i-Tree-Eco International Versions

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Executive Summary

To enhance the ability of i-Tree to work outside the United States, various actions are required or desired, and some functionality cannot be enhanced. International users must understand these limitations.

Required Items:

1) Location information – various local information on the city or area of analysis are required to run the model. International users must enter this data in to a form so the location information can be entered in the location database (*procedures under development)*

2) New species information – If new species are encountered that are not in the species database, international user must fill out a form with required information on the new species for species entry into the database (*procedures under development)*

Desired Information (some modules will not run without this information and other modules will run more accurately)

1) Hourly pollution data – user must obtain hourly local pollution data convert the data into the proper format (see i-Tree user's manual). Required for pollution removal estimates.

2) Hourly weather data –hourly weather data exist for most of the world in a standard format. User must search the weather database map to determine the monitor ID for the nearest weather station. Required for pollution removal, biogenic emission estimates and i-Tree Hydro.

3) Boundary layer height data - If boundary layer height data also exist, the user must obtain and format local boundary layer height data (see). Required for percent pollution removal estimates.

4) Shading coefficients for local species – percent light interception measures for species will help improve ecosystem service estimates of species

5) Biomass formulas – local biomass formulas with large diameter ranges (small to large trees) would help improve carbon estimates. Otherwise North American formulas are used.

6) Growth rates – average annual dbh growth for the area would help improve growth and sequestration estimates.

7) Local species CTLA base dollar values and species factors are needed to produce structural estimates, otherwise structural estimate will be based on US factors with user selecting which US state values they want to use.

Limitations

1) Energy – i-Tree cannot produce building energy effects for international cities. Users could select a US city to come up with estimates of energy effects and user can supply local energy values, but this approach is not recommended as the results would be based on average US building types, energy use and weather conditions.

2) Without local improvements (e.g., biomass formulas, growth rates) the model will default to US conditions. The model will produce estimates based on local international field data, but default to US equations without the additional desired information. Location information is required unless users want to run the model as if their trees existed in a US city (not recommended). New species information is required unless the user wants to substitute an existing species in the data base for the true species (not recommended).

i-Tree Overview

To enhance i-Tree Eco to produce better estimates for data from non-US countries, various data are needed. If these data are not provided, the model will still produce estimates, but based on US parameters. This may or may not be an issue depending upon the parameter. The model basically has 6 components:

1) Structure – estimates basic information on the tree (e.g., leaf area, leaf biomass, structural value, pest risk)
2) Carbon – estimates annual carbon storage and sequestration based on tree biomass equations and annual growth estimates, which are based on tree condition, competition and annual growing season length
3) Air pollution removal – estimates hourly pollution removal based on weather data, pollution concentration data, leaf area and location factors
4) Biogenic volatile organic compound (VOC) emissions – estimates hourly emissions based on leaf biomass and weather data and location information
5) Building energy use effects – estimates effects of trees on building energy use based on distance and direction from space-conditioned residential building (based on tables from McPherson and Simpson, 1999) for US states and climates zones.
6) Valuation - estimates values of effects based on literature values of carbon emissions, air pollution and building energy use.

Input Database Structure

To operate the model, there are various input data sets required:

1) Field data – populated by user

2) Species list database – contain basic information on species
3) Location database – contains basic geographic and other information on specific location
4) Weather data – generally obtained from National Climatic Data Center website
5) Pollution data – generally obtained from US EPA website

Issues and concerns

The following are thoughts on data needed and issues related to international data in i-Tree. These thoughts are structured around each model component and database.

Structure – basic issues here related to field data collection or information needed on species for the species database so structure can be assessed.

1) Use of commas as decimals in entering field data – many non-US countries denote numbers with commas and decimal points different than in the US (e.g., 1,234.56 vs. 1.234,56). This difference leads to issues with the model operation. This issue needs to be resolved in the code and the user will need to specify what kind of number system they are using.
2) Species list – the species database currently has about 4,800 species codes (no cultivars) with numerous synonym scientific names. To address international species, collaborators will need to provide a list of species likely to be found in their country that are not in the species list database, along with information on those species that are required in the database. This information includes the following items. In some cases, if the data are not provided, i-tree searches for a botanical average (e.g., if species information is missing it will calculate a genera average); in other cases the program requires these data
    a. Shading coefficients for trees (% light block by healthy full crown trees). Program will search for botanical relations if no specific data are available
    b. Leaf area to leaf biomass conversion (g/m2) – we have global data on these species factors, but if local data are available they could be added to the data set. Program will search for botanical relations if no specific data are available
    c. Leaf type I (see table). This information is required

LeafTypeTable
Leaf type description
Deciduous
Evergreen
Herbaceous
Unknown

    d. Leaf Type II (see table). This information is required

PercentLeafTypesTable
Percent leaf types description
Hardwood

PercentLeafTypesTable
Percent leaf types description
Herbaceous
Palm
Picea
Pinus
unknown

e. Native continent of species (see table). This information is required; more than one continent can be listed per species.

ContinentTable
ContinentName
Africa
Antarctica
Asia
Australia
Europe
North America
South America
Other

g. Native countries of species. This information is required (at least for country entering data – e.g., Australia will need to ID trees in the database that native to Australia). Data can also be identified down to sub-regions within the countries (e.g., states, providences)

PrimaryPartitionTable
Nation
Afghanistan
Albania
Algeria
American Samoa
Andorra
Etc….

h. Species CTLA factor – if country uses CTLA guide for valuing tree structural value, the species for the country or country sub-region is needed.
i. Pest susceptibility – for pest assessments in the program (currently Asian longhorned beetle, emerald ash borer, gypsy moth, Dutch elm disease) is the species a host to each pest
j. Sub-genus, genus, family, order, sub-class and class of species. This information is required.

k. Tree parameters – these data are to be entered in the database in i-Tree Eco in the near future, so more data will be coming on these variable parameters, but information will be needed on species growth rate (fast, medium, slow), average mature tree height, and average life span (short-lived, medium, long-lived).

Carbon – this component of the program will require the following data for species in the database

1) Biomass formulas – i-Tree Eco uses splined formulas from US data and species (for the most part). Biomass formulas from other countries would be helpful; otherwise the program will run with US species. The formulas should have a wide dbh range that is acceptable for the equation (that is why we used splined equations). Program will search for botanical relations if no data available
2) Average growth rate for healthy open grown trees in the area or length of growing season. I-Tree Eco uses length of growing season to estimate average growth rate of an open grown tree. It then uses crown competition and tree condition to adjust the growth rates downward. We are in the process of updating the species database to also enter slow, medium or fast growth rates for individual species. The current growth estimate method produces maximum average annual dbh growth of 0.8 in/year for a 365 day growing season. If average open grown annual growth is greater than this value for a 365 growth season, then default standard growth factor will need to be adjusted based on local growth data for the country or region (see http://www.treesearch.fs.fed.us/pubs/19526 for current model methods).

Air Pollution Removal – This component requires hourly weather and pollution data as well as geographic data in Location database.

1) Weather data – standard data format comes from the National Climatic Data Center and is available worldwide on their website. Issue here is sometime international weather data are missing and local user will need to find the weather data and provide in proper format as detailed in user's manual
2) Pollution data – there is no international data standard format for pollution data. Users need to find local hourly pollution data and provide in format specified in the user's manual. However, we are currently updating the pollution removal program to use the new EPA data format, so the manual will be updated soon with this new format, so there is no immediate need to format following the current user's manual unless you have data ready to be analyzed now.
3) Location database – if country is going to try and develop parameter for sub-regions with countries (e.g., states, provinces) or down to the place (community) level, we will need a GIS file including these boundaries to determine lat and long coordinates. We will also need the following information down to country sub-region and place level:
    a. Leaf on date (DOY)
    b. Leaf off date (DOY)
    c. Elevation
    d. GMT(Greenwich Mean Time) offset standard time

All of these can be calculated from a GIS database, if such a database exists.

e. Albedo, terrain factor, and seasonal function coefficients, and monthly ozone coefficients. These coefficients do not vary much across the US and are either at the state or local level. These values are used to help estimate solar radiation levels at the ground. We will need to work with users in each country to help determine the best values for each area. We will need to test how sensitive the model is to each of these coefficients to assess how accurate these values need to be. The details of this process come from the National Solar Radiation database.

VOC emissions – if weather data and location database information detailed under air pollution removal are updated, this model component will function without further updates needed. If countries have base VOC emission factors for species, they could be added to the database.

Energy – this model component is design for US climate types, building types and energy use and emission factors. It will not work well internationally, except for possibly Lower Canada. This component can run anywhere internationally, but would have to assume conditions (climate types, building types and energy use, and emission factors) from a US state. This leap would be quite suspect in term of estimates. For this component to possibly work outside the US, countries would need to go to: http://www.treesearch.fs.fed.us/pubs/6779 and determine the numerous factors needed to help calculate local energy and carbon effects. This would be a significant task.

Valuation – i-Tree Eco uses values from the literature to estimate dollar values. These values could be updated with national values from other countries. Dollars are estimated in US dollars. Users will need to supply exchange rates or convert the currency on their own from US values. Values currently estimated are:

1) Structural – using CTLA formula method. Users will need to supply base dollar values per cm^2 for each species in the database for their sub-regions or country if using CTLA values.
2) Carbon – uses $22.8/ tonne C based on paper by Fankhauser (see methods paper). Estimate is for 2000-2010. This number will be updated in a few years.
3) Pollution removal – uses national median externality values updates to 2007 values. We are currently looking new international literature and the EPA BenMap program to decide on how best to update these number
4) Energy – uses states energy costs per fuel type (e.g., natural gas, fuel oil, electricity, wood)

General Issues – the following are general logistical issues that will need to be addressed:

1) i-Tree Eco GUI and manuals may need to be translated to native languages in non-English speaking countries