Implication of Household Use of R.O. Devices for Delhi's Urban Water Scenario

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Abstract: The present research contribution attempts to study the increasing dependency of households in Delhi on R.O. devices and brings forward its implications on Delhi's urban water scenario. The research focuses on five colonies in Delhi where preliminary water quality assessment was carried out so as to conduct a need assessment of installing R.O. devices versus the actual installation of these devices in individual households. Reverse osmosis is essentially a technique to reduce the hardness of water and the process involves de-mineralization or de-ionization of water by pushing it under pressure through a semi-permeable membrane. Consequently, an R.O. device is effective in households receiving water with high Total Dissolved Solids (TDS). However, an R.O. is neither required nor effective in households receiving water with low TDS, which were noted in the study area. This is because R.O. devices are not an effective method against biological impurities. Despite this limitation, over 78% of the households in the study area were found to rely on R.O. devices as a coping strategy against impaired municipal water supply. While some of these R.O. devices are also fitted with UV-filters (which help address biological impurities in water), the large-scale use of R.O. devices in households that do not require this technology poses a serious threat to urban water sustainability in Delhi.

Keywords: urban water, water supply, Delhi, R.O., water management.

1. Introduction

Water is a basic human requirement and a critical resource for the survival and sustainability of any urban centre. India's National Capital Territory (NCT) of Delhi is well aware of this fact and has been struggling to bridge the gap between water demand and supply (Singh, 2011). With a Census population above 17 million and rising (Census of India, 2011), supplying drinking water to all the households of Delhi is becoming an increasing challenge for the Delhi administration each passing day. The high water demand of the NCT of Delhi is also the reason for the high pollution of River Yamuna which flows through the city and is the principal source of its freshwater supply (Singh, 2016). Despite consuming a major part of the flow of River Yamuna, the Delhi administration is still not able to meet the water demand of the city. Water shortage, as well as issues related to water quality in the municipal supply, have led to the development of coping strategies by the households in Delhi households (Zérah, 2000). One such coping strategy, mainly against impaired water quality, is the installation of reverse osmosis (R.O.) devices.

A Household R.O. device is a water treatment device which takes water supply from the tap as the intake, pushes the water through a semi-permeable membrane which retains most of the solid dissolved in water and provides largely chemical-free water as output (for drinking), along with releasing "reject water", which is rich in dissolved solids, as waste water. Reverse Osmosis can be defined as a process by which a solvent (in this case, water) passes through porous membrane in the direction opposite to that of natural osmosis when hydrostatic pressure > the osmotic pressure. Reverse Osmosis (R.O.) devices thus help reduce Total Dissolved Solids (TDS) in water. Despite their high cost (both installation and maintenance) R.O. devices are becoming increasingly popular in urban households across Delhi as water purification devices. Their popularity can indeed be also attributed to the fierce marketing as well as instilling doubt in the mind of the user over consistency in the ability of city administration to supply clean drinking water (Eureka Forbes, 2017).

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The present study attempts to explore the implications of the increasing popularity and installation of R.O. devices by urban households in Delhi. The principal objective of a R.O. device is to reduce the TDS of water. R.O. is therefore a requirement for households which receive water with high TDS values (>500.0 mg/l). One of the key motivations behind this study was therefore to analyse the TDS values of water being received by the households who are installing R.O. devices. A household R.O. device also leads to large-scale wastage of water, which has otherwise been sent as water supply (thus is meant for drinking as is). The research tries to carry out a need analysis of installing R.O. devices in Delhi and investigates the implications on Delhi's urban water scenario.

2. Study Area

The study is focused in the National Capital Territory (NCT) of Delhi which has a geographical area of 1,483 sq. km. The residential areas selected were located across different parts of NCT of Delhi (Fig. 1).

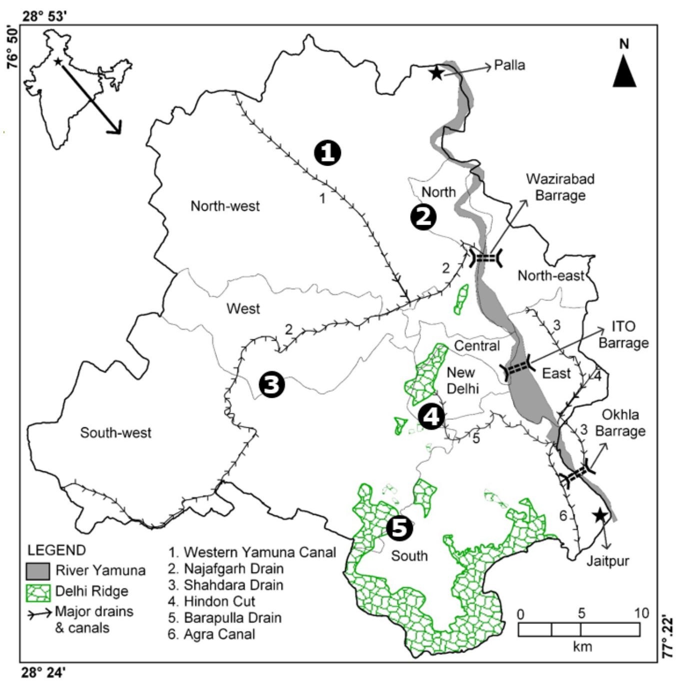

Figure 1. Map of Delhi showing the location of the five residential colonies (1-5) selected for the present study.

A total of five residential areas were identified to carry out this study (Table 1). The residential areas were selected to help develop a holistic understanding of the research problem in the entire NCT of Delhi. The residential areas selected corresponded to North-west, North, West, New Delhi and South Delhi districts of the NCT of Delhi.

Table 1. Residential areas selected for this study.

S. No.	Site ID	Details
1.	RS9	Rohini Sector 9
2.	WPC	West Parmanand Colony
3.	TN	Tilak Nagar
4.	LBN	Laxmi Bai Nagar
5.	VKC	Vasant Kunj, C-Block

3. Materials and Method

The study is a pilot investigation and was carried out in the month of October-December 2016. Five residential areas were identified in the NCT and 10 households (HHs) were randomly selected in each of these residential areas (n=50). Informed consent was taken from all the participants. Each HH was made to fill a survey sheet to find out the status of their access to 'clean, drinking water' on a daily basis. The preferred person in the HH for surveying was chosen to be a woman resident in each of the 10 HHs. Municipal water supply and R.O. outflow (wherever found) were sampled for TDS using HANNA portable pH/ conductivity/ TDS Meter (HI-9812, USA). Repeat sampling for municipal water supply and R.O. outflow was conducted at a two day interval for 30 days from one HH in each of the five selected residential areas subsequently. The data so obtained was analysed using descriptive statistics, and is presented below.

4. Observations

A detailed analysis of the HHs survey revealed high dependence of the residents on R.O. devices. 78% of the surveyed population (n=50) was found to have a functional R.O. device installed in their house. In total, four type of water purifies were found in the study, while 8% of the HHs did not have any water purifying device installed in their house. 56% of the HHs were found to have a R.O. device installed, while 22% of the HHs were found to have a R.O. + U.V. device installed in their houses (Fig. 2). 10% of the HHs were found to own only a U.V. based water purifying device. 4% of the HHs surveyed were found to own a non-electronic water purifiers (Fig. 2). In the 8% HHs who did not have any water purifying device, almost all the HHs agreed to boiling water before drinking. However, these HHs also reported that on some days water was directly consumed from the tap by them without treating it in any way.

The supply water flowing out of the drinking water tap was collected and tested for TDS value in each of the 10 HHs in each of the selected five residential areas. The data so obtained was plotted as box-plots (Helsel and Hirsch, 1992) in the same graph so as to compare the TDS values in municipal water supply across the five residential areas.

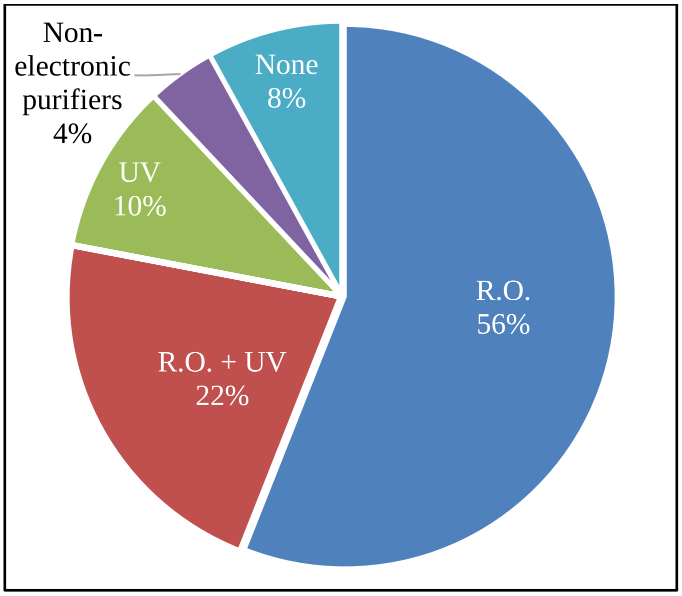

Figure 2. Percentage dependence on water purifying devices in the surveyed population (n=50).

The box-plots made using the TDS values obtained from 10 HHs in each of the selected five residential areas were also compared against the desirable and permissible value of TDS in drinking water (500.0 mg/l and 2,000 mg/l respectively), as prescribed by the Bureau of Indian Standards (BIS, 2012). The box-plot based descriptive statistics analysis shows that the median TDS value in all the sample population (n=50) is well within the prescribed desirable standard value of 500.0 mg/l (Fig. 3). Two of the five selected residential areas (WPC and LBN) do not note TDS above 500 mg/l at all, while the VKC residential area seems to have maximum HH receiving supply water with TDS values above the prescribed standard of 500.0 mg/l. On the other hand, the LBN residential area, which is located in the New Delhi district of Delhi, is found to be receiving water with lowest TDS values.

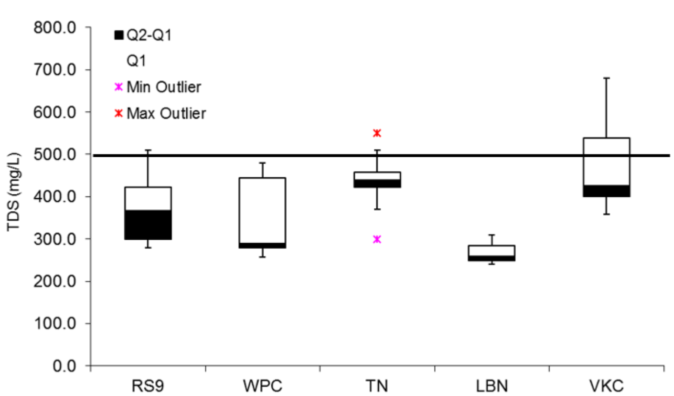

Figure 3. Box-plot analysis of TDS data collected from the five residential areas (RS9, WPC, TN, LBN, VKC).

The maximum value of TDS in the drinking water supply noted for the residential area RS9 is 510.0 mg/l, for WPC is 480.0 mg/l, for TN is 550.0 mg/l, for LBN is 310.0 mg/l and for VKC is 680.0 mg/l. It was therefore found that all the HHs surveyed receive water which is either well within the desirable level of TDS or between desirable and permissible level of TDS as prescribed by the BIS (2012).

The TDS data collected from municipal water supply, R.O. outflow and R.O. Reject (water discarded by the R.O. device as part of its inherent functioning) was further analyzed to find out the range difference between these values. Due to space constraints, data analysis from only one residential area site (RS9, Rohini Sector 9) is being presented and discussed. A similar scenario was observed in all the other residential areas. The RS9 residential area site has only 6 HHs who were found to be using a R.O. device. The TDS value of the intake water, outflow water and reject water were plotted on the same graph for all the six HHs at RS9 site to draw comparison among these three (Fig. 4). High correlation coefficient (r=0.991461) between TDS values in intake water and reject water indicates that higher is the TDS value in the municipal supply water, greater is the wastage of water from the R.O. device. This is an interesting observation which implies that wastage of water from R.O. devices located in individual households can be controlled by the municipal water supplying agency to some extent by providing water with lower TDS levels.

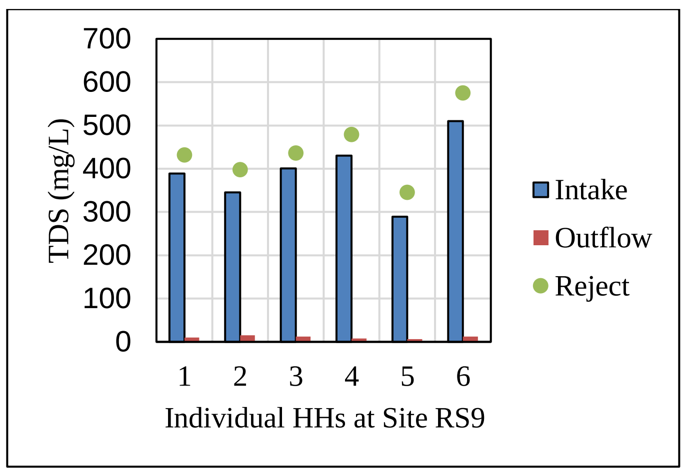

Figure 4. TDS value in intake water, outflow water and reject water from R.O. devices located in the 6 Households of the RS9 residential area.

The TDS value in outflow water, which is consumed by the residents, ranges from 6.0 mg/l to 15.0 mg/l in the six sites surveyed at RS9 residential area site. This means that

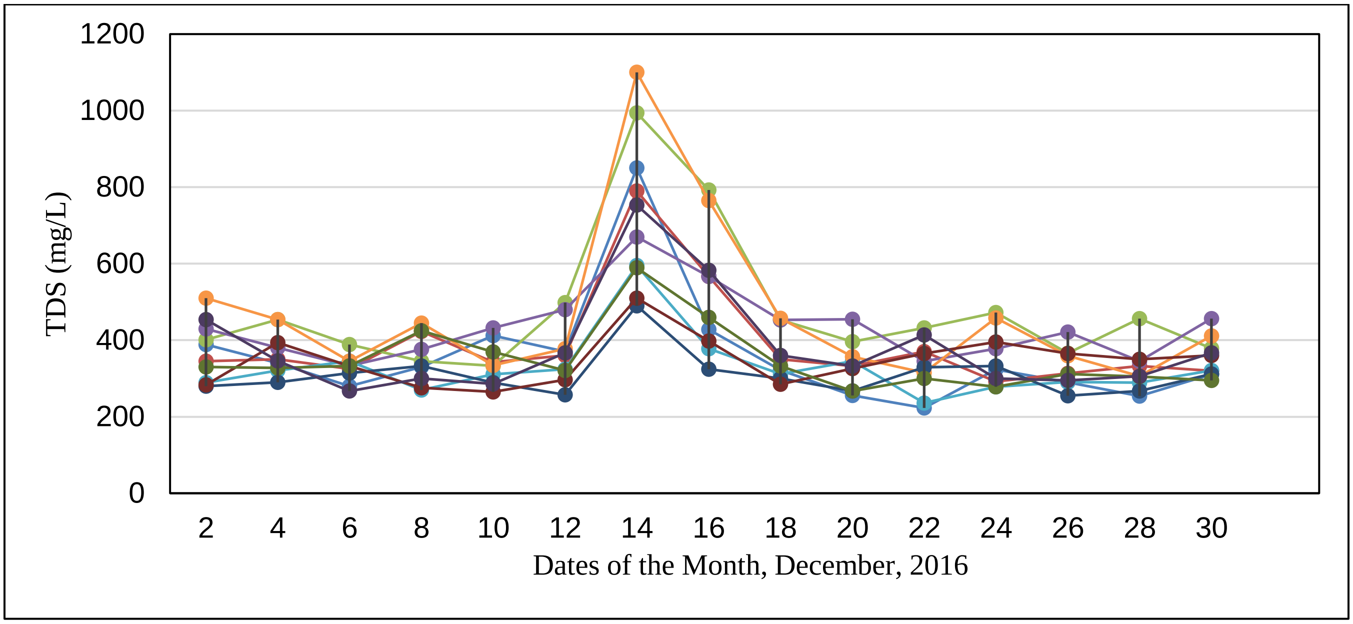

Figure 5. Monthly variation of TDS in municipal water supply recorded in the supply water from two Households from each of the five residential areas sampling sites at an interval of two days. Each line represents TDS value from one household and each point represents the date of the month.

the residents who use R.O. devices are consuming water with very less dissolved solids. This needs further investigation especially in the direction of finding out the impacts (if any) of consuming water with very low TDS for long durations, over months and years.

The data analysis until now seems to indicate that residents either do not require the installation of an R.O. device or very few of them need to install one as a necessary requirement. However, further analysis of the data collected in this research work has a different story to tell. Figure 5 brings forward an interesting insight into the municipal water supply system in Delhi. It represents the TDS value in the municipal water supply in different Households over a period of an entire month. The period of month investigated in the present study is December, 2016. The data shows that while the TDS in the water supply over a good part of the month remains less than 500.0 mg/l, there are one or two days observed in all the residential areas when the TDS value exceeds the 500.0 mg/l considerable (Fig. 5). On some days, the TDS values reach to the double that of the desirable value, giving a distinct taste to the water. Further analysis of water samples is required to establish the constituents of this water with high levels of TDS. However, at this stage it can be said with absolute surety that in terms of water quality, the municipal water supply system lacks consistency. It is perhaps this reason why the R.O. devices in Delhi continue to gain popularity in Delhi.

The survey carried out as part of this research work revealed that 88% of the people consuming R.O. water no longer find the taste of non-R.O. water acceptable. 98% of the people surveyed have not consumed water from a public facility in the last one year. At the same time, 30% of the people surveyed preferred to reach home to have water, if for example, they got thirsty in a market place and 62% choose to buy bottled water in such a scenario. None of the respondents would drink water from a public facility in case they feel thirsty while in a marketplace. Only 6% of the respondents remember seeing a public drinking water facility in the last one year.

5 Discussion

The United Nations considers water a basic human right (UN Water, 2009). This has motivated Governments across the world to provide water to its citizens at a subsidized cost. Delhi took a leap ahead and has made access to basic water supply free for all its citizens. Most water users in the city of Delhi are paying no money for receiving water up to a certain volume. However, water pricing has always been a challenging and complex problem (Rogers et al., 2002). Therefore, although water has been declared a free resource in the NCT of Delhi, large scale use of R.O. etc. devices indicates that Households in Delhi are actually paying a heavy price for obtaining clean, drinking water. While initial investigation of the municipal supply water in the NCT of Delhi does not seem to warrant the need of R.O. devices, a more detailed investigation highlights the need of these devices in the households of NCT of Delhi. Due to this, the sale and use of R.O. devices will only continue to rise. This has two direct implications, one that large volumes of municipal supply water will be further “purified” in R.O. devices at the household level and will be wasted as reject water. Second, the residents of Delhi will continue to consume water with very low TDS value. It is therefore no exaggeration to say that improvement in existing Water Treatment Plants, and provision of better quality water to the citizens can help optimize Delhi’s water demand and also reduce the waste water load of River Yamuna. At the same time, there is a need to initiate further research on studying the impact of continuous consumption of water with very low (5-15 mg/l) TDS on human health.

The health risks from drinking demineralized (or water with very low TDS) are now fully known in the present day (Kozisek, 2005). While some scientists believe our body can obtain some minerals from water only, others are of the opinion that lack of any minerals in drinking water can be accommodated through having a balanced diet (Pelican News, 2016). A consensus needs to be built on this before a policy decision in this direction can be taken. At the same time, there is a need to carry out detailed investigation of the reasons behind high TDS values in the municipal water supply in Delhi on some days. Water samples need to be regularly analyzed to ensure that high TDS values are not because of a toxic substance that has somehow entered the water supply system. The apathy shown by the residents of Delhi towards public water distribution outside their households is equally concerning. The Government of NCT of Delhi needs to take urgent measures for restoring the faith of the people of Delhi in the municipal water supply. This is also needed to be done since in the absence of such faith, the residents of Delhi are fully capable of exploring private acquisition of water using bore wells, etc. Indeed, greater dependency of residents on ground water is not healthy due to polluted ground water in various parts of Delhi (Singh, 2012).

Since the R.O. devices will only gain more popularity in coming years, the Government and citizens need to take innovative steps in ensuring that the R.O. reject water is reused perhaps for cleaning or other non-drinking purposes. The study clearly shows that the TDS value of reject water from R.O. devices is also mostly within the desirable value (500.0 mg/l) of TDS. While the reasons (chemical species) of high TDS are not known (since the original source of water is municipal supply, the reject water should not have any toxic substances under ideal conditions), this water may not be used for drinking but is safe for any other use. Citizens should therefore take proactive measures, and Government should focus on formulating a policy at the residential area level such that the reject water from R.O. devices is reused/ recycled and is not directly sent to the sewer.

6. Conclusion

Drinking water supply in the NCT of Delhi is managed by the Delhi Jal Board under the Government of NCT of Delhi. Although the water supply in Delhi seems to be state controlled, there is considerable micro-scale privatization of water in the city. A principal reason behind this is the lack of consistent supply of drinking water from the DJB. The fluctuating TDS of municipal water supplied to the residents of Delhi needs immediate Government attention. Citizens must be provided clean drinking water consistently, lest it will promote further penetration of R.O. devices which come with their inherent shortcomings. Large-scale use of R.O. devices not only increase Delhi’s water footprint but also its electricity demand. This Water-Energy Nexus needs further investigation.

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