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Households Perceptionand Use of Grey Waterin Makurdi Town, Nigeriaand Relationship to Socio-Demographic Variables.

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Abstract: This paper examines household perception and use of grey water in Makurdi town and the relationship to socio-demographic characteristics. The study utilized mainly primary data sourced using a structured questionnaire administered mainly to household heads (both male and female) selected from ten neighbourhoods in Makurdi town. Systematic random sampling was employed for questionnaire administration, using a ratio of 1:5 households. The survey covered a total 200 households but only 180 questionnaires were retrieved from the field for analysis. The findings revealed that most residents (77.2%) have knowledge and the willingness to reuse grey water. There are however some people who don't use grey water simply because it is not appealing to them. Findings also show that most people don't perceive any health risk associated with using grey water. The Fisher's Exact (F_{exact})statistic was employed to test for association between some socio-demographic variables and the perception and use of grey water by residents. The relationship between level of education and residents perceived health risk from grey water use was significant (F_{exact}=14.368;df=8;sig-value=.056). The results however shows the relationship between socio-demographic variables (income, education and occupation) and the knowledge and willingness to use grey water was not significant. Similarly, the relationship between socio-demographic variables and awareness of grey water reuse options was not significant. The paper concludes that water scarcity other than socio-demographic variables is the main determinant of perception and willingness to use grey water in Makurdi town. The paper recommends that Government and NGOs should do more in creating awareness and promoting water conservation programmes geared towards sustainable water management.

Keywords: Perception, Reuse, Grey Water, Socio-Demographic Variables, Water Scarcity, Makurdi.

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I. INTRODUCTION

Water scarcity has become a global problem as the demand for portable water exceeds supply in many countries around the world. It is has beenforecasted that if by 2025, the present rate of water consumption continues, two-thirds of the world's population may be subjected to varying degrees of water scarcity, ranging from moderate to high incidence of water scarcity [1]. The growing pressure on water resources triggered mainly by population growth, increased urbanization, irrigation agriculture and climate change has presented water managers with a huge challenge of trying to strike a balance between the demand and supply for fresh water. Consequently, there is a growing need to look for alternative sources of water to complement the available but limited water resources. To this end, the use of grey water has been widely advocated.

Grey water is all wastewater produced from homes with exception of toilet wastewater, which is termed black water [2]. Grey water reuse regarded as a form of sustainable development has proved to increase the efficient use of water in the home and minimizes the reliance on municipal water, thereby conserving portable water [3]. Grey water constitutes approximately 50% of the total volume of wastewater discharged from homes[4].

Grey water reuse in many parts of the world, particularly in the developed regions, has gained significance in the last few decades. In Australia for instance, targets are set annually to increase grey water reuse [5]. It is projected that grey water volumes in Texas, will increase from just over half a billion gallons per day currently to more than 1.3 billion gallons per day in 2050 [6]. These estimates notwithstanding, it is reported that several waste water reuse schemes around the world have failed. This has been attributed to the poor perceptions or misconceptions people have towards proposed projects [7]. [8],lays the blame on decision makers for underestimating or ignoring the importance and/or impact of varied social and economic factors. Public perception is recognised as a key element in determining the success and acceptability of water reuse [9].While some people have recognised the rational of recycling and using grey water, others feel uncomfortable using it,

based on the perception that grey water is risky-health wise. In view of this, [7] proposed minimum requirements aimed at improving the perception of grey water reuse: education about the efficiency of grey water recycling; how human health is safeguarded; the benefits of grey water recycling for protection to the environment and for the sustainability of the resource.

In Nigeria, grey water use and management has not been consciously given priority. Consequently, grey water systems are not commonly found especially in homes. The bulk of domestic wastewater generated is discharged into receiving waters[10] or indiscriminately on streets and into gutters[11]. This is because people have limited awareness about the importance and underlying opportunities related to the reuse of grey water.

Studies on grey water reuse in Nigeria are few and are limited in scope ([2], [10],[12], [11]).Very little research, if any, has been conducted on public perception towards grey water use. The aim of this paper is to assess people's perception towards grey water collection and reuse in Makurdi town. The study will therefore seekto provide answers to the following questions: What is the level of awareness about grey water reuse in Makurdi? What is the perception of households towards grey water reuse? Is the perception of households towards grey water reuse influenced by their socio-demographic characteristics?

II. MATERIALS AND METHODS

2.1 Study Location

Makurdi town, the capital of Benue Sate in north central Nigeria, lies between Lat.$7^0$44N and Long. $8^0$54N (see fig. 1). Makurdi is drained by the River Benue which bisects the town into two parts-north and south banks. Other minor rivers that drain the town, and in turn empty their waters in the River Benue includes: Rivers Idye, Genebe, Urudu, Kpege and Kereke.

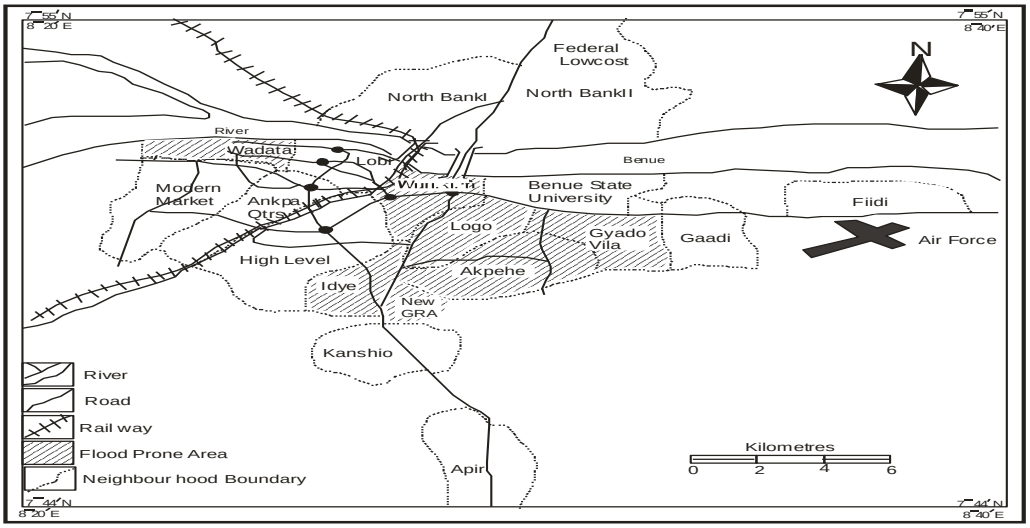

Fig. 1. Map showing Neighbourhoods in Makurdi Town. (Source: Ministry of Lands, Makurdi.)

Makurdi's climate is hot and humid, prompting high evaporation leading to high rainfall which occurs between the months of April and October. The average rainfall amount ranges between 1000mm-1300mm. The implication is that residentsof Makurdi should ordinarily have a lot of water at their disposal. Unfortunately, water from rainfall and the rivers is not harnessed for supply to households, hence there is perennial scarcity of water. Residents of Makurdi therefore need to recycle/reuse water in order to partially address their water scarcity problems.

2.2 Methodology

The study utilized mainly primary data sourced using a structured questionnaire which was administered to household heads (both male and female), selected from ten neighbourhoods in Makurdi town. Systematic random sampling was employed for questionnaire administration, using a ratio of 1:5 households. The survey covered a total of 200 households but only 180 questionnaire were retrieved from the field for analysis. The sample size was drawn based on related works carried out in the study area [13]. The questionnaire was designed to elicit information on socio- demographic characteristics of respondents, sources of water available to households, and estimated amount of water used for different purposes. Other information elicited include knowledge of grey water, awareness about grey water reuse options and the health concerns about grey water use. These parameters were used to gauge respondent's perception and use of grey water. The

Fisher's exact statistic was employed to analyse the relationshipbetween perception towards grey water use and household socio-demographic characteristics. Other results were presented using descriptive statistics.

III. RESULTS

3.1 Socio-Demographic Characteristics of Respondents

The results of findings on the vital statistics of the respondents (table 1) reveals that 62.2% are males while 37.8% are female; 25.0% are single while 75.0% are married. For age distribution, 23.9% are below the 30 years, 40.0% are between the ages of 31-40, 27.8% are between the ages of 41-50, 7.8% are between the ages of 51-60, while 0.6% age over 60 years. Results also show that 3.3% have no formal education, 3.9% have primary education, 34.4% have secondary education, while 58.3% have tertiary education. The results further reveal that 36.7% are civil servants, 15.6% are farmers, 9.4% are artisans, 20.0% are traders, 18.3% are either unemployed/retired.

These statistics have implications for respondent's perception and use of grey water. The high percentage of respondents with secondary (34.4%) and tertiary education (58.3%) for instance should have knowledge about grey waterand its potential to be used to reduce their water scarcity problems. Their perception towardsgrey water use should be positive.

The income distribution also show that most respondents earn relatively low (65.6% earn N50000 or less monthly). The inability of the Nigerian Government to provide basic amenities to its citizens has made people to provide water for themselves. Unfortunately, with this low income most of the residents of Makurdi town may not be able to provide water for their families. It is expected that this group of people will consciously embrace the use grey water especially for non-portable options. This will reduce pressure on the limited water available to them.

Table 1. Socio-Demographic Characteristics of Respondents

Gender	**F**	%	**Marital Status**	**F**	%
Male	112	62.2	Single	45	25.0
Female	68	37.8	Married	135	75.0
Total	180	100%	Total	180	100%
Age	**F**	**%**	**Education**	**F**	**%**
<30	43	23.9	Non-formal	6	3.3
31-40	72	40	Primary	7	3.9
41-50	50	27.8	Secondary	62	34.4
51-60	14	7.8	Tertiary	105	58.3
60+	1	0.6			
Total	180	100%	Total	180	100%
Income(N)	**F**	**%**	**Occupation**	**F**	%
<20000	36	20	Civil servant	66	36.7
21000-50000	82	45.6	Farming	28	15.6
51-100000	39	21.7	Artisan	17	9.4
Above 100000	23	12.8	Trading	36	20.0
			Unemployed/Retired	33	18.3
Total	180	100%	Total	180	100%

Source: Author's fieldwork, 2018

3.2 Household Knowledge about Grey Water

The study sought to find out if residents knew what grey water is. As presented in table 2, 77.2% of the respondents affirmed that they know what grey water is. Conversely, 22.8% of the respondents didn't know what grey water was.

Table 2. Knowledge about grey water

Response	Frequency	Percentage (%)
Yes	139	77.2
No	41	22.8
Total	180	100

Source: Author' fieldwork,2018

3.3 Previous utilization of grey water

The study also sought to find out residents level of utilization of grey water. Their response depicted in table 4 shows that 65% of the respondents use grey water, while 35% said they have never used grey water. The

reason given by majority of the respondents in this category is that is they don't know the usefulness of grey water (42.2%). Another reason as shown in table 5 is that grey water is not just appealing to them (27.2%).

Table 3. Previous utilization of grey water

Response	Frequency	Percentage (%)
Yes	117	65
No	63	35
Total	180	100

Source: Author' fieldwork,2018

Table 4. Reason for non-utilization of grey water

Reason for non-utilization of grey water	Frequency	Percentage
Unhygienic	26	14.4
I have enough water	28	15.6
I don't know it's usefulness	76	42.2
Not just appealing to me	49	27.2
It's costly to treat	1	6
Total	180	100

Source: Author' fieldwork,2018

3.4 Awareness about grey water reuse applications

Table 3 (below) depicts respondents and by extension household awareness about grey water reuse options particularly for non-portable applications. The findings show that 75% affirmed they were aware that grey water can be reused for different purposes, while 25% were not aware.

Table 5. Awareness about grey water reuse applications

Response	Frequency	Percentage (%)
Yes	135	75
No	45	25
Total	180	100

Source: Author' fieldwork,2018

3.5 Expression of health concerns about grey water use

Table 6 reflects people's health concerns over the use of grey water. The findings show that 70% of the respondents perceive that using grey water even for non-portable applications like toilet flushing can impact negatively on their health. Conversely, 30% of the respondents do not think that using grey water will affect their health.

Table 6. Health concerns about grey water use

Response	Frequency	Percentage (%)
Yes	54	30
No	126	70
Total	180	100

Source: Author' fieldwork,2018

3.6 Relationship between Socio-Demographic characteristics of respondents and their perception towards grey water use.

Evidence of association between some socio-demographic variables (Level of income, Level of education and Occupation) and the perception of residents towards grey water use was explored by contingency tables and tested using the Fisher's Exact statistic at 1% level of significance. Table 7 below summarises the results. The result reveals no association (F_{exact}=4.282, df=4,P- value=0.390) between respondents level of income and their knowledgeabout grey water.The results also shows no significant association (F_{exact} = 2.355, df=3, P-value=.506) between respondents educational status and their knowledge of and willingness to reuse grey water. Similarly, the relationship (F_{exact} = 2.768; df =4, P-value =.604) between the type of occupation people engaged in and their knowledge about grey water is not significant. This implies that none of the socio-demographic characteristics employed for this study influences residents knowledge about grey water.

Similarly, the results also show that there is no significant relationship between residents level of education (F_{exact} =2.975;df=3,sig-value =.377), level of income (F_{exact} = 3.782; df=4, sig-value = .456) and type of occupation engaged in (F_{exact}= 2.583;df=4, sig-value=.654) and their awareness about grey water reuse options. This follows that none of these variables can significantly help to create awareness in residents about grey water and reuse options available to them.

Table 7. Relationship between socio-demographic characteristics of respondents and their perception of grey water use.

	Measures of Perception of Grey Water Use								
Variable	Knowledge of and willingness to use grey water			Awareness about grey water reuse applications			Health concerns about grey water use		
	Yes	No	Total	Yes	No	Total	Yes	No	Total
Education									
Non formal	4 (2.2%)	2 (1.1%)	6 (3.3%)	4 (2.2%)	2 (1.1%)	6 (3.3%)	4(2.2%)	3 (1.3%)	7
Primary	7 (3.8%)	0 (0%)	7 (3.8%)	7 (3.8%)	0 (0%)	7 (3.8%)	1 (0.5%)	5 (2.7%)	6
Secondary	48 (26.6%)	14 (7.7%)	62 (34.4%)	48 (26.6%)	14 (7.7%)	62 (34.4%)	15 (8.3%)	47 (26.1%)	62
Tertiary	80 (44.4%)	25 (13.8%)	105 (58.3%)	76 (42.2%)	29 (16.1%)	105 (58.3%)	20 (11.1%)	85 (47.2%)	105
Total	139 (77.2%)	41 (22.8%)	**180 (100%)**	135 (75%)	45 (25%)	**180 (100%)**	40 (22.2%)	140 (77.8%)	**180 (100%)**
Statistic	F_{exact}= 2.355; df= 3, P(.506)			Fexact = 2.975; df= 3, P(0.377)			Fexact= 14.368; df = 8, P(0.056)		
Income(N)									
<20000	28 (15.5%)	8 (4.5%)	36 (20%)	28 (15.5%)	8 (4.5%)	36 (20%)	22 (12.2%)	14 (7.7%)	36(20%)
21000 - 50000	65 (36.1%)	17 (9.4%)	82 (45.5%)	63 (35%)	19 (10.5%)	82 (45.5%)	29 (16.1%)	53 (29.4%)	82 (45.5%)
51000 - 100000	26 (14.4%)	13 (7.2%)	39 (21.6%)	25 (13.8%)	14 (7.7%)	39 (21.6%)	16 (8.8%)	23 (21.6%)	39 (21.6%)
>100 000	20 (11.1%)	3 (1.6%)	23 (12.7%)	19 (10.5%)	4 (2.2%)	23 (12.7%)	12 (6.6%)	11 (6.1%)	23 (12.7%)
Total	139 (77.2%)	41 (22.8%)	**180 (100%)**	135 (75%)	45 (25%)	**180 (100%)**	79 (43.8%)	101 (56.2%)	**180 (100%)**
Statistic	Fexact=4.282; df= 4, P(.390)			Fexact=3.782; df= 4, P(.456)			Fexact=12.298, df=8, P(.139)		
Occupation									

Civil servant	50 (27.7 %)	16 (8.8%)	66 (33.6%)	48 (26.6%)	18 (10%)	66 (36.6 %)	27 (15%)	39 (21.6%)	66 (36.6%)
Farming	23 (12.7 %)	5 (2.7%)	28(15.5%)	21 (11.6%)	7 (3.8%)	28 (15.5 %)	20 (11.1%)	8(4.4%)	28 (15.5%)
Artisan	11 (6.1 %)	6 (3.3%)	17 (9.4%)	11 (6.1%)	6 (3.3%)	17 (9.4%)	8 (4.4%)	9 (5 %)	17 (9.4 %)
Trading	30 (16.6 %)	6 (3.3%)	36 (20%)	30(16.6%)	6 (3.3%)	36 (20%)	15 (8.3%)	21 (11.6%)	36 (20 %)
Unemployed/Retired	25 (13.8 %)	8 (4.4%)	33 (18.3%)	25 (13.8%)	8(4.4%)	33 (18.3 %)	19 (10.5%)	14 (7.7 %)	33 (18.3%)
Total	139 (77.2 %)	41(22.8 %)	**180 (100%)**	135 (75%)	45(25%)	**180 (100 %)**	89 (49.4%)	91 (50.5%)	**180 (100 %)**
Statistic	Fexact=2.768; df= 4, P(.604)			Fexact=2.583; df= 4, P(.654)			Fexact=6.606; df=6, P(.377)		

Source: Author' fieldwork,2018

The relationship between residents' level of income, their occupation and their health concerns about grey water use is not significant (also see table 7). This implies that their level of income or occupation they are engaged in will not make them feel or even fear that grey water use will impact negatively on their health. The relationship between resident's level of education and their health concerns about grey water use was however found to be significant (F_{exact}=14.368; df=8, sig-value= 0.056). This means that the health concerns raised by the respondents about grey water use is significantly influenced by their level of education. From the respondents that didn't raise health concerns about grey water use, 47.2% of them have attained tertiary education, 26.1% have attained secondary education, 2.7% have attained primary education, while 1.3% have no formal education. This follows that the higher the level of education attained by a respondent, the lesser their fear/concerns (health-wise) about grey water use.

IV. DISCUSSION OF RESULTS

Water reclamation and reuse provides a unique and viable opportunity to augment traditional water supplies [14]. The knowledge about grey water is growing and its reuse is gaining acceptance in the developing world including most parts of Nigeria, particularly in Makurdi town as demonstrated by this study. Other studies undertaken separately by [2] and [11] in Lokoja and Maiduguri respectively also reveal that there is a growing use of grey water.Most people that use grey water are aware of the available applications, which is predominately for toilet flushing. In developed parts of the world there are advances made in the use of grey water. Grey water is treated and used to support irrigation agriculture consequently reducing pressure on fresh water resources ([15]; [16]).

Despite the growing use of grey water, quiet a large number of people in Makurdi town still don't use grey water. Among the reasons given for this position is a lack of knowledge about the usefulness of grey water. Others reason that they have enough water so do not need it. Due to the threat to water in Nigeria, Water Managers have continuously advocated water reuse as a way to averting the water crisis that looms in Nigeria.

The question of safety of grey water use and associated health risk have been hotly debated. In Makurdi, most residents surveyed perceived, contrary to expectations, that grey water use poses no health threat to them or the public (see table 6). This is because there are no known or documented cases of contamination or death of people associated with grey water use. A studyconducted in Barcelona, Spain also showed that grey water reuse was seen to be relatively safe, with 84% of respondents perceiving health threats to be low or very low [17]. This is also consistent with findings of [18]in their study conducted in Durban, South Africa. Elsewhere, some people believe that grey water reuse is not a safe practice due to the fact that grey water contains bacteria and other pathogens. For instance, findings from a study conducted by Cates [19]in California

show that people don't water their edible fruits or vegetables with grey water so as to avoid accidental contamination.

This study also examined the relationship between socio-demographic characteristics of respondents and their perception towards grey water reuse. Findings reveal a significant relationship between level of education and health concerns over grey water use. The relationship in the other cases was not significant, meaning socio-demographic characteristics of respondents in Makurdi town does not influence their perception: knowledge and willingness to reuse grey water; awareness about grey water reuse options, and expressed health concerns about grey water use. This is consistent with findings from a study conducted in Jordan by [20] where a conclusion was drawn that water scarcity is the main determinant of willingness to reuse grey water compared to socio-demographic variables such as income and education level.

V. CONCLUSION AND RECOMMENDATIONS

Findings from the study demonstrate that most residents have knowledge and the willingness to reuse grey water. They are also aware of the available grey water reuse options. They perception among such group of people is that grey water reuse has no associated health risks. However, there are some people who don't use grey water simply because it is not appealing to them. Others reason that they don't need grey water because they have enough water. Consequently, they discharge the water away carelessly. The study concludes that if managed properly, grey water could be a sustainable option for address water scarcity in Makurdi town.Based on the foregone, the study therefore makes the following recommendations:

1. Government should formulate policies for installation of grey water systems in homes, hotels and industries, so that water used can be easily recycled and used. This will mean that going forward, new building plans should be approved only when they have installed grey water recycling systems.
2. Government and NGOs should expend more energy and resources on awareness campaigns and water conservation programmes that will promote sustainable water management practices like grey water reuse. This will help reduce pressure on available but limited fresh water resources.

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