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Impact of behavioural change among citizens after conversion of intermittent water supply to continuous drinking water supply in Chandigarh- A case study

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Abstract

For any change in facility provided to the public brings behavioural change among the masses. This brings considerable impact when habits of using water gets changed of people living in a city having population over one million. The proposed continuous water supply scheme is likely to have moderate environmental and social impact risk during construction and at operational stage. Most of the nuclear families living in cities have set schedule according to the water supply coming to their house. In Indian culture, most of kitchen related works are being done by the ladies of the house. Even in urban slums, the ladies have to struggle to fetch water from the common stand posts installed in slums. So for the execution of such continuous water supply project, there is a need of simplified environmental and social impact assessment. The specific environmental and social issues considered are topography, climate, loss of productive soil, water resources, social-environmental, air, noise, soil quality, ecology, socio-economic and gender issues and other sensitive socio-environmental sites. Before conceiving any project which can change life of common people should be well consulted with public. The public consultations provide a platform for people's participation in the process through information dissemination, discussions about people's concerns and issues, developing ownership and participatory decision-making. Public participation and community consultations are integral part of environmental and social assessment.

Keywords – Continuous water supply, Intermittent water supply, Behavioural change, Non-revenue water, water charges, Survey data

1. INTRODUCTION:-

1.1 Area, population and history of water source for Chandigarh

Area: 114 Sq. Km

Population: 1.16 Million (Figure for 2021 as per data received from government offices provided to U.N. World Urbanization prospects)

In the early 50's the population of the city was sparse and the yield of tube wells was sufficient to meet the water supply demand of the city. The water supply of the town was based on tube wells only. No surface water source was available in the city before 1983. Over the passage of time, the population of the city has increased considerably. The administration then decided to tap surface water from Bhakra main line flowing at a distance of 27.5 Km from Chandigarh to meet the immediate needs of the city. Since the level of Bhakra main line at off-take point Kajauli is 177' lower than the ground level of water works, Sec.39, Chandigarh. The project has been based on pumping of water against gravity. Chandigarh's sectoral grid has a well-designed system of piped water supply and sewage disposal. Under the city's Water Byelaws, every planned dwelling unit has to have water arid sewerage connections.

Table 1: Environmental features of the project area

Sr No.	Project Particulars	Details
1	Geographical location	Lat. 30.74° N; Long. 76.79° E
2	Elevation	Average 321 amsl
3	Lakes	Sukhna lake, Dhanas lake, City lake (Sec-42)

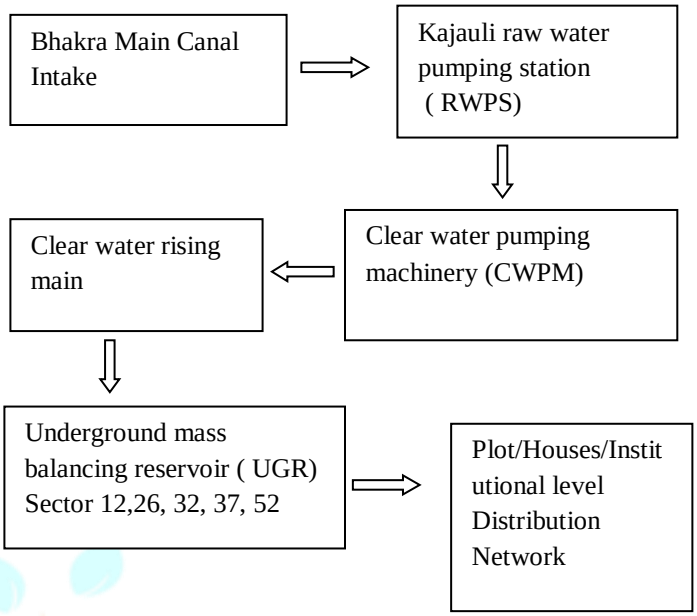

Fig1: Flow process of current water supply

At present, 115 MGD water is reaching at waterworks, Sector 39 for further distribution to the city and to the beneficiary States/Organizations. The storage capacity at all the water works is being augmented by the ground water from deep bore tube wells installed all over the city. Some of the tubewells are also connected to the distribution system as per requirement in the localized areas. At present the water supply in the city is intermittent.

2. Need to assess the behavioural change

For more than 50 years, the citizens of Chandigarh have habituated their ways of living with intermediate water supply. Changing the course of water supply from intermediate to continuous water supply will be a sudden change to the residents as well as to the water supply departments of Chandigarh. Behavioural assessment for this allows us to look how an individual would adapt to the changes in his daily lifestyle. Since there will be more availability of water now, there is also a need to monitor the behavioural change with respect to using water economically, rather than futile water consumption. Citizens are required to understand the importance of making a sustainable change. For this the target sample was selected where the behavioural change would impact greatest in the city. By studying and understanding the targeted sample, the behavioural change can be studied in the most effective way.

2.1 Sample size equation:-

Determining the right sample size for your survey is one of the most common question researchers ask when they begin a market research study. Luckily, sample size determination isn't as hard to calculate.

Necessary Sample Size = $(Z\text{-score})^2$ * StdDev*(1-StdDev) / $(\text{margin of error})^2$

By choosing a 90% confidence level the Z-score would be of 1.64. If the standard deviation is taken as 0.6 and margin of error (confidence interval) as +/- 4%., we get –

Sample size equation = $[(1.64)^2 \times .6(.6)] / (.04)^2$
Sample size equation = $(2.68 \times 0.0.36) / .0016$
Sample size equation = $0.9648 / 0.0016$
Sample size equation = 603

603 respondents becomes our sample size. [Ref. Bartlett et al 2001]

3. Objectives

1. To assess the behavioural change of residents with continuous water supply.
2. To study on the effective ways to make the behavior change outcome in a positive way to conserve water.
3. To study the behavioural changes during retention periods in continuous water supply.

4. Methodology and impact

4.1 Present variation of water usage compared to CPHEEO norms

Average water consumption in the Chandigarh City is observed to be 245 LPCD which is much above the average consumption of 135 LPCD as per CPHEEO norms. A large gap is observed in water consumption between northern and southern sectors. A graph showing the average consumption of sector wise data has been shown ahead where the average consumption as per data obtained from water work department grievance cell is shown by the blue color line and the red line indicates the average consumption as per CPHEEO i.e. 135 LPCD.

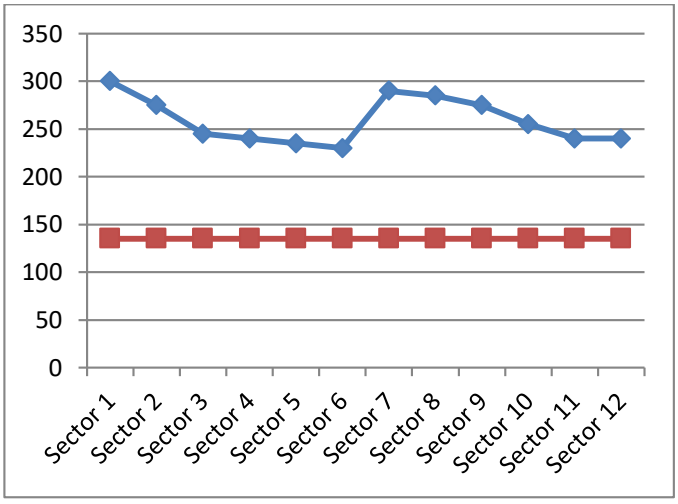

Fig2: Variation in water consumption from sector 1 to sector 12

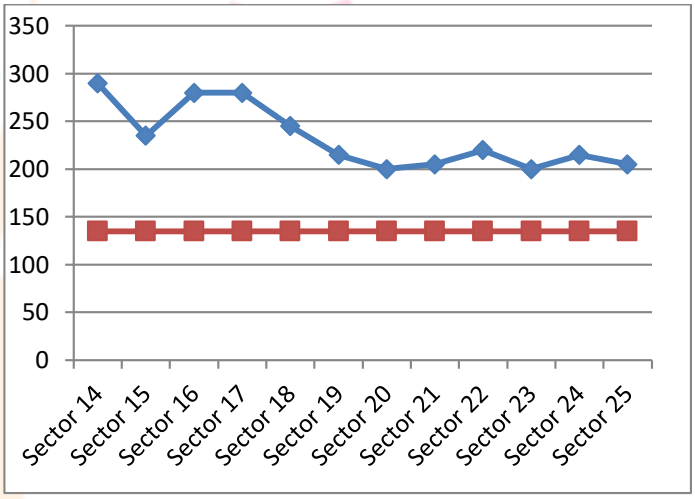

Fig 3: Variation in water consumption from sector 14 to sector 25

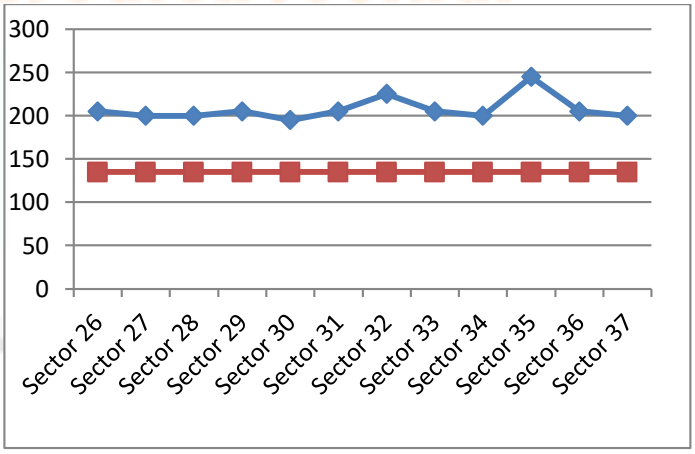

Fig 4: Variation in water consumption from sector 26 to sector 37

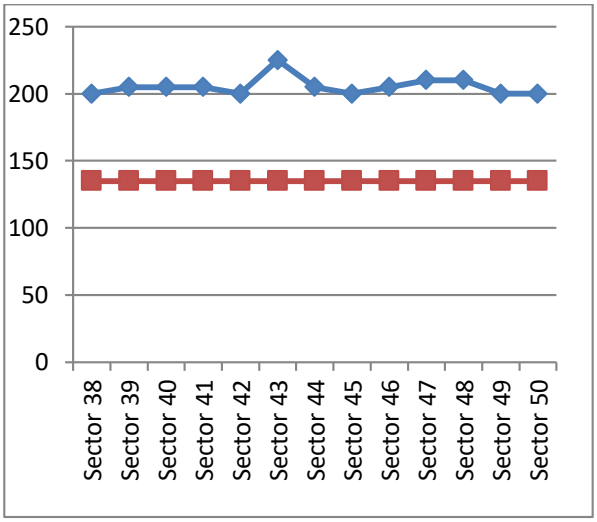

Fig 5: Variation in water consumption from sector 38 to sector 50

Rating between 0 to 100%, how much do you think getting continuous water supply at your home and offices will affect your daily schedule and routines.

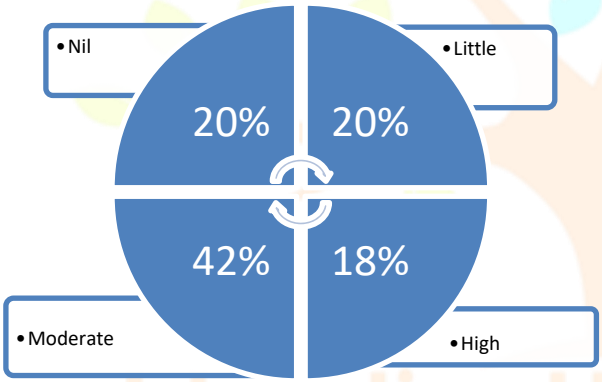

Fig. 6: Probability of change in daily schedules after introducing continuous water supply

The data indicates that a large proportion has awareness that continuous water supply would affect their daily habits in many ways. However, still 40% of the citizens from the targeted area believe that changing from intermittent to continuous water supply would hardly bring any change to their routines.

4.2 Opinion on continuous water supply

As per the survey data it reflects that people of the city area are in favour of the project and they want implementation of the continuous water supply project as soon as possible. 2204 households out of 2371 proposed the opinion in favour of continuous water supply amounting to 92.86%. Below is the data collected from the survey.

Table 2: Opinion on continuous water supply

Sr. No.	In favour of proposed 24*7 water supply facility	No. of households	Percentage
1	Yes	2204	92.96
2	No	149	6.28
3	No response	18	0.76
	Total	2371	100

4.3 Willingness to pay more

In the village areas, respondent were not willing to pay extra charges for the 24*7 water supply benefits. However, in the slum area, people are willing to pay if they are shifted to the rehabilitation colonies and they get individual household connections as per the tariff presently being paid by the rehabilitation colonies. The same has been shown in the table below.

Table 3: Willingness to pay more

S No.	Willingness to pay more	Number	Percentage
1	Yes	29	9.67
2	No	271	90.33
3	No response	-	-
	Total	300	100

4.4 Water storage spaces

As per the present data, 95.49% (2264 out of 2371) households have storage spaces in tanks or drums for domestic purposes. A survey was carried out among 600 houses that after getting continuous water supply in their home, would they be willing to keep the use of storage tanks still.

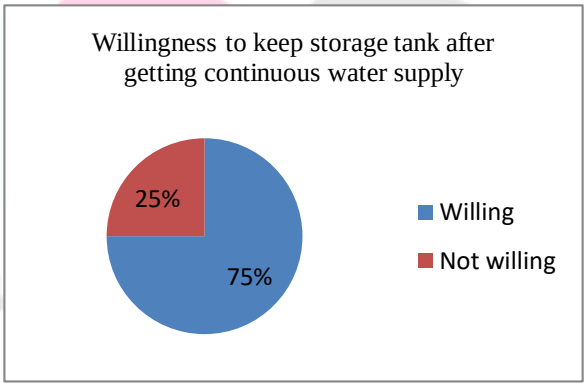

Fig 7: Willingness to keep storage tank after getting continuous water supply

The data states that the dependency on stored water supply is an old habit which most of the residents would not prefer to let go, even if the water supply is provided for 24*7 hours.

5. Creating behavioural change for economical water consumption

5.1 Interactive monitoring of water consumption

The use of monitoring a sample as a means to bring positive and environment friendly behaviour change specially for conserving water has been investigated in the past as well. Survey researches demonstrate that nearly 30% of the target sample was unaware on how to save water, suggesting that users should be provided with more practical knowledge for this. [Ref. Froehlich at al, 2012]

The effect on different behavioural phases and their needs accordingly are discussed below.

Table 4.Model for multi-stage behavioural change process for water saving

Behavioural phase	Plan of action
1st phase survey :- i) People unaware of the need for behavioural change. ii) Intention to conserve water very less. iii) Intention to change behavior is very less.	i) Make a plan to acknowledge problematic water consumption behavior. Moving from old repetitive habits to new active conscious habits through proper awareness and teaching tips. ii) Negative environmental consequences of consuming too much water need to be visualized to make the consequences less (e.g. Corral-Verdugo et al., 2003).
2nd phase survey after spreading awareness on water saving :- i) Most of the people are getting aware of the need for change. ii) Most of the people intend to act accordingly for best behavioural results. The consideration/identification of appropriate actions and their benefits can result in postponing the old behaviour.	i) In this phase, factual knowledge about water consumption and water behaviour contributed to more positive attitudes towards saving water. ii) Goal framing theory (Lindenberg & Steg, 2007) suggests that it is important that comfort and enjoyment should not be impacted by introducing new water saving actions. As per Lindenberg & Steg's goal theory, personal gains can be achieved in exchange for only a slight reduction of comfort (e.g. reducing shower time by one minute). Most of the people showed readiness for this change.
Actions observed: Targeted sample has started taking small steps towards better behavioural changes but need to be prevented from slipping back.	Provide positive reinforcements with social, virtual or physical rewards and it is expected to keep users engaged with water saving at this stage.

[Ref. J. Novak et al, 2016]

5.2 Survey data used for the targeted area

A survey was conducted on the following survey questions and a rating between 0 to 10 points was given the by the targeted sample. The graph below depicts the data obtained from the survey where the responses received between 0 to 5 is shown by the blue color and the red color indicate the response between 6 to 10 points.

1. How easy was for you to use water consumption chart. (0 -10 points)
2. How much useful was the water consumption chart for you. (0 -10 points)
3. How much knowledge do you think you have regarding the quantity of water used daily in your household. (0 -10 points)
4. How much useful was the knowledge of having the household consumption data for you. (0 -10 points)
5. How easy was for you to take notice of water saving tips. (0 -10 points)
6. To what extent were you able to put water saving tips into practice. (0 -10 points)
7. How much do you think the water saving tips made you aware now regarding water consumption than before. (0 -10 points)

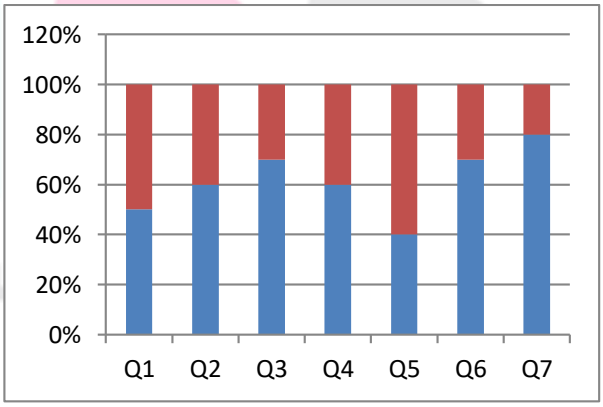

Fig 8: Graphical representation from data obtained after surveying

Rating from 0 to 10, (10 being the highest i.e. most responsible) how much responsible do you consider yourself towards water wastage in your house or at office.

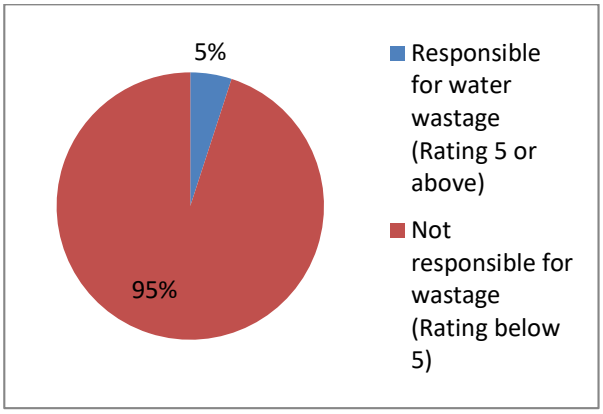

Fig 9: Awareness on self water wastage done by an individual

Rating from 0 to 10, (10 being the highest i.e. most active) how much do you think you have been active towards water conservation in your house or at your office.

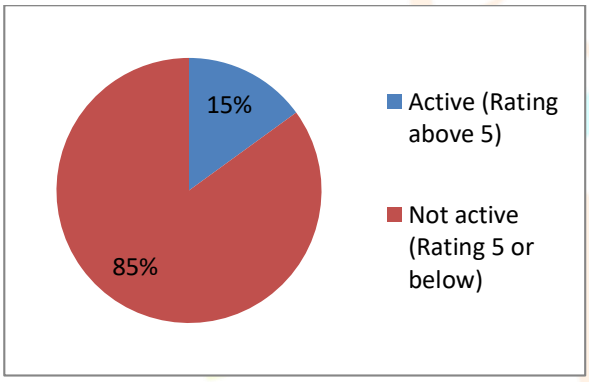

Fig 10: Activeness towards water conservation

6. Revision of Tariff System

6.1 Indian psychology on having water free of cost

The time has already come when water has become an economic good worldwide. Bottled waters are becoming costlier than ever and ground water level is deteriorating at an alarming rate. Yet most of the population in India lives under a false notion that water being their necessary right does not cost any money and should be distributed for free. The cost involved in maintenance and distribution for drinking water is huge, but most of the population is unaware regarding it and hence feel that there is nothing wrong in demanding water for free. It is proved beyond doubt that free supply of any good to consumers will result in inefficiency. If intermittent water supply is converted to continuous water supply, the project costs, such as operation, maintenance, management etc. will be high. For this reason it may be possible that water charges are increased when continuous water connection is started, but this shall be done solely for the sake of meeting the project costs involved in it earlier.

6.2 The need to increase current tariff rates

With the increase in daily water availability to the consumers, there is also a risk of consumers being slack in using water and therefore again leading to water wastage from their end. Keeping the cost revenues involved in the process and the risk of water wastage, it is best to maintain a practice such that water is utilized in the most efficient manner possible. One such means to achieve this target is by raising the current water cost per unit paid by the consumer. This will lead to awareness for reducing water losses done by the consumer and, more importantly, add to the amount of revenue to be met for implementing the hydraulic model. [Ref. Kojima *et al*, 2005]

Below is a graph observation based on a rough estimation if the tariff is increased by 10% for domestic and industrial water.

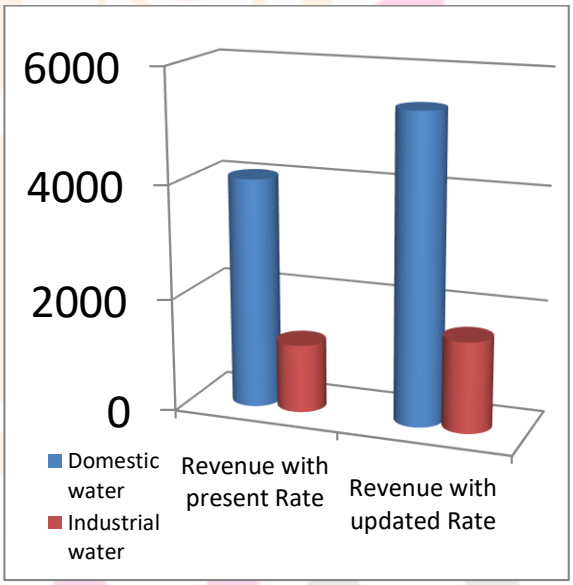

Fig 11: Revenue comparison with updated tariff rates

7. Literature Review

A brief description of relevant literature collected for assessing the Impact of behavioural change among citizens after conversion of intermittent water supply to continuous drinking water supply.

Table 5: Literature Review

Author(s)	Title of the paper	Description and findings
Isaac B. Addo, Martin C. Thomas, Melissa Parsons	Household water use and conservation behaviour:	This paper states that household water-use behavior is associated with three conditions: capability, opportunity, and motivation. As

	A Meta-analysis (2018)	hypothesized by the BCW framework, the study stated that households may adopt water conserving behaviors when they have a higher perception of being capable, when having all the necessary opportunities at their disposal, and when motivated to conserve water.
J. Novak M. Melenhorst, Micheel, Pasini, Fraternal , A. Rizzoli	Behaviour change and incentive modelling for water saving: first results from the SmartH2O project (2016)	This paper with the help of small pilot experiments suggest regarding the suitability of the designed incentive model for water saving in future continuous water supply schemes. The experiments are done in systematic alignment with the changes in adopted behavioural process observed during the study.
Hongxing Li, Alasdair Cohen, Zheng Li, Shibo Lv, Zuan He, Li Wang, Xinyl Zhang	Intermittent Water Supply Management, Household Adaptation, and Drinking Water Quality: A Comparative Study in Two Chinese Provinces (2020)	This paper describes the water demand and behavioural change associated with it in various cities of China. The paper clearly stated that it was inevitable that utilities in some areas in rural China should opt to use intermittent water supply. The study further describes the changes observed in behavioural patterns of households.

8. Conclusion:-

In a city where residents have adapted to intermittent water supply for more than 50 years, a sudden change of continuous water supply can bring behavioural and psychological changes with respect to water usage. The stats taken from the survey done with various groups in Chandigarh show that people are ready to adapt to the changes that 24*7 water supply would provide. However it is also observed that for different areas the impact of the behaviour change is different. One reason for this is due to the already existing large variation in water usage between northern and southern sectors. Graphical representation for the variation in water usage has been shown in the case study. From the surveys conducted, the case study concludes that there could be a large behavioural pattern change when converted to continuous water supply, but there has been methods and readiness shown to adapt slowly to the new changes.

Acknowledgement

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