NUDGING URBAN WATER CONSERVATION: EVIDENCE FROM INDIA ON THE EFFECT OF BEHAVIOR ECONOMICS ON WATER CONSUMPTION

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ABSTRACT

Urban water conservation is a major challenge for policy makers and researchers. Water managers have relied on coercive regulation, pecuniary action and awareness campaigns for conserving water, with mediocre outcomes. Consumers aver empathy but display a sizeable knowledge –action gap between professed awareness of water scarcity and actual action. The present empirical field study investigates the application of behavioral interventions on the water consumption practices of residents of Chennai City India, using randomized controlled trials. Drawing critical insights from behavioral economics a "Nudge" – 'Shut the Tap' was employed. The Nudge was designed to address behavior bottlenecks, identified in consumer discussions, underlying the knowledge–action gap. The intervention involved modifying the "choice architecture" around behavioral dimensions of social norms, status quo bias and encouragement. These intervention tools were delivered to individual households through reminder Stickers at consumption points, resource Warnings, Cards reiterating social virtue of conserving water, modified default options in a how to conserve Tool Kit and consumption Comparison with best in class. In the study area, treatment households were administered the nudge (n=615) whereas the control group (n=150) received only a generic conservation message. This intervention resulted in the treatment group recording an average monthly energy savings of 23.61 kwh, and a 10.3 percent water saving, equivalent to a 9689 liters reduction in monthly water consumption. The control group recorded a saving of only 1.8 percent. This indicates that the Nudge intervention outperformed business as usual by nearly 470 percent. The study results indicate that Behavioral Nudges can provide policy makers an inexpensive and effective intervention to address the urban water conservation challenge.

Keywords: Behavior Economics, Nudge, Household Behavior, Choice Architecture, Water Conservation.

1. INTRODUCTION

The Urban Water Crisis persists despite multipronged efforts aimed at 'conservation, augmentation and infrastructure development'. The reduced spatial and temporal availability of fresh water is further worsened by increased urbanization, rapid climate change, and competitive sectoral demands and reduced public financial outlays. This exacerbating the issue of the competing demand for water from other sectors is substantially growing with the nine billion populations (World Bank 2015). In an urban context, augmenting the increase of water resources to meet out the growing demand is very limited and the only alternative is 'Demand Side Management' with some innovative management techniques.

2. DRINKING WATER STATUS

2.1 GLOBAL LEVEL

Drinking Water supply is not well distributed in the world. Only 0.007% of worlds freshwater are available for human consumption. As the human population increases the demand of freshwater resources is also increases. Globally, more people live in urban areas than in rural areas, with 54 per cent of the world's population residing in urban areas in 2014. In 1950, 30 per cent of the world's population was urban, and by 2050, 66 per cent of the world's population is projected to be urban (United Nations, 2014)

2.2. NATIONAL LEVEL

In India, the water supply in most of the cities is available for a few hours per day (4 to 5 hours) with an irregular pressure and with questionable quality. Piped water is never distributed for more than a few hours per day irrespective to quantum of water available. Less than 50% of urban population has access to piped water. Average use of the Urban Water is 126 liters per person per day. In India few urban residents are depending exclusively on water vendors and they are the only way-out for the poor during the periods of scarcity (and in some case the rich as well).

2.3. THE MACRO CONTEXT OF DRINKING WATER STATUS IN TAMIL NADU

As per 2011 Census of India, Tamil Nadu urban population is 34.95 millions (Total Population is 72.138 millions), constituting 48 % of the total population. The operational area of the Chennai Metro Water Supply and Sewerage Board (CMWSSB) is 426 sq.km and providing safe drinking water in adequate quantity to people of the Chennai city is the most important function of the Board. Water supply and demand in Chennai Metropolitan Area is estimated at 1750 MLD (22.56 TMC) and 2248 MLD (28.98TMC) in the Chennai Second Master Plan and Chennai revised City Development Plan respectively. The existing storage capacity of all water reservoirs is estimated at 11.057 TMC. This gap between supply and demand requires a combination of conservative resource utilization with sustainable supply augmentation. .

In Chennai metro, the residents who are not in the reach of the water utilities meet their water requirements through the following means viz., shared standpipes operated by the local bodies, individual house-hold tube wells and through water vendors. The constraints in meeting out the demand are mainly due to bottlenecks in managing the available water resources as detailed below.

2.3.1. INEFFECTIVE REGULATING MECHANISM

As of now, there is no legal framework to manage both 'Surface water and Ground water Resources' effectively. Though, the Tamil Nadu government enacted the 'Tamil Nadu Ground Water (Development and Management) Act' in 2003, rules for implementation of the Act was not framed till the Act was repealed during September 2013.

2.3.2. LACK OF MECHANISM TO MEASURE SUPPLY OF WATER

At present, there is no mechanism in place to quantify the water supplied to the consumers. Despite severe water shortages, metering of drinking water supply is a rarity. Hence, the most of urban water utilities adopt adhoc charges (monthly charge), instead of volumetric tariffs.

2.3.3 PRICING OF WATER USAGE IN HOUSEHOLDS

In Tamil Nadu, both irrigation water and electricity to farmers are free for irrigation without any charges being levied. From a small category, Very low monthly rates collected for unlimited drinking water use.

The Problems indicated above emphasise the fact that the demand side management of Household water consumption is the factor to be dealt with. This necessitates adoption of several strategies to promote water conservation in urban areas to provide urbanites to access fresh water. This is truer considering the behaviour of the household water users in water consumption for various domestic usages. People are not aware that water is a scarce resource. Even if they know, they are not giving due considerations. Also, they do not own the responsibility in reducing the wastage in water consumption, leading to water scarcity as they think that providing water is the responsibility of the Govt., /Govt., Agencies. This attitudinal behaviour of the household water users has not been taken in to consideration while tackling the issues related to water crisis.
Hence, in this study it has been decided to experiment the effectiveness of applying behavioural economics using 'Nudges' for water conservation in select areas of the Chennai Metropolitan Area.

2.4 THE MICRO CONTEXT

Hidden underneath the generic tragedy of the commons is inherent resistance to change that manifests as inertia, political distaste for pecuniary disincentives, absence or disregard of both contextual knowledge and feedback, cognitive discounting of future gains and Mindless rather than deliberate action.

The solution lay in addressing the status quo bias and unmindful waste of water by leveraging loss aversion, redesigning the choice architecture, generating feedback for mindful decisions and referencing social norms.

Behavioural Economics suggests that "human decisions are less cold calculated outcomes and more an amalgamation of cognitive biases, emotions and social influences which are strongly persuaded by context and choice architecture". (Amishi, 2017)*

3.0. APPLYING BEHAVIOURAL ECONOMICS FOR WATER CONSERVATION

Water Conservation by way of reduction in water use in urban areas can be done by adopting **"**Pecuniary or Non-Pecuniary Approaches**"**. The Pecuniary approaches involve certain financial or tariff related measures to motivate residents in reducing their water usage and thereby conserve water. In the absence of assured and regular water supply to households, any increases of tarrifs are socially and politically unacceptable. In the absence of meters for volumetric tariff, despite its shortcomings, any incentive to save water is not feasible. Similarly, despite the "economic benefits associated with efficient water management", consumers have not invested or shown interest in water efficient products and practices. On the other end of the spectrum regulatory efforts focused on " Rationing of water supply" try to reduce the demand supply gap, though it is critiqued for being contrary to freedom of choice. This requires policy level decisions on fixing prices for the supply of water.

Similarly this approach includes providing information on water scarcity and to foster water conservation. However, studies indicate that "providing consumers with information can

increase their awareness of a topic, but infrequently provides actionable knowledge and more rarely produces significant changes in behaviour". (Ashby, et.al 2010**).**To quote an example, in one of the studies the individuals who participated in a workshop on residential energy conservation showed changes in attitudes and knowledge but did not produce changes in behaviour. (Geller, 1981). Similarly, in another study, the "individuals who had undergone a two and half months course on water conservation showed change in knowledge of the need to conserve water but did not display any subsequent change in water consumption patterns" (Geller, et.al 1983).

Tamil Nadu and especially Chennai have witnessed number of government supported awareness campaigns to save water and the media has also reported on such programs However, these have mostly not made any visible impact on consumption patterns. This dichotomy was also reflected in the focus group discussions conducted as prelude to this study.

Considering the above facts, Non-Pecuniary Approaches based on simple and inexpensive behavioral interventions are chosen for this study to test their efficacy in reducing water consumption. "Non-pecuniary interventions (i.e. psychological interventions) do influence the behavior which is water conservation, with a higher effectiveness of social comparison in the group of high-use households, and a larger effect in the short-term rather than in longer periods". (Ferrara and Miranda, et.al 2013).Also, the behaviour is influenced by considerations beyond information and financial factors.

3.1. NUDGES

Nudges are simple low-cost behavioural interventions within the choice architecture to steer individuals by addressing specific psychological effects to make use of or overcome them. They do not specify any restrictions on behaviour but influence by giving many opt-out options and centers on social interaction, social influence and related 'Social Norms'

Social and Psychological factors play a significant role in shaping consumers' decisions and behaviours in resource use. Therefore, Behavioural economics when used strategically has the potential to assist in achieving organization objectives, in this case drive down water usage and to achieve a measurable gain in water conservation and efficiency.

Behavioural Economics combines psychology and economics to strengthen the development of a human behaviour model with due consideration for reasonable limitations with minimum complications. This model enables "individuals use different cognitive systems to assess information during the decision making process".

Automatic System (System 1) - Uncontrolled, Effortless, Associative, Fast, Unconscious, Skilled

Reflective System (System 2) - Controlled, Effortful, Detective, Slow, Self aware, Rule following (Thaler and Sunstein, 2009)".

"The mind's two modes of thinking: are the reasons for the above two systems. System 1 is intuitive, fast, and impulsive whereas System 2 is slow rational and deliberate". People evaluate actions and their consequences thoroughly only when they are in the System 2, the "cold state" – something that doesn't happen very often. In most situations, people are in their System 1 or "hot state", in which they rely on simple heuristics and emotions and in which they are prone to forgetting important facts (Nobel Prize winner Daniel Kahneman 2011)".

During the focus group discussions, it is observed that the residents living in urban areas have mindless attitude in water usage without any rule following. Of the two systems

mentioned above, Automatic System determines the day today activities, making the decision prone to heuristics and biases. Heuristics are simple thumb rules, which facilitate and accelerate the decision making process by reducing the amount of information processed. Moreover, the external environment, or choice context, is an important parameter in the decision making process as different contexts may alter the assessment of tradeoffs or comparisons.

The Pecuniary approaches with limited effectiveness in reduction of water usage necessitate an alternative approach. Accordingly, the Non-Pecuniary Approaches based on simple and inexpensive behavioural interventions (Psychological Interventions) are chosen for this study to test their efficacy in reducing water consumption. "Such behavioural interventions or Nudges have been found to be effective in changing other environmentally–related behaviours such as electricity consumption (Alcott 2011 and Brown et.al.2013) or water consumption (Ferraro and Price 2013) as well as other socially beneficial behaviours such as organ donation (Thaler and Sunstein2008) and the uptake of influenza vaccination (Chapman et.al.2010)". Though water conservation through reduction in water usage is a policy priority globally, such behavioural interventions on water use remain relatively underexplored. This is very relevant to India and in particular to Tamil Nadu. This necessitates application of behavioural economics for developing cost-effective strategies for adaption and implementation

3.2. SOCIAL NORMS

"Social norms constitute a social standard from which people typically do not want to deviate" (Schultz at.al.2007). They are the regulatory mechanisms set in place by the society of its own volition. Social Norms are nothing but certain normative social behaviours expected from the societal members. A typical example of such behaviour was exhibited by some part of the group in the recent agitation for reviving 'Jallikattu (Bull Taming)' in TamilNadu.

In Water Sector, the Social Norms can be applied by Social comparison (with reference to water consumption). Non-pecuniary interventions (i.e. psychological interventions) do influence water conservation, with a higher effectiveness of social comparison in the group of high-use households, and a larger effect in the short-term rather than in longer periods.

Applying Behavioural Economics to water conservation studies are based on four different behavioural frameworks, namely "prospect theory, asymmetric price elasticity (APE), reference transaction and social comparison" (Behavioural Economics in Water Management, An overview of behavioural economics applications to residential water demand (Ricardo Correa & Catarina Roseta 2012). Social comparisons are based on framing individuals with comparative information in order to promote specific behaviour. Studies reveal that Social comparison has the strongest impact on Consumer behaviour, using as reference consumption the neighbours' consumption levels. This social comparison framework could have some potential contributions to water management, such as development of water conservation strategies, redefinition of water policies and influence the price elasticity's in terms of magnitude and persistence.

4.0. DESIGNING BEHAVIOURAL INTERVENTIONS (NUDGES) TO REDUCE CHENNAI METROPOLITAN WATER CONSERVATION

4.1. PROBLEM IDENTIFICATION

In the study area, Focus Group Discussions (FGDs) were organized to identify the problems in conserving the water by the residents. The following questions formed the basis for the FGD.

1. How many liters of water are lost through leaks?
2. How many liters of water can you save by using low-flow showerhead?
3. How many liters of water used for flushes your toilet?
4. How many of you know that front load washing machine is water efficient?
5. How many liters of water used for dishwashing with the open tap?

The focus group discussions revealed that almost (98 percent) of the residents do not know about their usage/wastage but they felt need for water conservation. A few residents shared that they are consciously use less water. Secondly, the per capita consumption as per standards is not known to many of the residents.

It was explained to the residents that the wastages by way of leakages will be 37 liters per day and they can save 55 liters of water if they use low- flow shower head. The wastages from flushing of toilets amount to 74 liters per day. Further it was explained to them that front-loading washing machines are energy and water efficient using just over 74 liters a load, while top-loading machines, are less energy-efficient, use 148 liters per load. It was also told that the dishwashing machine consumes more than 80 liters. The young volunteers from the households were trained on conservation practices to be followed

4.2. NUDGES FOR THE STUDY AREA

Based on the problems identified through Focus Group Discussions, the nudges in this study were designed considering the following dimensions mentioned by Kim lee et.al, (2013).

4.2.1. Activating a Desired Behaviour (Child- Parent-Household)

"In this case, a nudge is designed an activating a desired behaviour or norm and influence a decision that an individual is indifferent or inattentive to. These behaviours are not at the top-of-mind for the majority of people; hence people are unlikely to impose nudges that influence these behaviours upon themselves. Therefore, nudges that seek to activate latent or non-existent behavioural standards in people rely on exposing them to conditions in which those standards become more salient" (Kim Ly, Nina Mažar, Min Zhao and Dilip Soman 2013)

4.2.2. SELF-IMPOSED

Self- imposed nudges are voluntarily adopted by people who wish to enact a behavioural standard important to themselves (Kim Ly, Nina Mažar, Min Zhao and Dilip Soman 2013). In this study, the residents' viz., the target groups were convinced about this kind of intervention and came forward voluntarily to implement the intervention as they got convinced about this nudge.

4.2.3. MINDFUL

To make better inter temporal choices by the people, the mindful nudges are helpful, so that their behavior in the present reflects their wishes for the future which is expected in the study.

4.2.4. ENCOURAGEMENT

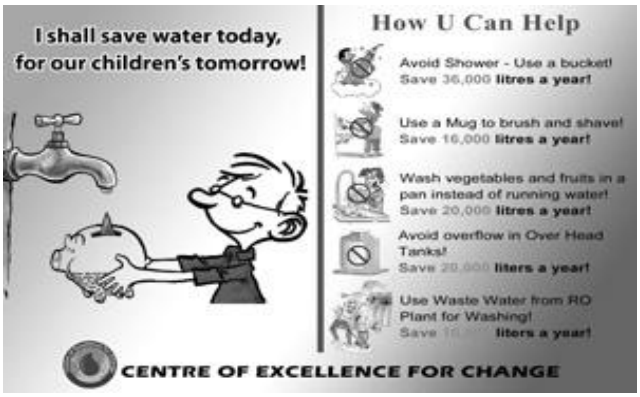
Encouraging nudges facilitate the implementation or continuation of particular behaviour.

The above nudges "Activation of a Desired Behaviour- (Child-Parent-Household), Self-imposed, Mindful and Encouragement" are chosen due to the fact that the emotional bond between the child and the parent is the key factor for exercising nudges, with children playing a role of change champions, who carry and enable the implementation of nudges.

5. IMPLEMENTATION OF THE NUDGES IN CHENNAI METROPOLITAN

Inspired by Behavioral Economics and Theory of Decision points, focused on influencing the behavior of city families through their children in conserving water and reducing its wastage, Nudges were designed. The Nudge practices based on the principles' viz., Social Norms, Social Comparison, Encourage and Changing the Choice Architecture with Mindful and Default, were adopted in this study, through the following Nudge tools 1) Personal Appeal to Households, 2) Information Card *(highlighting* the *plight of have notes, Positive acts of Peer Group & Action points on how to save water with quantification)* and 3) Reminder stickers (at decision check points).

In order to carry out the study based on the above approach, the following methodology is adopted. The Youth volunteers named as change champions from Interact / Environmental Club of Senior School were selected and they were given awareness about water scarcity and



water wastage in Chennai and also the struggle in rural Tamil Nadu for water. Also, they were appraised about the nudges to be used and about the messages they have to share with the students of middle school. Trained change champions were given the Nudge intervention materials i.e. Appeal Letter, Information cards and Reminder stickers along with user survey forms. The students were motivated to fix the stickers in their house in selected three places i.e., wash basins, bath room and kitchen sinks.

In the study area, treatment households were administered the nudge (n=615) whereas the control group (n=150) which has similar characteristics received only a generic conservation message. The survey forms to collect data during the study period was given through trained change champions to student volunteers to record the energy meter readings in which the pump lifting water for their use is attached.

The electricity billing system in Chennai is bimonthly which varies by time and place. We refer in this paper; energy consumption pertaining to the pre study period (baseline data) is converted to monthly consumption (30 days) from the bimonthly bill of Month X. For the study period, the energy meter reading recorded for 15 days, is extrapolated for 30 days.

The above said data collected and statistically tested with regression analysis using dummy variable (Equ i), to assess the reduction in electricity consumption (correlated to Water-Use reduction) in their house-holds due to the impact of the Nudges.

$$Y_i = \beta_0 + \beta_1 Z_i + e_i \quad \text{----------(i)}$$

Where,

Y_i - Water savings in liter

Z_i – 1, nudge practice followed (treatment group)

0, nudge practice not followed (control group)

In our research design, a dummy variable is used to distinguish treatment and control groups. Treatment Group where the nudge practice is followed, dummy variable is "1" and "0" for control group.

6. RESULT AND DISCUSSIONS

6.1. WATER CONSUMPTION REDUCTION COMPARISON BETWEEN TREATMENT AND CONTROL GROUP

Table 1 shows the average monthly electricity consumption of both treatment and control groups during the pre study period and study period. The designed nudges had greater impact amongst the students which encouraged them to influence the adults, in their family and the related circle of influence, resulted in average monthly energy savings of 23.61 kWh, a 10.3 percent water saving equivalent to 9689 liters reduction in water consumption, whereas the control group with generic conservation messages shown 4.23 kWh saving, only 1.8 percent water saving equivalent to 1735 liters reduction in water consumption, confirming that treatment outperformed control group after nudge practices by nearly 470 percent.

Table 1: Reduction in Average Monthly Electricity and Water Consumption

Treatment / Control	Average Monthly Consumption of Electricity in wk.		Difference in Average Monthly Electricity Consumption in kW.h	Change in Monthly Water Consumption in Liters	Percentage of Change
	Pre Study Period	Study Period			
Treatment (N=615)	227.58	203.98	23.61	9688.68	10.30
Control (N= 150)	223.24	219.01	4.23	1734.75	1.89

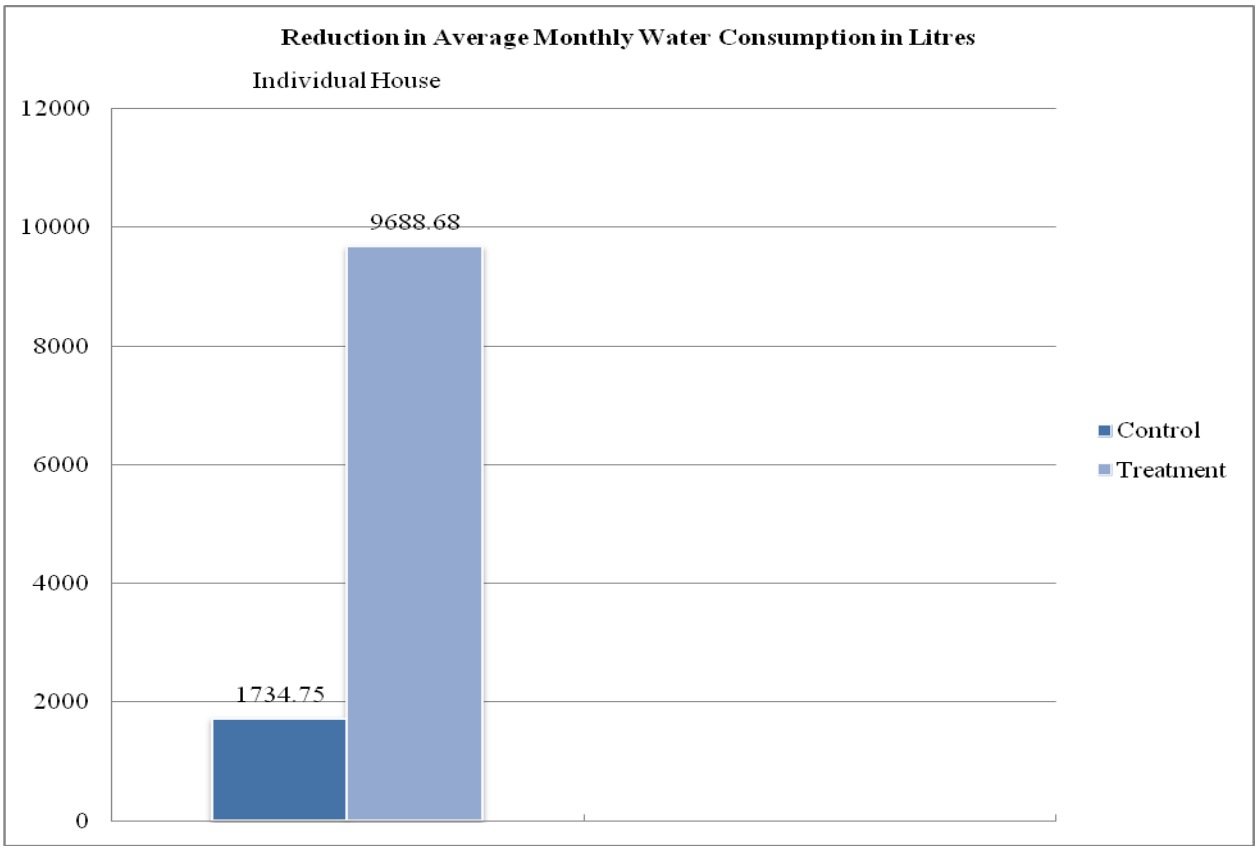
The impact of the nudge (designed tapping the power of the behavioral economics and theory of decision points) rolled out in five large school reaching about 615 households was studied through regression analysis of the data obtained through the survey. From the Table 2 differences in difference between the average monthly water consumption by the treatment group and control group during the pre study period and study period. In our study, the estimated regression coefficient of the treatment group is 9688.68 and 1734.75 for the control group. This clearly shows the differences in difference between the average monthly water consumption is 7953.93 liters when the group followed a nudge practice. The p-value is less than 0.01. This indicates that the statistical analysis is highly significant.

Table 2 Differences in Difference in Water Consumption

Water Consumption in liters	Δ Control	Treatment (Peer comparison and Motivational sticker nudges) Δ Treatment	ΔT-ΔC
Difference between average monthly consumption in the pre study period and study period	1734.75	9688.68	7953.93***
SE	(4.0)	(0.80)	(0.49)
n	150	615	765

Notes: 1. Numbers in parentheses are standard error s
*2. Stars indicate statistical significance: *=p<0.10, **=p<0.05, ***=p<0.01*

Figure – 1 Reduction in Average Monthly Water Consumption



6.2 TREATMENT GROUPS INCREASE THEIR COST SAVINGS THROUGH THE ENERGY SAVINGS

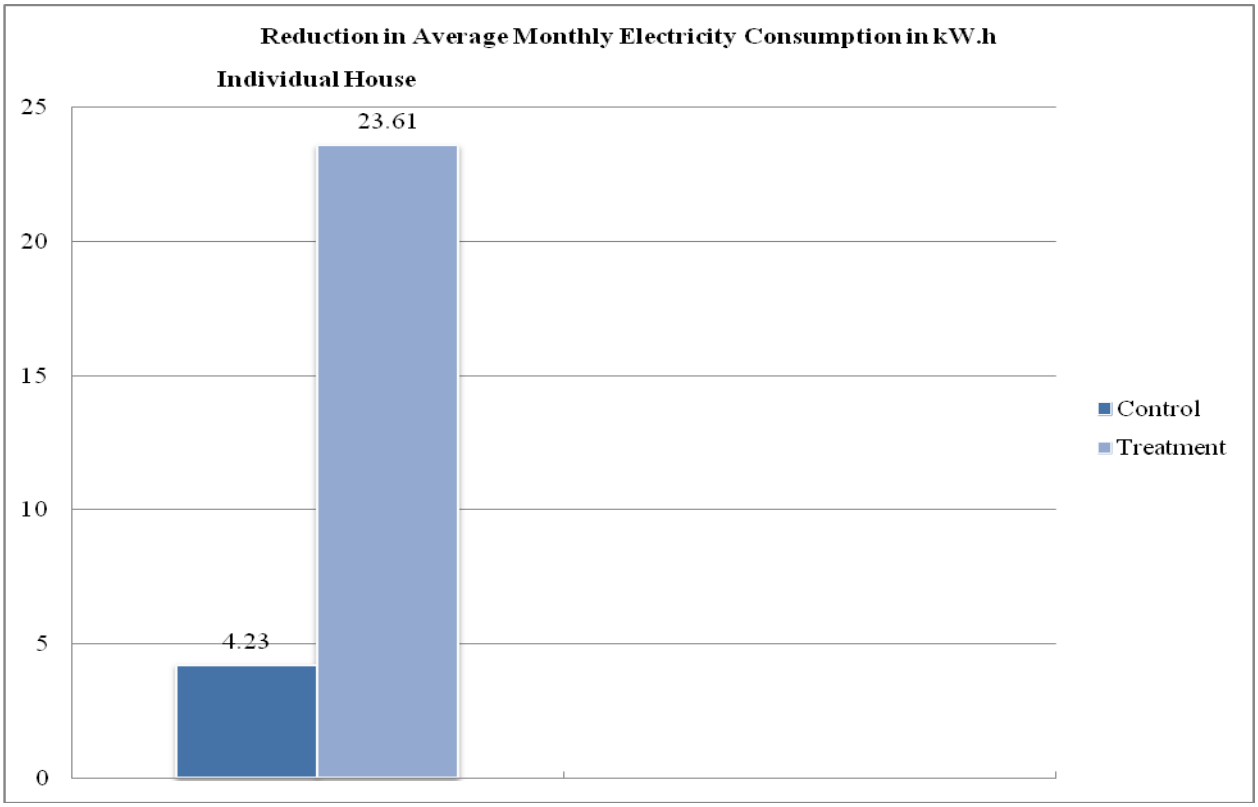
Table 3 shows the monetary benefit due to the reduction in energy consumption. The cost savings of the treatment group (Rs 864.00) is six times more than the control group (Rs.144.00) for a period of one month.

Table 3 Cost savings through the energy savings of household

Treatment / Control	Average Monthly Consumption of Electricity in kW.h during Pre Study Period	Pre Study Period Amount paid in Rs	Average Monthly Consumption of Electricity in kW.h during Study Period	Study Period Amount paid in Rs	Cost savings per Year in Rs	Cost savings Value in $
Treatment (N=615)	227.58	311.00	203.98	239.00	864.00	13.23
Control (N= 150)	223.24	299.00	219.01	287.00	144.00	2.21

It is estimated that the city will receive the economic benefit of Rs 7.00 crore a year after nudge interventions, followed by households.

Figure – 2 Reductions in Average Monthly Electricity Consumption



7. POLICY IMPLICATIONS

This study encourages practitioners and policymakers to consider the impact of nudges and the potential opportunities created by these persistent cognitive biases and 'irrationalities' when determining how best to shift consumer behaviour in the desired direction i.e. water wastage reduction. "Notably, Nudges have exciting potential for conservation because they do not require changes in awareness or attitudes or potentially costly incentives. (Shiela.m.w.Reddy2016)". All the above said nudge treatments from behavioural economics can guide the effective design and delivery of consumer-focused strategies and public policy interventions to improve residential water conservation, particularly solutions that capitalize on message framing, choice architecture and incentivization to shift human behaviour. Elisha, et.al 2015 studied some examples of these implications and opportunities follow, with an

emphasis on identifying practical, cost-effective and mass-scalable solutions to encourage more renewable and sustainable energy use among consumers.

Using the default settings, like in energy-related practices for water equipment also can easily be modified and the effectiveness of behavioural interventions can be enhanced (McCalley, 2006). In our context, we can encourage households to perform actions, such as setting default program to 'short-cycle', in dishwasher or washing machines.

Intransigent behaviour can be addressed through reducing the knowledge action gap and mindless action by providing specific reminders at decision points and use of mobile technology. Social consumption comparison, especially by the metro water Billing Agency, will also be critical in utilizing norms to change behaviour. Underlying these should be an official program to change the choice Architecture by mandating changing in default settings of house hold equipment like washing machine, showers, R.O Plants etc.

Similar to Saugato Datta, et.al 2015, this is a unique behavioral economics study on water use in a developing country especially in the setting of a corporation or other local government city. It is therefore, significant for two related reasons. First, reason is that the practiced interventions based on selected nudge in a business as usual environment are effective at reducing water consumption. Given that constraints on pricing and on the ability to increase supply and increasing water stress have made plummeting water use a priority for governments across the developing countries. The findings of this study are heartening in so far as they suggest that behavioral economics interventions can usefully supplement the persuasion-based tools currently in use to undertake this issue at the neighborhood level.

Secondly and more importantly, the study shows that behavioural nudges provide a potent alternative to policy makers to address the urban water conservation challenge, and are effective in resource and technology-constrained settings, such as in Chennai city.

Third the study also provides policy makers a hint of addressing "future discounting tendency". Educating school students to influence the family can address the behaviour to discount future gains. Future gains when equated with the needs off-springs get valued at a much higher level and are not discounted. Therefore education department can explore adding this to the syllabi with more emphasis on resource conservation especially water besides environmental concerns like pollution. These are fertile areas for more detailed study in the future.

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