**FREE WATER**

An analysis of potential impacts of large-scale residential rainwater harvesting

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Master of Landscape Architecture '22

Special thanks to:  
Dr. Philip Stoker, CAPLA & Lisa Shipek, Watershed Management

INTRODUCTION

The following document will attempt to calculate the potential impacts of residential rainwater harvesting if implemented across the Tucson city limits. As this precious renewable resource becomes ever more precarious, this study aims at providing a case that municipal programs aimed at making rainwater harvesting accessible to all Tucasons is environmentally, socially, and economically viable.

**REVIEW OF WATER SOURCES**

The majority of Arizona's water is sourced from underground aquifers. The State of Arizona estimates 2.8-million acre-feet of water is pumped annually. Because the recharge of groundwater can take many tens to hundreds of years, Arizonans are now more conscious of this dwindling resource. As climate models predict Arizona's weather to increase in heat and drought, state officials have begun to preemptively store unused portions of the Colorado River water. Currently, the Arizona Water Banking Authority estimates the state has stored over 3 trillion gallons of water. Enough to supply the city of Phoenix for 30 years.

The Colorado River is Arizona's second largest water source. The Colorado River Compact of 1922 allocated 50% of the river's water to both the Upper and Lower Colorado Basins.

Arizona initially refused the compact due to fears of California receiving the majority of the Lower Colorado Basin's allotment. In 1984, Arizona would increase their allotment to 2.8-million acre-feet under the condition that California's allotment of 4.4-million acre feet allocation was prioritized during years with drought.

Today, between 36 and 40 million people in the United States are reliant upon the flow of the Colorado.

**RESULTS**

It is difficult to imagine the size of 2.4-billion gallons of water. If the Empire State Building was completely empty, it would not be able to store the amount of rainwater harvested.

A family of three in Tucson uses approximately 112 gallons of water per day. This amount of water could provide 58,188 families a year supply of water. If the Empire State Building was completely empty, it would not be able to store the amount of rainwater harvested. It is difficult to imagine the size of 2.4-billion gallons of water.

**APPLICATION**

There is a link between poverty, health, and urban heat island effect. People that live below the median income in Tucson are more likely to live in a neighborhood with low tree canopy and higher surface temperatures. These factors have a wide variety of effects such as worsening health outcomes, lack of exercise, and overall discomfort.

**IMPACTS**

At the neighborhood scale, it is clear what immediate impact could be made. Well-placed trees on the west and north side of a home can decrease air conditioning bills by 50%. Households in the Flowing Wells neighborhood, which is less than 10% tree canopy, can save money on air conditioning. If all harvested rainwater was used for the planting of native trees, Tucson could sustain 850,000 new trees on residential properties alone.

**CONCLUSION**

With simple area and volume calculations, it is apparent each single-family home in Tucson carries the potential to harvest thousands of gallons of water per year.

As the scientific community continues to produce research that confirms the relationships between health, urban heat island, and tree canopy, further research is required to fully realize the economic value of rainwater harvesting and tree canopy in and climates.

The City of Tucson's One Million Trees Initiative to increase tree canopy should consider incorporating a residential rainwater harvesting programs in order to meet this goal. If all harvested rainwater was used for the planting of native trees, Tucson could sustain 850,000 new trees on residential properties alone.

*Please see REPORT for METADATA and DATA ACKNOWLEDGMENTS.*
INTRODUCTION

The following document will attempt to calculate the potential impacts of residential rainwater harvesting if implemented across the Tucson city limits. As this precious renewable resource becomes ever more precarious, this study aims at providing a case that municipal programs aimed at making rainwater harvesting accessible to all Tucsonans is socially and economically viable.

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WHERE DOES ARIZONA’S WATER COME FROM?

The majority of Arizona’s water is sourced from underground aquifers. The State of Arizona estimates 2.8-million acre-feet of water is pumped annually. Because the recharge of groundwater can take many tens to hundreds of years, Arizonans are now more conscious of this dwindling resource. As climate models predict Arizona’s weather to increase in heat and drought, state officials have begun to preemptively store unused portions of the Colorado River water. Currently, the Arizona Water Banking Authority estimates the state has stored over 3 trillion gallons of water, enough to supply the city of Phoenix for 30 years.
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Today, between 36 and 40 million people in the United States are reliant upon the flow of the Colorado.
For this study, we isolated 119,859 building footprints within low-medium density zoning, calculated the area of the roofs, and multiplied the total area by the total amount of annual rainfall in Tucson.

\[
\text{7.472 ACRES} \times 0.99 \text{ FEET} = 7.472 \text{ ACRE FEET}
\]

RAINWATER HARVESTED
It is difficult to imagine the size of 2.4-billion gallons of water. If the Empire State Building was completely empty, it would not be able to store the amount of rainwater harvested.

A family of three in Tucson uses approximately 112 gallons of water per day. This amount of water could provide 58,188 families a year supply of water.
WHO WOULD BENEFIT FROM WATER HARVESTING?

There is a link between poverty, health, and urban heat island effect.¹²³ People that live below the median income in Tucson are more likely to live in a neighborhood with low tree canopy and higher surface temperatures. These factors have a wide variety of effects such as worsening health outcomes, lack of exercise, and overall discomfort.

For further analysis, surface heat temperature and tree canopy were analyzed in order to locate a census tract that had below average tree canopy (0-7%) and above average surface temperature. CENSUS TRACT 4505, located in the Flowing Wells neighborhood, was selected.
With remote sensing imagery, it is easy for us to determine the amount of tree canopy in an area. Within Tract 4505, a golf course provides most of the tree canopy. The canopy remarkably decreases near residential development, sparking concern for aging residents, those with underlying health conditions, and the very young.

Without any nearby public parks, the residents of Tract 4505 have little opportunity to enjoy spending time outside during the hot summer months.
At the neighborhood scale, it is clear what immediate impact could be made. Well-placed trees on the west and north side of a home can decrease air conditioning bills by 56%. The median-size family home in Tract 4505 can harvest enough water to support the planting of six trees.
CONCLUSION

With simple area and volume calculations, it is apparent each single-family home in Tucson carries the potential to harvest thousands of gallons of water per year.

As the scientific community continues to produce research that confirms the relationships between health, urban heat island, and tree canopy, further research is required to fully realize the economic value of rainwater harvesting and tree canopy in arid climates.

The City of Tucson’s One Million Trees Initiative to increase tree canopy should consider incorporating a residential rainwater harvesting programs in order to meet this goal. If all harvested rainwater was used for the planting of native trees, Tucson could sustain 850,000 new trees on residential properties alone.
## Metadata for ResidentialRainwater

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