Environmental Problems of Sachet Water Waste Disposal in Nsukka Urban, Enugu State, Nigeria

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Abstract

The study examined the environmental problems of sachet water waste disposal in Nsukka urban. Copies of questionnaire were used to collect data from a sample size of 720 respondents. Mean score, Principal Component Analysis (PCA) and One-way Analysis of Variance (ANOVA) was used for data analysis. Results show that the environmental problems of sachet water waste disposal in the study area ranges from blockage of drainage systems (M=4), air pollution (M=2.8), to water pollution (M=3.8) .To avert the environmental threats posed by sachet water waste, the study recommends: 1) Government at the local government level should make adequate provision for waste disposal facilities 2) The government agencies concerned with making policies should introduce a policy that would mandate the makers of sachet water to 'buy-back pack' from users. This would serve as incentive to users not to dispose sachet waste indiscriminately rather to see the sachet wastes as valuable material that could be sold to make money 3) Government should also make policies that before any company is allowed to start sachet water production, she would have shown her reusing and recycling machines. The machines would be used to recycle the waste when bought from users.

Keywords: Sachet water, waste, environmental, disposal, Nsukka.

1. Introduction

Sachet water entails the packaging of drinking water in a non-biodegradable synthetic polyethylene (polythene). Sachet water, popularly called pure water in Nigeria has become an everyday intake for an average Nigerian. The evidence of this is seen in the amount of disposed sachets littering the streets and also the increased number of drainages blocked by 'blocks' of sachet water waste.

Sachet water was introduced to the Nigerian markets around 1990 but its regulation by the National Agency for Food and Drug Administration and Control (NAFDAC) started in 2001 (Akunyili, 2003). Sachet water gained much popularity in Nigeria because the product is convenient for use, affordable and economically viable. It brought 'potable' water to the doorsteps of many Nigerians. The venture has also given employment to Nigerians which enables them to put food on their table.

Notwithstanding the benefits accruing from sachet water production and consumption, the indiscriminate disposal of the waste in various undesired sites such as along the streets, gutters, motor parks, schools, markets, homes, and venues of social functions etc. poses a lot of threat on the environment. The sachets are made of non-biodegradable synthetic polyethylene (polythene) which does not decompose in the soil even after many years. The polythene even when subjected to burning produces major known and harmful green house gases (GHGs) like carbon monoxide, nitrous oxide and carbon dioxide.

Sachet water waste disposal is a vast problem that needs to be tackled because of the implications it has on biophysical environment such as soil, vegetation air and water. In Nsukka Urban, it is a common sight to see sachet water waste indiscriminately littered (see Figure 1). This suggests that Nsukka urban dwellers seem not to know the negative impact of indiscriminate disposal of sachet water waste on the environment.

Some studies have been carried out on polythene sachet water in Nsukka and environs; for instance, Okafor (1999) examined the water quality of sachet water found within Nsukka and its environs. He reported that the iron level of the sachet water was about 2.59mg/l, a level much higher than the WHO (2004) accepted limit of 0.03mg/l. However, he attributed this large disparity to long storage in the tank before packaging. Anyadike (2006) also examined the quality of commercial sachet water in Owerri metropolis which has their sources from boreholes. He reported that the water from the borehole is not been treated before packaging inside the sachets. Virtually most literature reviewed on the study area, concentrates on the water quality and the recycling techniques. There was no detailed study on the environmental problems of sachet water wastes disposal on the environment; this is a research loophole/gap this study sets to fill. To achieve this it becomes pertinent to address the following research questions – what is the method of sachet water waste disposal in the study area? What is the trend or spatial pattern of the indiscriminate disposal of sachet water wastes? What are the environmental impacts of the sachet water waste in the study area? Specifically, the study aims to examine the environmental problems associated with sachet water wastes disposal in the study area.

2. Methodology

The study was conducted in Nsukka urban. Nsukka is one of the major towns in Enugu State of Nigeria, situated towards the northern part of the state (Fig.2). The land surface of Nsukka lies between latitudes $06^0 18'$ North and $07^0 06'$ North and longitudes $06^0 52'$ East and $07^0 54'$ East. Nsukka has a humid (forest) mega thermal climate. But, there is a seasonal drought from November to March, when soil moisture storage is nil. Consequently, the climate is of the tropical wet-and-dry (savanna) type. Atmospheric temperature in Nsukka is high with mean daily minimum temperatures between 21.4^0C to 25.0^0C and mean daily maximum temperatures between 28.1^0C to 34.6^0C, while the mean daily range varies from about 6.6^0C to 12.2^0C. Nsukka urban is divided into Nru, Nkpunano, Ihe, Owerre, University of Nigeria, Nsukka and Government Reserved Area (GRA) wards.

Data were collected using questionnaires. Simple random sampling technique was used to select 120 respondents from each ward. This gave a total of 720 respondents i.e 120 x 6. Seven hundred and twenty copies of questionnaire were distributed for data collection. Out of these, only five hundred and thirty-five (535) copies were properly filled and returned and used for analysis. Eleven structured environmental problems in the checklist were used to analyze the respondents' level of awareness on the effects of the environmental problems of sachet water wastes disposal on the environment. The mean score of the responses was assessed on Likert five point response continuum scale: Strongly Agreed was rated 5, Agreed 4, Undecided 3, Disagreed 2 and Strongly Disagreed 1. Adding all the ratings together gave a total of 15 points. Therefore, in the interpretation, any mean score above 4.5 is very high, 3.5 and above is high, between 3.4 and 2.5 is moderate and below 2.5 is low.

The result was further subjected to Principal Component Analysis (PCA). This was used to identify major underlying dimensions influencing the environmental problems associated with sachet water wastes disposal in the study area. One-way Analysis of Variance (ANOVA) was used to examine if there is a significant difference on the perception of environmental problems associated with sachet water wastes disposal between different wards of the study area using the following formulae:

$\bar{\bar{X}} = over$ all total values = $\sum\sum Xij$

overall total case, N $\sum nj$

the sums of the sum of squares for each column = $\sum\sum i^2 j^2$

the total sum of squares, TSS = $\sum\sum ij^2 - N\bar{\bar{X}}^2$

the between-group sum of squares, BSS = $[\sum nj \bar{\bar{X}}^2_i] - NX^2$

the within-group sum of squares, WSS = TSS – BSS

The between-group variance estimate is given by:

$S_B^2 = \dfrac{BSS}{K-1}$

The within-group variance estimate is given by:

$S_W^2 = \dfrac{WSS}{N-K}$

The ratio between the variance estimates is known as Snedecor's F, where

$F = \dfrac{S_B^2}{S_W^2}$

3. Results and Discussion

3.1 Environmental problems associated with sachet water wastes disposal

Entries in Table 1 show analysis of the results obtained for environmental problems associated with sachet water waste disposal thus: blocking of the drainage systems (A1): Responses indicating that sachet water wastes contribute to the blocking of drainage systems scored 40% under the Agreed, 37.6% for Strongly Agreed, 9.3% for Undecided, while Strongly Disagreed and Disagreed scored 6.7% and 6.4% respectively. 77.6% of the sampled respondents agreed that A1 contributes to the hazardous nature of the environment by blocking of gutters and sewages. There is a strong consensus that the environmental problem caused by A1 is high because it recorded a mean score of 4.0. Therefore, people in the study area are aware that sachet water wastes disposal block drainage systems.

Littering of the environment (A2): From the opinion of the sampled respondents, it was equally very high. The analysis returned a mean score of 4.5. This is because the highest score of 68.8% was obtained for Strongly Agreed, 22.4% for Agreed while 3.7%, 3% and 2.1% were obtained under Undecided, Disagreed and Strongly Disagreed respectively. 91.2% of respondents agreed that sachet water wastes disposal contribute immensely to

the problems of the environment by littering the streets, markets and motor-parks. 5.1% disagreed and 3.7% of the respondents could not express an opinion.

Impeding visibility for motorists (A3): Responses indicating that sachet water wastes impedes visibility for motorists scored 25.6% for Agreed, 25.4% for Disagreed, 23% for Undecided while 16.1% and 9.9% were scored for Strongly Disagreed and Strongly Agreed respectively. There is a consensus that 41.5% of the respondents agreed that sachet water wastes disposal impede visibility for motorists thereby causing accident. It has a mean score of 2.9 which implies that A3 is not a major environmental problem and the level of people awareness is moderate.

When burnt it gives out offensive odour (A4): Sampled respondents' indicating that sachet water wastes produces offensive odour when burnt, scored 25.2% under Disagreed column, 24.1% for Agreed, 22.4% for Strongly Agreed while 15% and 13.3% were scored under Undecided and Strongly Agreed respectively. 47.6% of the respondents agreed that A4 is an environmental problem thereby causing air pollution. The analysis returned a mean score of 2.8 which was also moderate.

Blockage of ruminant tracts (A5): From the result, it showed that responses indicating that sachet water wastes block the digestive tracts of ruminant animals scored 31.4% for Agreed, 25.2% for Strongly Agreed, 16.8% for Undecided while 13.5% and 13.1% were scored for Disagreed and Strongly Disagreed respectively. A high number of respondents (303) or 56.6% agreed with A5 which results to death of animals. It recorded a mean score of 3.4 which is moderate. This implies that A5 is an environmental problem from people's opinion.

When buried it causes soil infertility (A6): From the opinion of the sampled respondents, it was equally high that sachet water wastes causes soil infertility when buried. Analysis returned a mean score of 4.1. This is because the highest score of 43.7% was obtained for Strongly Agreed, 35.9% for Agreed, 11.6% for Undecided while 5.6% and 3.2% were scored for Disagreed and Strongly Disagreed respectively. Therefore 79.6% of the respondents agree that A6 could be a problem, thus reducing or impedes the growth of tuber crops when buried in the soil. Furthermore 8.8% of the respondents disagree while 11.6% were indecisive to express an opinion.

When children used sachet water wastes as toy, it causes child mortality (A7): Responses indicating that sachet water wastes cause child mortality when used as toy, obtained 32.1% under Disagreed, 20.9% for Strongly Agreed, 20% for Undecided, 18.1% for Agreed and 8.8% for Strongly Disagreed. Although (219) or 40.9% majority of the respondents disagree that A7 could be an environmental problem by causing infant mortality. 39% of the respondents agreed and 20% were indeed uncertain and unwilling to express an opinion on A7. Our analysis recorded a mean score of 3.1 which was moderate and this implies that A7 is an environmental problem.

Sachet water wastes provide breeding ground for mosquitoes (A8): Sampled respondents indicating that sachet water waste provides breeding ground for mosquitoes recorded 39.6% under Agreed column, 21.9% for Strongly Disagreed, 18.3% for Strongly Agreed while 10.5% and 9.7% were obtained for Undecided and Disagreed respectively. 57.9% of the respondents agree that A8 could be a problem by infecting malaria to man. 31.6% of the respondents disagree while 10.5% of the respondents could not express an opinion on A8. It has recorded a mean score of 3.2 which is moderate from people opinion. Thus this implies that A8 is an environmental problem.

Pollution of ponds (A9): The opinion of the sampled respondents concerning the pollution of ponds with sachet water wastes was equally high, with a mean score of 3.8. 40.4% was obtained for Strongly Agreed, 24.3% for Agreed, 16.6% for Undecided while 10.7% and 8.0% were recorded for Disagreed and Strongly Disagreed respectively. 64.7% of the respondents agree that A9 causes environmental problems by polluting of water. 16.6% of the respondents were uncertain to express an opinion on A9 while 18.7% of the respondents disagree that A9 could be an environmental problem.

When marched upon it squirts to soil clean clothes (A10): Responses indicating that sachet water wastes with remnant of water, when marched upon squirts to soil clean clothes recorded 33.8% under Strongly Agreed column, 28.6% for Agreed, 18.1% for Undecided while 12.5% and 6.7% were scored for Disagreed and Strongly Disagreed respectively. 62.4% of the respondents agree that A10 could be a problem by soiling clothes and shoes. 19.2% of the respondents disagreed while 18.1% of the respondents could not express an opinion on A10. Our analysis obtained a mean score of 3.7 which was high and this implies that A10 is an environmental problem.

Accidental falls (A11): From the opinion of the sampled respondents over sachet water wastes causing accidental falls, it was equally high with a mean score of 3.7. Strongly Agreed column recorded the highest with 33.5%, followed by Agreed column with 28.2%, Undecided recorded 19.4% while Disagreed and Strongly Disagreed were recorded at 11.2% and 7.7% respectively. 61.7% of the respondents agree that A11 contributes to the environmental problems of breaking of bones such as ankle, waist and arm. 19.4% of the respondents were indecisive to express an opinion while 18.9% of the respondent disagreed on A11.

From the result above, we can conclude that sampled respondents' opinion on the environmental problems of

sachet water wastes disposal in Nsukka urban was high. This is because five variables were moderate while six variables were high from the sampled respondents' opinion and none was low.

Furthermore, the Principal Component Analysis (PCA) was employed to identify major underlying components influencing the environmental problems associated with sachet water wastes disposal in Nsukka urban.

3.1.1 The Principal Component Analysis (PCA) of environmental problems associated with sachet water wastes disposal.

To analyze the environmental problems associated with sachet water wastes disposal, the Pearson correlation matrix was employed to correlate the relationship between eleven (11) variables used in the analysis. A correlation matrix analysis which eventually resulted into 11 x 11 matrix of the correlated relationship is shown in Table 2.

The correlation matrix in the table above shows that six (6) variables have positive correlations with each other, while the remaining five (5) variables have no significant correlation coefficient. A total of sixteen (16) significant correlations coefficient at 0.05 levels were obtained, while a total of six (6) variables have significant correlations coefficient at 0.01 levels. Variables that have significant correlations are: Blocking of drainage systems (A1), Littering of the environment (A2), Blockage of ruminant tracts (A5), Soil-infertility (A6), Pollution of ponds (A9) and Squirts water to soil clean cloth (A10) while variables that have no significant correlation are: Impeding motorists visibility (A3), Offensive odour when burnt (A4), Child mortality when used as toy (A7), Breeding ground for mosquitoes (A8) and Accidental falls (A11).

In this correlation matrix six (6) out of eleven (11) variables had a positive correlation and are strongly correlated with each other. To reduce the effect of this inter-correlation and for easy interpretation of the relationship, Principal Component Analysis (PCA) was used for the analysis using the SPSS program. PCA is a relatively straight forward method of transforming a given set of variables into a new set of composite variables that are orthogonal to each other. For this analysis, the significant loadings on components were considered from significant variable exceeding 0.7. Each variable possesses significant loading only on one component. Table 3 shows the result of Principal Component Analysis using Varimax Rotation.

Interpretation of the components

Component I has an eigen value of 7.008 and thus explains 63.71% of the total variance, its high positive significant loadings are found on 7 variables namely; Blocking of drainage systems (A1), Littering of the environment (A2), Blockage of ruminant tracts (A5), Soil infertility (A6), Pollution of ponds (A9), Squirts to soil clean clothes (A10) and Accidental falls (A11). These variables describe the environmental degradation caused by sachet water wastes disposed indiscriminately on the environment.

Component II has an eigen value of 2.108 and explains 19.17% of the variance in addition to 63.71% explained by Component I, thus making a total cumulative variance of 82.88% explained. Two variables have high positive significant loadings which are Impeding motorist's visibility (A3) and Offensive odour when burnt (A4). These variables describe the underlying dimension of traffic hazards experienced from the sachet water wastes disposal on the environment.

Component III has an eigen value of 1.444 and thus explains 13.13% of the variance. Together with Component I and Component II they explain a total cumulative variance of 96.01%. There is only one factor that has a high positive significant loading which is Child mortality when used as toy (A7). This variable indicates infant mortality.

Therefore, the three components explained almost all the variance at 96.01%, leaving 3.99% of the total variance unexplained.

The PCA model has been used to identify three (3) important components which could be used to explain the significance of environmental problems associated with sachet water wastes disposal in Nsukka urban. The model has successfully transformed eleven (11) variables to three (3) components which are shown in the order of importance in Table 4.

3.2 Analysis of Variance (ANOVA) of the environmental problems associated with sachet water wastes disposal in different wards in the study area.

The results of the One-way ANOVA are contained in Table 5 for the six wards, the critical F value is 2.21 and based on this value, the environmental problems according to blocking of drainage systems (5.351), littering of the environment (2.569), impeding motorists visibility (5.555), offensive odour when burnt (12.585), blockage

of ruminant tracts (13.422), causes soil infertility (2.933), causes child mortality when used as toy (4.219), breeding ground for mosquitoes (5.348), pollution of ponds (15.217) and accidental falls (5.117) show significant difference in the perception of environmental problems associated with sachet water wastes disposal among the six wards in Nsukka urban. These categories have calculated values more than that of the critical F value for the wards, while squirts to soil clean clothes (0.342) is the only variable that do not show significant difference in the perception of environmental problems associated with sachet water wastes disposal among the six wards in Nsukka urban.

4. Conclusion

The study concludes that in the study area, the environmental problems of sachet water waste disposal ranges from blocking of the drainage systems, squirts water to soil clean clothes, blockage of ruminant tracts, soil infertility, pollution of ponds, littering of the environment to air pollution. These have implications on the biophysical environment of the area, the health and social life of the dwellers. The PCA of environmental problems subsequently produced three (3) underlying components namely the environmental degradation, traffic hazard and infant mortality that explained 96.01% of the total variance associated with sachet water wastes disposal in the study area. To avert the environmental threats posed by sachet water waste, the following recommendations are made:

1) Government should make adequate provision for waste disposal facilities

2) The government agencies concerned with making policies should introduce a policy that would mandate the makers of sachet water to buy-back pack from users. This will serve as incentive to users not to dispose sachet waste indiscriminately rather to see the sachets wastes as valuable material that could be sold to make money.

 3) Government should also make policies that before any company is allowed to start sachet water production, she would have shown her reusing and recycling machines. The machines would be used to recycle the waste when bought from users.

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Figure 1. Picture Showing Indiscriminate Disposal of Sachet Water Waste in Nsukka Urban
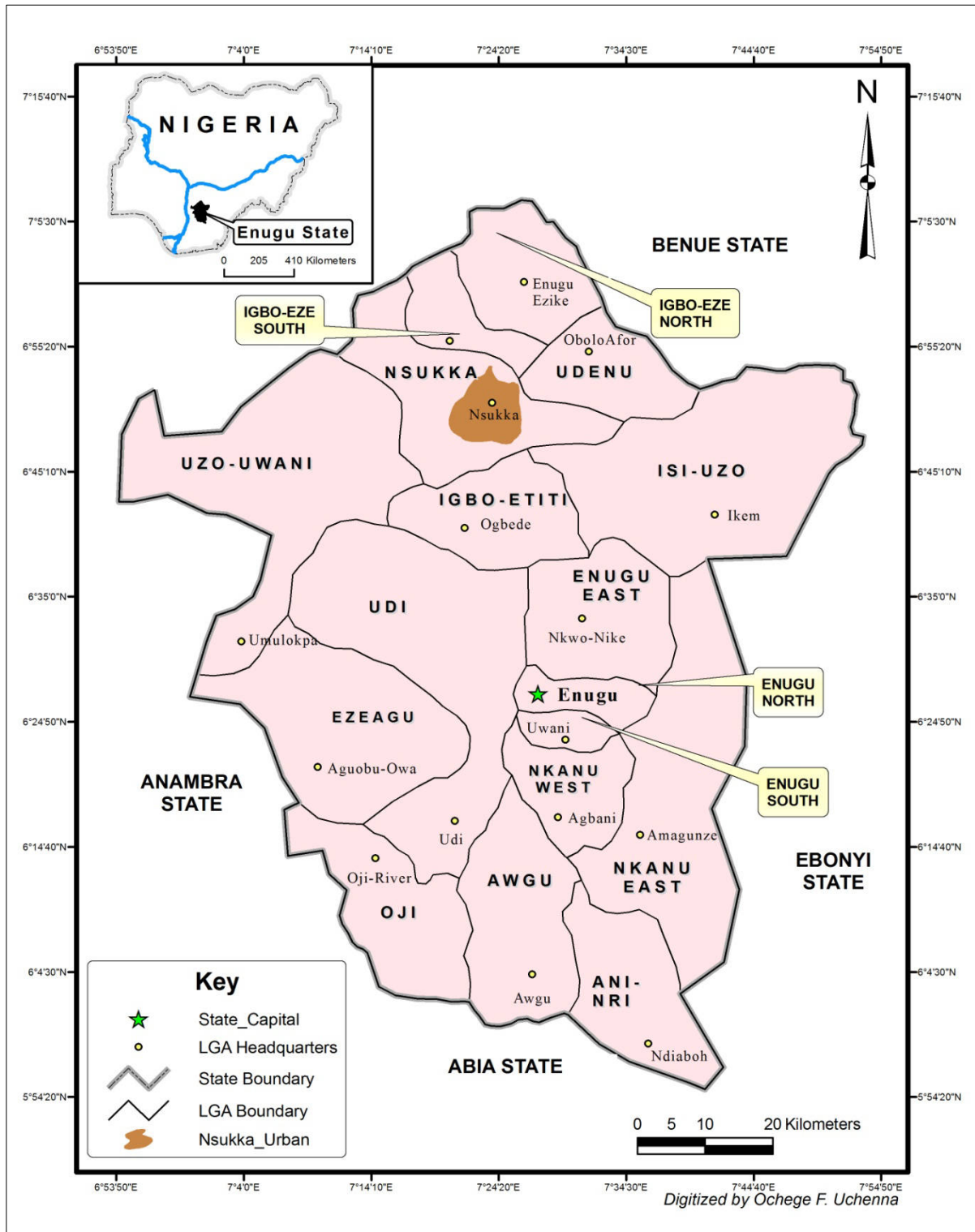
Figure. 2. Enugu State Showing Nsukka Urban

Source*:* Department of Geography, University of Nigeria, Nsukka

Table 1: Relative Frequency Distribution of Respondents on the Environmental Problems Associated with Sachet Water Waste Disposal.

		5	4	3	2	1		
Code	Problems	Strongly Agreed	Agreed	Undecided	Disagreed	Strongly Disagreed	Total	Mean
A1	Blocking of drainage systems	201 37.6%	214 40.0%	50 9.3%	34 6.4%	36 6.7%	535	4.0
A2	Littering of the environment	368 68.8%	120 22.4%	20 3.7%	16 3.0%	11 2.1%	535	4.5
A3	Impeding visibility for motorists	53 9.9%	137 25.6%	123 23.0%	136 25.4%	86 16.1%	535	2.9
A4	Gives out offensive odour when burnt	71 13.3%	129 24.1%	80 15.0%	135 25.2%	120 22.4%	535	2.8
A5	Blockage of ruminant tracts	135 25.2%	168 31.4%	90 16.8%	72 13.5%	70 13.1%	535	3.4
A6	Causes soil infertility when buried	234 43.7%	19 35.9%	62 11.6%	30 5.6%	17 3.2%	535	4.1
A7	Causes child mortality when used as toy	112 20.9%	97 18.1%	107 20.0%	172 32.1%	47 8.8%	535	3.1
A8	Breeding ground for mosquitoes	98 18.3%	212 39.6%	56 10.5%	52 9.7%	117 21.9%	535	3.2
A9	Pollution of ponds	216 40.4%	130 24.3%	89 16.6%	57 10.7%	43 8.0%	535	3.8
A10	Squirt to soil clean clothes	181 33.8%	153 28.6%	97 18.1%	67 12.5%	37 6.7	535	3.7
A11	Accidental falls	179 33.5%	151 28.2%	104 19.4%	60 11.2%	41 7.7%	535	3.7

Source: Field work, 2012

Table 2. Correlation Matrix of Environmental Problems Associated with Sachet Water Wastes Disposal

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
A1	1.000										
A2	.788*	1.000									
A3	-.253	-.703*	1.000								
A4	-.227	-.587	.630	1.000							
A5	.967**	.621	-.031	-.132	1.000						
A6	.974**	.887*	-.370	-.412	.910*	1.000					
A7	-.066	.037	.395	.122	-.069	.010	1.000				
A8	.695	.189	.107	.341	.769*	.521	-.456	1.000			
A9	.857*	.965**	-.549	-.631	.743*	.950*	.073	.247	1.000		
A10	.927*	.856*	-.283	-.487	.883*	.978**	.142	.399	.953*	1.000	
A11	.917*	.846*	-.303	-.540	.879*	.972**	.079	.398	.952*	.996**	1.000

*Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level

Source: Field work, 2012

Table 3: PCA of the Environmental Problems Associated with Sachet Water Wastes (varimax rotation)

Code	Variables	Components		
		I II	III	
A1	Blocking of drainage systems	.982*	-.067	-.162
A2	Littering of the environment	.749*	-.608	.034
A3	Impeding motorists visibility	-.123	.884*	.315
A4	Offensive odour when burnt	-.218	.874*	-.104
A5	Blockage of ruminant tracts	.973*	.122	-.167
A6	Soil infertility	.965*	-.256	-.040
A7	Child mortality when used as toy	-.091	.186	.960*
A8	Breeding ground for mosquitoes	.631	.450	-.630
A9	Pollution of ponds	.848*	-.520	.088
A10	Squirts to soil clean clothes	.953*	-.264	.125
A11	Accidental falls	.938*	-.299	.082
	Eigen value	**7.008**	**2.108**	**1.444**
	% of explained variance	**63.71**	**19.17**	**13.13**
	Cumulative%	**63.71**	**82.88**	**96.01**

*Significant variable 0.7

Table 4: The Relative Strength of the Major Environmental Problems Associated with Sachet Water Wastes Disposal in Nsukka Urban.

S/N	Components	Underlying Dimensions	Relative Contribution (%)	Cumulative (%)
1.	I	Environmental Degradation	63.71	63.71
2.	II	Traffic Hazard	19.17	82.88
3.	III	Infant Mortality	13.13	96.01

Source: Field work, 2012

Table 5: ANOVA of Environmental Problems Associated with Sachet Water Wastes Disposal in the six wards of Nsukka urban**.**

Variables	Calc. F	Table F	Sign. Level
Blocking of drainage systems	5.351	2.21	0.000*
Littering of the environment	2.569	2.21	0.026*
Impeding motorists visibility	5.555	2.21	0.000*
Offensive odour when burnt	12.585	2.21	0.000*
Blockage of ruminant tracts	13.422	2.21	0.000*
Causes soil infertility when buried	2.933	2.21	0.013*
Causes child mortality when used as toy	4.219	2.21	0.001*
Breeding ground for mosquitoes	5.348	2.21	0.000*
Pollution of ponds	15.217	2.21	0.000*
Squirts to soil clean clothes	0.342	2.21	0.888
Accidental falls	5.117	2.21	0.000*

Source: Field work, 2012