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AN INVESTIGATION INTO GREY WATER QUALITY AND REUSE

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ABSTRACT

Chittagong is one of the most densely populated cities in the world. Due to rapid population growth and unplanned urbanization, the scarcity of water is one of the major concerns. The reuse of greywater is an attractive solution to minimize the deficit between demand and supply of water in Chittagong city. Everyday a significant amount of greywater is produced from different sources. Greywater from different sources and different locations of Chittagong city were characterized. A lab scale treatment system was run to treat greywater from Sources. The main goal of this paper is to propose some efficient, cheap and sustainable greywater treatment systems for households use. The treated greywater can be used for non-potable use purposes such as irrigation, toilet flushing, car washing and dust control as well as to Fire hydrating.

Determination of water use for each household on both working day and holiday and estimation of grey water generated by subtracting the amount of black water from the total amount of water useis performed. This study has shown that the amount of greywater generated (82.5 % of total use) is greater than that of blackwater (17.5 %) in both cases. Per capita water consumption is 200-300 lpcd on average.Our another objective has been charecterization of the greywater.For this purpose we have tested Seven categories (Shower, Cloth washing, Drinking Water, Basin, Ablution and Floor Finish) for five water quality parameters-pH, BOD,COD, TDS and TSS. pH varies from 4.7 to 8.4; BOD varies from 0 to258 mg/l ; COD varies from 0.9 to 347(mg/l); TDS varies from 43 to 1073 mg/l; TSS varies from 15.2 to 423 mg/l in our tested samples.After the study of our test results and comparison with available standards for water reuse we have found that Drinking water and Ablution almost lie in the maximum permitted range of some Parameter so they can be used for agricultural sector without any treatment. And the rest of the sample need further treatment for toilet flushing or domestic water recycling or even for agricultural use. So from our study some scopes of further works in this study regarding the present work can be data collection from different points of the city,more survey for knowing the actual level of public acceptanceetc.

Keywords: *Grey Water, Water Quality Parameter, Analysis of Grey Water, Recycling, Reuse*

1. INTRODUCTION

Surface water and ground water are the limited resource of the potable water of which surface water is often found polluted. Groundwater plays a very significant role in the supply of water for human activities. Chittagong, the bussiness capital of Bangladesh, has experienced large scale abstraction of groundwater to meet up the water supply needs with its rapid growing population. Ground water depletion has become alarming for last few years. In 2002 the water level in the city center (Agrabad area) was about 50 meters below mean sea level. Wasa personnel also reported that the city's groundwater level is dropping by about 2/3 meter per year on an average. No further extraction from the upper aquifer is viable. With mounting pressure on water resources, the idea of favorable use of treated wastewater has rapidly become vital for water agencies in countries like Bangladesh. Water reclamation, recycling and reuse are now recognized as key components of water and wastewater management. As long as the problem is about the scarcity of water and no new sources can be developed without the traditional underground water, surface water and some other sources of potable water, the only choice remain is to reuse the household water. Residential wastewater is divided into two categories: greywater and black water. Blackwater is the drainage from toilets and urinals; containing high concentrations of bacteria and organic contaminants in addition to disease causing microorganisms and ingested chemicals. Greywater is the washwater from bathtubs, showers, sinks, washing machines, and dishwashers which contains little or no pathogens and 90 percent less nitrogen than black water. International plumbing code (IPC) defines grey water in its titled "grey water recycling systems" as "waste discharged from lavatories, bathtubs, showers, clothes washers, and laundry sinks." (varghese 2007). With respect to detected levels of organisms used to signal pathogenicity, including faecal coliforms, enterococci, and bacteriophages, greywater has been found to

be only mildly less (Jefferson et al. 2004, casanova et al. 2001), and in one study even more (Brandes 1978), contaminated than full wastewater.Reviews of various characterization studies that include microbial parameters (Eriksson et al. 2002, Lazarova et al. 2003) show that kitchen sink and dishwater effluent are often the most highly contaminated due to the presence of food and grease particles and warn of high salmonella counts in these streams. Other sources, such as shower, hand basin, and washing machine are the principal contributors of organisms of fecal origin, attributable to the washing of soiled clothing or diapers, hand washing after toilet use and showering(Rose, Sun, Gerba and Sinclair (1991) found that the total coliform count of used shower water was higher than that of laundry wash and rinse water, averaging respectively 10,199 and 56 cfu/100ml. Ottosson (2003) outlines the full spectrum of hazardous microbial agents potentially present in household greywater and provides an outline for assessing the health risks they represent. Storage of greywater prior to reuse is discouraged because it can affect the pathogen load of both raw and treated greywater. Dixon et al. (2000) tested a model for predicting quality changes in stored greywater, based on observed processes of settlement of suspended solids, aerobic microbial growth, anaerobic release of soluble COD from settled organic matter, and atmospheric re-aeration. Potential impacts of these most common forms of greywater reuse have been outlined by Christova-Boal et al. (1996).

Greywater can be reused vastly in toilet flushing, irrigation, commercial car washes or industrial cooling water.The introduction of grey water recycling will surely give a lasting momentum to economy and society alike. This study has been an attempt to introduce grey water recycling in Bangladesh. It will apparently change the current water crisis scenario of densely populated Chittagong city.

One of the natural resources available in nature is water; however, it is not readily available for domestic use for millions of people across the globe. An increasing global population coupled with growing urbanization worldwide has led to increased demands on water supply. The rapid growth of water-intensive agriculture in developing countries and inefficient water management practices in the developed world are contributing to a global reduction in future freshwater supplies. The world is currently in the midst of cross roads where the unsustainable and impractical uses of water are no longer acceptable. The recycling and reuse of water is therefore imperative in some areas and increasingly such in the others to meet the demands for urban, industrial and agricultural water requirements. Greywater which can be defined as all in-building wastewater streams with an exception of toilet wastewater is a potential water source for urban reuse, as it contains a few or no pathogens and 90 percent less nitrogen than black water. This study reveals the generation and quality of greywater in Chittagong city. The groundwater level is depleting by 2/3 of a meter per year in Chittagong.Thus, the recycling and reuse of water have become imperative to meet the demand for it to analyze the generation of greywater in Chittagong city, water use in five households has been studied and about 67% of water was found to be reusable, whereas about 17% of potable water was wasted in toilet flushing. From the quality analysis, kitchen water was found to be polluted to some degree, and judging by its quality, it should not be reused. Greywater must be treated before any kind of reuse as it exceeds the standards of the acceptable quality of potable water and irrigation water.

2. METHODOLOGY

2.1 Study of working areas

In order to estimate the water consumption of households, 5 houses in 5 areas- air port, patenga, bandar, agrabad and bahaddar hat were selected. The quantification of water use was done for both working days and holidays. To accumulate data of water use for cloth washing, dish washing, floor washing, hand washing, bathing, ablution, drinking water. A specific bucket was used for holding the water and grey water was collected from those areas for qualitative analysis. Tests were performed on water obtained from cloth washing, dish washing, floor washing, and hand washing and bathing. Samples were tested for 5 quality parameters in environmental engineering laboratory of southern university Bangladesh.

2.1.1 Study areas location

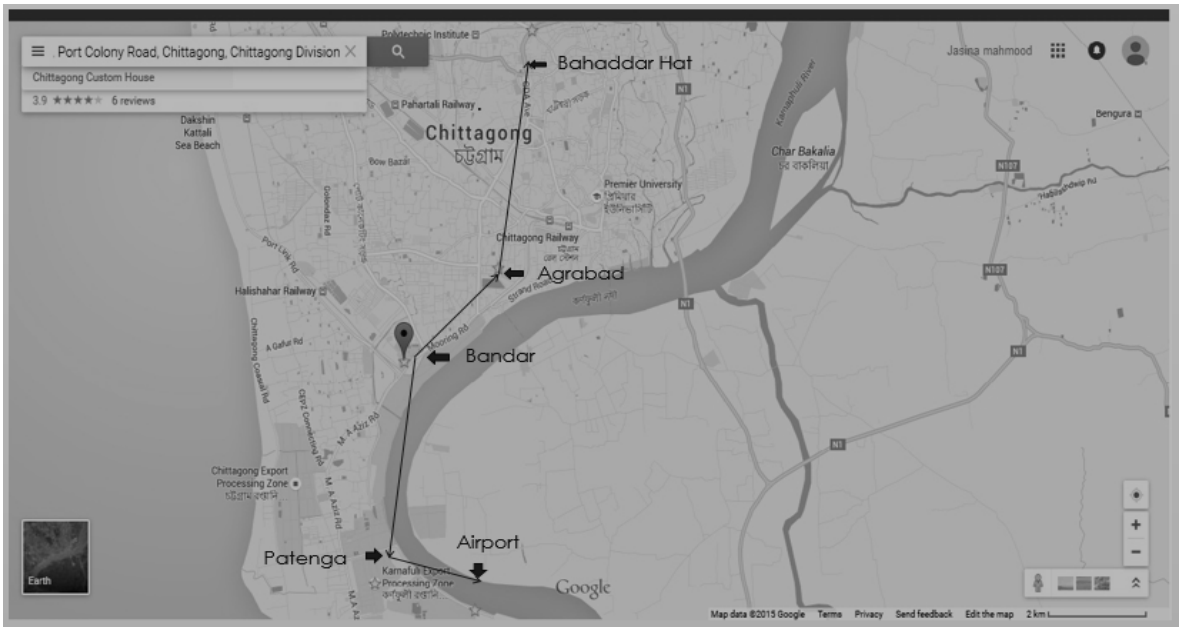

Figure 1: Study Location

3. ILLUSTRATIONS

3.1 Figures and Graphs

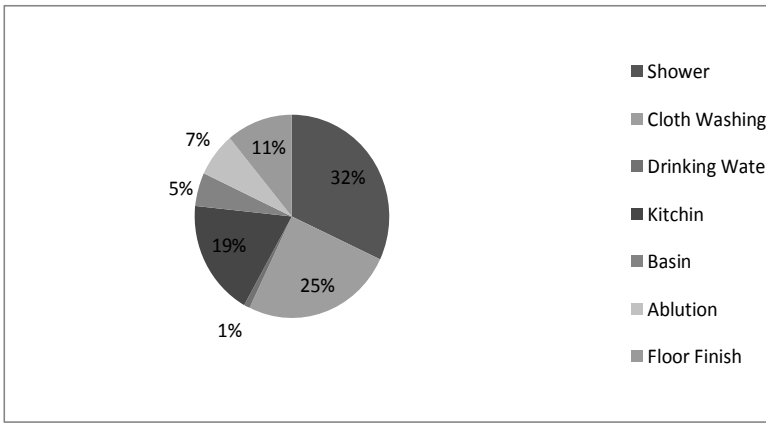

Figure 2: Avg of Holidays & Weekdays Water consumption.

The average water consumption for the middle class families is 200-300 lpcd.The maximum water consumption is 25% for the purpose of cloth washing.The small amount of water is used for Basin.

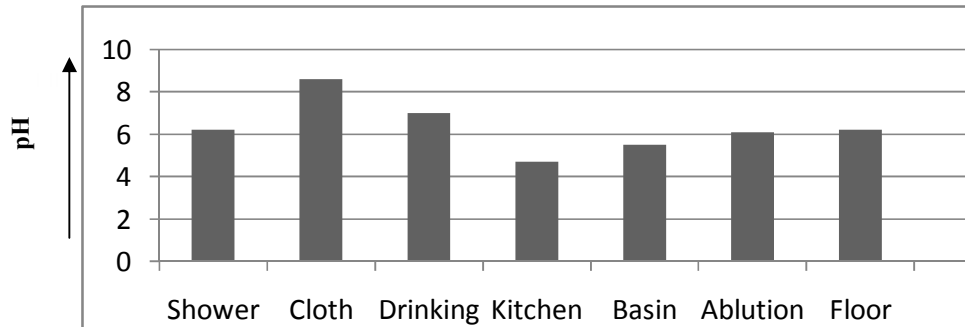

Figure 3: The variation of pH for different category grey water

(The standard characteristics of Grey water for pH is 6.5 to 8.5mg/l.The maximum value is 8.6 for cloth washing but all other values are below the range.)

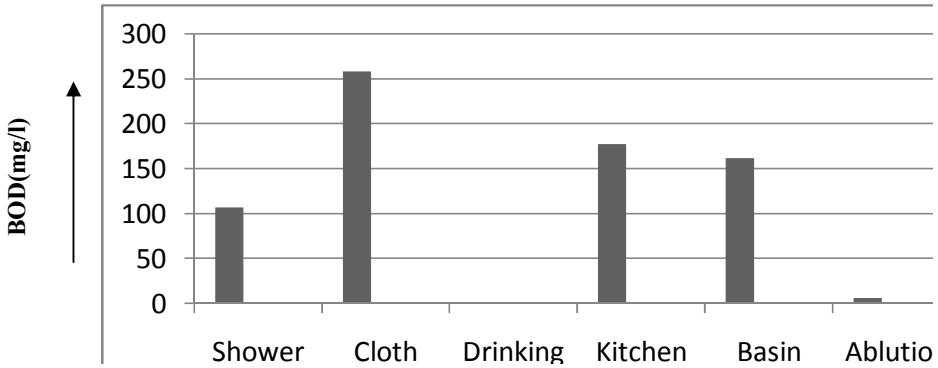

Figure 4: The variation of BOD for different category grey water

(The standard characteristics of Grey water for BOD is .2mg/l.The BOD value is highest for cloth washing and it is very low for ablution.)

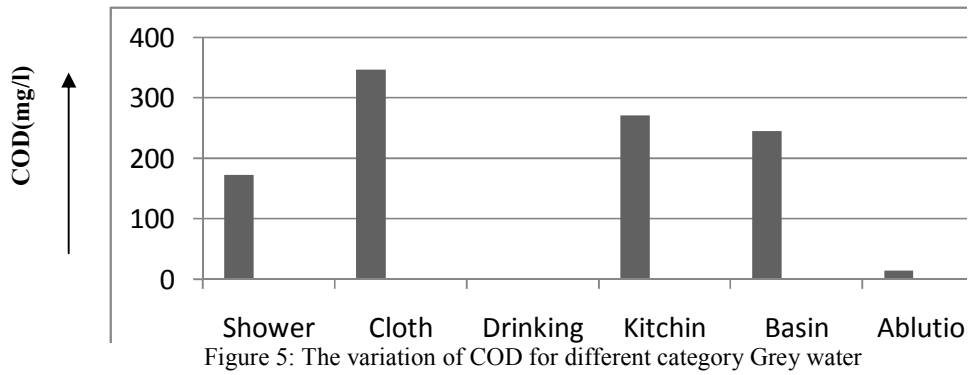

Figure 5: The variation of COD for different category Grey water

(The standard characteristics of Grey water for COD are 10mg/l.The COD for all purposes exceeds the acceptable limit.)

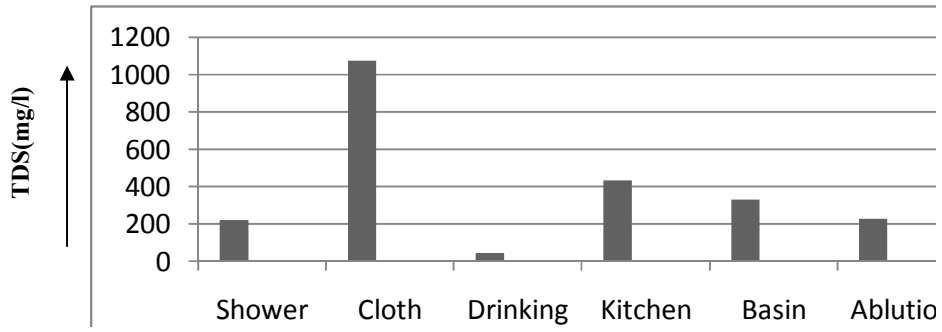

Figure 6: The variation of TDS for different category Grey water

(The standard characteristics of Grey water for TDS are 250mg/l.The TDs for cloth washing purpose is very high which is 1050 mg/L.)

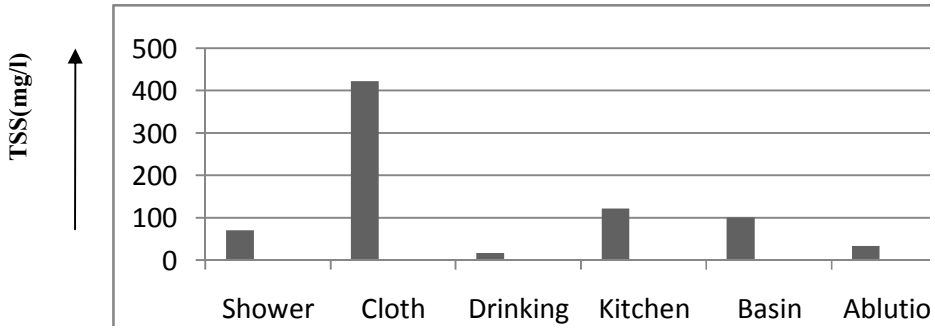

Figure 7: The variation of TSS for different category Grey water

(The standard characteristics of Grey water for TSS are 10 to 40mg/l.The TDS value is above 400 mg/L for cloth washing purpose and all other values except ablution are neaer to standard value.)

3.2 Tables

Table 1: avg. Water consumption(%) in different purposes

Average water consumption	Shower	Cloth washing	Drinking water	Kitchen	Basin	Ablution	Floor Finish
Holidays	31.73	24.45	1	20.1	5.34	7.37	10.55
Weekdays	32.33	26.2	0.92	17.02	5.25	6.73	11.56
Average	32.03	25.33	0.96	18.56	5.3	7.05	11.06

Table 2: pH variation of Grey water for different purposes in different location

Sample No	1	2	3	4	5	Avg
Shower	6.1	6.4	7.6	5.3	5.4	6.2
Cloth Washing	8.8	8.5	7.7	8.4	8.8	8.6
Drinking Water	6.5	7.3	7.5	6.9	6.3	7
Kitchin	4.8	4.7	4.4	4.2	5.4	4.7
Basin	5.8	5.3	4.8	5.9	5.9	5.5
Ablution	6.1	6	6	6.1	5.7	6.1
Floor Finish	6.2	6.2	6.2	6.4	6.2	6.2

Table 3: BOD variation of Grey water for different purposes in different location

Sample No	1	2	3	4	5	Avg(mg/l)
Shower	66	78	155	160	175	107
Cloth Washing	390	326	180	195	198	258
Drinking Water	0	0	0	0	0	0
Kitchen	138	145	190	201	209	177
Basin	234	221	105	120	128	162
Ablution	6	6.1	5	6.7	7.2	6.2
Floor Finish	66	110	145	170	189	100

Table 4: COD variation of Grey water for different purposes in different location

Sample No	1	2	3	4	5	Avg(mg/l)
Shower	176	135	175	185	194	173
Cloth Washing	452	390	290	298	302	347
Drinking Water	0.9	1.8	1	1.2	1.3	1.24
Kitchen	235	180	300	320	324	272
Basin	309	278	190	221	232	246
Ablution	14	12.3	15	16	16.9	15
Floor Finish	149	175	265	191	225	201

Table 5: TDS variation of Grey water for different purposes in different location

Sample No	1	2	3	4	5	Avg(mg/l)
Shower	124	154	1178	231	402	218
Cloth Washing	1015	1120	1567	1318	344	1073
Drinking Water	43	49	40	42	41	43
Kitchen	40	48	1814	154	101	432
Basin	58	73	1320	77	112	328
Ablution	10	12	1038	61	11	227
Floor Finish	65	91	1010	132	260	312

Table 6: TSS variation of Grey water for different purposes in different location

Sample No	1	2	3	4	5	Avg(mg/l)
Shower	5	9	240	25	70	70
Cloth Washing	303	430	560	320	500	423
Drinking Water	16	17	20	13	10	15.2
Kitchen	12	19	223	26	323	121
Basin	6	8	82	11	391	100
Ablution	18	23	72	29	29	33
Floor Finish	3	13	110	16	364	101

4. CONCLUSIONS

This study has mainly highlighted the generation and quality assessment of grey water.

• The average water consumption for the middle class families is 200-300 lpcd.

• The tested five parameters (i.e. pH, BOD, COD,TDS,TSS) of the generated grey water except some location exceed the standard permissible values.

•This study has shown that the amount of greywater generated (82.5 % of total use) is greater than that of blackwater (17.5 %) in both cases. Per capita water consumption is 200-300 lpcd on average.

.• We have tested seven types of categories (shower, cloth washing, drinking water, basin, ablution and floor finish) for five water quality parameters- pH, BOD, COD,TDS,TSS.

• pH varies from 4.7 to 8.4; BOD varies from 0 to258 mg/l ;COD varies from 0.9 to 347(mg/l);TDS varies from 43 to 1073 mg/l; TSS varies from 15.2 to 423 mg/l.

• Kitchen water was found the most polluted which indicates its non-reusability. About 67% of the generated greywater is reusable with further treatments.

•After the study of our test results and comparison with available standards for water reuse we have found that drinking water and ablution almost lie in the maximum permitted range so they can be used for agricultural sector without any treatment.

•Rest of the sample need further treatment for toilet flushing or domestic water recycling or even for agricultural use. So from our study some scopes of further works in this study regarding the present work can be data collection from different points of the city, more survey is required for knowing the actual level of public acceptance etc.

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