Catch it from the Sky | Behavioral Nudges to move Residential Homes to Practice Rainwater Harvesting

SUMMARY

Water scarcity is a pressing issue in drought-prone states like Texas, California, and Colorado in the United States which is further worsened by climate change in this era. Rainwater harvesting (RWH) can act as a sustainable solution to mitigate water scarcity by capturing rainwater especially for residential households. Our policy brief examines the low adoption of this technique across the three states through a behavioral perspective. The challenges include high upfront costs, habit changes, cognitive biases, and a lack of widespread social acceptance. We propose recommendations based on social influence strategies and community-led interventions to normalize RWH. RWH is a sustainable solution to water scarcity, increasingly vital due to climate change altering rainfall patterns. Despite its environmental and cost benefits, misconceptions, and regulatory uncertainties hinder its broader implementation. For instance, there are myths about its legality and effectiveness, alongside concerns about installation costs and maintenance.

RWH has the potential to significantly reduce household water consumption and save energy used in water management. However, current policies in states like Texas, California, and Colorado focus mainly on financial incentives for installation, which might not fully influence long-term behavior and perceptions. Our recommendations emphasize understanding the complete user journey of RWH, from installation to habitual use. Addressing misconceptions, leveraging technology for user-friendly systems, and integrating RWH into community norms are key strategies. This comprehensive approach aims to facilitate wider adoption of RWH, contributing to sustainable water management and environmental conservation.

"If the rain used to come in one inch 30 times a year and now it's coming in three inches 10 times a year, you're going to have longer periods of droughts. Rainwater harvesting is going to allow you to have water during periods that are hotter and dryer due to climate change" - **Fouad Jaber, Specialist in water management at Texas A&M University**

The next world war will be for water

The United Nations has projected that by 2025, two-thirds of the global population may experience water scarcity, highlighting the urgent need for alternative water sources.[1] **Rainwater harvesting offers a promising solution, particularly considering changing rainfall patterns due to climate change, where precipitation is concentrated in fewer, heavier events leading to longer drought periods.** The scope of the problem extends beyond just water scarcity; it includes the environmental impact of traditional water sourcing methods. For instance, the traditional water supply and sewer systems in the U.S. have seen a significant increase in costs, rising over 50% since 2012[2]. Rainwater harvesting systems, in contrast, offer a more cost-effective and environmentally friendly alternative, reducing reliance on these conventional systems and thereby decreasing associated carbon emissions. It also helps divert storm runoff from pavements, where it could otherwise cause flooding or carry pollutants into natural bodies of water.

However, despite these benefits and the potential for significant savings on water bills, as evidenced by the **American Rainwater Catchment Systems Association's finding that homeowners could cut their annual water bills by half, adoption remains low.** This is particularly striking in drought-prone states such as Texas, California, and Colorado, which stand at the point of either transitioning or running out of fresh water. For instance**, a county in Texas has faced more than 200 weeks (about 4 years) in 'exceptional drought' circumstances[3].**

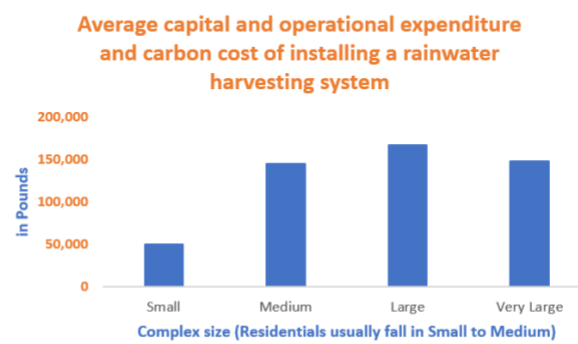
Several factors contribute to the limited adoption of rainwater harvesting in the United States. For instance, there's a prevalent "yuck factor" or unwarranted apprehension towards using rainwater, alongside a general unawareness of its long history and effectiveness. Moreover, the cheapness of municipal water and the overwhelming presence of immediate, everyday problems overshadow the long-term benefits of rainwater harvesting. This situation is exacerbated by varying political and legislative landscapes, such as the myth surrounding the illegality of rainwater harvesting in Colorado and Utah, which further complicates efforts towards widespread adoption.

Despite these challenges, the potential of rainwater harvesting to mitigate water scarcity is substantial. A study shows that compared to an average national water use of 60 gal/person/day, a rainwater harvesting user only uses 35 gal/person/day. Ghaffarian Hoseini et al. (2016)[4] suggest these collected water uses can globally account for 80–90% of overall household water consumption. In Texas, using just 10% of roof area for rainwater harvesting in a city like Dallas could generate an estimated 2 billion gallons of water annually. Harvesting also saves energy: 20% of all the power generated in California goes into moving, treating, and using water. The urgency of addressing water scarcity through sustainable methods like rainwater harvesting is clear and overcoming the current barriers to its adoption is vital for both environmental conservation and human well-being.

Current RWH Policy Landscape

As a sample of the US RWH programs, we look at the policies of three states – **Texas, California and Colorado that are at different stages (High, Medium & Low) of their implementation programs** and lowering restrictions to evaluate the approach taken by different governments

These include the high upfront cost of installation, misconceptions and legal confusion about the practice, and a lack of awareness about its personal benefits beyond conservation.



"I have friends out here that have rainwater collection systems. None of them have gone dry during this entire drought,"

Mooney, resident of Texas

TEXAS: High

Texas, leading in the implementation of rainwater harvesting, offers substantial financial incentives, such as tax exemptions and rebates. The City of Austin, for instance, offers up to a $5,000 per site rebate for rainwater harvesting systems. The 'liquid gold' sentiment expressed by some users indicates a positive reception among those who have adopted the system, yet the broader population may still view rainwater harvesting as a secondary or optional water source. This perception is a crucial behavioral hurdle to overcome. The high level of implementation in Texas, however, suggests that if economic incentives are combined with robust public education and outreach, there's potential for widespread adoptions

CALIFORNIA: Medium

California's Rainwater Capture Act of 2012 and various city-level rebates reflect a progressive stance toward rainwater harvesting but with restrictions. The bill outlines that certified landscape contractors can install water collection systems "used exclusively for landscape irrigation or as a water supply for a fountain, pond, or similar decorative feature in a landscaping project." For personal residences, there are incentives that completely fund the purchase of a rain barrel up to a set gallon size. Despite the tax rebates these policies face an upfront confusion on the legislation acting as a deterrent. Public knowledge about rainwater harvesting is also low given that most search results for 'rainwater harvesting' simply tackle the legality of it within the state.

Colorado: Low

Colorado's approach to rainwater harvesting has been historically restrictive due to water rights laws. This stems from the state catering to senior water rights per the Prior Appropriation System. To simplify things, it basically means that the first person to take some water and use it for a beneficial reason has the first right to claim exclusive use of it. The state's legalization of rainwater collection for non-potable purposes in up to two barrels is a step forward, but the limit of 110 gallons (about half the volume of a large refrigerator) and restrictions to non-potable use might not be enough to incentivize widespread adoption. These legal limitations may contribute to a perception that rainwater harvesting is not worth the effort, which can be a significant deterrent.

Each state's approach to promoting rainwater harvesting follows the common string of easing the upfront cost of installation with tax rebates and discounts, yet they all seem to fall short in fully harnessing the potential of this sustainable practice**. While these incentives are generous, they may not sufficiently alter long-term behavior or perceptions toward sustainable water use. Behavioral concepts like habit formation and perceived ease of use play a significant role in the continued use of these systems.** If residents find maintenance cumbersome or if they don't perceive an immediate benefit from using harvested rain, these systems risk becoming underutilized.

Understanding human behavior, particularly in how people interact with environmental policies and incentives, is crucial in evaluating these programs.

Recommendations

It is key to look beyond one touchpoint of RWH which is the installation and consider the complete user journey of an individual specially **involving the different stages of decision making.** We can break down different proposals for reform adhering to these four stages:

1. Bringing the behavior on the Radar | Tapping on Community Action to remove myths

In the current US landscape, there is a lot of confusion around the legality of RWH as seen through the restrictions in the policy programs mentioned above. Even in states like Texas which have legalized RWH a few decades ago, collection systems are not subject to state building code and the absence of clear construction guidelines discourage homeowners and developers from installing these systems. Misconceptions extend beyond legalization to environmental and maintenance concerns, such as groundwater depletion or disease spreading from stagnant water in storage tanks. To effectively promote RWH, especially re-introducing it with today's technology, leveraging peer effects is crucial.

Social perceptions are key—If harvesting rainwater is seen as atypical or unorthodox, it may face resistance but through community engagement we can create a culture where rainwater harvesting is a norm can be pivotal (Suleiman et al., 2020[i]). By engaging stakeholders in discussions about the technology's benefits, addressing concerns like space constraints, and clarifying misconceptions about system maintenance, like sedimentation issues, we can foster a more favorable environment for RWH. Community engagement can improve RWH acceptance and sustainability by allowing system adaptation to specific contexts (Zimmermann et al., 2012[ii]). Finally, consistency in regulations will help in standardizing RWH implementation, ensuring clarity and ease of compliance for homeowners and developers alike. **One of the biggest advantages of rainwater harvesting as a public policy solution is that it can win bipartisan support.** While rainwater can be a popular cause for Democrats concerned with climate resilience, Republicans can advocate rainwater collection without accepting the science of climate change or standing up to fossil fuel lobbyists.

2. Making them Consider this Behavior | Perceived Immediate Benefit

In promoting rainwater harvesting (RWH), it's crucial to focus not just on the installation process but also on the tangible, immediate benefits that households can experience. **These benefits need to resonate on a personal level, extending beyond the broader goal of water conservation.** While the long-term environmental effects of RWH are important, they might not sufficiently motivate immediate behavior change. The harvested water can be used for various purposes, including gardening, washing, and in some cases, even for non-potable indoor use, reducing the water bill. Financial benefits beyond tax rebates can also play a role in encouraging RWH. For example, a program in New Delhi, India, offers free water to households if their electricity bill falls below a certain threshold, something similar can be done for water bills incentivizing water conservation.

Furthermore, indirect benefits, such as delaying major water infrastructure upgrades, replenishing underground aquifers, or controlling combined sewer overflows (Coombes and Kuczera, 2003[iii]; Gwenzi and Nyamadzawo, 2014[iv]), offer additional motivations. According to studies by Brodie (2008[v]) and Burns et al. (2015[vi]), **RWH can significantly reduce urban runoff's frequency, peak flows, and volume.** Hamel and Fletcher (2014[vii]) also suggest that RWH can mitigate environmental impacts on water bodies. These insights provide a more holistic understanding of RWH's role in urban planning and environmental management. In 2023, RWH was the top gardening trend on Pinterest, indicating a growing interest in the practice. Beyond gardening, RWH helps reduce stormwater runoff especially in states like California which are also prone to flooding, thereby preventing pollution in water bodies like the Pacific Ocean.

More information to understand the capacity of rain barrels (typically 40 to 90 gallons) and **planning the usage of harvested rainwater can lead to more efficient and purposeful adoption, helping the cost-benefit analysis on the space taken up by tanks in the household.** These benefits should be communicated to provide a comprehensive view of the system's return on investment.

3. Aiding Concrete planning| Building Habits through Tech-Enabled Comfort

Incorporating technology and smart design into rainwater harvesting (RWH) systems can significantly aid in planning and habit-building for users, ensuring both ease of adoption and maintenance. The maintenance of RWH tanks is vital for clean water storage, as long-term storage can lead to increased bacteria concentrations and mosquito breeding (Mankad & Greenhill, 2014[viii]; Moglia et al., 2016[ix]). Mankad and Greenhill's study highlights the importance of both intrinsic and extrinsic motivation, such as **government subsidies for such technology in encouraging system owners to maintain their tanks.** Recent advancements have led to the design of dual storage facilities in RWH systems, as proposed by Brodie (2008). These systems have separate tanks for stormwater detention and retention, efficiently managing the water for user demands and runoff control. This design, utilizing a small orifice connecting the two storage volumes, optimizes space usage in the tank prior to the next rainfall (Gee and Hunt, 2016[x]).

Operational, maintenance, and treatment costs significantly impact the affordability of RWH systems. Designing systems prior to implementation, such as opting for gravity-based systems over pump-based ones, can reduce expenses (Hafizi Md Lani et al., 2018)[xi]. **Customization of RWH systems is crucial to address the conflicting objectives of water saving, runoff control, and cost minimization.** This customization is where technology, such as Information and Communication Technologies (ICT) and Supervisory Control and Data Acquisition (SCADA) systems, plays a significant role. By integrating sensors into tank systems, these advanced technologies can automate and optimize the management of stored rainwater (Han and Mun, 2011[xii]; Gee and Hunt, 2016). Furthermore, 'smart regulation', trialed in the German market, represents an integrated approach involving water abstraction fees, water supply and effluent fees, and subsidies (Partzsch, 2009[xiii]).

4. Taking Action | More Data, More Evidence, More Norm

Effective policy analysis, augmented by data trackers and program evaluation, is key to understanding and encouraging the use of rainwater harvesting (RWH) in the United States. Currently, there is a notable gap in data regarding the usage and savings achieved through RWH. A thorough program evaluation focusing on the reduction of utility bills could play a significant role in normalizing RWH behavior.

Innovative collaborations, like the partnership between a government office and Coca-Cola to repurpose soda syrup drums into rain barrels, demonstrate creative solutions to promote RWH. Such initiatives not only facilitate water conservation but also contribute to waste reduction. By reusing industrial materials, these programs set a precedent for sustainable practices. **The development of incentive programs is also crucial for integrating RWH systems into the design of new residential, commercial, and industrial buildings.** Looking at international examples, some states in India have mandated RWH in all new constructions. Similarly, RWH is legally required in the U.S. Virgin Islands and many Caribbean islands, setting a model for policy adoption.

The literature currently lacks a comprehensive view that addresses the socio-technical complexities of RWH. Understanding these dynamics is essential to develop effective policy frameworks that can manage these complexities, preventing exploitation by certain groups at the expense of others. Such nuanced policy frameworks can lead to more informed, equitable, and widespread adoption of RWH systems.

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