International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Water Sensitive Appliances: A Solution to Water Crisis in Dhaka, Bangladesh

S. I. Sharif[1], R. Mamtaz[2], F. Khan[3]

[1]Graduate, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

[2]Professor, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

[3]Undergraduate, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

Abstract: ***Water crisis is a severe problem in Dhaka city, the capital of Bangladesh. The current population of 1.7 crore of the city is already deprived of clean water along with other basic facilities. In context of this problem, this study has tried to investigate whether use of water sensitive fixtures in households can minimize water crisis by reducing losses or not. A cost benefit analysis has also been conducted to assess the financial viability of introducing these fixtures in the city. Various water saving equipments such as low flush toilets, low flow showerheads, low flow basin faucets, water efficient dish washer, front loading washing machine etc. were considered while analyzing the efficiency of water savings. A thorough literature review was conducted to find out water requirement of the proposed and traditional fixtures. Cost of these water sensitive fixtures and also conventional ones were collected from field survey. Around 45% less annual water consumption was found in a typical 5 storied building for the water sensitive fixtures in comparison to traditional ones. The proposed system was also found financially viable as its cost minimization capacity was significantly higher than the conventional system. The results of the study indicate that current water crisis in Dhaka can be reduced noticeably by introducing water sensitive fixtures in households.***

Keywords: Water crisis, Water consumption, Water Saving Appliances and Cost-benefit analysis

1. Introduction

The potential challenges faced by Bangladesh are due to aggressive urbanization, climate change, environmental degradation, drainage system and search for cost effective reliable infrastructure delivery and operation. The capital, Dhaka is undergoing rapid urbanization process. Due to the unplanned, unsymmetrical urban sprawl, the city dwellers are deprived of basic human rights among which water supply crisis has appeared as one of the most censorious problems. Water supply in Dhaka city is mostly dependent on ground water extraction. However, an extensive pumping causes a great depletion of ground water storage which questions the sustainability of this city in the context of water supply and sanitation. 82% of the city's water supply is abstracted from groundwater through 577 deep tube wells, while four relatively small surface water treatment plants provide the remaining 18% [1]. The groundwater level of this locality are dropping at the rate of two to three metres every year. The observation says that the city's water table has sunk by 50 metres in the past four decades and the closest underground water is now over 60 meters below the ground level.[2],[3] But ignoring this issue, DWASA has announced in 2012 that it will develop a new well field with 46 wells providing 150,000 cubic meters of water per day at a cost of USD 63 million. [4]

Water sensitive fixtures can play an important role to solve this problem. If these fixtures are used, then water consumption can be reduced which leads to less water extraction from ground, slower depletion of ground water level, greater capability to ensure water supply to mass people, which eventually results into solving water crisis in Dhaka city.

2. Methodology

The prime objective of this research is to decrease ground water extraction in an urban area. So this study aims at the application of different water saving modern appliances to minimize water losses and to increase ground water recharge. This research has been undertaken in Purbachal New Town project. It is assumed that this project will be one of the well-planned residential areas of the Dhaka city. This project is currently under construction and is supervised by the well-known organization named RAJUK. This 6150-acre project is divided into 30 irregular sectors and is located in between the Shitalakhya and the Balu River at Rupgonj Thana of Narayanganj District and at Kaligonj-Thana of Gazipur District, in the northeastern side of Dhaka and at a distance of 16 km from the zero point of Dhaka.(Fig: 01)

2.1 Study Area Selection

A study has been carried out for the feasibility of implementing water saving appliances in a typical household. For the study, Sector 10 of Purbachal New Town has been selected which contains four types of plots. Such as: 3 Katha (1 Katha=720 ft^2), 5 Katha, 7.5 Katha and 10 Katha plot. Here 5 Katha plot has been chosen because most of the plots of sector 10 are 5 Katha. (Fig: 2)

2.2 Application of Water Saving Modern Appliances

The present study has been undertaken with a view to conserve and save water in day to day use. To reach this goal, there are specific objectives as follows:

- Outline the economic and environmental benefit of water conservation.

- Explore the various water efficient fixtures which are available worldwide and in Dhaka's Local market.
- Carryout economic analysis for the integrated system to check if these approaches are sustainable in future.

3. Analysis and Result

3.1 Considerations

- Average family size: 4.3 persons/family [5].
- Plot size 5 Katha (3600 ft^2).
- Free space is 1080ft^2 (30% of total area) [6].
- Drawing of a typical 5 storied residential building on proposed area. (Fig: 3).
- Water bill: 10 BDT per thousand liters [7]
- Increment of water bill is neglected.
- Labor cost of installation of different fixtures is not added to the calculation.
- Dhaka WASA has undertaken three mega projects to collect 70% water from surface sources by 2020 [8].
- Average shower time per person is taken as 5.3 minutes.
- The data has been quoted in the AWWA Residential Water Supply (1999) and also verified here by directly measuring the shower time of 30 random people among the responds [9].
- Daily faucet use was taken as 4 minutes per person per day [9].
- Daily average flushing was taken as 5.1 flushes per person per day [9].

3.2 Estimation

As Purbachal New Town Project is under construction, we have to use the water consumption data of nearby locations. These data has been collected from the survey work done by ITN-BUET. (TABLE: 1). Fig: 4 and Fig: 5 are drawn based on the information provided by TABLE: 1.

From the Fig. 4, it is estimated that water consumption is 379 LPCD for an area of 2520 ft^2. From the Figure 5, it is estimated that water consumption is 415 LPCD for a family size of 4.3 persons/family. From the charts shown in Fig: 2 and Fig: 3 it can be assumed that the average water consumption is about 397 LPCD (Average of 379 LPCD and 415 LPCD).

3.3 Data Collection of Available Appliances

Data had been collected from market surveys and websites of the companies. A lot of shops were visited and efforts had been given to ensure the latest price of the products and the clients' comments about the products. Table 2 and Table 3 represent the data of conventional and water saving appliances used in a typical 5 storied residential building.

3.4 Calculation

Total saving by the use of water saving appliances is 115LPCD and it is almost 45% of the total water requirement using conventional appliances.

To mitigate total water requirement including gardening and car wash etc. additional water requirement is equal to (397 LPCD-260 LPCD) =137 LPCD.

If this water is served by water saving fixtures, then the total amount of water saving will be equal to (115 LPCD + 0.45*137 LPCD) = 177 LPCD Total amount of water saving of the five-story building is nearly 138907.5 liters/year (water saving per capita per day* population per *no. of floor*365).So, annual saving is = (138907.5 liters/year *10 BDT/1000 liters) =13890.075 BDT= 13890 BDT (approximate).

Water saving from surface water source= (0.70% of supply water collected from surface source) *1308907.5 liters= 972305 liters.

Water saving from ground water source=0.3(% of supply water collected from ground source) *1302685 liters= 4142672 liters.

From Table: 4 and Table: 5 it is found that the installation cost of water saving appliances is higher than that of conventional appliances. But it shows an ultimate saving (When saving of water tariff of 20 years is included) about 7.4% compared to conventional appliances.

3.5 Figures

Figure 1: Location Map of Purbachal New Town Project

Figure 2: GIS Map of of Sector 10, Purbachal New Town Project

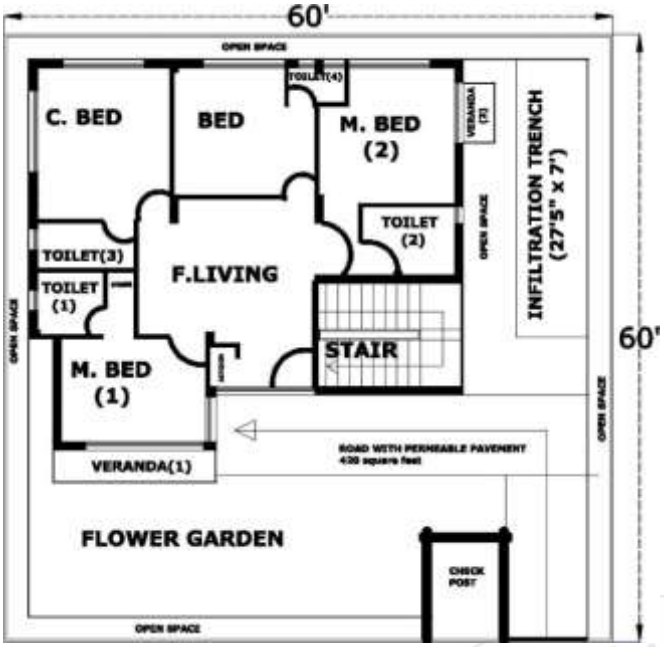

Figure 3: Plan View of a Typical Five-Story Building on 5 Katha Plot

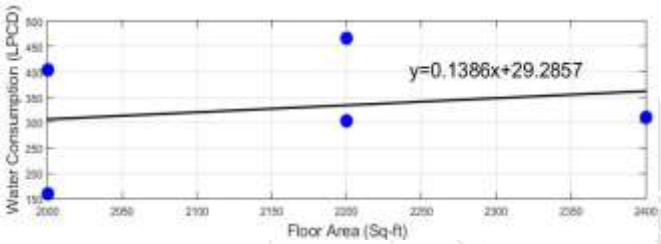

Figure 4: Water Consumption Vs Floor Area

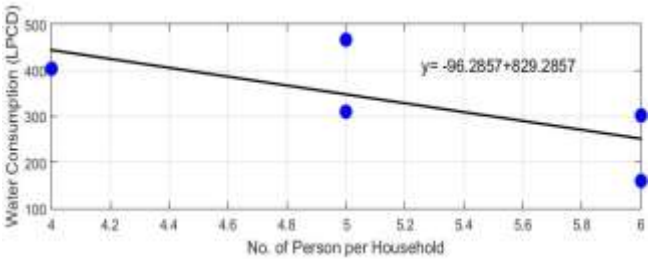

Figure 5: Water Consumption Vs Person Per Household

3.3 Tables

Table 1: Area –wise household water consumption [9]

Location of house	*Floor Area (ft^2)*	*No. of persons per Household*	*Water Consumption (LPCD)*
Dhanmondi	2000	4	403
DOHS	2000	6	159
Mirpur	2400	5	311
Tejgaon	2200	5	467
Banasree	2200	6	303

Table 2: Estimation of water requirement of a five storied residential building using conventional appliances

Fixture Name	No. of Fixture per Floor	Frequency of Use per Person	Water Need-ed	Annually Water Needed (Liters) ***	Water Consumption (LPCD) ****
Flush Toilet	4	5.1 flush/ day	4 gpf	803306	260
Shower-Head	4	5.3 mins/ day	3 gpm	6266106	
Basin Faucet	8	4 mins/day	3 gpm	472533	
Dish Washer	1	0.1 loads /day	11 gpl	43316	
Washing Machine	1	0.37 loads/day	51 gpl	743058	

Table 3: Estimation of water requirement of a five storied residential building using water saving appliances

Fixture Name	No. of Fixture per Floor	Frequency of Use per Person	Water Needed	Annually Water Needed (Litres)***	Water Consumption (LPCD)****
Low Flush Toilet	4	5.1 flush/day	1.6 gpf	321322	145
Low Flow Shower head	4	5.3 mins/day	2.5 gpm	521755	
Low Flow Basin Faucet	8	4 mins/day	1.5 gpm	236266	
Water efficient Dish washer	1	0.1 loads/day	7 gpl	27564	
Front Loading Washing Machine	1	0.37 loads/day	27 gpl	393384	

*gpf=gallon per flush, gpm=gallon per minute & gpl=gallon per load
*1 US gallon=3.785411784 litres
*** Annually water needed= No. of story*water needed*frequency*total population.
**** Water consumption=Total water needed annually/ (no. of story*population per floor*365)

Table 4: Price Analysis of different conventional appliances in Dhaka, Bangladesh

Fixture Name	No of fixture per floor	Service Time (years)	Cost/unit (BDT) Sep, 2015	Annual Cost (BDT)	Total Cost for 20 Years (BDT)
Flush Toilet	4	3	3700	493333	12,61,767
Shower-head	4	5	735	58800	
Basin Faucets	8	3	845	225333	
Dish Washer	1	5	1125	22500	
Washing machine	1	5	23090	461800	

Table 5: Price Analysis of different water saving appliances in Dhaka, Bangladesh

Fixture Name	No of fixture per floor	Service Time (years)	Cost/unit (BDT) Sep, 2015	Annual Cost (BDT)	Total Cost for 20 Years (BDT)
Flush Toilet	4	3	5645	752667	14,46,124
Shower-head	4	5	1045	83600	
Basin Faucets	8	3	1135	129714	
Dish Washer	1	7	1410	20143	
Washing machine	1	10	46000	460000	
Additional cost for water saving appliances is =(14,46,124-					

12,61,767)BDT=1,84,337 BDT and Water Tariff Saving=20*13890=2,77,800 BDT

4. Conclusion

As demand of water in Dhaka City is increasing rapidly, the authority must look forward to identifying the solution of the depletion of water table using modern technologies. This study has highlighted a new approach for ground water saving in an economic way for a residential area. Results of our study may help the policy concern authority to take necessary steps in the context of sustainable development of the capital city.

The main findings obtained from the present study are as follows:

- From the study on a 5 Katha plot, it is found that total water saving is 138907.5 Liters/year, ground water saving is about 4142672 Liters/year by applying water saving appliances and additional cost for installing these water saving appliances is about taka. As there are 894 five Katha plots in sector 10 of Purbachal New Town Project, nearly 3,79,29,48,768 Liters of ground water can be saved in each year by using water saving appliances.

- It has been observed from the cost analysis conducted over 20-year period that the use of traditional appliances cost BDT 12, 61,767 whereas the use of proposed appliances cost BDT 14, 46,124 along with the saving of water tariff of BDT 277800 for 20 years indicating 7.4% savings on that issue.

References

[1] Azharul Haq, Khondaker (June 2006). "Water Management in Dhaka". Water Resources Development 22 (2): 291–311. doi:10.1080/07900620600677810., p. 296
[2] Wadud, Mushfique (15 August 2011). "Dhaka turns to rainwater harvesting to ease water crisis". Alertnet. Retrieved 24 August 2011.
[3] Institute for Water Modelling, 2009
[4] OOSKAnews, 19 October 2012, reporting about a decision by Bangladesh's Executive Committee of National Economic Council (ECNEC) on 16 October 2012.
[5] [Population & Housing Census 2011,Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh].
[6] 'Dhaka Mohanagar Imarat Nirman Bidhimala, 2008' (DMINB)
[7] http://dwasa.org.bd/wp-content/uploads/2016/12/notice-for-water-bill.jpg
[8] http://www.thedailystar.net/city/dhaka-wasa-collect-70pc-water-surfacesources-2020-4724 last viewed2 Sep, 2015
[9] Study of water through water use of water Efficient Appliances in Dhaka City, ITN-BUET)

Author Profile

Shariful Islam Sharif received his BSc in Civil Engineering degree from Banglagesh University of Science and Technology (www.buet.ac.bd) which is considered not only the best university of Bangladesh but also one of the best educational institutions of South Asia. After completing his degree at 20 September 2015, he joined to Bashundhara Group (www.bashundharagroup.com) as a Civil Engineer and served there from 19 October 2015 to 13 July 2017. He is currently living in 1903, Anderson Road, H-7, MS: 38655, USA. His contact number is 0016623800943.