The cost of urban rainwater harvesting in the Sonoran Desert.

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Abstract

Purpose: Water is a scarce resource, especially in hot-arid areas like the Sonora Desert. In urban areas like Hermosillo city with an average precipitation of 250 mm/year, it is of imperative interest to save as much water as possible and apply alternative solutions, such as rainwater harvesting systems. In this line, the cost is a critical factor in the decision process.

Methodology: Based on life cycle costing, 6 different configurations are evaluated for indoor and outdoor uses of rainwater: laundry and car washing.

Results and discussion: Results indicate that the rainwater tank located at ground level instead of underground derives in 30% lower costs of installation and also 30-40% better financial outcomes in the lifespan.

Conclusions: The cost of urban rainwater harvesting systems demonstrates that this alternative solution can play a key role in helping relieve water supply problems in cities with similar conditions, in addition to other more conventional water supply sources.

Keywords: Life cycle costing; water scarcity; urban water management.

1 Introduction

Hermosillo city has been struggling with water scarcity for decades. Nonetheless, water demand is expected to increase 57% in 2030 compared to 2006. This disarrangement between the availability and the increment in water demand generates a severe problem for the economic and social development of this city.
We study the cost of rainwater harvesting systems as a helping way to alleviate water supply problems in cities with similar conditions.

2 Methodology

LCC methodology was applied following the ISO 15686-5:2008(1).

Financial tools: Net Present Value (NPV), Internal Rate of Return (IRR) and Payback Time (PB).

Databases: Material quantities were calculated from experts in the field and prices were obtained directly from supply stores.

Software: Plugrisost® simulation model.

The lifespan of the systems was considered as 50 years.

3 Case study

Six different scenarios were defined to study the applicability and feasibility of rainwater harvesting systems in Hermosillo, varying the size of the house (78 m², 130 m² and 210 m²) and the location of the tank (ground level or underground). Figure 1 represents ground level and underground storage tank.

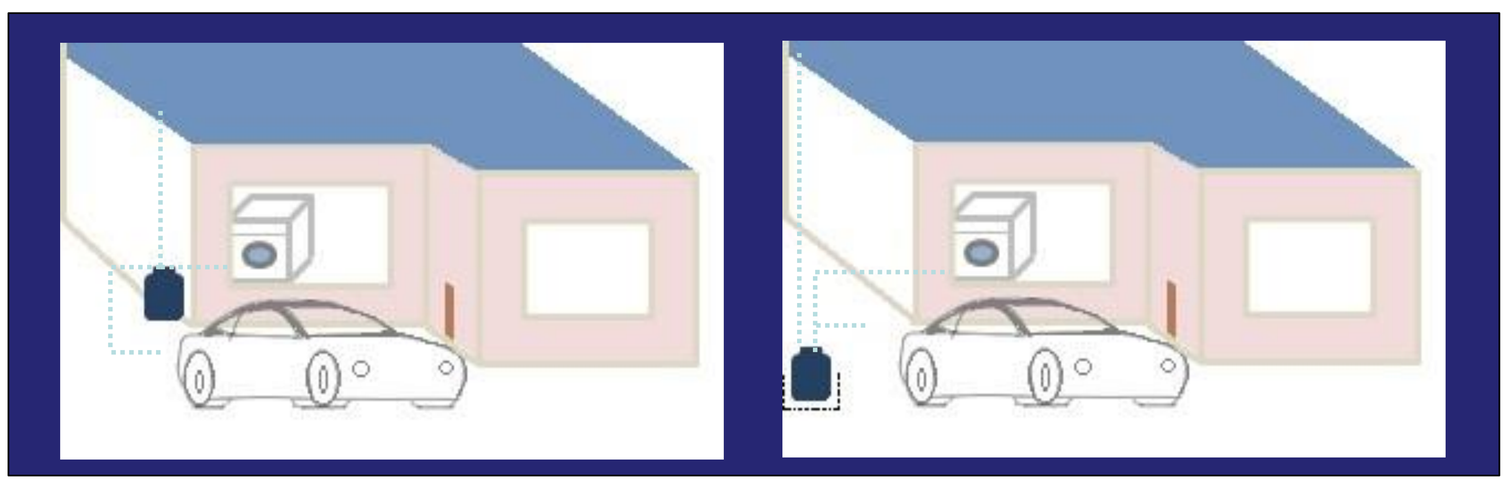

Figure1. Tank installation diagram. Left: ground level; Right: Underground

Potential rainwater supply and storage tank size were calculated using Plugrisost®, a free simulation model developed by Gabarrell *et al.* (2014)(2).

Demand was based on two household activities: laundry and car-washing. Laundry demand was estimated based on average behavior, considering 3 wash loads per week and 92 liters of water per wash load. And car-washing was estimated as one car-wash per week and 63 liters of water per car. Table 1 summarizes rainwater demand and supply for each of the three house sizes.

Characteristics	Collecting area (Roof)		
	78 m²	130 m²	210 m²
Total demand (year) Laundry Car-washing	17.7 m³ 14.4 m³ 3.3 m³	21 m³ 14.4m³ 6.6m³	21 m³ 14.4m³ 6.6m³
Tank size	1.10 m³		
Rainwater supply (year)	17.3 m³	19.2 m³	19.2 m³

NOTE: Tank sizing was calculated using Plugrisost software and then adapted to available market solutions, in consequence, supply was reduced in some cases.

Table 1. Rainwater demand and supply basics

4 Results and Conclusions

Results show that scenarios with bigger collection surfaces and with the tank installed at ground level have better financial outcomes. Figure 2. presents the cumulative cash flows of each scenario, demonstrating how tap water savings compensate capital and operational expenditures.

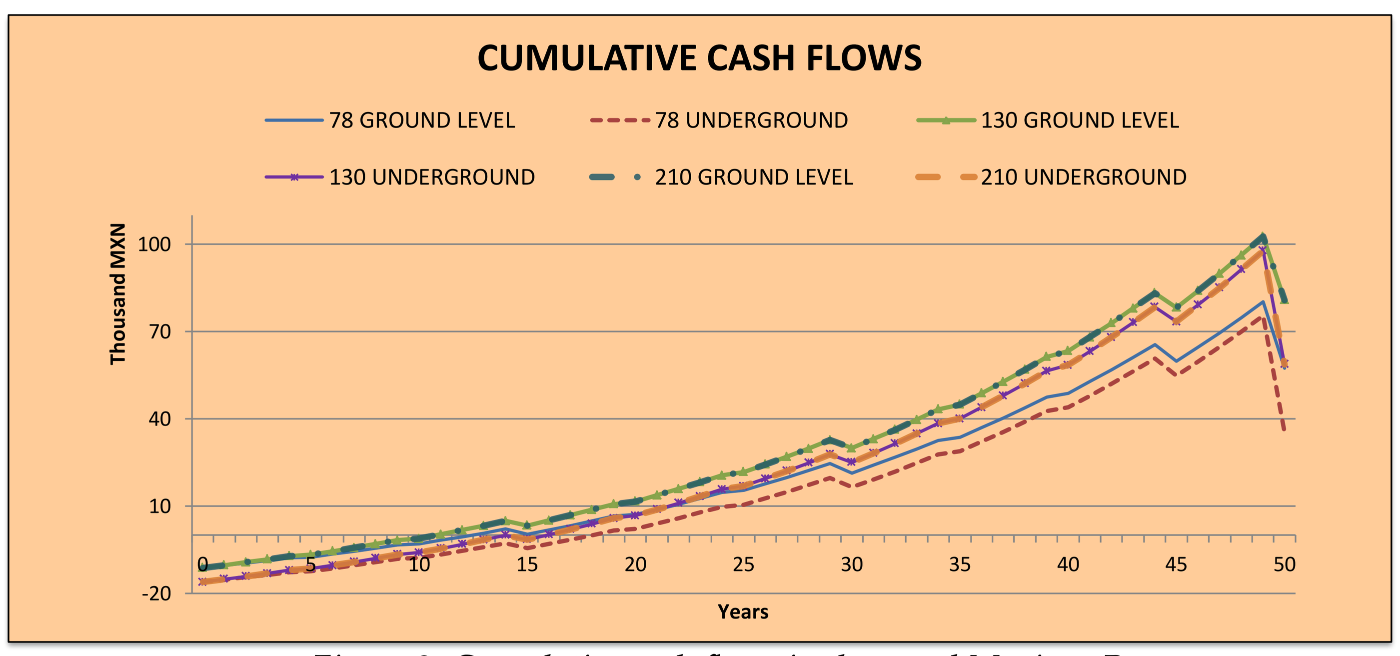

Figure 2. Cumulative cash flows in thousand Mexican Pesos

TANK LAYOUT	HOUSE SIZE	INITIAL INV.	NPV	IRR	PB
GROUND LEVEL	78	$ -11,196.76	$21,231.12	9%	14.92
	130	$ -11,196.76	$30,455.98	11%	13.36
	210	$ -11,196.76	$30,455.98	11%	13.36
UNDERGROUND	78	$ -16,049.50	$12,703.51	6%	18.84
	130	$ -16,049.50	$21,928.38	8%	17.00
	210	$ -16,049.50	$21,928.38	8%	17.00

Table 2. Financial results for each scenario in Mexican Pesos

The results from this study lead us to conclude that a rainwater harvesting system is potentially economically viable for domestic laundry and car-washing in this city and others with similar conditions. Table 2 shows the financial results where NPV results in higher values for ground level scenarios as well as higher IRR and lower PB compared to underground scenarios.

References

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Acknowledgments

The authors would like to thank the project "Análisis ambiental del aprovechamiento de aguas pluviales" (Spanish Ministry for Science and Innovation, ref. CTM 2010-17365) for financing this study and express appreciation for the grant awarded to M. Violeta Vargas-Parra by Conacyt (National Council of Science and Technology, decentralized public agency of Mexico's federal government).