ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 10, Issue 1, January 2023

Analysis of Improper Solid Waste Disposal: A Precursor for Urban Flooding in Selected Riverine Communities in Bayelsa and Rivers State

Walter G. A, *Achadu M. Abah , Omorogiuwa, E

Centre for Engineering and Technology Management (CETM), Institute of Engineering and Innovation Management (METI)
Dept. of Chemical Engineering,
Dept. of Electrical/Electronic Engineering, University of Port Harcourt, Rivers State, Nigeria.

ABSTRACT: The article focused on analysis of improper solid waste disposal method, a precursor to urban flooding in selected riverine communities in Bayelsa and Rivers states. The study was carried out using standard procedure and aimed at establishing the correlation between solid wastes disposal and flooding especially in riverine communities, an annual occurrence that have caused several deaths and destroyed properties worth billions of naira. Flooding is usually linked to a number of factors including blockage of natural water course due to unsustainable development of infrastructures and improper solid waste disposal. A simple, fit-for-purpose and practical approach involving development and deployment of well-structured and peer reviewed questionnaire was adopted. The questions were closed-ended, fixed-choice/ odd number Likert-type responses with short and simple sentences, precise questions, zero double or multi-barreled questions and zero leading or loaded questions. The questionnaires were populated by the interviewer and not the respondent. The study established that most urban floods results from solid waste disposal into canal because of high travel time (11 to 20 minutes) from home to temporary collection points, absence of temporary disposal sites, weak or absence of workable laws preventing residents from dumping wastes into gutter and proximity of storage/ holding zone to drains as well as dilapidated or complete absence of bund walls around temporary holding facilities. Sustainable solid waste management in these areas will include building and operating a sanitary dumpsite in the area and recycling recyclable solid wastes for reduction and wealth creation thereby prevents flood occasioned by drain blockage linked to solid waste disposal.

KEYWORDS: Sustainable, solid waste disposal, urban flooding, Likert-type responses, recycling, sanitary dumpsite

1. INTRODUCTION

Several deaths have been recorded and properties worth billions of naira have also been destroyed due to flood. Flooding is often referred to as weather-related threat that is widespread across the globe (Oyegbile, 2008) and occurs virtually everywhere. It is a common environmental problem in Nigeria and usually occurs when a body of water moves over and above an area of land that is not normally submerged i.e covering of dry land with overflown water resulting from heavy rain. Flooding is almost an annual occurrence especially in riverine communities in Nigeria and linked to a number of factors including blockage of natural water course due to unsustainable development of public and private infrastructures, non-desilting of existing streams, narrow and shallow man made canals and improper solid waste disposal (Tchobanoglous et al., 1993), a precursor to blockage of gutters by solid wastes. This phenomenon has rendered many homeless, destroyed farmlands and crops, fishing camps and ponds, destroyed many businesses thereby impoverishing the citizen living within the flood plain. Flooding is usually linked to heavy rainfall, but can also be attributed to other factors like the opening or collapsing of dams which are not directly dependent on rainfall. Floods are generally destructive in nature due to high and powerful current that usually removes almost everything on its path and leaving lot of ***dirt and debris*** when flood waters finally recede (Atdhor, 2011). Poor or improper solid waste management contributes to urban flooding across the globe and as urban population increases, waste management becomes critical and sometimes overwhelming (*Abdel – Shafy et al., 2016*, Senzige *et al.*, 2014). The occurrence of flood represents a major risk to

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

riversides populations and floodplains, in addition to causing substantial impacts on the environment, including aquatic fauna and flora, and bank erosion. According to *Aderogba, (2012)*, flooding occurs in Nigeria in three main forms: river flooding, urban flooding and coastal flooding. Urban flooding are usually diverse from coastal floods as it mostly occurs during rainfall or wet seasons. The resulting effects are divided into direct, indirect and socioeconomic consequences. The direct consequences are often refers to as material damages while the indirect are traffic detours (Konig et al., 2002). Flooding is becoming an increasingly severe and more frequent problem in Nigeria. The outcome of the water itself are usually devastating on structures because of the high dissolved solids like salts. It also damages household items like books, furniture, electronic equipment etc. Floodwaters generally characterized with suspended silt and dissolved chemicals which are toxic microorganisms. It also contaminates potable water (USAID, 2006, UNEP, 2010). The cost of cleanup of the left over mud and debris are usually high and if left unattended to, could be highly hazardous to man. Some of the hazardous substances include decomposing left over of drown animals (*Jha et al., 2012)*. The consequence of flooding to man is both beneficial and destructive. Sometimes, the soil becomes fertile when the flood waters recedes. Proper solid waste management within areas at risk of flooding has the potential to reduce risk by minimizing the amount of waste blocking water channels *(Mahmood et al., 2015).* Also, the attitudes of the habitat in these flood zones may determine the extent of flood in the area. It is common knowledge that during rainfall, people are seen to empty their wastes into the drains, temporary waste collection centres sited near drains which sometimes spill into the gutters thereby blocking them.

This study therefore seeks to investigate the remote causes of flooding originating from man activities, proffer solution and make recommendations to the government and the community dwellers.

II. MATERIAL AND METHODS

A. Methodology

The method employed for data collection was adoption of a simple, fit-for-purpose and practical approach which involves questionnaire development, actual assessment phase and completed questionnaire analysis.

B. Questionnaire Development

A well-structured questionnaire fit for actualizing the objectives of the study was developed and reviewed before deployment. The questions were closed-ended, fixed-choice/ odd number Likert-type responses with the following characteristics: short and simple sentences, precise questions and zero double or multi-barreled questions. Others include zero negatives and double negatives questions, zero leading or loaded questions and zero hypothetical questions. Analysis from the feedback of the completed questionnaire determined the appropriateness and sufficiency or otherwise of the questionnaire for the purpose.

C. Assessment Phase

In order to obtain the relevant information (data) at source, avoid mass populating the questionnaires by single individual and doctored response as well as the literacy level of some of the key players and avoiding difficulty in retrieval of questionnaire, the following methods were employed: one on one (face-to-face) interview was the means of administering the questionnaire, populating questionnaires by the interviewer (not the respondent) and use of voice recorder to support completion of questionnaire at a later time where applicable. A total of two hundred and twenty (220) questionnaires were deployed by the team. The team composed of previously trained and examined personnel on the use of the questionnaire. The deployment of the questionnaires were carried out over a month (Saturdays only) and this was aimed at assessing the right sets of people that are likely to provide objective answers to the questions posed to them.

D. Method of Data Analysis

Upon completion of the questionnaire, descriptive statistical analysis were performed. This enabled the data to be presented simply and clearly from where meaningful deductions could be made.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

III. RESULTS AND DISCUSSION

This section focused on results and its discussions from the empirical study. The results are presented in Tables and Figures. While Figures constituted graphs (bar chart, histogram and pie charts), the tables are normal statistical tables. The results addresses the various responses from the various questions posted to the respondent from the developed, reviewed and tested questionnaire. One hundred populated questionnaires were selected and analysed for each community. The results are presented and discussed accordingly in the following subsections.

A. Sex Distribution among Respondents

The population in every human settlement comprises of male and female and so the respondents interviewed in this riverine community were picked based on availability and willingness. The sex distributions are presented in Table 1 below:

Table 1: Sex Distribution among Respondents

	Location	
Sex	**Community A**	**Community B**
Male	49	47
Female	51	53
Total	100	100

The values showed female 51% while the male counterpart was 49% in community A while in community B, the male respondents were 47% and the female interviewee is 53%. The higher value of female than male in the two communities are in line with the population figures and also because of the fact that women are more available at home and readily more disposed for sampling then men. This could be attributed to the fact that men engaged in ventures that takes them away from home than women.

B. Age Distribution among Respondents

Age is often associated with maturity which in turn could determine the quality of responses to enquiry. The age range of the respondents in this survey are presented in Table 2 below:

Table 2: Age Distribution among Respondents

Range (yrs)	Community A	Community B
Below 18	3	5
18 – 25	9	10
26 - 35	33	31
36 - 45	40	36
46 – 55	5	6
56 – 65	3	7
Above 65	7	5
Total	100	100

The interviewee in the two communities were predominantly within two age brackets (26 - 35 and 36 - 45 years). The two Communities' settlers has the highest interviewee between the 36 - 45 years bracket.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

C. Educational Qualification of Respondents

It is believed that the extent and quality of education is a key performance indicator in measuring how a society fares. From the statistics presented in Table 3 below, it can be adjudged that the community is a literate habitat.

Table 3: Educational Qualification of Respondents

Level of Education	Locations	
	Community A	**Community B**
Primary/Standard 6	15	19
Secondary	50	48
Higher Institution	26	21
Vocational training	7	9
Secondary + vocational	1	1
Higher Institution + vocational	1	2
Total	100	100

The survey showed that 50% and 48% of those interviewed in communities A and B respectively completed senior secondary education while 26% and 21% of the respondents in communities A and respectively attended higher institutions. The results implied that the two communities are literate settlements and means that awareness of any kind in its simple form can be communicated, understood and complied with.

D. Profession (Means of Livelihood) of Respondents

The type and quantity of wastes generated and disposed off in any region is directly linked to the affluence and predominant lifestyle of the people. Table 4 showed the distribution of the means of livelihood across the two areas surveyed.

Table 4: Profession (Means of Livelihood) of Respondents

Career	Location	
	Community A	**Community B**
Government employee	4	12
Private employee	13	11
self-employed (craft, fishing etc)	72	66
Student	8	7
Retired	8	4
Total	100	100

The respondents were primarily engaged in self-employment/business. The data showed that 72% and 66% of those interviewed in communities A and B respectively are involve in personal business comprising of craft or retail outlets. Though, a riverine community, fishing seems not to be predominant in the areas and was be attributed to the water pollution caused by either oil bunkering activities or indiscriminate waste disposal into the water ways or both.

E. Awareness on Waste Management

Awareness is the principal key to doing things right way or otherwise. It determines whether decisions or actions of men will be beneficial or destructive as one can be sincerely wrong because of the absence of sensitisation. All the respondents in the areas covered by the study were positive to the question "**Have you heard that if waste gets to the gutter, or block canal it can cause problem**?" The residents affirmed to have obtained the information from the radio, television

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

or school. Few confirmed that it is common sense. This means that throwing waste into canal or by the shoreline is a deliberate act and not through ignorance of the consequences.

F. Type of solid waste comes found in the Area

Generally, the characteristics of waste (waste type) is dependent on many factors including lifestyle and economic status of the area. The wastes generated in the study location are general municipal solid waste comprising Cartons/paper, plastics/ Nylons, food waste etc. as evident along the shoreline.

G. Methods of Waste Disposal in the Community

Proper waste disposal is one of the indices of a healthy environment and precursor to healthy living. The methods of disposal of waste in the area includes burning, burying, sending to collection centre, throwing into gutter/by shoreline and using local waste vendors. Table 5 and Figure 5 shows the distribution how wastes are disposed in the area.

Table 5: Applied Waste disposal Options

	Options in the Questionnaire									
	a	b	c	d	e	ad	bd	cd	acd	Total
Community A	1	0	14	62	1	10	1	10	1	100
Community B	2	1	16	49	2	12	2	13	2	99

a = Burn them by your house without taking to shoreline or collection centre, b= Bury them
c = Send them to collection centre in waste container, d= Throw them into gutter or by shoreline
e = By the road side,

Among the 100 and 99 respondents from community A and community B residents, fourteen (14) and sixteen (16) for community A and Community B respectively sends wastes to collection centre in waste container (bags, baskets, buckets etc) while the bulk of the respondents dumps their waste into gutter or by the river banks, for instance, 62 out of 100 respondents in community A disposed off their waste into the gutter/ shoreline while 49 out of 99 respondents in community B empties their wastes into nearby canal. Over 50% of the respondents in the two communities employs the gutter/shorelines and canals as disposal sites. Another twelve (12) and ten (10) for community B and community A respectively combines burying with gutter disposal while ten (10) and thirteen (13) combines collection centre and stream bank disposal for community A and community B respectively. The statistics further showed that those living close to the shoreline are prone to disposing their wastes by the shoreline.

H. Type and Volume of waste containers

The containers used for collection/dispose of wastes in the area comprised the following; Carton, Plastic containers (basket/ buckets), Old iron bucket/ Tin/Can and Nylons. The average volume cannot be ascertained. During the survey, it was gathered that type of containers used are based on availability.

I. Frequency of household waste disposal

The aesthetic conditions around the house depends largely on the frequency of household waste disposal. It is reported widely that the contents of waste in developing countries are organic in nature and these are prone to decay. Table 6 presents the frequency of disposal of the waste generated by the households in the communities.

Table 6: Frequency of household waste disposal

	Options in the Questionnaire									
Location	a	b	c	d	e	ab	ad	bd	de	Total
Community A	19	25	15	39	1	1	0	0	0	100
Community B	40	19	14	22	3	0	1	1	1	100

a= every day, b= Once every two days, c= Once every three days d= Once a week e= Other

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

Majority of those dwelling in community B (close to a stream) dispose their wastes every day while those in community A dispose theirs generally weekly.

J. Identity of household waste disposal

The quality of tasks could be linked to the age and experience of people who carry out the tasks. Table 7 depicts the survey results.

Table 7: Identity of household waste disposal

	Options in the Questionnaire						
Location	a	b	c	ab	bc	abc	Total
Community A	63	4	16	0	14	3	100
Community B	61	1	18	0	16	0	96

a = Adult (above 18 years), b = Child (less than 18 years) c= Wastes are collected by the city corporation from the house, d = Wastes are collected by a locally-recruited person from the house

The wastes are generally dispose off by adult family member (above 18 years) across the two communities, hence any careless or indiscriminate disposal can be adjudged intentional. The survey shows that reasonable number of people in community B contracts their waste disposal to locally-recruited person. Children below the age of 18 that disposes waste are more among the Community A dwellers.

K. Awareness about Disposal Site and Travel Time

The place of waste disposal is often linked to availability of disposal site, distance and sometimes allowable period for such disposals. Over 90% of the residents are aware of the availability of a temporary dumping area in the community but quite a number still prefer to dump either into the gutter or along the shoreline. The timeframe to get to the various temporary dumping areas in the community from the households are presented in Table 8

Table 8: Timeframe to get to temporary waste disposal point

Time Interval (Minutes)	Community A	Community B
2 – 5	20	18
6 – 10	23	21
11- 15	18	20
16 – 20	32	33
Total	93	92

The distance to and from the temporary dumping/collection centre determines the timing and subsequently the place for disposal of waste. Table 5 depicts that about 62% and 49% of the respondents from Community A and Community B respectively dumps their wastes by the shoreline or into the gutter that eventually ends up by the shoreline. This could be attributed to the time frame between the residents and the collection centres. For instances, over 50% of residents in both communities takes between 11 – 20 minutes to get to the temporary disposal points and because there is no workable laws preventing residents from dumping wastes into the gutter or by the shoreline, this households have a very strong likelihood to dump their wastes into the drains that eventually empties its contents into the water body. It also possible that the dwellers that takes about 6 – 10 minutes to get to the collection points to still dump into drains since there is no monitoring especially in the night hours. Again, the fractions of households that uses wastes vendors cannot account for the final disposal sites for their household wastes.

L. Frequency of emptying public dumping areas

The timeframe/frequency of emptying the public dumping centres by the respective agency is directly linked to state of place. The state of cleanliness or otherwise of the dumping area also determines its level of patronage. Table 9 shows that the public dumping areas are emptied every day and so the tendencies of them being messy are very slim.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

Table 9: Frequency of Emptying public dumping area

Timeframe	Location	
	Community A	Community B
Every day	65	69
Once every two days	11	6
Once every three days	7	3
Once a week	3	5
Other	12	11
Total	98	94

The statistics showed 65 out of 98 of the community A dwellers and 69 out of 94 for community A respondents confirmed that the place is evacuated on a daily basis. However, data showed that the collection centre in community B receives more attention than that at community A.

M.Adequacy of dumping space

In addition to the frequency of evacuation of waste by waste agents, adequacy of space for receiving waste is another factor that determines the state of the dumping area. The survey (Table 4.10) showed that 21 and 28 at community A and community B respectively confirmed adequacy of space and therefore no overfill of wastes, 33 and 37 admitted inadequacy of space and occasional overflow with wastes in community A and B respectively.

Table 4.10: Description of the space of the public dumping area (Question number 10)

Options	Location	
	Community A	Community B
a	21	28
b	33	37
c	22	24
bc	4	3
Total	63	72

a. Adequate space / no overfill of wastes. b. Inadequate space / overfilled with wastes occasionally.

c. Always messy/overfilled with wastes and smelly d. others

N.Challenges with waste disposal in the area surveyed

The problems confronting waste disposal is hydra-headed especially in developing countries. It usually overwhelms the community and needs serious Government intervention. It usually comprise one or combination of the following: absence of large collection dustbin in the area, long distance trekking to locate available dustbin and dustbin being in a bad shape. Others include dustbin not being in the way of movement, area around dustbin smelly or bad path/ road to waste disposal point (e.g. muddy, grassy etc). All these challenges made some of the populace to either dump their waste by the road side, nearby bush/uncompleted buildings/undeveloped facility and sometimes into the canal/gutters especially during rainfall or night time. The challenges identified in this survey are tabulated in Table 4.11 below:

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

Table 4.11: Problems with disposing waste in the area (Question number 12)

Locations	Options in the Questionnaire												Total
	a	b	c	d	e	f	ab	be	bc	ce	bce	ef	
Community A	2	22	3	1	21	2	13	3		3	1	1	72
Community B	5	14	8	3	23	12	10	1	1	1	2		80

a = No dustbin in the area, b= Dustbin is quite far away, c= Dustbin is in a bad shape, d = Dustbin is not in the way of movement, e= It is smelly/ near the dustbin, f = Path/ road to waste disposal point is bad (e.g. muddy, grassy etc),

It was evident from the survey that the majority of those interviewed were of the opinion that the area around the collection centres were smelly and unkempt hence many retort to dumping by the roadside and into drains. About 37 out of the 72 people that responded from community A settlement attributed their not using the temporary collection centres to absence of dustbin in the area and long distance to the collection centres while 29 out of 80 in community B corroborated their reasons with community A.

O.Sustainable waste management Options in the area

Sustainable waste management is one of the components of sustainable environment which is a key performance indicator in the overall global sustainable development initiative. Table 12 presents the summary of suggestions on the means of achieving sustainable waste management in the area.

Table 12: Solution to Waste Management Problem in the Area

Locations	Options in the Questionnaire													Total
	a	B	c	d	ab	ac	Ad	bd	Cd	abc	abd	acd	bcd	
Community A	17	11	4	18	4	2	2	3	5	6	2	20	1	95
Community B	12	14	4	24	6	5	4	3	4		1	18		98

a. Supply waste bags b. Collect waste from the house c. Evacuate temporary collection area frequently like daily, d. Build and operate dumpsite

The analysis of the survey outcome showed that majority of the respondents from the two communities (A and B) strongly believes with one accord that building and operating a dumpsite in the area will ameliorate the problem of dumping wastes by river banks, nearby bushes and into the gutters. Also, the respondents noted that supplying waste bags will also reduce waste littering while a combination of waste bags supply, timely evacuation of temporary collection area and building/operating dumpsite could be rated the best option.

P.Suggestion on location of the public/ temporary dumping area

Generally, the aesthetic conditions around the dumping sites are always detestable to people living in such neighborhood. However, this response to the survey is related to the distance between the dumping site and the households. The results in Table 13 showed that 72 out of 88 respondents among the community A habitat and 63 out of 87 in community B were of the opinion that the present location should be changed.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

Table 13: Decision to public dumping area (Question number 23)

Options	Location	
	Community A	Community B
yes	72	63
No	4	6
really doesn't bother me	12	18
Total	86	87

Q.Activities along River bank

River banks are usually accompanied by bevy of activities ranging from fishing, swimming and transportation. Others include beach soccer, sand mining and sometimes religious rituals like water baptism. However, from Table 14, the activities presently going on along the creek and river banks includes basically fishing and transportations. Others include defecation and waste disposal.

Table 14: Activities along the water banks (Question number 25)

Location	Options in the Questionnaire								Total
	a	b	d	ab	ad	ae	abc	abd	
Community A	49	3	5	32	2	1	1	3	96
Community B	51	4	4	27	1	2	2	1	92

a=Fishing, b= Transportation, c= Religious rituals, d = Sand mining, e= others,

R.Summary of Response to monosyllabic questions

Table 15 showed the response to yes/no choice questions in the questionnaire employed in the survey to obtain information from the respondents. The analysis are also presented in this section.

Table 15: Summary of Response to Yes/NO choice questions

	Community A			Community B		
QN	Yes	No	Total	Yes	No	Total
Q7	60	40	100	71	29	100
Q10	12	48	60	15	52	67
Q11	46	14	60	44	16	62
Q13	96	4	100	91	8	99
Q14	24	76	100	26	74	100
Q16	87	13	100	89	11	100
Q17	79	21	100	75	19	94
Q19	57	40	97	60	38	98
Q20	48	40	88	50	43	83
Q21	40	24	64	42	28	70
Q22	28	33	61	31	36	67
Q24	34	66	100	32	64	96

**the details questions are in appendix 1*

Are there public temporary dumping area in the community? (Q7)

The place of waste disposal is often linked to availability of disposal site, distance and sometimes allowable period for such disposals. A total of 100 and 100 of those interviewed in community A and community B respectively responded to the question on availability of public temporary dumping area in the community. 60

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

and 40 answered yes and No respectively among community A dwellers while community B were 71 and 29 respectively. Over 70% of the community B residents are aware of the availability of a temporary dumping area in the community but quite a number still prefer to dump either into the gutter or along the shoreline. These could be attributed to lack of adequate awareness of the dangers and/or probable laziness because of the distance from the waste disposal point.

Are there bund walls or anything to secure the waste in the holding place before final evacuation by waste trucks? (Q10)

Bund-walls are usually used to prevent the spilling of the contents of an enclosure. The contents could be liquid, slurry, powder or solid. In this case, the bund-wall is meant to prevent littering of the waste on nearby roads, drainages and the environment by wind, domestic animals or fast moving vehicles if the dumping area is by a major road. A total of 60 and 67 of those interviewed in community A and community B respectively responded to the question on availability of bund walls or anything to secure the waste in the public temporary holding place before final evacuation by waste trucks, 12 and 48 answered yes and No respectively among the community A dwellers while community B were 15 and 52 respectively. The responses implied that there are either dilapidated or no bund walls and hence the area overflows with waste while some finds their way into the canal especially during rainfall.

Is the temporary waste storage/ holding area close to drains (gutter) or water channels? (Q11)

Spilling of waste into an area (or drains) depends on its proximity to the storage/ holding zone. The responses to the question of closeness of the temporary waste storage/ holding area to drains (gutter) or water channels showed that of the 60 respondents from the community A, 46 and 14 answered yes and No respectively while for community B, the responses were 44 and 18 (totaling 62) respectively. It can therefore be inferred that temporary holding area is close to water channel and most of the wastes found their way into the drains and finally end up along the water bank and drainage therefore blocking free flow of its liquid contents.

If the Government or a private company sets up a recycling programme, will you support it by separating your wastes into different containers? (Q13)

Globally, waste recycling is a waste to wealth program that seeks to make reuse of part of the things discarded by individuals. It is often aimed at reducing quantity of waste as well as putting things into multiple applications. On the question bordering on support to setting up a recycling programme in the community, the rejoinders were impressive, 91 out of the 100 people that responded among the shoreline residents showed willingness to support such programme while 92 out of the 100 respondents in community B indicated interest for such venture. These responses implied that waste recycling is an acceptable option in the two communities and so are willing to support such projects which will not only reduce solid waste in the communities but also create wealth and prevents flood occasioned by drain blockage by solid waste disposal.

Have you ever seen people dumping their waste into gutter or river in this community? (Q16)

Indiscriminate dumping of waste into gutter, channels, water body or undeveloped lands is common in many communities in Nigeria. The practice is often observed during heavy downpour. **On the question relating to observance of this notorious practice of dumping waste into gutter or river in the communities**, 87 out of the 100 people that responded among the community A residents acknowledged observing people dumping their wastes into gutter while 89 out of 100 among community B residents also confirmed observing this ugly incidence. The wastes either clogs the water channels causing flooding or find their way to the shoreline where the drains empty their contents.

Have you ever observed burning of waste in the community? (Q17)

Burning of waste especially old fabrics, paper and nylon materials is common in sub-Saharan Africa. It however causes environmental pollution especially air which has been attributed to the numerous respiratory diseases being experienced today in the region. 79 of the 100 respondents amongst the community A residents admitted to observing burning of waste especially old clothes in the community while 81 out of 100 of the respondents in community B had either participated or observed burning of waste in the community. The statistics showed that wastes burning occurs more frequently among community B than among community A dwellers. The

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

remnant of the burnt wastes are pushed to the gutters or river banks and therefore contributing to the carbon content of the creek.

General Conditions around waste dumps (Q18)

The surroundings of solid waste dumps (temporary or permanent) are usually messy and smelly in Nigeria. Generally, these waste disposal sites are characterized by pollutants migration (which can result in contamination), acts as feeding places for domestic animals, insects and rodents (incubation/ proliferation points) which can carry germs to nearby homes resulting in epidemics such as dysentery, diarrhea, malaria, Lassa fever etc. Almost all the respondents who admitted presence of temporary dumping area also admitted to all the options ((leachate - Dark flowing liquid, foul odour, flies, mosquitoes and cockroaches as well as domestic animals, rats and scavengers (men picking cans). Dumpsites fire were not reported by the respondents, this implied that waste are not burnt at the designated temporary waste holding places in the communities. Community joint efforts are usually put in place to address situations or challenges that can overwhelm an individual or a family. This joint efforts could be in the area of water supply, roads, security or solid waste management. It involves setting of rules, fund raising and sometimes manual works while offenders are fined accordingly.

Whether there are any community joint efforts for managing wastes (Q19)

Community efforts in the area of waste management seems to be more pronounced among community along the community B compared to the community A dwellers. 57 out of the total of 100 respondents whose residents are within community A confirmed existence of community efforts for waste management while 60 of the respondents in community B affirmed presence. The residents maintained that the scope of waste management by the community is however limited to the Monthly sanitations when the town crier is made to announce the exercise. The exercise basically involves cleaning the adjoining drainages and pushing the waste into the creek while those in the community B mainly clean the drainages.

Amongst the respondents in the community A that responded to the query '**if there are community rules/ laws for collection and/or disposal of waste**', 48 of the 88 respondents of the shoreline habitats were positive while 50 out of 93 in community B respondents confirmed nonexistence of such rules/laws within the community. This statistics implied that the people living community A are more conversant with the happenings in their community and hence, more awareness should be encouraged for community B.

However, with the confirmation of the existence of laws/rules concerning waste management within the communities, the survey further probed whether there are community sanctions for not complying with the community rules/ laws for collection and/or disposal of waste. Again, the trends in the response was similar to those for existence or nonexistence of rules/laws regulating waste management in the community. Here, 33 out of 61 respondents within the community A affirmed nonexistence of sanctions while 36 out of 67 in community B asserts nonexistence of fines for offenders. Virtually, all the respondents that averred the presence of fines/sanctions for offenders unanimously agreed that the law is weak and no longer in practice. 24 out of 64 and 28 out of 70 of community A and community B respectively responded negative to the question 'has **anyone been sanctioned/ punished for not complying with the community rules/ laws for collection and/or disposal of waste'.** However, pockets of respondents confirmed seizing of household items from offenders that refused paying the fines but also confirmed that the practice generated a lot of acrimony among the residents and so died a natural death.

Drainage cleaning aids the free flow of waste water along the channels/drains and it's a components of flood control mechanism in flood disaster management. The process is called desilting in rivers/stream or creek cleaning to free the channels of debris/silt in order to allow natural flow at its normal capacity. The water channels in the two communities are presently full of junks and solid wastes especially in community A closer to the bank of a creek. The adjoining drainages had been cleaned a number of times by concerned individuals and nongovernmental organization. On the query of the '**awareness of previous massive cleaning of the water channels in the community of solid waste**', Majority of the respondents across the two communities were not aware of such exercise. 66 out of 100 (66%) of the respondent from community A residents confirmed lack of knowledge of past holistic cleaning exercise of the nearby waste recipient channels while community B recorded 68 out of 100 of ignorance of cleaning exercise. The trend is such that the information about the cleaning reduces with increase of distance away from the water channels.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 10, Issue 1, January 2023

On probing whether the residents like the **present state of the water body** especially the community side of the river bank, almost all the people interviewed answered no. Again, on further enquiry if they **want it to be cleaned,** almost all the respondents across the two communities admitted support for cleaning. On how to maintain the area around the shoreline i.e '**how do we stop waste from getting there'**, the following suggestions were made

- ✓ Create awareness on wastes and health resulting from indiscriminate waste dumping
- ✓ Set up committee for inspection, control and monitoring
- ✓ Barricade area with barbwires and put no 'waste dumping' sign
- ✓ Liaise with community development committee for enforcement of no dumping by shoreline rule
- ✓ Provide giant waste bins at strategic places in the community especially near the shoreline and evacuate daily
- ✓ Provide screen /Net in the drainage that empties waste into the shoreline
- ✓ No dumping of waste into water campaign should also be extended to other shoreline communities upstream as waste also emanates from them.
- ✓ Build and operate temporary dumpsite

IV. CONCLUSION

Sustainable solid waste management as means of flood control in two riverine communities in the Niger Delta was carried out. The methods of disposal of waste in the areas include burning, burying, sending to collection centre, throwing into gutter/by shoreline and using local waste vendors. The analysis of the survey outcome showed that

- ✓ The two communities are literate settlements hence awareness of any kind can be communicated, understood and complied with if enforced.
- ✓ Though, riverine communities, fishing were not predominant and was attributed to the water pollution caused by both crude oil bunkering activities and indiscriminate waste disposal into the water ways.
- ✓ Over 50% of residents in both communities takes between 11 – 20 minutes to get to the temporary disposal points and due to absence of workable laws preventing residents from dumping wastes into gutter or by the shoreline, a good number of the households dump their wastes into the drains that eventually empties its contents into the water body.
- ✓ people living close to the shoreline are prone to disposing their wastes by the shoreline.
- ✓ majority of the respondents from the two communities strongly believes that building and operating a sanitary dumpsite in the area will ameliorate the problem of dumping wastes by river banks, nearby bushes and into gutters.
- ✓ Spilling of waste into an area (or drains) was linked to proximity of storage/ holding zone to drains, dilapidated or complete absence of bund walls. It was therefore inferred that temporary holding area close to the water channel caused most of the wastes to find their way into the drains therefore blocking free flow of its liquid contents.

REFERENCES

Abdel – Shafy, H. I., Elkhateeb, M.A., Mansour, M.S.M (2016). Solid Waste Issue: Sources, Composition, Disposal, Recycling and Valorization. Egyptian Journal of Petroleum, Volume 27, 4, pp 1275-1290.

Aderogba, K. A., (2012). qualitative study of recent floods and sustainable growth and development of cities and towns in Nigeria. Int. J. Basic and Appl. Sci. Insane akadnika publications. (October). Pp. 200-216.

Atdhor O, A,, Odjugo P. A. O, & Uriri A. (2011). Changing rainfall and anthropogenic- induced flooding; impacts and adaptation strategies in Benin City. Nigeria. J. Geo. Regional Planning. 4(1):42-52.

Konig, A., Sægrov, S. and Schilling, W., (2002). Damage assessment for urban flooding, Ninth International Conference on Urban Drainage, Portland, Oregon, USA. ENVIS, 2005, Monograph on flood hazard, ENVIS Centre on human settlements, School of Planning and Architecture, New Delhi.

Mahmood, K., Batool, S. A., Chaudhery, M. N., Daud, A. (2015). Evaluating municipal solid waste dumps using geographic information system. Polish Journal of Environmental Studies 24: 879 - 886.

Marfai, M.A. (2011). Urban coastal flooding and risk management(an overview of Jakarta and Semarang City. Presentation in the consultation workshop. Preparation of a Global Handbook for Urban Flood Risk Management, Jakarta, May 25-6.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 10, Issue 1, January 2023

Oyegbile, O. (2008). Battling a global threat in tell magazine Lagos. Tell communications limited, Ikeja (August, 11). Pp. 20 -25.

Pervin, I. A., Sheikh, M. M., Mahbubur, R., Mani, N., Abdul K. E., (2020). Adapting to urban flooding: a case of two cities in South Asia. Water policy 22 (s1), 162 – 188.

Sankoh, P. F., Yan, X., Conteh, M.A.H (2012). A Situational Assessment of Socioeconomic factors affecting Solid Waste Generation and Composition in Freetown, Sierra Leone. J. Environ. Prot. 3, pp 562-568

Senzige, J. P., Makinde, D. O., Njau, K. N., Nkansah-Gyeke Y. (2014). Factors influencing solid waste generation and composition in urban areas of Tanzania: The case of Dar-es-Salaam

Taiwo O. (2011). Flood sacks 500 in Babura in this day. 13(4867: 18. Unity Nations (2007). Sustainable development issues Geneva: Un Division for sustainable development (issues).

Tchobanoglous G., Theisen H., and Vigil S.(1993). Integrated Solid Waste Management, "Water Quality Management: Engineering principles and management Issues. Thuvienso.vanlanguni.edu.vn. Tata McGraw Hill International Edition.

United Nations Environment Program, UNEP (2010). Trends in Solid Waste Management: Issues, Challenges and Opportunities. International Consultative Meeting on Expanding Waste Management Services in Developing Countries, 18 – 19, Tokyo, Japan.

UN-Habitat (2010). Solid waste management in the world's cities, Water and Sanitation in the Worlds Cities 2010, London/Washington: Earthscan.

UN-Water Annual Report (2011)

USAID (2006). Environmental issues and best practices for solid waste management, Environmental guidelines for the USAID Latin America and Caribbean Bureau.

US CODE (1976). Solid Waste Disposal Act as amended. Resource Conservation and Recovery Act: Subtitle D (Solid Waste Program). US Code (Acts of Congress) Title 42, Chapter 82, Subchapter 1 (Section 6901).

US Environmental Protection Agency (2013). Wastes – Non-Hazardous Waste – Municipal Solid Waste, 1200 Pennsylvania Ave., N. W. Washington, DC 20460, U.S.A.

Valkenburg, C., Walton, C.W., Thompson, B.L, Gerber, M.A, Jones, S., Stevens, D. J. (2008). Municipal Solid Waste (MSW) to Liquid Fuels Synthesis. Pacific Northwest National Laboatory, Richland, WA.

Vergara, S. E., and Tchobanoglous, G. (2012). Municipal Solid Waste and the Environmment: A Global Perspective. Annual Review of Environment and Resources. 37(1): 277-309. Doi:10.1146/annurev-environ-050511-122532.