

Two large, light green maple leaves are positioned behind the text, one on the left and one on the right, with their stems pointing downwards. The leaves have a detailed vein structure and serrated edges.

# TREE CO-BENEFIT CALCULATOR

## Final Presentation

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# INTRODUCTION

- 420 million hectares of land have been deforested in the past 30 years (FAO, 2020)
- Regional initiatives, such as Planting for the Future, can encourage resident participation in tree planting efforts
- Baltimore's goal of 40% tree cover by 2030 has not yet been achieved (USDAFS, 2017)
- Tree co-benefit calculators can help people learn more about the importance of tree canopy, but existing calculators are limited in their abilities



# OBJECTIVES

- Research the factors in current tree co-benefit calculator tools
- Recommend a framework of helpful co-benefits
- Find data supporting the mental and physical health benefits of increased tree density in urban and suburban areas
- Investigate and summarize the various community impacts associated with tree planting
- Identify research into the economic opportunities created by urban tree planting and maintenance



# METHODS

## Tree Co-Benefit Calculator

- Searched Google: “Tree co-benefit calculator,” “tree calculator tools,” and “tree forest calculations”
- Examined tree calculators from websites
  - Analyzed for urban and rural tree planting, user friendliness, and benefits calculated
  - Ran multiple test trials for GPS ability, plotting trees and their characteristics, accessibility, limited steps, and categorically distinct benefits
- Filtered out non-intuitive calculators and set a framework for non-environmental benefits



# METHODS

## Mental/Physical Health

- Examined scholarly articles and reports on the relationship between trees, green space, and well-being
- Used keywords: “urban health,” “greenspace and well-being,” “forests and mental health,” “psychological distress,” “trees and physical health,” “urban asthma,” “respiratory illness and pollution,” and “urban exercise”
- Referenced databases: Google Scholar, JSTOR, and Web of Science
- Used diverse journals: topics from urban health to physiology



# METHODS

## Social Impacts

- Researched community impact of tree planting through in journal articles
  - Used journals focusing on public health, urban planning, and environmental psychology
- Used keywords such as “urban green spaces,” “social impacts of urban forests,” and crime rates and tree canopy”
  - Searched using Google Scholar and UMD Libraries databases



# METHODS

## Economic

- Researched economic impacts and benefits through keyword searches on Google Scholar
  - E.g. “urban tree planting homeowner benefits,” “urban tree density energy saving,” “urban trees shading benefits,” “quantifying aesthetic benefits of urban trees,” “tree planting job creation,” “urban forestry management jobs,” “sustainable urban greenscape jobs,” “economic stimulus through urban forestry 2020,” and “green economy urban tree planting 2020”
- Source material from scholarly journals such as *Ecological Economics*, government agencies such as CDC, and non-governmental research organizations such as World Resources Institute



# FINDINGS

## Tree Co-Benefit Calculator

- Many duplicate or out-of-date designs on the market
- Most extensive and up to date tools come from i-Tree domain
  - 15 different tree tools
  - Calculations based on peer-reviewed, USDA Forest Service research
- Two notable calculators
  - i-Tree Design
  - Trees for the Future carbon calculator





# FINDINGS: i-Tree Design Tree Co-Benefit Calculator

## i-Tree Design v7.0

College Park, MD 20742, USA

Save Progress  
About

Get started with these easy steps:

### 1. Draw Structures

### 2. Place Trees

Please break large projects into smaller projects of no more than 25 trees at a time.

#### Describe your tree:

- Tree species: Northern red oak  
Common
- Tree diameter: 40 Inches  
or circumference: 125.7
- Tree condition: Excellent
- Tree exposure to sunlight: Full sun

#### Tree benefit zones:

- The colored zones surrounding the structure, which appear as you describe your tree, illustrate the relative monetary value of energy savings that the tree would provide in each zone.
- Hover over each zone to see that energy benefit information displayed below the map.

#### To place a tree:

- Drag this icon to the location on the map where you would like to place your tree.
- Repeat to place additional trees.
- Hover over any tree you have placed on the map to display its benefits.

#### Model the tree(s) future crown growth over time:

Model Crown Growth

### 3. Estimate Benefits



Image of i-Tree interface (i-Tree, 2020)

# FINDINGS: i-Tree Design Tree Co-Benefit Calculator

Overall Benefits

Stormwater

Energy

Air Quality

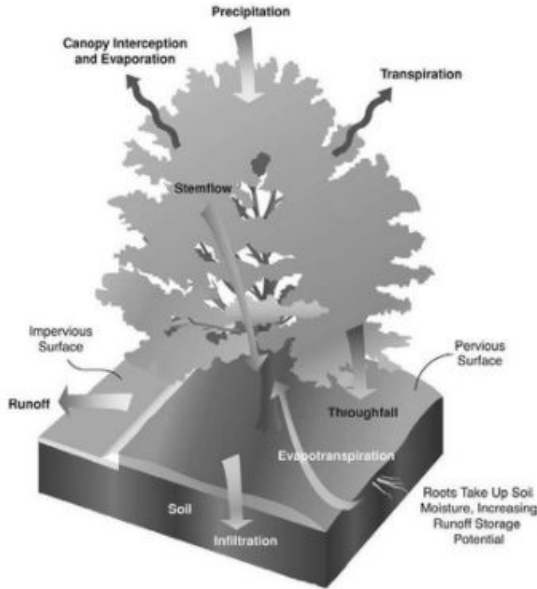
Carbon Dioxide

Current Year (2020)

Future Year (2032)

Total (2020-2032)

Total to Date



## Summary page

- Co-benefits on the x-axis: stormwater runoff, energy savings, air quality, and carbon reduction
- Current to future time estimates on the y-axis
- Mix and match co-benefits and times
- Simple images and diagrams accompany text
- Projects can be saved and downloaded for later use

# FINDINGS: Trees For the Future

## Tree Co-Benefit Calculator

### The Trees for the Future Carbon Calculator

I am  an individual  a business

Calculate how many trees you need to plant to offset your carbon footprint.

Image of donation option (Carbon Footprint Calculator, 2020)

- Individual and business donations
- Aimed at offsetting the user's carbon footprint
- Input estimated annual carbon emissions/output monetary value to offset carbon footprint
- Can be used as a tax credit



# FINDINGS

## Mental Health

- Research consistently demonstrates that green space is positively correlated with improved mental health  
(Beyer et al., 2014 & Wood et al., 2018 & Hedblom et al., 2019).
- Three benefits commonly emerge to suggest an association between the presence of tree canopy and improved mental health, reduced levels of:
  - Anxiety
  - Depression
  - Stress



### Case Study Timeline

- Difficult to convert data into a quantitative format for use in a tree canopy calculator—only two studies address this challenge
- In Sydney, residents of areas with dense of low-lying vegetation were 71% more likely to self-report psychological distress compared to residents of neighborhoods with moderate to heavy tree canopy (Astell-Burt & Feng, 2014)



# FINDINGS

## Mental Health

- Researchers attempted to break down benefits associated with each tree in Toronto, stating that the health benefits of 10 or more trees/block was comparable to living in the next income bracket or being 7 years younger (Kardan et al., 2015)
- There isn't enough research to support quantification of mental health benefits within tree calculators

# FINDINGS

## Physical Health

- There is a correlation between green infrastructure/urban trees and a reduced risk of asthma, reduced chances of a heat-induced medical condition, and reduced risk of lung cancer (Wolf et al., 2020)
- Sidewalk tree location can provide shade during the day's sunniest hours, protecting residents (Sanusai, et al., 2016)
- Remote sensing and spatial resolution techniques were used to determine a positive or negative relationship between green space and better physical health (Tsai, et al., 2019)

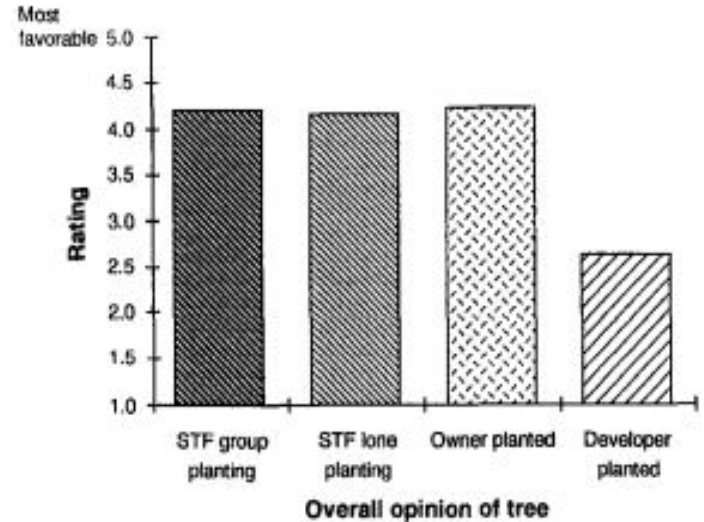


Strong association between green space access and sense of community among nearby residents (Jennings & Bamkole, 2019)

- Due in part to the activities in green spaces: walking, biking, community events, etc.

Green spaces allow residents to become more invested in their communities

- Greater investment can contribute to increased satisfaction and further environmental developments, such as parks and gardens (Sommer et al., 1994)



**Figure 1. Overall opinion of the tree among the four groups of respondents.**

Graph of satisfaction of tree planting based on who planted the tree (Sommer et al., 1994)

Tree cover can have a positive and negative effect on crime rates (Troy et al., 2012)

- Planting trees on public land may reduce crime more than planting on private land

Dense vegetation is linked to a fear of crime (Kuo & Sullivan, 2001)

- Vegetation should be planted in a way that doesn't impact visibility, to both reduce crime and to minimize a perception of crime

# FINDINGS

## Economic Impacts

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### Homeowners

- higher property values

### Homeowners/renters

- lower energy costs

### Employers/employees

- jobs, jobs, jobs
- boost commerce
- lower health care costs

### Governments

- cost-effective carbon sequestration
- lower stormwater control and treatment costs





# FINDINGS

## Economic Impacts

- Austin, Texas: ISA method found tree value to be 13% of appraised value, predictive modeling found 19% of appraised value (Martin et al, 1989)
- Greece, New York: used ISA method and multiple regression analysis (Morales et al, 1983)
- Greenville, South Carolina: regression analysis (1991-1993) and quality measures (type, size and condition) show trees to have positive impact on housing prices (Henry, 1994)
- Lake Tahoe Basin, California: 1990-1994, estimated contribution of healthy forest in the high end market, 5% - 20% of market price (Thompson et al, 1999)
- Salo, Finland: 1984-1986, homes with views of forested area sold for 4.9% more than those without (Tyrvaainen, 2000)
- Castellon, Spain: found that every 100 meters from a green space lowered the value of the property by 1,800 euros (Morancho, 2003)

# FINDINGS

## Economic Impacts

Statewide and nationwide—  
reducing peak loads

California—saved \$485.7m/yr

Wind speed reductions as  
much as 80%



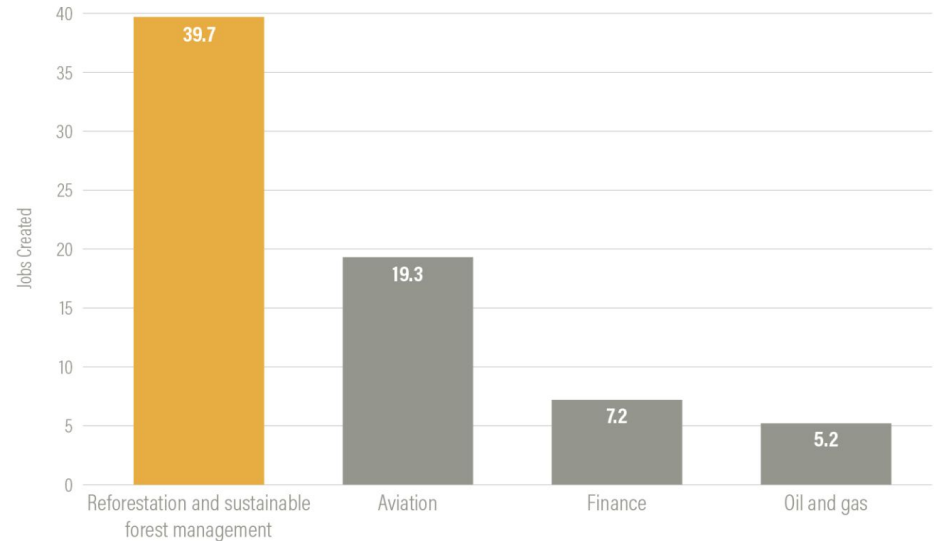
39.7 per \$1 million

Almost 8x greater than oil and gas

150,000 per year with \$4-4.5 billion annually

Long-term effort

U.S. Job Creation per \$1 Million Investment



Source: Political Economy and Research Institute

 WORLD RESOURCES INSTITUTE

Graph of economic opportunities in urban planting (Rudee, 2020)



# FINDINGS

## Economic Impacts



—  
\$3 trillion per year

Better air quality = less  
lung cancer, asthma, and  
hospitalization

Lower stress levels

Increase exercise levels







# RECOMMENDATIONS

## Tree Co-Benefit Calculator

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GBWC should base its tree calculator model on i-Tree Design, which includes residential tree planting records, design structure, and benefit calculations

Efficient tool for homeowners who wish to easily quantify new and old trees

Digital trees can be placed in optimal community locations to strengthen social cohesion and awareness



# RECOMMENDATIONS

## Tree Co-Benefit Calculator: Regional Green Maps

Integrate the tool in the GBWC's regional green infrastructure map

Place on the left side, next to resilience maps

Embed within the resilience maps

Show residential tree planting locations (social cohesion and awareness)

Greater Baltimore Wilderness Coalition

Coastal resiliency strategies



Background and Definitions

Resiliency Maps

Methodology

Register

Login



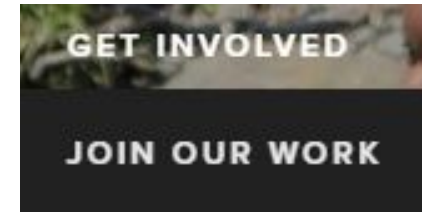
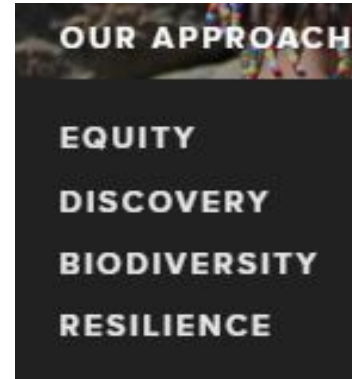
# RECOMMENDATIONS

## Tree Co-Benefit Calculator: Non-Environmental Benefits

—  
Add to either “Our Approach” or “Get Involved” sections on GBWC main page

List on the side panel of the regional green infrastructure map in the “Background and Definitions” tab


List, but don’t quantify, on the tree benefits spreadsheet



Background and Definitions

# RECOMMENDATIONS

## Tree Co-Benefit Calculator: Donation Calculator

A large, green, rounded rectangular button with the text "Offset My Footprint" in white, bold, sans-serif font. A small orange horizontal line is positioned to the left of the button.

### Offset My Footprint

Donation feature similar to Trees for the Future

- not everyone is willing or able to plant/maintain trees

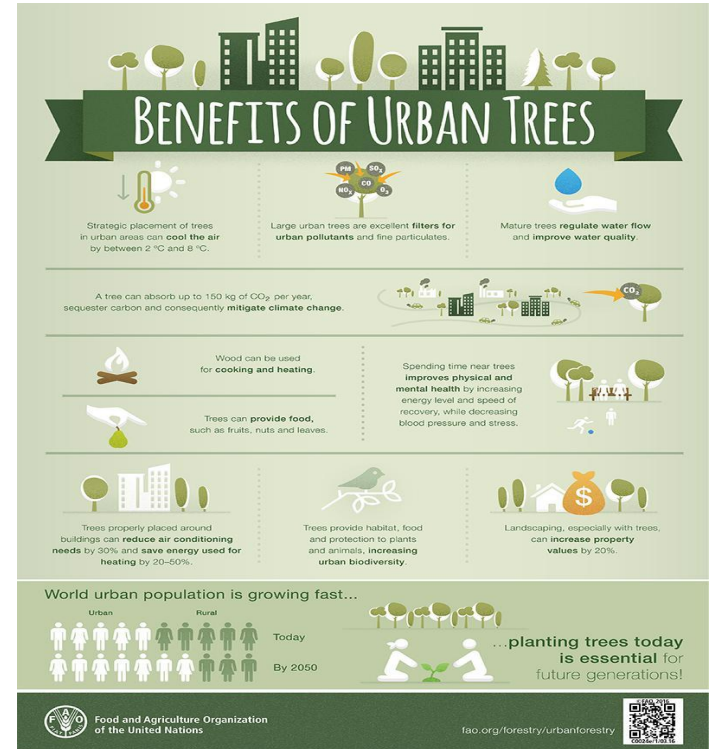
Help individuals offset their carbon footprint

Increase funding for regional green infrastructure goals

Provide a way to improve the quality of life for Central Maryland residents and visitors

Visually transmit information that resonates with users

Customize existing templates to focus upon non-quantifiable benefits of canopy

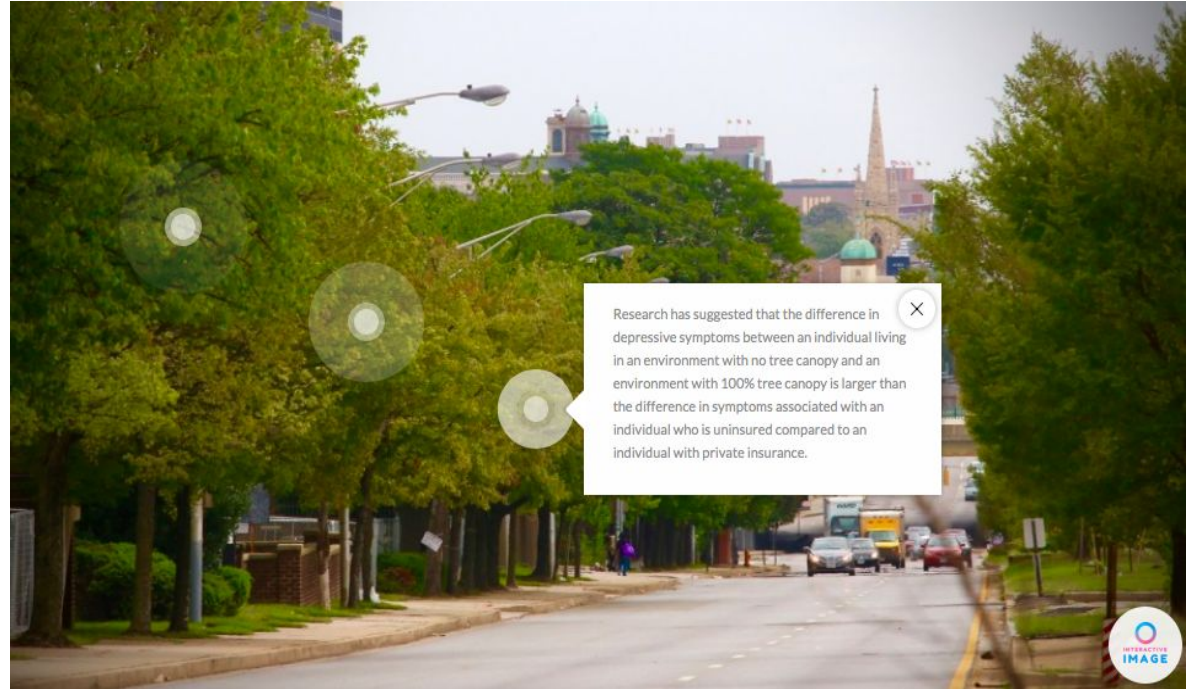


The benefits of urban trees (FAO, 2016).

# RECOMMENDATIONS

## Mental Health

Create an interactive image that allows users to choose information they want to learn



Original image edited to display how photos can be altered to elicit a greater sense of interest from viewers and better convey the mental health benefits of urban forestry (Simon, 2017)



# RECOMMENDATIONS

## Mental Health

Include a pictorial representation of non-forested/forested areas



Images used to indicate the differential responses between similar photographs based on the presence of tree canopy (Conniff, 2012)

# RECOMMENDATIONS

## Physical Health

—  
Create a “find out more” link to intrigue the reader to keep looking

Create a “visuals” page with graphics to show statistics and data

Add a section on “why should we care” that could include multiple factors that are harder to quantify







# RECOMMENDATIONS

## Social Cohesion

### Engage residents and communities directly

- Information can be targeted toward groups to describe the different impacts of green space on various populations
- Other information could include types of activities that green spaces promote

### Inform developers and community planners

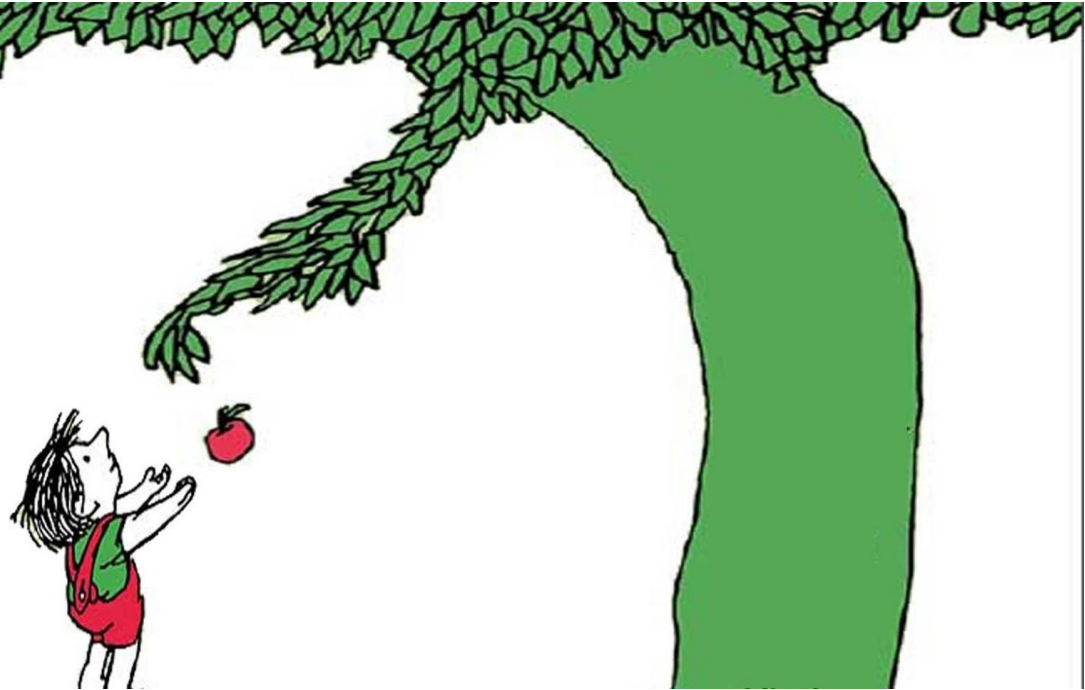
- Provide information about where to plant trees and create green spaces
- Create programs to increase community involvement

# RECOMMENDATIONS

## Economic

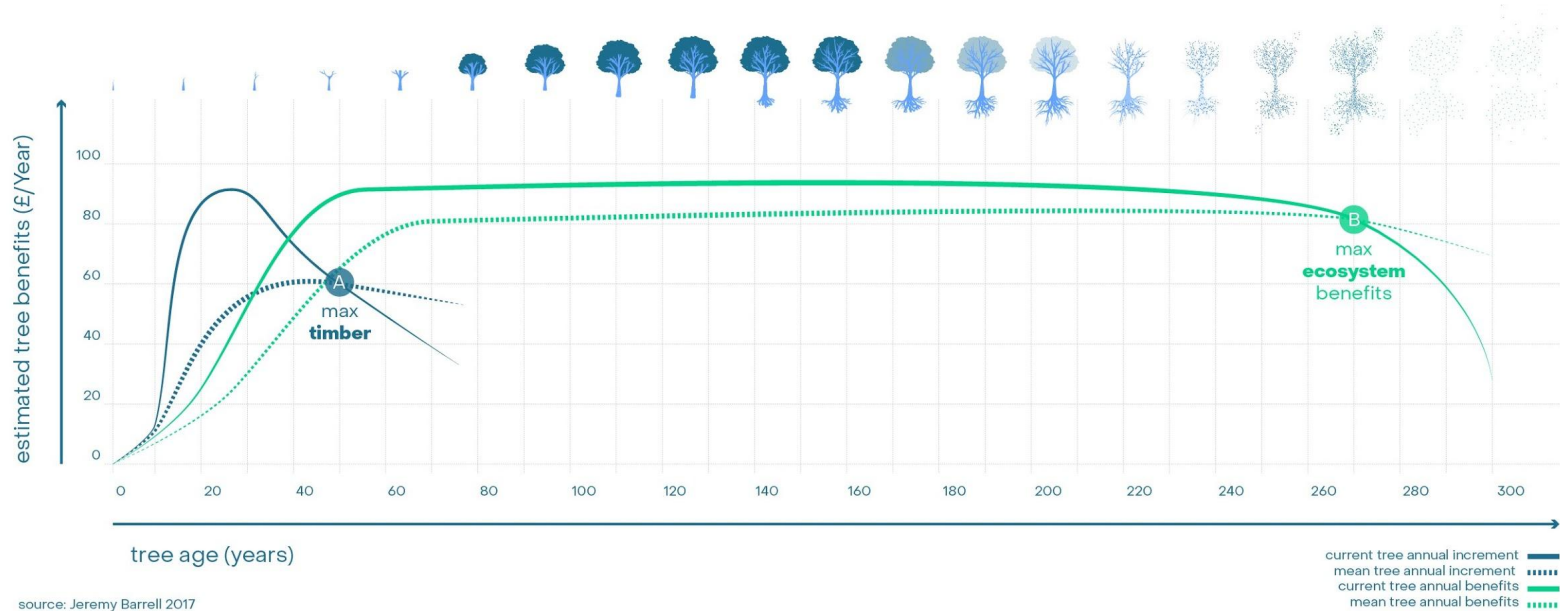
Specify individual economic benefits from diffuse ecological services

Localize impacts of regional and national benefits



# RECOMMENDATIONS

## Economic



source: Jeremy Barrell 2017

Quality over quantity model (Dark Matter Labs, 2020)

—

Unable to assess all tree co-benefit calculators

- Focused on primary search results

Insufficient research limits quantification of mental/physical/social effects

- Non-quantifiable features should be separated from tree calculations and added alongside benefits to augment the educational aspect of the tree calculator



# CONCLUSIONS

Incorporate all the benefits of tree canopy—mental/physical health, social cohesion, and the economy—into one tool

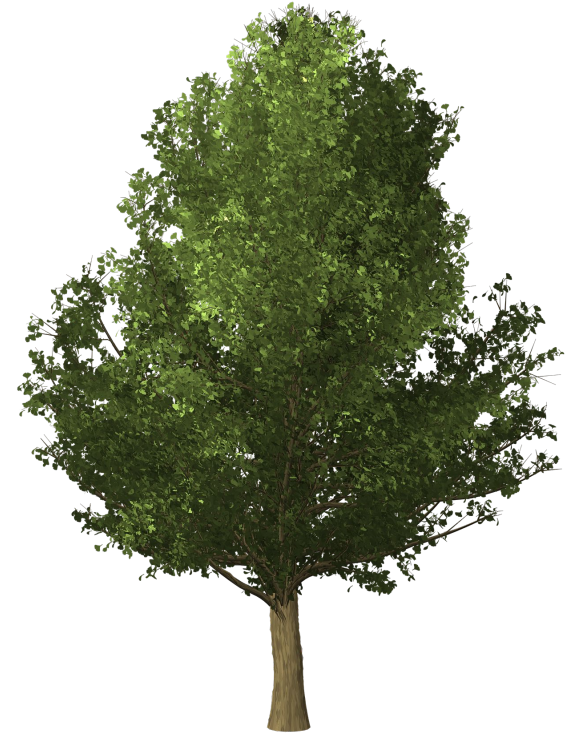
Use i-Tree Design because it offers the best framework for residential tree benefit calculations

Aggregate monetary benefits of tree canopy can be quantified and incorporated along with traditional co-benefits

# CONCLUSIONS

Combining the mental/physical/social factors along with traditional features gives users the chance to explore a calculator that demonstrates all of the benefits of tree planting and will, hopefully, encourage them to plant some of their own.

What questions do you have for us?





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