Precipitation Perks

EVALUATING THE MULTIPLE BENEFITS OF URBAN RAINWATER CATCHMENTS IN AUSTIN, TX

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A Multi-Benefit Approach

Over the next century, climate change adaptation requires significant improvements and changes to urban water infrastructure. These measures will require multifaceted strategies addressing many challenges, such as flooding, impaired water quality, and inefficiency.

The **Pacific Institute's Multi-Benefit Framework** brings together diverse stakeholders to systematically address benefits and tradeoffs within water infrastructure projects, watershed improvement programs, and water policies. The framework divides benefits into five categories: **Energy**, **People & Community**, **Risk & Uncertainty**, **Water**, and **Land & Environment**. We evaluated benefits within the People and Community and Energy categories. Within the People and Community category, we evaluated the potential of green infrastructure to cool Austin's neighborhoods. Within the Energy category, we evaluated the potential of green infrastructure to provide energy savings and prevent greenhouse gas emissions.

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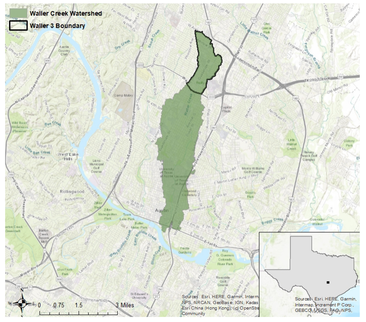
The Austin Test Case



The city of Austin plans to install rain gardens and rainwater cisterns on residential properties for its rain catcher pilot program (RCPP). These distributed stormwater-catching devices provide numerous benefits to homeowners and the watershed including:

- **Decrease in potable water demand**
- **Reductions in urban heat island (UHI)**

The city of Austin and the Pacific Institute have already quantified other benefits that the RCPP provides, such as:

- Reduced stormwater runoff
- Reduced nuisance flooding
- And many others


Example of a 100-cubic-foot rain garden


Example of a 1000-gallon rain cistern

RCPP will be scaled up to include 1200 homes within the Waller-3 project area over 3 years

Project Objectives

- **Quantify energy savings from reduced potable water demand produced by RCPP**
- **Evaluate potential opportunities for incorporating equity into the RCPP**
- **Quantify the RCPP's effect on urban heat island incidence in the Waller-3 project area**
- **Compile useful resources for future users of the multi-benefit framework**

Methods

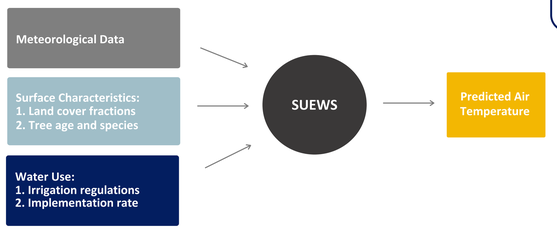
ENERGY SAVINGS

To quantify energy reduced through offsetting potable water demand in the project area, we used the Pacific Institute's **Water-Energy Simulator Model (WESim)**.

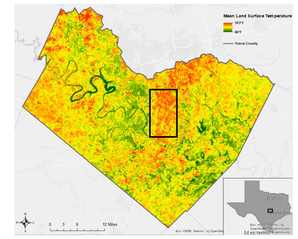
- **Quantify energy intensities.** The WESim model quantifies energy intensity for each step in a water system.
- **Combine energy intensity with flow data.** This is combined with flow data to estimate total energy and carbon emissions for a period of interest .
- **Examine energy consumption and distribution patterns.** Our application considered the energy consumed for water treatment and its distribution to the RCPP study area.

We also incorporated estimated reductions in Urban Heat Island from the RCPP to quantify potential reductions in energy use from reduced air conditioning demand.

URBAN COOLING



Urban heat island (UHI) effect refers to warming in urban areas due to high levels of dark, impervious surfaces and lack of vegetation. As shown below, urban areas of Travis County (black box) have higher temperatures compared to rural areas.



Austin's urban heat island(downtown and project area shown in the black box).

To quantify RCPP's impact on urban heat island (UHI) we followed two approaches:

1. **Modeled energy and water balances in the neighborhood.** To calculate temperature reductions resulting from increases in irrigation from captured rainwater, we used the **Surface Urban Energy and Water Balance Scheme (SUEWS)**, which used meteorology, tree cover, soil moisture and other data inputs to predict sensible heat reductions. We then used these predicted temperature reductions to estimate reductions in residential energy consumption.
2. **Quantified temperature reductions from tree cover on individual plots.** To calculate temperature reductions from additional tree cover, we compared land-surface temperatures (LST) determined from satellite imagery to estimate the effect of tree cover on temperature reductions.

Results

ENERGY SAVINGS

POTABLE WATER REDUCTIONS	AIR CONDITIONING REDUCTIONS
1,600-2,100 kWh/year for the project area	55,000-100,000 kWh/year for the project area
3.9-4.5 tons/year for for the project area	110-200 tons/year for for the project area
Equivalent to one car off the road per year for the entire project area	Equivalent to 40 cars off the road per year for the entire project area

URBAN COOLING

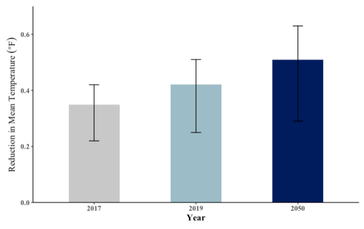


Figure 1. Predicted mean temperature reductions based on 2017, 2019, and projected 2050 meteorological data.

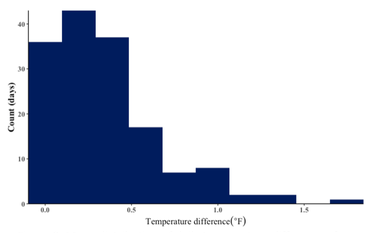
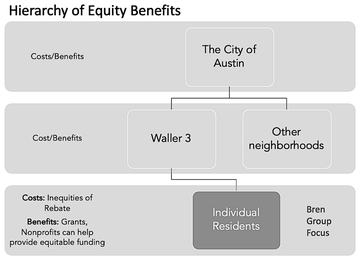


Figure 2. Mean distribution of daily temperature differences for 2017.

Shading from mature project trees could cool the temperature on individual plots by **0.17-0.33 degrees Fahrenheit** (Figure 1). Increases in irrigation could decrease in mean neighborhood temperature by **0.35 degrees Fahrenheit** (Figure 2). This will save up to $10,000 in annual energy costs for the entire neighborhood.

INTEGRATING EQUITY

Hierarchy of Equity Benefits



Equity is a holistic lens through which one should view our whole project, rather than a discrete component. Therefore, we have identified opportunities to consider equity within each step of our project. We have also created:

- **Interactive Web Application.** The web application identifies areas that would benefit most from UHI and energy reductions resulting from RCPP based on existing UHI, environmental factors, and socioeconomic data
- **Recommendations.** A list of recommendations for more equitable rebate structures and financing that would assist low socioeconomic status residents in installing rain cisterns and gardens on their own properties.

Recommendations

ENERGY SAVINGS

1. As potable offsets does not lead to significant energy savings, emphasize energy reduced from cooling and consequent decreases in air conditioning.

URBAN COOLING

1. Prioritize distribution of trees within the Waller-3 neighborhood.
2. Optimize tree species, maintenance, and placement for shading.
3. Maximize irrigation from optimized rainwater cisterns.

INTEGRATING EQUITY

1. Partner with local non-profits and apply for existing grants.
2. Continue to emphasize inter-agency benefits.
3. Include equity early in decision making process.

MULTI-BENEFIT RESOURCES

1. When using models consider project scale, impact categories, and computational investment.
2. Use the Pacific Institute's Multi-Benefit Resource Library to find background material, case studies, and quantification resources.

ACKNOWLEDGEMENTS

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