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Assessing the impact of demand management and alternative sources on water consumption in urban environments: a case study in Manaus, Brazil

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Highlights:

- Offering various alternative water sources is crucial due to differing acceptance levels.
- Stakeholder engagement is important for defining the best solutions to implement.
- Measures implemented even individually show gains in drinking water savings.

Keywords: Efficient water consumption; Greywater; Rainwater collection.

INTRODUCTION

Population growth, economic development, and climate change pose challenges to urban water management. Solutions such as demand management and alternative sources (greywater and rainwater) have been studied (Hoepers et al., 2024). However, the user acceptance of these solutions must be evaluated.

Proposing measures aligned with stakeholder expectations and evaluating performance across scenarios are key to the Urban Water Use model (Santos and Steen, 2011). This model supports decision-making for urban water and sanitation infrastructure.

Through stakeholder engagement in a community in Manaus, Brazil, this research assesses the impact of demand management and alternative sources on daily water consumption considering stakeholder acceptance of these measures.

METHODOLOGY

We applied two steps from the Urban Water Use model (Santos and Steen, 2011): scenario building and community vision. These steps assessed the impact on daily per capita water consumption (Fig. 1) by implementing demand management through rational use and the use of alternative sources in buildings.

The study area is a sub-catchment of the Educandos Basin in Manaus, Brazil, covering 1.51 km² and housing 5,877 inhabitants in 2021. This area includes informal settlements, primarily due to the lack of a sewage system. The decision-making process involved two key stakeholder groups: Technical staff and Community individuals.

The scenario building step evaluates uncontrollable external factors influencing selected strategies, such as population growth, economic performance, annual rainfall, and average temperature (Santos and Steen, 2011). Technical staff, comprising experts from various fields, set the simulation horizon, external factors, and scenarios over three meetings.

In the community vision step, we gauged resident acceptance of the measures. Community individuals were consulted during the field survey to determine their interest in the measures (Fig. 1). The evaluated measures and their acceptance rates were:

- Measure 1 – efficient water consumption from various sources (89%).
- Measure 2 – greywater use for toilets and garden faucets (56%).
- Measure 3 – rainwater collection for garden faucet use (67%).

We applied the equations from Ferreira et al., (2024) to assess the impact of measures on water consumption. We conducted eight simulations:

1. No measures.
2. Measure 1 alone.
3. Measure 2 alone.
4. Measure 3 alone.
5. Measures 1 and 2 combined.
6. Measures 1 and 3 combined.
7. Measures 2 and 3 combined.
8. All measures combined.

RESULTS AND CONCLUSIONS

Our results reveal differences in water consumption across the four scenarios and measures. Fig. 2a shows that Scenario 3 has the highest water consumption, due to higher values assigned to external factors. Scenario 2 has the lowest water consumption, driven by lower external factor values.

The simulation without measures exhibits the highest water consumption, reflecting a critical baseline. Measures 1 and 2 save around 26 L/inhab.day (Fig. 2b), while Measure 3 saves 5.26 L/inhab.day. Consequently, combining Measures 1 and 2 yields greater water savings than combining them with Measure 3. Hence, there is a slight disparity in water savings between Measures 1 and 2 alone and when combined with all measures.

The findings suggest that prioritizing Measures 1 and 2 could achieve greater reductions in water consumption than combining all measures. However, user acceptability highlights the need to offer different alternative sources. The difference in savings stems from Measure 3 being limited to garden use, while Measure 2 includes the toilet. Therefore, to determine the best measure for implementation, we recommend extending the analysis to the impacts on the urban sewage and drainage systems.

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Figures

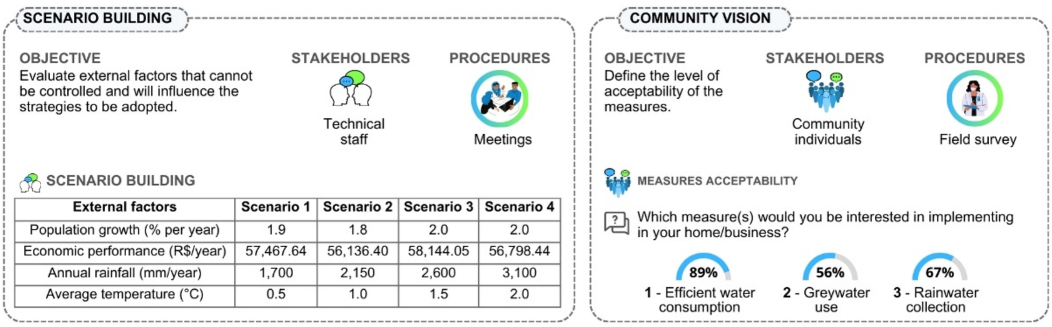

Fig. 1 – Scenario building and community vision from Urban Water Use model for this research.

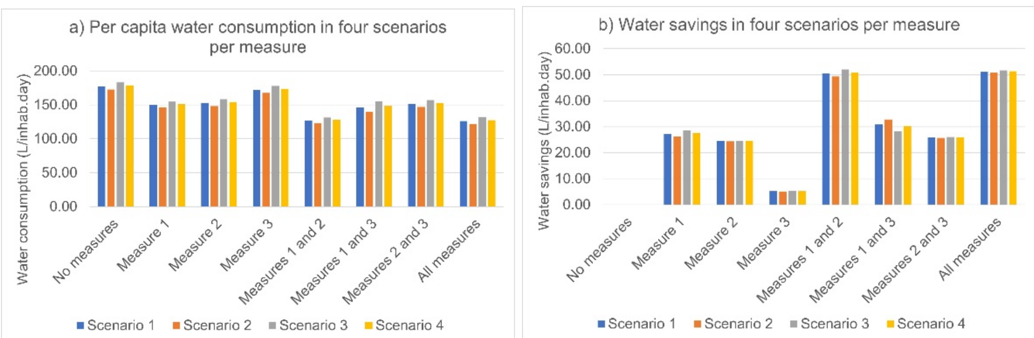

Fig. 2 – Results of water consumption and water savings in four scenarios per measure.