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Research Paper

The design of climate-adaptive water subsidies: financial incentives for urban water conservation in Morocco

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ABSTRACT

In a 500-household pilot, we tested an innovative approach to water demand management, implemented in collaboration with a water utility in a large city in the Middle East and North Africa (MENA) region. We provided a novel intervention, called a Water Savings Credit (WSC), which granted participants volumetric rebates on their water bills for their reductions in water consumption. WSCs were effective at encouraging conservation in our pilot in Marrakech. Our approach has the benefits of a price incentive, without the political risk of a tariff increase. For urban water utilities that provide highly subsidized services, this approach could ultimately pay for itself, or potentially result in net financial savings. Our approach may be especially effective in the countries of the MENA region, as the region has a high rate of subsidization for water services, and because it is facing increasing water scarcity from economic growth, urbanization, and climate change.

Key words: climate adaptation, conservation-oriented pricing, demand management, MENA, subsidized water services, utility policy

HIGHLIGHTS

- A Water Savings Credit (WSC) is a novel intervention that provides a volumetric reward for reduced consumption.
- WSCs were effective at encouraging conservation in our pilot in Marrakech.
- WSCs have the potential to be more politically acceptable than rate increases and can protect equitable access while encouraging conservation.

INTRODUCTION

Our proposed intervention utilizes a price incentive, leveraging the relationship between a utility and its customers. By providing a financial incentive for conservation, it has the benefits of a price incentive, without the political risk of a tariff increase. It has distinct benefits for urban water utilities with highly subsidized services: subsidization is especially prevalent in the Middle East and North Africa (MENA) region.

Water availability in MENA

Water demand around the world is outstripping supply. Rapid urbanization, growing economies, and shifting precipitation patterns due to climate change are all resulting in diminished water availability (Flörke *et al.* 2018). An estimated two-thirds of the globe faces water scarcity at least 1 month out of the year, while half a billion face it all year long (Mekonnen & Hoekstra 2016). Nowhere is this truer than in the MENA region. The World Resource Institute (WRI) rates the water resource availability of nearly all countries in the MENA region as being under 'high stress' or 'extremely high stress' (Gassert *et al.* 2013). By 2050, it is projected that total water demand will be double the renewable freshwater available in MENA, as a whole (Verner 2012).

Climate change impacts exacerbate the stresses associated with rapid urbanization. In urban areas, climate-adaptive water management is vital; a key to improving water management is to increase water use efficiency.

Management of urban water demand through conservation-oriented tariff design

The price elasticity of demand for water has been estimated to be around −0.51, on average (Dalhuisen *et al.* 2003). This would imply that a 20% decrease in demand would require an increase in the volumetric price of water by 40–50%, all else being equal. Rogers & Leal (2010) observed that when the Massachusetts Water Resources Authority increased its price of water by 10fold (over the course of many years) the demand for water dropped by 35%. Lahlou & Colyer (2000) found that the price elasticity of demand for domestic connections in Morocco was roughly in line with estimates elsewhere.

There is some evidence that price-based interventions for reducing demand are more cost-effective than other interventions, in part because they do not require the monitoring and enforcement that others do such as command and control interventions like rationing (Olmstead & Stavins 2009). Having said that, they can be politically risky: the entire city council of Tucson (USA) was voted out due to a substantial water tariff increase (Hall 2009).

Our intervention uses a simple reversal of conventional practices, it takes advantage of the effectiveness of conservation pricing while avoiding the political backlash and turning any social resistance into public support. Rather than reduce demand through higher tariffs, participants in our pilot were paid a volumetric rebate or credit for the water that they saved. In this way, subsidies that encouraged water wastage, are instead turned into subsidies that encourage water conservation (see Methods section for a detailed description of the intervention). We tested this idea with a pilot, implemented in Marrakech, Morocco.

Subsidization of urban water provision

Public water subsidies can amount to a significant portion of GDP. Using data from 2004, the IMF estimated that in the region covering MENA, roughly 1.8% of GDP was spent on public water subsidies, higher than any other region (Kochhar *et al.* 2015). In MENA, conventional sources (including surface and groundwater) are subsidized at an average rate of roughly two-thirds of the cost of production, while desalination is subsidized at an average rate of roughly 90% of the cost of production (World Bank 2017).

Political and social considerations can often influence the design of water tariffs and push for the allocation of subsidies. Yet, the allocation of subsidies for water services provision has important implications for demand management and is of particular importance in areas of scarce water resources, such as MENA. Keeping prices relatively low compared to the cost of service provision, or to the social cost of water, has the risk of signaling that the value of water is low, and thus fostering higher usage and a greater waste of water than there otherwise would have been.

Higher usage in the MENA region also translates into exacerbating greenhouse gas (GHG) emissions.

In the MENA region, there is a strong connection between energy and water. Pumping and drainage consume 6% of the total electricity and diesel consumption (Borgomeo *et al.* 2018). It was estimated that Saudi Arabia may be using up to 7% and in the United Arab Emirates up to 22% (Siddiqi & Anadon 2011). Electricity production in MENA is largely done through fossil fuel consumption, leading to a relatively large carbon footprint. Improved water use efficiency will contribute to a broader policy goal of reducing the carbon intensity of the MENA region.

An innovative solution: subsidize conservation through a volumetric rebate

Examples exist where conservation was subsidized through rebates, such as payment for water efficient retrofits; purchase of water efficient devices; installation of rainwater harvesting systems or water re-use systems; and conversion of landscaping to ground cover or plants with low water requirements (Tull *et al.* 2016; Baker 2020). Also, economists have supported the idea of a uniform price plus a volumetric rebate (Fuente *et al.* 2017). Many examples exist of fungible water credits of some kind, where water rights are traded in markets among farmers and urban utilities in the US, Australia, Chile, South Africa, and China (Grafton *et al.* 2011). One such example comes from a pilot in Valley of the Moon, CA implemented by one of the authors (Workman 2017).

While conservation-oriented tariff design is an effective tool for encouraging conservation, price increases reduce affordability, which may impact access for low-income households and result in political backlash. For this reason, most governments around the world subsidize urban piped water services, including the MENA region (Andres *et al.* 2019). Our approach is to turn around the subsidy and subsidize conservation, through a volumetric rebate. While other kinds of rebates have been used elsewhere, and a volumetric rebate has been discussed previously in the research literature, this is the only instance that we are aware of where a volumetric rebate has been implemented in an urban water utility.

METHODS

Location: Marrakech, Morocco

Morocco is located on the western coast of North Africa, part of the MENA region. It has a similar climate to other Mediterranean countries, with rainfall gradients declining from north to south and west to east. Water resources vary between 180 m^3 per capita per year for areas in the southwest of the country and 1,800 m^3 per capita per year for the northeast (AfDB 2006). Like much of the rest of the MENA region, droughts, while historically not uncommon, have more recently occurred with increased frequency. According to one assessment, the frequency of drought in Morocco has shifted from 5 in 40 years to 4 in 10 years (Moumen 2019).

The criteria for choosing a location for our pilot included an urban area with a population of around 1 million people or more; located in an arid area, with water scarcity issues; all connections metered; and local urban water services that are highly subsidized by the government. The city of Marrakech, Morocco, fits all these criteria.

Although urban water services are subsidized in Morocco, Marrakech's utility, RADEEMA (a French acronym for 'Autonomous Distribution Authority of Water and Electricity for Marrakech'), which only provides distribution of water (including operation and maintenance of the treatment works and network). Water is supplied to RADEEMA by the national government at a subsidized price, with government oversight to ensure that the subsidies are passed on to the consumer in the form of lower tariffs.

In our interviews with senior officials in the Office of Water and Electricity (ONEE), they relayed to us that they subsidized roughly 70% of the cost of bulk water supplies to urban utilities, such as RADEEMA. They claimed that the average national cost of supplying bulk water to urban utilities was MAD 10 per m^3, whereas they were selling that water to RADEEMA for roughly MAD 3 per m^3.

Increasing block tariffs (IBTs) are one type of tariff structure that many utilities have used with the intended goal of keeping rates affordable to low-income households. IBTs are especially popular in the MENA regions, where they are adopted by 70 and 78% of all utilities, respectively (Andres *et al.* 2019). IBTs provide a volumetric price, which increases in a set, stepwise fashion, with increasing consumption. Optimally, the first block would be set at a volumetric rate that is affordable for all low-income households. Unfortunately, the ideal pricing scenario is hard to achieve: high-income households have been observed receiving a disproportionately large portion of subsidies (Fuente *et al.* 2016).

For domestic customers, RADEEMA uses a standard IBT of up to 12 m^3 per month with two blocks, breaking at 6 m^3 (see Supplementary material, Table S1). RADEEMA describes this standard structure as a 'Progressive IBT'. Once a customer consumes 13 m^3, bringing them into the third block, then all 13 m^3 are charged the rate listed for the third block. Likewise, once a customer's consumption reaches the fourth (or fifth) block, then all of their consumption is charged at the rate assigned to the fourth (or fifth) block, not just the consumption which occurs within the fourth block (see Supplementary material, Table S1 for all of the blocks, their breaking points and the rates assigned to them). There were no tariff increases associated with this intervention. All private connections are metered in Marrakech and sharing of a single connection among several households is rare.

A price-based conservation-oriented intervention: Water Savings Credits

Working in collaboration with RADEEMA, we piloted a new approach to conservation in Marrakech. Rather than reduce demand through higher tariffs, participants in our pilot were paid a volumetric rebate for the water that they saved. Participants that saved water earned a Water Savings Credit (WSC); 1 m^3 conserved equaled one WSC. The WSC is volumetric, has a designated monetary value, and can be 'cashed in' toward a participant's water bill. A WSC could be earned by anyone who decreased their usage compared to an individual baseline, which we called a 'WaterMark.'

In our pilot project, WaterMarks were set as a 3-year historical monthly average for each connection.[1] We calculated WaterMarks for all of our participants, using data supplied by RADEEMA. To ensure that we would not be encouraging

[1] Three years of consumption data, for the period of July 2014–June 2017 were used whenever available. If data were only available for 2 years, up to 3 years, then the average of the data available during the same time period was used. Potential participants that had less than 2 years of data were not accepted for inclusion in our pilot program.

people to use less water than is necessary for maintaining proper health and hygiene, we also set a minimum level of the water as well. Any household that reduced consumption below the minimum level did not continue to earn additional WSCs. We set the minimum level based on the WHO standard, of 50 l per person per day (Gleick 1998; Howard & Bartram 2003). During enrollment, we asked potential participants to tell us the number of people in their households. We then calculated, for each household, the volume of water equivalent to 50 l per person per day and set their minimum level to this quantity.

In other locales, the WaterMark could be set based on the local context, or the needs of the water utility; this part of the WSC concept is flexible and can be tailored to local policy goals. For example, it would be possible to set WaterMarks according to historical water rights or have a standard WaterMark for each customer class.

In the example given here (see Table 1), with the WSC valued at MAD 5 per m^3 saved, reducing usage by 26 m^3 over 12 months results in a MAD 130 rebate for the customer. As long as the local subsidy given to water is more than DH 5 per m^3 (as is the case in Morocco), and assuming that the implementation costs of a WSC program are negligible, then paying for conservation would result in net financial savings for the government.[2] In this way, subsidies that encourage water wastage, are instead turned into subsidies that encourage water conservation.

The Marrakech Pilot

Participants were recruited in person, at all RADEEMA's customer service offices. In the same face-to-face session, immediately after being recruited, we explained the program to prospective participants and requested that they provide their full name, account number, number of members in their household, and a working phone number associated with a mobile phone. We verified that each prospective participant had active accounts with at least 2 years of continuous consumption data from July 2015 to June 2017 before accepting them into the pilot. Through this process, we enrolled 514 households. This sample size was sufficient to detect a 10% reduction in consumption, at a 95% confidence level, with a 10% dropout rate.

Watermark calculation

We calculated the monthly WaterMark for each household based on their consumption from July 2014 to June 2017. We calculated the monthly average for each connection, using the following equation.

$$WM_{im} = \frac{1}{N}\sum_{y=1}^{N} w_{imy} \tag{1}$$

where w_{imy} is the consumption for each individual connection i {1 … 516} during month m {1 … 12} in year y {1 … 3}, for a total of N years {2,3}. This gives the WaterMark (WM_{im}) for each month (m) and individual connection (i). We calculated each WaterMark using data from up to 3 years but ensured that all participants had at least 2 years of historical data before enrolling them in the project. Each participant's WaterMark used data between 2 and 3 years; this was to incorporate at least some of their annual variation.

Assignment rebate amounts

We randomly assigned participants to one of two valuations for the WSCs: either MAD 5 or MAD 10. At the end of the first 6 months, half of each of these two groups was randomly chosen and assigned the other rebate value for the remaining 6 months. This was done to explore whether a rebate value change had any impact on conservation behaviors. MAD 5 was chosen because it was comparable to the price charged in the second and third blocks of the IBT, and because it was less than the subsidy provided by ONEE. MAD 10 was chosen since this was roughly the cost of bulk water supply, and comparable to the prices charged in the fourth and fifth blocks of the IBT. These rebate amounts were therefore thought to be salient and reasonable in comparison to the tariffs already being paid.

SMS communication

After the initial, in-person, recruitment, all subsequent communication with participants was through their mobile phones. Starting in January 2018, and for every month after that until December 2018, we sent them an SMS message in Arabic

[2] Once a program is set up, we anticipate that the only cost would be sending a monthly bulk text message to all participants. Pricing varies, but if large volumes of texts are sent (greater than 200,000) per month, the cost per text drops to below $US 0.02. Therefore, we estimate the on-going cost of the program to be roughly $0.25 per household. For more information about pricing, see https://www.forbes.com/advisor/business/software/best-mass-texting-services/.

Table 1 | An example application of the full set of WaterMarks for a single customer, covering all months of the year, along with the consumption, WSCs earned, and the value of those WSCs

	WaterMark	Consumption during pilot	WSC earned	Value of WSCs	Total value accrued
Jan	5	7	0	0	0
Feb	5	4	1	5	5
Mar	7	6	1	5	10
Apr	8	6	2	10	20
May	12	8	4	20	40
Jun	13	10	3	15	55
Jul	16	11	5	25	80
Aug	17	12	5	25	105
Sep	15	12	3	15	120
Oct	10	9	1	5	125
Nov	7	6	1	5	130
Dec	6	6	0	0	130
Total	**121**	**95**	**26**	**130**	

Note: In this example, all WSCs were valued at MAD 5. All data in this table are hypothetical and provided for illustration purposes only.

during the first week of the month, with information specific to their account (see Supplementary material, Table S2). This included their consumption (m^3), conservation (m^3), WSCs earned, the value of the WSCs during the previous month, and the total value of all WSCs earned to date.

In September, we called all participants to ask if they had been reading our monthly SMS messages. We found 50% reported that they had noticed our monthly SMS messages, and 50% either had not noticed, did not answer when we called or had a non-working phone number For the purposes of our data analysis, we considered those participants which confirmed having seen our SMS messages as being 'active' for the purposes of our results, but we did not stop sending our monthly messages to all participants until the end of the pilot. We continued our program until December 2018, at which point we paid all remaining WSC credits earned by active participants as a rebate on their bills.

Data analysis

We estimated the impact of the pilot program on the conservation of water through a difference-in-difference (DiD) modeling, according to the following equation.[3]

$$C = \beta_C + \beta_i * X_i + \beta_P * P + \beta_{PP} * PP + \beta_{DiDi} * DiD_i \qquad (2)$$

where C is the monthly consumption for each connection; X_i is a vector of confounding variables; P is a dummy variable, either for all participants or active participants; PP is a dummy variable covering the pilot period; DiD_i is the difference in difference indicator for rebate valuation category i. Our DiD indicators included specific rebate valuation categories, in order to differentiate the different rebate valuation regimes. There were four possible rebate valuation categories: category (1) included participants who received a rebate of MAD 5 per m^3 conserved during the first 6 months, and MAD 5 during the last 6 months; (2) received MAD 5 first and then MAD 10; (3) received MAD 10 first and then MAD 5; and (4) received MAD 10 first and then MAD 10. Confounding variables included dummy variables for spring, summer, and autumn, and a continuous variable for time (on a monthly basis), starting with June 2014. All β are estimated coefficients for the corresponding variables, except for β_C which is a constant. The model incorporated data from pilot participants as well as non-participants, who were randomly selected from the list of all of RADEEMA's customers.

[3] For an in-depth explanation of difference-in-difference modeling, please see: Michael Lechner (2011), "The Estimation of Causal Effects by Difference-in-Difference Methods", Foundations and Trends® in Econometrics: Vol. 4: No. 3, pp. 165–224. http://dx.doi.org/10.1561/0800000014.

RESULTS

RADEEMA sent us monthly consumption data on all the pilot participants. We then processed that data to calculate the WSC earned each month, and sent out a bulk SMS, with individualized information, to all our participants. In this way, our communication was inexpensive, and minimally invasive, and the participants' role was largely passive (being one-way) with regard to project communications. Though a more invasive communication might have produced a higher percentage of active participants.

Regarding the two questions asked during our follow-up phone call, the vast majority stated that their strategy for saving water was just being very aware of how they used it. Most participants reported very similar motivations; either minimizing waste (47% of respondents), or a desire to use it very efficiently (50% of respondents). All respondents were interested in redeeming their earned WSCs as a credit on their water bill. None had any issues with the program.

Comparing the consumption patterns for pilot participants, with those for the comparison group of non-participants, we see a very different pattern in the Pilot Group for consumption levels below 6 m^3 per month, but a similar pattern for higher consumption levels (see Supplementary material, Figure S1). This resulted in a higher average consumption for our pilot participants (16.3 m^3) as compared to our sample of the rest of Marrakech (10.2 m^3). This is likely due to an under-representation of short-term rentals, temporary residences, riads, or pied d'terres in our sample since recruitment was during the off-season for tourism.

Our DiD models showed modest levels of conservation behavior. Our estimated models controlled for changes over time, including seasonal impacts, and the differences in consumption patterns between participants and non-participants. Looking at the DiD estimates, we see statistically significant drops in consumption among active participants, in rebate valuation categories two and four (Table 2). According to model 4, the average fall in consumption was 1.2–1.5 m^3 per month for active households who experienced a WSC price of MAD 10 per m^3. Compared to an average monthly consumption of 16.3 m^3, this represents a reduction of roughly 7–9%, on average.

DISCUSSION

With this pilot study, we have clearly shown that this innovative intervention can be successfully implemented without any major backlash from water users, in a middle-income country with highly subsidized water services. For 2018, to the extent that they participated in our intervention, a few hundred residents of Marrakech were given a pricing signal (in the form of a rebate), telling them that their water was more valuable than the prices in their tariffs. This increase in the value of water, as embodied in their monthly bills, was accepted, even welcomed by them. This is in stark contrast to the public reaction usually encountered by tariff increases, a more common method to increase the value of water and the efficiency of its use.

Our impact on water conservation in Marrakech showed that three out of four rebate valuation categories had statistically significant results. The two rebate valuation categories which had the most statistically significant results contained a MAD 10 per m^3 rebate during the last half of the pilot; perhaps therefore they both exhibited conservation behaviors among active users in the DiD model. This may be an indication that active participants reacted more strongly to the higher rebate value. The increase in consumption in rebate valuation category three may also indicate that participants were confused or put off by a 50% reduction in the value of WSCs after 6 months. Based on these uncertainties, it is recommended that future pilots invest, even minimally, in customer engagement and outreach before their rollout; the WSC is a new concept, and public awareness may need to be built before making large changes to the value of a WSC.

WSCs expand the potential to incorporate the social cost and social value of water

When a utility's customers decide how much water to use, they are in part basing their decision on the price of water. If the price of water is low, they will use more (on average): if it is higher, they may use less. But they do not incorporate the opportunity costs of water usage or the cost of environmental externalities in their consumption decisions, nor are they paying for any intrinsic value of water. The full social cost of water is not currently, in any meaningful way, incorporated into their decisions regarding water consumption.

When utilities set their tariffs, they are taking into many considerations. For utilities that aim to achieve full cost recovery, they are considering the impact that tariff levels will have on their potential revenue collection, both in terms of the volumetric price and the impact of that price on water demand among their customers. For subsidized services, a more complicated political process must engage with local economic realities and available government resources. In either

Table 2 | DiD model, estimating the impact of the pilot intervention on consumption patterns, while controlling for key confounders

Difference-in-Difference (DiD) results

	Dependent variable: monthly consumption (m^3)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Time	0.009*** (0.003)	0.008*** (0.003)	0.008*** (0.003)	0.007*** (0.003)
Participant	6.062*** (0.136)		6.184*** (0.136)	
Active participant		5.305*** (0.189)		5.420*** (0.188)
Pilot period	−0.482*** (0.097)	−0.402*** (0.097)	−0.377*** (0.097)	−0.303*** (0.097)
DiD (All price categories, all participants)	−0.121 (0.270)			
DiD (All price categories, active participants)		−0.316 (0.374)		
DiD (Price category 1, all participants)			−0.751 (0.522)	
DiD (Price category 2, all participants)			−0.075 (0.467)	
DiD (Price category 3, all participants)			−0.666 (0.459)	
DiD (Price category 4, all participants)			0.366 (0.454)	
DiD (Price category 1, active participants)				−0.281 (0.754)
DiD (Price category 2, active participants)				−1.503** (0.637)
DiD (Price category 3, active participants)				1.295** (0.640)
DiD (Price category 4, active participants)				−1.221* (0.650)
Summer			2.790*** (0.078)	2.761*** (0.078)
Spring			0.749*** (0.081)	0.751*** (0.081)
Autumn			1.997*** (0.077)	1.955*** (0.077)
Constant	10.021*** (0.064)	10.239*** (0.064)	8.582*** (0.080)	8.821*** (0.080)
Observations	407,937	407,937	407,937	407,937
R^2	0.006	0.003	0.010	0.006
Adjusted R^2	0.006	0.003	0.010	0.006

Note: Standard errors have been provided in parentheses next to each coefficient. We have noted statistical significance using the following convention: '*' indicates statistical significance with a ≥90% confidence interval (CI), '**' at a ≥95% CI, and '***' at a ≥99% CI. The mean consumption for all participants was 16.3 m^3 per month, before the start of the intervention. There were four possible pricing categories: pricing category (1) included participants who received a price of MAD 5 during the first 6 months, and MAD 5 during the last 6 months; (2) received MAD 5 first and then MAD 10; (3) received MAD 10 first and then MAD 5; and (4) received MAD 10 first and then MAD 10. Confounding variables included dummy variables for spring, summer, and autumn, and a continuous variable for time (on a monthly basis), starting with June 2014.

case, urban utilities are not incorporating the full social cost into their rate design processes, leaving out many important economic and environmental considerations.

The combination of decisions made by an urban water utility and its customers determines the allocation and aggregate consumption level of their city. Such decision-making processes include households and businesses choosing to invest (or not) in water-saving technologies, or whether to put in a lawn or drought-resistant native plants, for example. To the extent that they were influenced by price, they have the potential to be influenced by the introduction of a WSC rebate system as well.

Our pilot in Marrakech was designed with a focus on using subsidies to encourage conservation. But WSCs can be designed with many other funding sources as well, depending on the local context, and policy priorities. They can be made fungible, as has been done elsewhere, turning them into a potentially powerful tool for water management policy. There is currently a gap between the full social cost of water and the prices paid for water. The WSC concept has the potential to bridge this gap, by opening new types of urban water markets and incorporating new types of participants in these water markets, with new ways to incorporate the full value of water through a combination of tariffs and volumetric rebates.

CONCLUSION

The fourth Dublin Principle states that 'water has an economic value in all its competing uses and should be recognized as an economic good.' This WSC system allows water to be recognized as an economic good, without threatening notions of water as a human right. It does this by putting a value on water conservation This WSC system allows the customer to better understand the value of water by coupling the tariff with the monetary value of the WSCs earned. Yet it does this without penalizing customers with higher prices, avoiding the associated political backlash and the risk of making access unaffordable for poor households.

Funding already allocated for subsidizing water services can instead be used to encourage water conservation, potentially saving both money and water in the process. Competing alternatives for arid and drought-prone regions include expensive infrastructure, requiring extensive setup costs and time. In many locations, and especially in the MENA region, these large-scale infrastructure investments also require ongoing energy use and the resulting GHG emissions. This WSC system, on the other hand, requires minimal ongoing costs, no extra energy expenditure or GHG emissions. Policies focused on urban demand management and improved water use efficiency will contribute to a broader policy goal of reducing the carbon intensity of the economy of the MENA region. Water providers (i.e., government-sponsored or otherwise) may find it more cost-effective to encourage conservation by paying for WSCs than to build expensive desalination plants (as is currently being planned for the city of Agadir, Morocco, not far from Marrakech).

We originally created the four rebate valuation categories to try to estimate the elasticity of demand for the WSCs. Unfortunately, our sample size proved too small to allow us to create a robust model of elasticity. Future work, with larger sample sizes, may be able to fill this gap. We recommend that a single rebate value is used for future pilots, in order to have a clear price signal. Future research on this WSC, and future implementation of similar projects, should include an assessment of subsidies as well as the political, social, and cultural context surrounding water equitable access. And while the institutional set-up of this WSC was straightforward, it does have some minimum requirements: water metering or other means of measuring past and ongoing customer consumption and a system to send information to potential participants. In addition, this type of intervention would not work in settings with extensive sharing of meters, or where water is resold again after the meter. This could be done through SMS messages, the customer's water bill, or some other form of passive communication.

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DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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