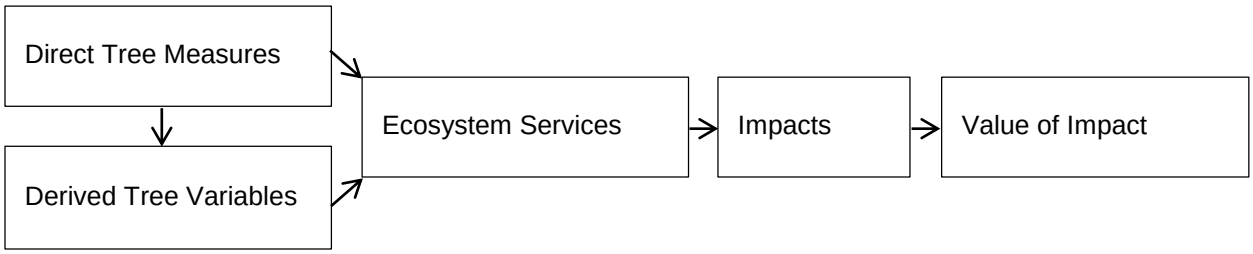
ECO GUIDE TO
Model Differences

Changes in technology and science over time influence the development of software applications. Just as i-Tree Eco v6.0 offers many new features, there are several important changes in the science and methodologies used by the model that should be noted. If you are familiar with past versions of Eco, you may notice that various estimates are different in i-Tree Eco v6.0.

Model Overview

The Eco model is primarily informed by tree data, or direct tree measures (e.g., diameter at breast height or DBH), that are collected by the user in the field. Derived tree variables (e.g., leaf area) are calculated by the model using those direct tree measures. Direct tree measures and the derived tree variables are then used to calculate ecosystem services (e.g., pollution removal) and impacts (e.g., cleaner air). Lastly, the economic value of impact (e.g., improved health) is calculated.



General Reasons for Change

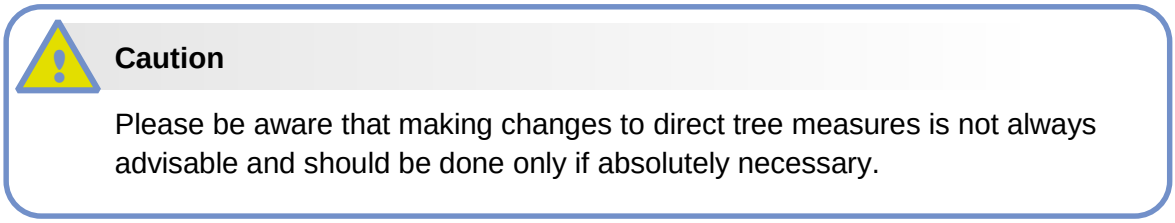
Here are some of the more general reasons why estimates may be different from one version of Eco to the next.

User Inputs

As we describe some of the reasons why your estimates may change from one version of Eco to the next, we are assuming that the user inputs have not changed. However, projects can be

altered over time, decisions changed, and field data corrected. Making changes to any of the following user-provided inputs is one reason why your Eco estimates might change:

- **Direct tree measures –** As described in the **Model Overview** section, users collect direct tree measures in the field and input them into Eco. Should you find a reason to edit the field data that you collected (e.g., to correct an error), those changes will be reflected in your results.



- **Pollution data –** Pollution data are used by Eco to calculate some ecosystem services. Users are required to either select the year of the pollution dataset that they would like to use or in some cases provide the dataset themselves. The results for pollution removal will vary based on the pollution data that are used. Users may be more inclined to change this input now that Eco v6.0 offers more pollution datasets to choose from than past versions of the application.

- **Weather data –** Weather data are used by Eco to calculate some ecosystem services. Users are required to select a weather station and the year of the weather dataset that they would like to use or in some cases provide the dataset themselves. The results for avoided runoff, bioemissions, and pollution removal will vary based on the weather data that are used. Users may be more inclined to change this input now that Eco v6.0 offers more weather datasets to choose from than past versions of the application.

- **Benefit prices –** As described in the **Model Overview** section, value of impact is one component of the Eco model. Value of impact is calculated as the economic value associated with the ecosystem services that are provided by trees. While Eco includes default benefit prices for the value of impact estimates, users are also allowed to provide their own. The addition of or changes to user-defined benefit prices from one Eco run to the next will result in different value estimates.

Species Data

i-Tree Eco calculates many of its derived tree variables and ecosystem services using species-specific data that are stored in a database and accessed by the model during processing. As new information and science become available, the species database is updated so estimates using this data have the potential to change as well.

For example, derived tree variables, such as leaf area and leaf biomass, are calculated based on equations or conversion factors. These variables will change if new conversion factors or new species information are added to the database. Likewise, some ecosystem services will be directly affected by changes to species data. For example, adding a new biomass equation will result in differences in carbon storage estimates. Changes in some ecosystem service and value estimates will also be seen as a consequence of changes to derived tree variables.

Valuation Data

As described in the **Model Overview** section, value of impact is one component of the Eco model. Value of impact is calculated as the economic value associated with the ecosystem services that are provided by trees.

Simple valuation methods involve multiplying the amount of ecosystem service (e.g., tons of carbon stored) by the associated economic value (e.g., dollars per ton of carbon stored). This method is used to calculate the value of energy effects, carbon storage and sequestration, avoided runoff, and pollution removal. Users are able to provide their own benefit prices for these calculations. However, valuation data is also inherent to the model. The following data are updated regularly:

- **Energy values –** Trees have an effect on the amount of energy (i.e., MBTUs or MWHs) used for heating and cooling residential buildings in the study area. The dollar value associated with increases or decreases in energy usage are based on local energy costs.

- **Carbon values –** The dollar value associated with the amount of carbon stored or sequestered by trees in your study area is based on calculations of the social cost of carbon.

For other valuation data that are not updated regularly (e.g., pollution removal value), the producer price index (PPI) is used to adjust benefit prices based on the average change in base prices over time. To keep those estimates current, PPI data are updated regularly with newer versions of Eco.

(**Note:** The valuation methods used for your project depend on your project location and whether or not you choose to provide your own benefit prices.)

Specific Changes in v6.0

Changes in estimates from one version of Eco to the next can also be due to changes in model procedures. This is especially true for ecosystem service estimates. For example, improved

rainfall interception or evaporation modeling will result in differences to avoided runoff estimates. The following model improvements have been made for Eco v6.0.

Carbon Sequestration

Carbon sequestration is the amount of carbon annually removed from the atmosphere and stored in the tree's biomass. To estimate annual carbon sequestration in i-Tree Eco, average annual diameter growth is added to the existing tree diameter (year *x*) to estimate tree diameter and carbon storage in year *x*+1. Projected carbon estimates from year *x*+1 are subtracted from carbon estimates in year *x* to determine gross carbon sequestration.

The Eco model uses an average annual diameter growth rate or base growth of 0.33 inches per year for each tree. In past versions of Eco, this growth rate was adjusted based on the diameter at breast height (DBH) of each tree and the number of frost free days in the study area. This methodology helped to account for the effects of tree size and local climate on growth rates.

For Eco v6.0, the methodology for estimating carbon sequestration has changed. The new methodology adjusts base growth rates based on the crown light exposure (CLE) of each tree and the number of frost free days in the study area. This method still accounts for the effect of local climate on growth rates. However, emphasis is now placed on the growing conditions (i.e., closed, mixed, or open conditions) of each tree rather than the size of the tree. It is believed that the base growth (0.33 inches per year) used by Eco is most closely associated with trees growing in open conditions, such as street trees, where CLE is measured between 4 and 5. For trees in more mixed (CLE 2-3) or closed (CLE 0-1) conditions, growth rates are adjusted downwards.

Pollution Removal

Pollution removal is an estimate of the amount of air pollution that is removed by trees either by interception or absorption. The amount of pollution removed is correlated to leaf area so i-Tree Eco uses a measure of leaf area index (LAI) in its modeling methods. Eco v6.0 is using a new methodology for estimating the LAI used for pollution modeling.

For a more technical description of this model enhancement, please read:
https://www.itreetools.org/landscape/resources/Air_Pollutant_Removals_Biogenic_Emissions_and_Hydrologic_Estimates_for_iTree_v6_Applications.pdf

Model Precision

In i-Tree Eco v6.0, the number of decimal places carried within the model was increased for all structural estimates (e.g., leaf area and biomass). This means that rounding takes place when

estimates are reported rather than during their calculation. The purpose of this change is to provide better, more precise estimates, though the impact will be relatively small.

Plot size was also made more precise for Eco v6.0. The plot size used by the model is estimated to 6 decimal places where it was estimated to only 4 decimal places in the past. This change will produce more noticeable differences in estimates across the board. However, the change will not affect all projects. Complete inventory projects or projects that do not use the default plot size (in metric units) will not be affected.

One final model change to mention is in calculations of sampled area in study areas with split plots. Split plots are sample plots that are assigned more than one actual land use. Eco previously inflated the sampled area for split plots leading to larger average plot sizes. For Eco v6.0, calculations have been adjusted to provide more accurate sampled area and thus better estimates.

Reinventory Projects

As part of the discussion of changing Eco estimates, it is important to note the following:

Users who wish to monitor their urban forest and analyze how it changes over time will need to remeasure their field data at another point in time. For these reinventory projects, users may choose to analyze both of their datasets by using either the latest version of i-Tree Eco or a past version. However, in either case, the same version of i-Tree should be used to process both years of data. This will ensure a clean comparison where any changes in estimates are due to actual differences in direct tree measurements, rather than also reflecting model updates.

For example, let's say that you collected data in 2012 and ran Eco v5.0 at the time to get your results. Then, in 2017, you decide to remeasure your data. Now that Eco v6.0 is available, you can choose to analyze your 2012 and 2017 data using v6.0, or you can use the legacy version (v5.0) to analyze the new data in 2017 for purposes of comparison.

Tip

The model is always improving with new routines or new tree data. Try using the latest version of i-Tree for your reinventory project!