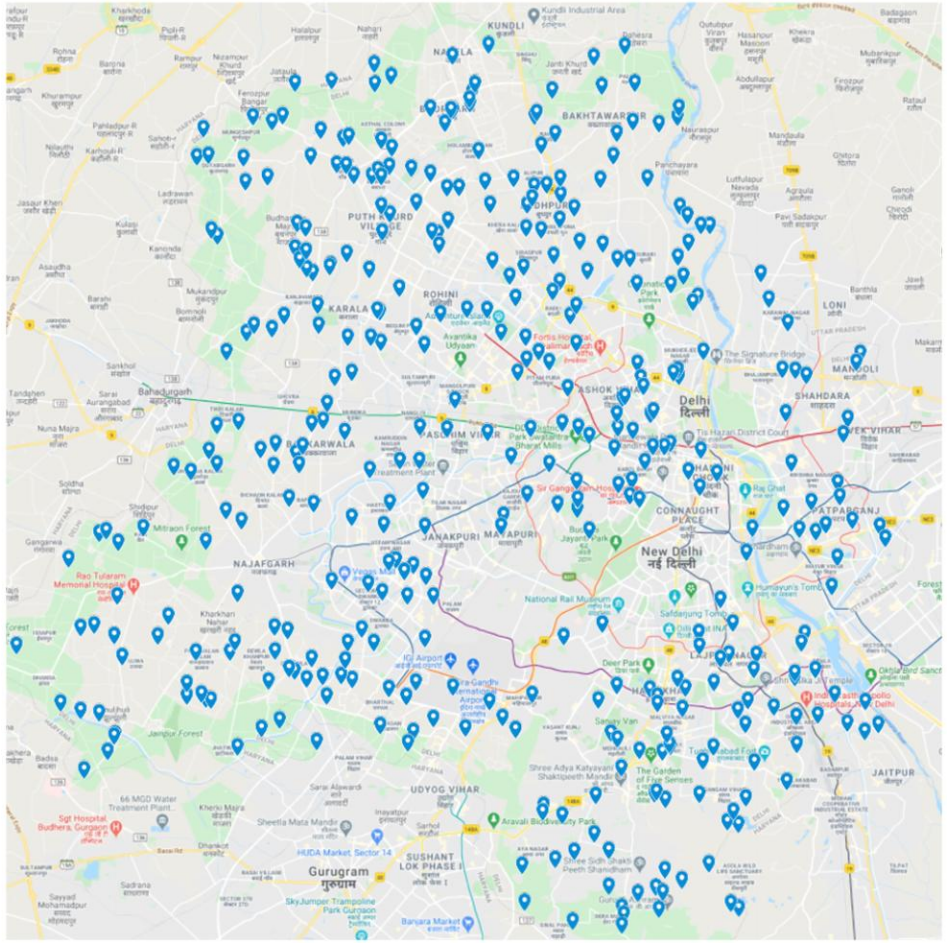
Step-4 Measuring tree variables

Step-5 Take multiple photos of trees for virtual proof and future reference

MAJOR CHALLENGES IN THE FIELD

- ❑ Inaccessible plots & permission issues
- ❑ Monkeys, dogs & bees
- ❑ Interference by people
- ❑ Long distance travelling

Plots in our study



SNAPSHOT OF HOW RESULTS LOOK
(Based on a sample of 10 trees)

Snapshot of Results (Species wise benefits)

Tree ID	Species Name	Pollution Removed (oz/yr)					Removal Value (Rs/yr)				
		CO	O3	NO2	SO2	PM2.5	CO	O3	NO2	SO2	PM2.5
2	Peepul tree	3.6	18.3	10.3	7.8	2.2	11.32	408.28	228.95	42.52	33.23
3	Putranjiva	2.9	14.6	8.2	6.2	1.8	9.06	327.04	183.39	34.06	26.62
4	troipical almond spp	3.2	16.6	9.3	7.1	2.0	10.26	370.32	207.66	38.57	30.14
5	troipical almond spp	2.9	15.0	8.4	6.4	1.8	9.31	336.04	188.43	35.00	27.35
6	Putranjiva	2.2	11.3	6.3	4.8	1.4	6.97	251.48	141.02	26.19	20.47
7	Putranjiva	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00
8	Canafistula	1.8	9.3	5.2	4.0	1.1	5.78	208.42	116.88	21.71	16.97
9	White mulberry	2.9	14.7	8.3	6.3	1.8	9.12	329.06	184.52	34.27	26.79
10	Putranjiva	0.3	1.6	0.9	0.7	0.2	1.02	36.63	20.54	3.81	2.98
11	Putranjiva	0.4	2.3	1.3	1.0	0.3	1.41	50.97	28.58	5.31	4.15
	Total	**20.3**	**103.8**	**58.2**	**44.2**	**12.7**	**64.25**	**2,318.24**	**1,299.96**	**241.45**	**188.71**

Most effective species in air pollution removal : Peepal tree

Snapshot of Results

*Ficus religiosa (*Peepal tree – native)

Carbon absorbed in lifetime by mature tree:
1,500 kg

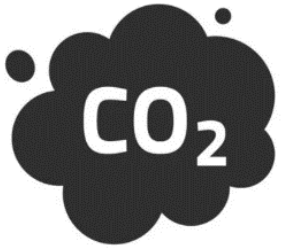
Prosopis juliflora (Vilayati keekar/ Mesquite- invasive)

Carbon absorbed in lifetime by a mature tree:
30 kg

Results & Findings

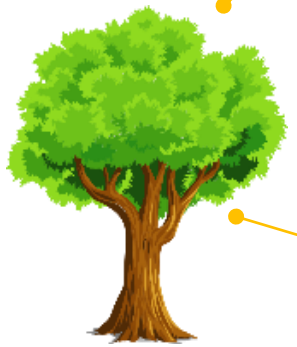
Key Findings

Tree Density: 70 trees per hectare



- **Carbon Storage** of (equivalent to carbon emissions by almost 1.5 million cars)
- Almost 1.5 times the weight of the Titanic

Avoided runoff
(approximately equivalent to water in 1400 Olympics size swimming pools)



10,440,000 trees in Delhi with a **tree cover** of **8.1%**

Oxygen Production of 174 thousand metric tons/year

7.017 thousand metric tons/year of **Air Pollution Removal**

Is ‘Green cover’ effective?

Green cover: 23%

Top 10 species with highest population = 66 % of all trees

Invasive and ornamental
42%

Least benefits

Naturalized
14%

Medium benefits

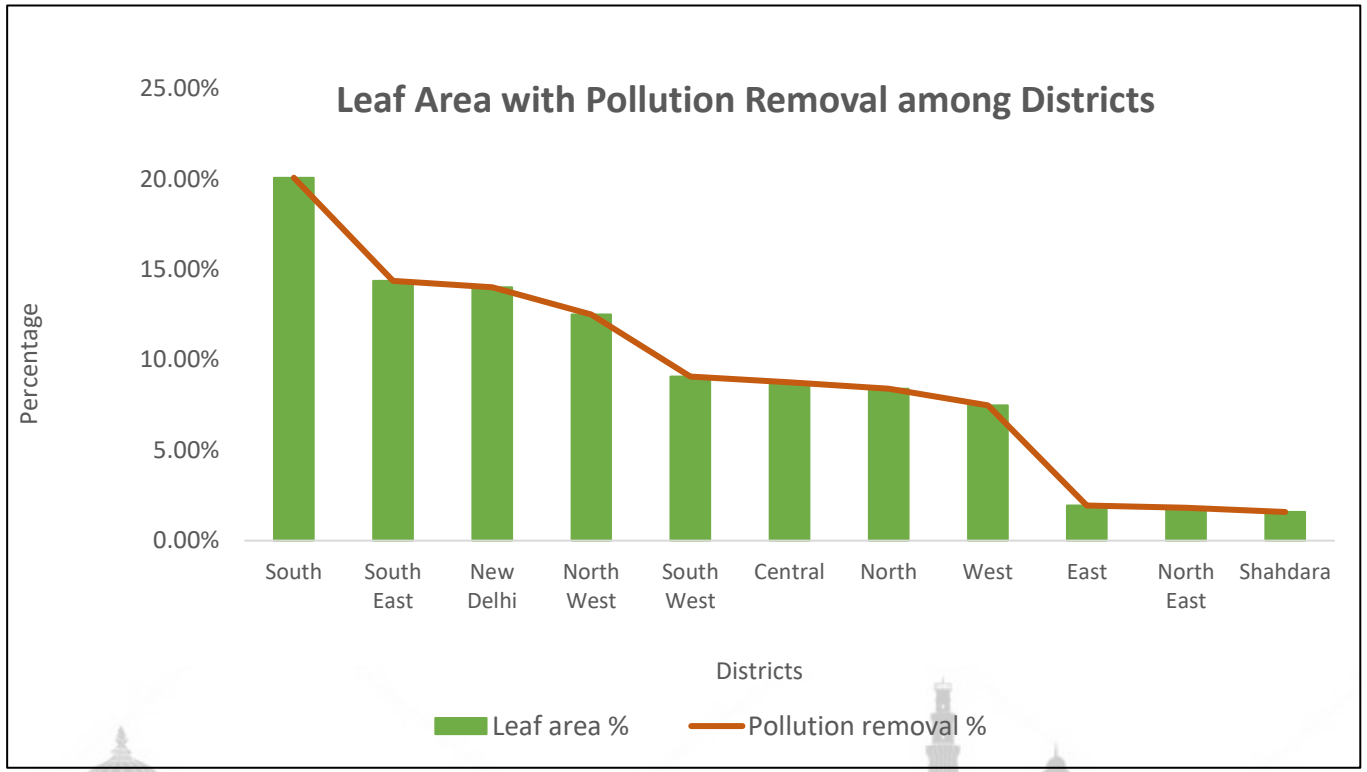
Native
10%

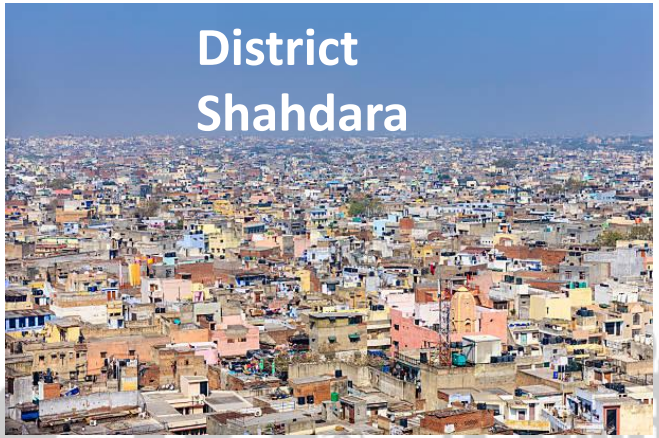
Highest benefits

Tree cover: 8.1%

Air pollution removal

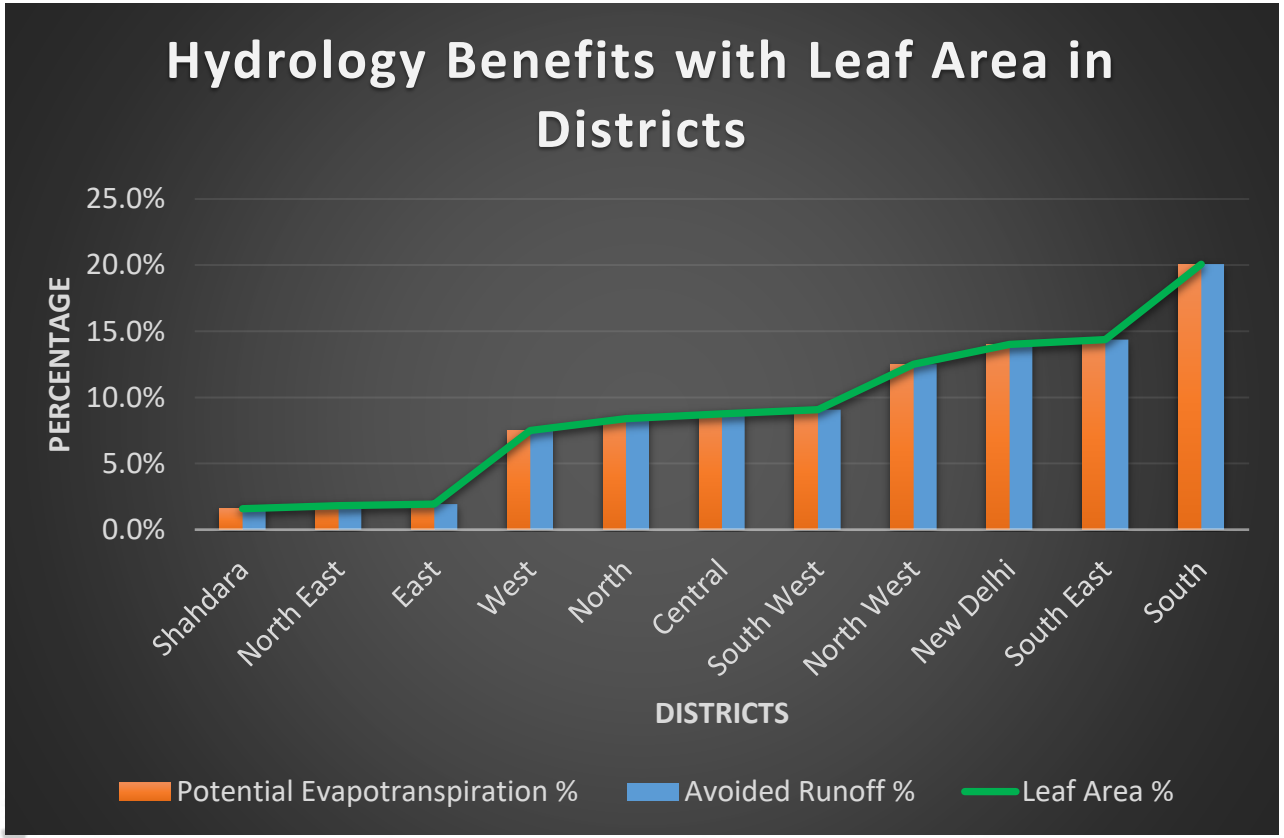
Higher leaf area -> Higher air pollution removal



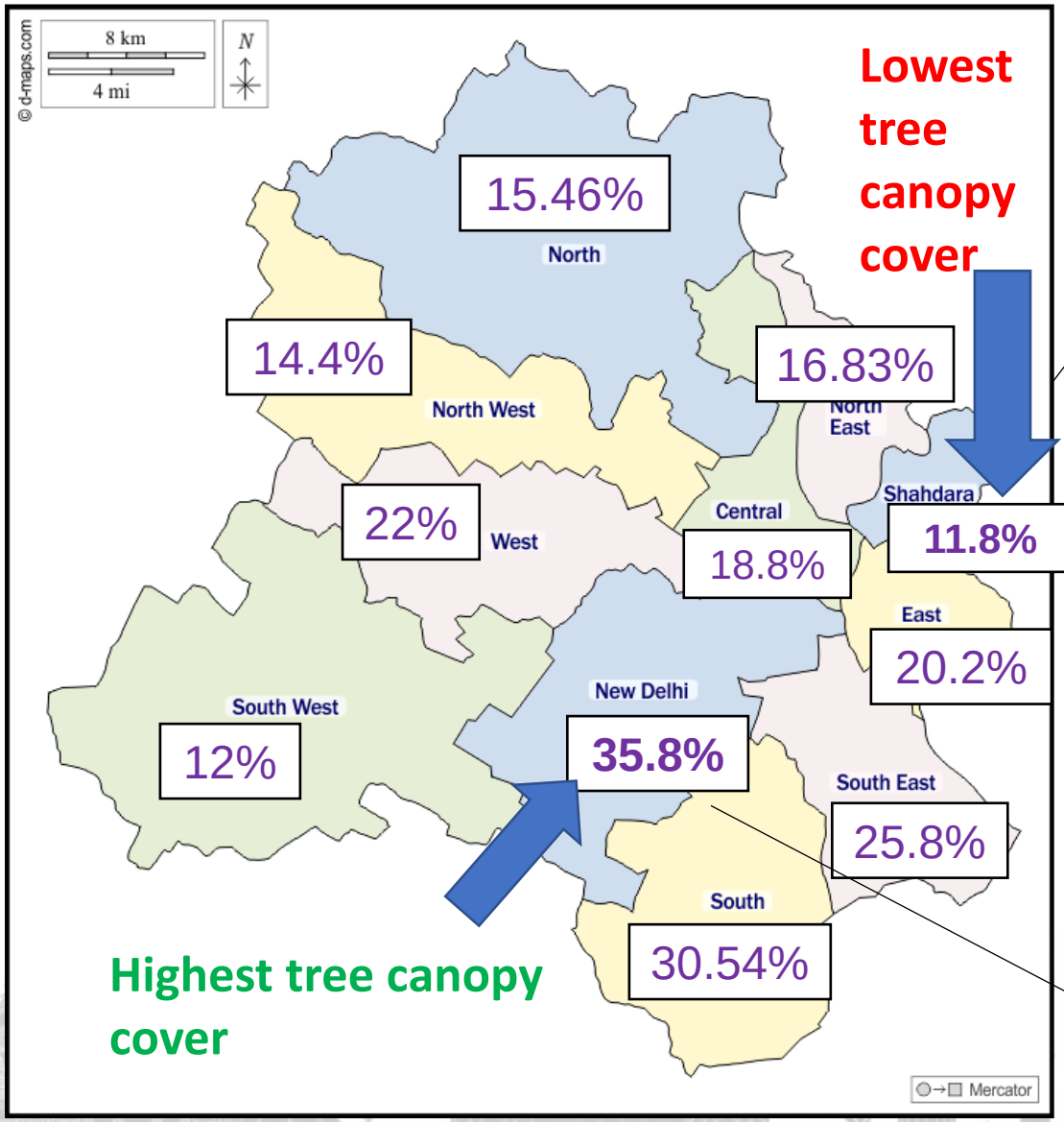


Hydrology benefits

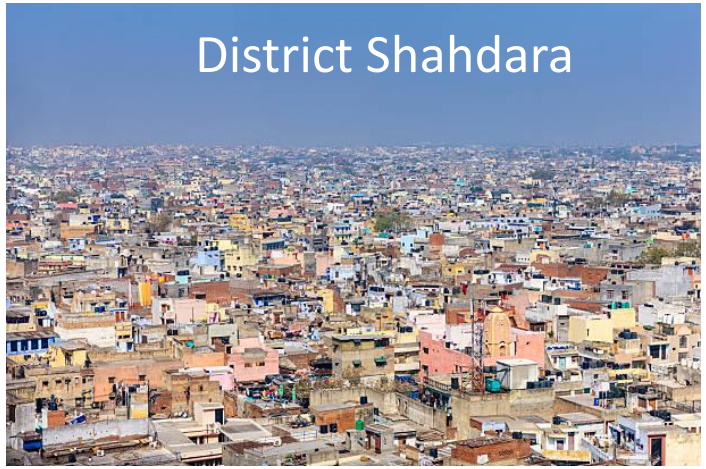
Higher the leaf area =>
Higher the potential evapotranspiration and avoided runoff



Tree Equity



Districts of Delhi



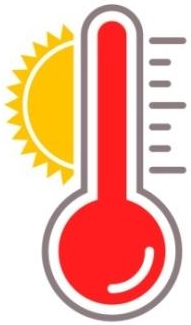
Generally,

Wealthier the area →
Higher the tree cover

Trees Help Boost Livelihoods

Under the shade of trees, people run businesses to earn their livelihood.

- **Tea Vendors**
- **Vegetable/Fruit cart vendors**
- **Barbers**
- **Cobblers & Shoemakers**



Current average day temperature in Delhi:

43 deg C (109 deg F)

TYPES OF PLOTS

Agricultural

Residential/multi-family residential

Industrial/commercial

Forest & parks

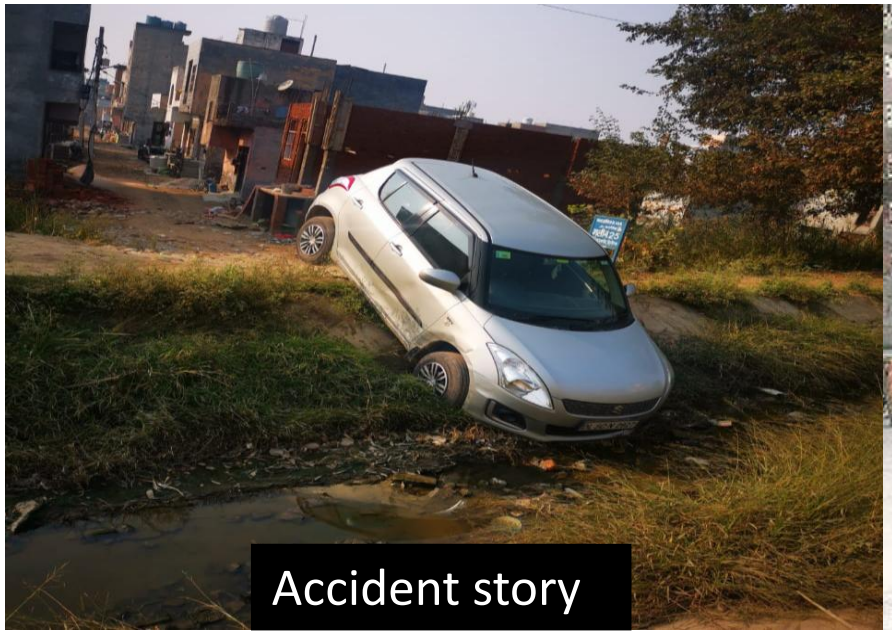
River/wetland/drain

Roads/railway & metro lines

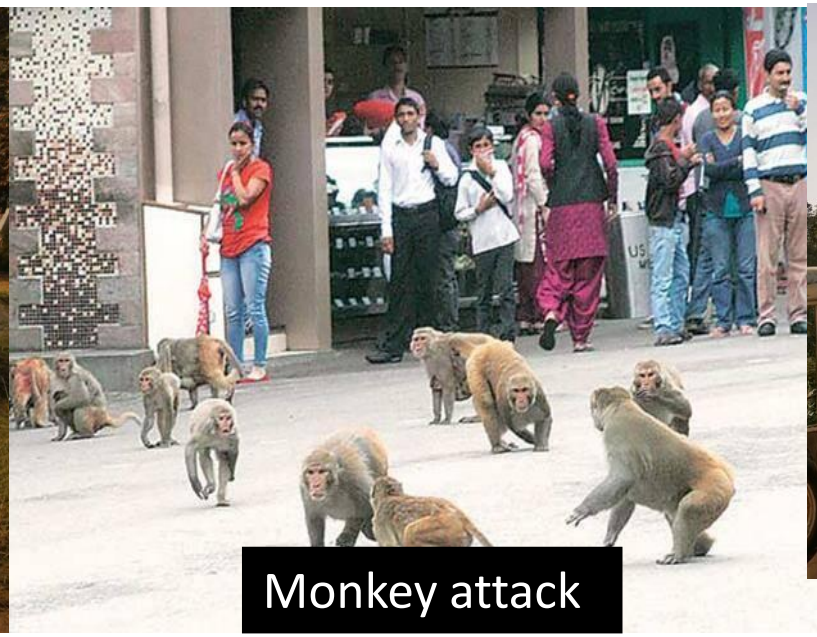
RESIDENTIAL COLONIES

DENSE FORESTS

STORIES FROM THE FIELD



Accident story



Monkey attack

Drug dealer

THANK YOU