UC San Diego

WHY WE PLANT TREES: THE IMPORTANCE OF THE CAMPUS URBAN TREE CANOPY

September 2022

BACKGROUND

Context, challenges and opportunities

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CORE VALUES FOR THE CAMPUS LANDSCAPE

WELLBEING

Central to the university mission

Cultivating personal mental and physical resilience

Space that is healthy and functional

ENVIRONMENT

Sustainability as a core value and an obligation

Positioned as a global leader in research and innovation

CULTURE

Public expression of the mission

Demonstrating research and other core activities

Attracting and retaining the best talent

THE CHALLENGE

Increased competition

for resources, both physical and financial, with continued development in limited space

Natural decline

of the original tree canopy as it nears the end of its expected lifespan

Climate change

exacerbating existing stresses and introducing new challenges

CLIMATE CHANGE IMPACTS

+10°F

Increase in daily average temperatures by 2100

20-50%

more extreme heat days

Longer and more frequent heat waves

decreased water reliability

LONGER & MORE FREQUENT DROUGHTS
MORE EXTREME RAIN EVENTS & FLOODING
UNCERTAINTAINTY IN SUPPLY & DEMAND

heavy urban runoff impacts: stormwater

INCREASED VOLUME + POLLUTION LEVELS
INCREASED POTENTIAL FOR SEWAGE SPILLS
DEGRADATION OF DOWNSTREAM HABITAT

changes in coastal marine layer

Temperature + precipitation changes will have unkown impacts on current protective cloud layers

heat-related illness

exacerbated on the coast

Lack of air conditioning and less acclimation to heat increases the impact of heat events

magnified habitat degredation

exacerbation of current evelopment pressure and habitat fragmentation

changing fire patterns

DRIER AUTUMNS
LOW WINTER PRECIPITATION
MORE FUEL DURING SANTA ANA WINDS
LONGER FIRE SEASON

Source: California's Fourth Climate Change Assessment, San Diego Region Report

Fortunately,
trees are beautiful, efficient multi-taskers.

THE VALUE OF TREES

Financial, environmental and cultural benefits of a thriving tree canopy

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THE VALUE OF TREES

In California, the average total *cost* of an urban tree is $19 per year, with a *value* of services of $100.63 per tree.

This adds up to a return of $5.82 for every $1 spent.

Lower maintenance costs:

- **Energy use**
- **Paved surface maintenance**

Functional services:

- **Air pollution reduction**
- **Carbon sequestration**
- **Stormwater management and treatment**
- **Soil stabilization**

Competitive advantage:

- **Real estate value**
- **Talent acquisition**

Source: Structure, function and value of street trees in California, USA

In California,
urban trees provide $ 1 billion
per year in value of services.

Source: Structure, function and value of street trees in California, USA

TREE BENEFITS

TREE BENEFITS: CULTURE

identity + design

community cohesion

research + innovation

IDENTITY + DESIGN

- **Cohesive design elements** for an ever-evolving architectural landscape
- Strategically **framed views** and **highlighted key features**
- **Human-scaled** places and spaces
- More **intuitive wayfinding** and a recognizable **“campus character”**

Heritage trees and new plantings create comfortable space and provide wayfinding along Ridge Walk

Source: EPA Heat Island Compendium;

COMMUNITY COHESION

- Trees enrich space for **casual and non-programmed** interactions.
- High tree coverage areas have **70% more people engaged in social activities.**
- Interactive trees programs enhance a community's **sense of social identity, self-esteem and territoriality.**

Colleagues meet outside at East Campus Office Building

Source: Tree San Diego: Learn About Trees; UC Davis Arboretum and Public Garden

EDUCATION, RESEARCH + INNOVATION

- **We have a once-in-a-generation opportunity to lead research and demonstrate success** in the transition to a climate-resilient campus.
- UC San Diego researchers **are leaders in their fields, such as climate science, ecology and social sciences**, and could use the campus landscape as **a living laboratory.**
- Inclusion of students has been shown to **increase feelings of ownership and build career pathways into related fields.**

A tree tag describing research into new climate-ready tree species at UC Davis
Source: UC Davis Arboretum and Public Garden

TREE BENEFITS: ENVIRONMENT

ATMOSPHERIC COOLING

- **Urban areas are on average 2.6° F warmer than surrounding rural areas** due to the Urban Heat Island Effect.
- Trees can **reduce peak air temperatures by 2-9° F** through reduced reflectivity and evaporative cooling.
- Trees **reduce production of greenhouse gasses, mitigate global warming, reduce reliance on mechanical cooling** and **reduce the impact of heat-related illness** and death.

Visitors huddle in the shade at North Torrey Pines LLN during a heat wave

Source: EPA Heat Island Compendium;

CARBON CAPTURE + SEQUESTRATION

- Across California, urban trees store nearly **7.8 million tons of CO_2**, with net sequestration of **375,700 tons/year.**
- Trees support **meeting carbon reduction goals and mandates**, providing on-site offsets and avoided emissions, **a CA value of $2.4 million per year.**
- The amount of carbon sequestered **increases with the size and health of the trees.**

Established groves in the core of campus store large amounts of carbon

Sources: California OPR Urban Forestry and Forest Health; EPA Heat Island Compendium; National Park Service: Carbon Storage by Urban Forests; Structure, function and value of street trees in California, USA

AIR QUALITY + POLLUTION REDUCTION

- Trees **remove pollution** through dry deposition or absorption:
  - **Fine particulate matter (PM 2.5),** which cause and exacerbate chronic conditions, such as heart and lung disease
  - Nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO) and ground-level ozone (O_3), **primary greenhouse gasses**
- **Large trees remove 60–70 times more** air pollution annually (3.1 pounds/year) than small trees (0.05 pounds/year).

Trees shade parked cars in a surface lot

- **Compound benefits of cooling** include lower vehicular VOC emissions from shaded cars and avoided emissions from buildings.

Sources: EPA Heat Island Compendium; Air Quality Effects of Urban Trees and Parks

WATER QUALITY + STORMWATER MANAGEMENT

- Trees **actively filter pollutants** from runoff, reducinging impacts to downstream habitat.
- Trees, as part of bio-retention areas, can **reduce nitrogen loading 50% and phosphorus loading by 75%.**
- Tree canopies and roots **decrease peak runoff during storms**, reducing demand on hard infrastructure.
- Beneath tree canopies, **infiltration rates are 50% higher than outside of a tree canopy.**

Trees perform biofiltration at Revelle Plaza

Sources: EPA Heat Island Compendium; Nutrient and sediment removal by stormwater biofilters: a large-scale design optimisation study; Review of the Available Literature and Data on the Runoff and Pollutant Removal Capabilities of Urban Trees

SOIL RETENTION + HEALTH

- **Trees stabilize soil** by reducing the impact of raindrops, slowing overland stormwater flow and increasing water infiltration.
- Trees can **prevent erosion by 7%**, reducing the need for erosion control structures.
- Tree **roots loosen soils** compacted by urban activities, such as construction.
- Decompacted **soils support understory plants** by allowing for more water infiltration, better nutrient retention and easier root expansion.

Trees support understory growth at the East Campus Office Building

Source: Tree San Diego

BIODIVERSITY + LOCAL ECOSYSTEMS

- San Diego is a **“biodiversity hotspot.”** 2018 analysis of campus observed:
  - Likely 15 protected fauna species
  - 10 sensitive plant species
- Modest climate changes could **displace entire ecosystem zones** in the area.
- Recommended strategies include **actively creating and extending habitats in the coastal zone** (“assisted migration”).

Some species of concern on campus (clockwise): Cooper’s Hawk, Rofous Crowned Sparrow; Monarch Butterfly; Engelmann Oak

Sources: The Ecological Impacts of Climate Change on a Biodiversity Hotspot
UC San Diego 2018 LRDP EIR Biological Resources Report

WHAT TREES DO: WELL-BEING

PHYSICAL HEALTH + WELL-BEING

- People living near green space have **less mental distress, are more physically active and have extended lifespans.**
- **Views of greenery can speed healing times** for people in healthcare settings.
- When people **exercise outdoors** in natural environments, they do so **for longer periods of time and at greater intensities.**
- Urban heat is more deadly than all other weather events combined. Trees can **provide micro-cooling relief** and **mitigate Urban Heat Island Effect.**

Views of nature from inside healthcare settings, such as the Komen Outpatient Pavilion, can speed recovery time from injury and illness.

Sources: Urban Nature for Human Health and Well-Being; Increasing trees and high albedo surfaces decreases heat impacts and mortality in Los Angeles, CA

MENTAL HEALTH

- **Mental health issues were the number one health concern** at post-secondary schools.
- **10–20 minutes sitting or walking in green spaces can significantly reduce stress**, anger and anxiety and increase vigor, comfort, positive affect and a sense of feeling refreshed.
- Classroom views to green landscapes are linked to **higher performance on tests of attention** and increased **recovery from stress and mental fatigue.**

First-year UC Davis students learn healthy outdoor practices in a Nature RX seminar course (Image: UC Davis Arboretum and Public Garden)

Sources: Minimum Time Dose in Nature to Positively Impact the Mental Health of College-Aged Students, and How to Measure It; Impact of views to school landscapes on recovery from stress and mental fatigue; Urban Nature for Human Health and Well-Being; UC Davis Nature RX

HUMAN COMFORT

- Building-adjacent trees **reduce heat gain in summer and loss in winter** and **block low rays on east and west facades.**
- Trees are **most beneficial where people are meant to congregate**; shaded surfaces can be 20–45° F cooler than unshaded ones.
- Well-placed trees can **shield neighboring spaces from light, wind and noise** (up to 10 dB with a mature stand of trees).

People shelter from the afternoon heat and enjoy the view at Marshall College

Sources: EPA Heat Island Compendium; Effects of Tree Shading on Building's Energy Consumption

EXPANDING ON FINANCIAL VALUE

reduced maintenance

functional services

competitive advantage

LOWER MAINTENANCE COSTS

- Urban trees in California **save $101 million on energy costs** per year, heating and cooling.
- It's best when trees are planted close enough to buildings to cast shade, optimally **within 12 meters (36') of south, west and east facades.**
- Shade and lower ground temperatures **slow the deterioration of paved surfaces**, including roadways, sidewalks and plazas, **decreasing maintenance costs by 15–60%.**

Sources: EPA Heat Island Compendium; Structure, function and value of street trees in California, USA; Effects of Tree Shading on Building's Energy Consumption

Trees shade western facades in Roosevelt College

FUNCTIONAL SERVICES

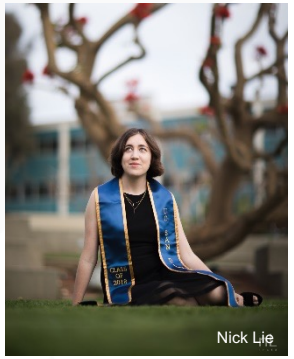
- **Carbon**: net annual CO_2 removal is 567,000 tons, a **value of $10.32m statewide**
- **Air pollution:** net value of pollutant uptake and avoided emissions from energy production adds up to an **annual benefit of $18.2m statewide**
- **Stormwater:** 26.2 million m3/yr in intercepted rainwater, an **equivalent value of $41.5m statewide**

An olive grove absorbs air pollution, stores carbon, and slows rainwater at a retention basin near Jacobs Pavilion

Sources: EPA Heat Island Compendium; Structure, function and value of street trees in California, USA; Effects of Tree Shading on Building's Energy Consumption

COMPETITIVE ADVANTAGE

- In California trees **add to property values by nearly $840m** overall
- **Shoppers will pay up to 12% more** in well-landscaped districts
- Commercial areas see **6% higher office rental rates** with high quality landscapes
- Students say that **outdoor environments strongly influence college selection** via visible activity, memorable interactions with nature, and navigability (culture)



Students take graduate portraits in iconic areas of campus.

Sources: Structure, function and value of street trees in California, USA; University of Washington Urban Forestry/Urban Greening Research; Nishimura, Kelly, COLLEGE SELECTION AND THE CAMPUS OUTDOOR ENVIRONMENT,UC Davis 2020

RESOURCES

Selected references

SELECTED RESOURCES

U.S. EPA: Using trees and vegetation to reduce heat islands

Governor's office of planning and research (OPR): Urban Forestry and Forest Health

U.S. Forest Service, UC Davis: Structure, function and value of street trees in California, USA

U.S. Forest Service: Southern Pacific Research Station

Tree San Diego: Learn About Trees

San Diego Climate Change Adaptation Plan: Urban Forestry Program 5-year plan

USFS, American Forests, NARC: Vibrant Cities Lab

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