2019/2020
November-January
coou African Journal of Environmental Research *Vol 2, No. 1, 2019. pp 118-134*

Analysis Of Solid Waste Evacuation From Residential Areas Around Major Markets In Awka Urban, Southeast Nigeria

Kelechi F. Nkwocha[1], Philip O. Phil-Eze[2], Angela Akanwa[3], Samuel O. Iheukwumere[4] Sebastine G. Eze[5]

[1]Department of Geography, University of Maiduguri, Borno State, Nigeria
[2]Department of Geography, University of Nigeria, Nsukka, Enugu State, Nigeria
[3]Department of Environmental management, Chukwuemeka Odumegwu Ojukwu University, Uli
[4,5]Department of Geography & Meteorology, Nnamdi Azikiwe University, Awka, Anambra State

Email: kelechinkwocha@unimaid.edu.ng

Abstract

The paper analysed solid waste evacuation from market neighbourhoods in two major markets in Awka urban. The study is hinged on the concept of sustainable solid waste management. Sustainability in this study encompasses all solid waste management practices that ensure the safety of the environment for the present generation without compromising the future of coming generations. Primary data were obtained from 200 copies of structured questionnaires, photo camera and a handheld GPS. Data from questionnaire was analysed using descriptive statistics while ArcGIS 10.3 NA was employed for the creation of optimized solid waste collection and disposal routes. The findings showed that 83% of residents in Eke-Awka neighbourhood indicated unavailability of dumpsters, while 17% agreed that dumpsters were available in their neighbourhoods. Similarly, majority of residents (94%) in Nkwo-Amaenyi neighbourhood indicated absence of dumpsters while 6% indicated presence of dumpsters in their neighbourhoods. For frequency of solid waste evacuation, a high proportion of respondents (63%) in Eke-Awka neighbourhood noted that wastes were collected twice a week, while majority of respondents (54%) in Nkwo-Amaenyi opined that wastes were collected once a week. Finally, ArcGIS 10.3 NA was employed to optimize solid waste collection routes to 18.8km in Eke-Awka and environs and 9.7km in Nkwo-Amaenyi and environs. The study therefore concludes that solid waste management around market environments in Awka urban is still in an embryonic phase of development and therefore recommends that more dumpsters should be provided within and outside the various markets to avoid heaps of market wastes.

Keywords: dumpsters, eke-awka, nkwo-amaenyi, market waste, solid waste

INTRODUCTION

Urban areas of most developing countries are growing at an alarming rate and this is largely due to increasing economic activities and population explosion. Increase in population as well as availability of markets, trade and commerce are the major catalysts for the rapid development of

any city. The resultant effect of population increase is solid waste management problems, which happens to be top among major environmental problems facing most urban areas of developing countries such as Nigeria. This therefore reinforces the fact that an accretion of human settlement has the potential of generating large amounts of waste. Waste production in itself is a continuous process as it is part of metabolism. Humans only stop producing waste when they die, and even when they die, they become waste themselves. Waste is therefore defined as materials or substances which are regarded as un-useful by its handlers and therefore discarded. Solid waste can be defined as unwanted materials or substances with little or no free-flowing liquid content.

The high rate of urbanization and population growth in most African countries has made it difficult to develop and implement effective Solid Waste Management (SWM) systems (Abdulrasoul & Bakari, 2006). With a land area of about 73 square kilometres (Nwagwu, et al., 2018) and a 2018 population projection of about 359,751 inhabitants, Awka urban is among the most densely populated cities of the southeast region. Researchers have opined that an increasing population tends to be a precondition for increased problems in handling excess solid waste generated (Omololu & Lawal, 2014; Tahir, Hussain & Behaylu, 2015; Amasuomo & Baird, 2016). In the last few years, rapid industrialization as well as increasing trade and commerce opportunities have forced rural residents of surrounding towns to migrate to Awka as well as to other prized urban centres of the southeast region thereby putting pressure on existing urban infrastructure, leading to increased solid waste generation and other environmental problems. One of the direct consequences of population boom is urban expansion; addressing the issue of urbanization, Butu and Mshelia (2014) stated that urbanization affects land use and when not properly controlled can result to emergence of illegal structures and neighbourhoods. These are major characteristics of some quarters in Awka Urban. Therefore, as urban areas expand there is a need to put in place holistic measures for managing urban solid wastes collection and disposal so as to maintain the aesthetics of the city.

Trade and commerce are propellants of accelerated development in cities, while the negative externalities associated with the location of markets include but not limited to traffic congestion (see Plate 1), air pollution, indiscriminate solid waste disposal, and noise pollution. Over the years, Awka town has witnessed increased urban growth and economic development which has in turn brought about increasing commercial and industrial development coupled with various forms of environmental pollution.

Plate 1: Vehicular traffic at Eke-Awka market roundabout
Source: (Odogwublog.com, 2019)

Since the production of waste is an integral part of economic activity, it is obvious therefore, that economic growth leads to an increase in the production of market waste. Residential houses located around major markets are always at the receiving end of the wrong methods of handling market waste by traders as this has led to heaps of refuse being left around the market areas (see Plates 2 & 3). This practice of indiscriminate disposal of market waste has the potential of giving rise to water and air pollution, greenhouse gas emission and the emission of other gases that cause serious problems to human health and environment (Remigios & Wiseman, 2012).

Plate 2: Indiscriminate market waste Disposal at Court Road junction, Awka
Source: Fieldwork, 2019

Plate 3: Heaps of market waste at Court Road, Awka
Source: Fieldwork, 2019

The proliferation of indiscriminate market waste disposal problems has recently caused environmentalists as well as other stakeholders to conceptualize various solid waste management practices with varying degrees of efficiency. Several solid waste management practices in use include: open dumping, burning, separation, scavenging, and recycling. Pivotal to the aforementioned management practices is collection and transportation of these wastes to places where these respective management practices could be applied. The prompt evacuation of market waste however, can only be assured if routes for its efficient transportation are properly identified. Thus, the study set out to examine the state of solid waste evacuation from residential areas around major markets in Awka urban in order to proffer suggestions that will aid in sustainable waste management in the city.

CONCEPTUAL FRAMEWORK

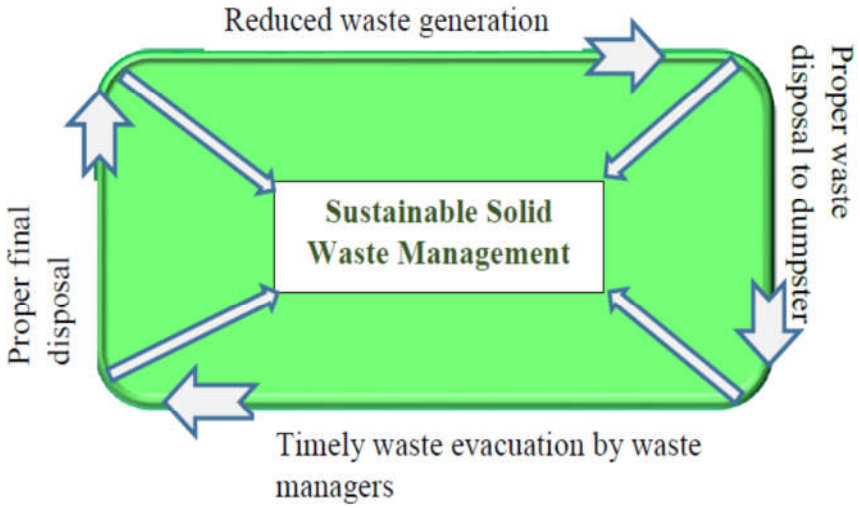

Figure1: Concept of Sustainable Solid Waste Management

This study is underpinned by the concept of sustainable solid waste management. Sustainability in this study encompasses all solid waste management practices that ensure the preservation of the environment for the present generation as well as the future generations. The concept recognizes waste reduction from source as the first step in solid waste management. Source reduction of waste is the elimination of waste before it is created. It can also be called reuse of waste; the ultimate goal of source reduction is to ensure a lesser waste stream.

The second step is proper waste disposal to available dumpsters; this is to ensure that the environment is clean and not littered with garbage. It is one thing to propose prompt disposal of waste to dumpsters while it is another thing for the dumpsters to be available at walking distances at least not more than 100meters away. The third step is timely waste evacuation by waste managers. As the dumpsters get filled with garbage, it is the duty of waste managers to ensure prompt evacuation of waste from the dumpsters before overflowing to avoid health hazards. The last step is to ensure a proper final disposal of the collected waste. Different methods/techniques can be employed in this final stage of solid waste management. The most common method in most developing countries is landfilling. Solid wastes collected all through the city centre are used to landfill erosion sites. Recycling, incineration, burying, and so on, are other common methods of final waste disposal.

MATERIALS AND METHODS

Study Area

Awka is the capital of Anambra state, southeast Nigeria. Geographically, Awka is located between latitude 6^0 5' N and 6^0 15'N and longitude 7^0 0' E and 7^0 5'E (Fig. 2). It is bounded by Nibo in the southwest, Mbaukwu and Okpuno in the northeast and Umuawulu, Isiagu and Ezinato in the southeast. Awka urban has a land area of about 73 square kilometres (Nwagwu, et al., 2018) and a 2018 projected population of about 359,751. It experiences two distinct seasons-wet and dry seasons. The wet or rainy season occurs from April to October. This is followed by 5months of dryness starting from November to March. Geologically, 80% of the area consists of Imo shale group of lower Eocene era, while a small band of Nanka sand is seen in the western parts of the area (Ezenwaji, et al., 2013).

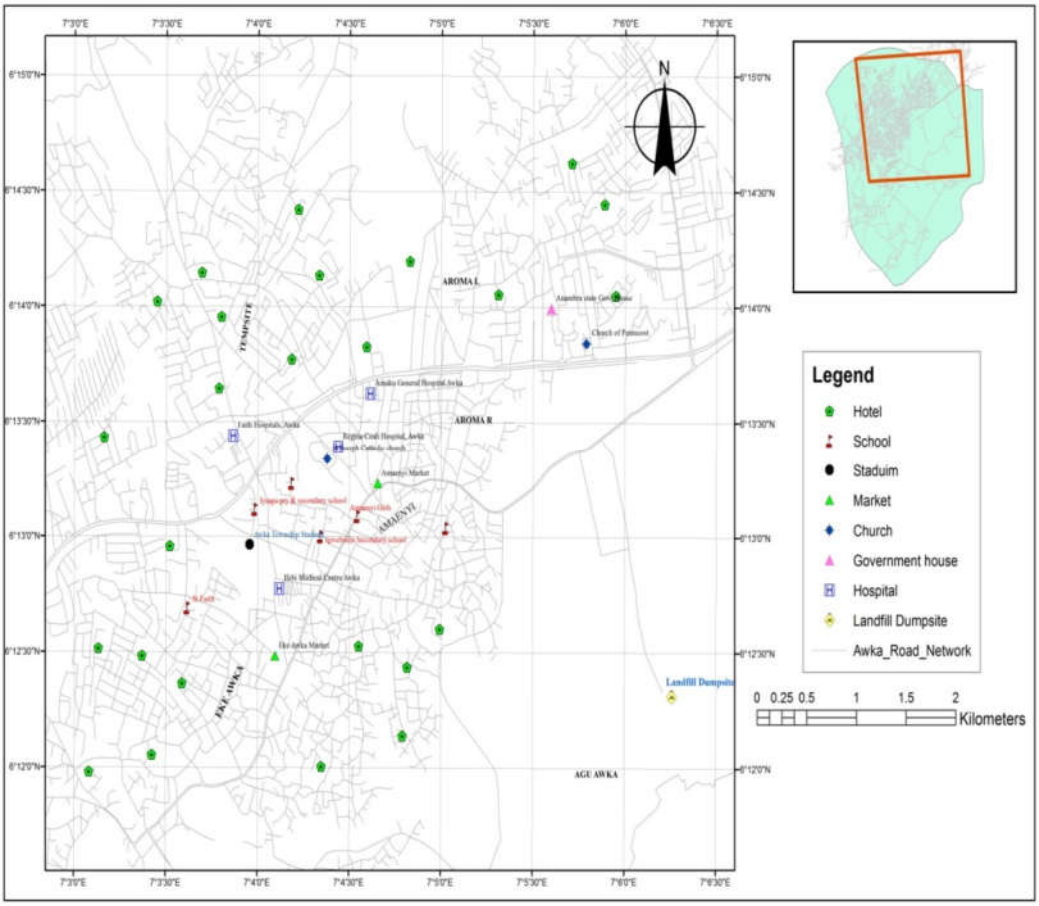

Figure 2: Map of Awka Urban

Source: Department of Quantity Survey GIS lab, Nnamdi Azikiwe University, Awka.

Data Collection and Analysis

Data for this study were collected from two market neighbourhoods in Awka urban. The two major markets in Awka urban are Eke-Awka and Nkwo-Amaenyi markets, both located in the capital city. The target population for this study are the residents of neighbourhoods around the two aforementioned markets. The study used a cross sectional survey design to obtain required qualitative and quantitative data. The cross section study is a research that permits the use of various methods of data collection including questionnaires, interviews and direct observation (Abdulrasoul &Bakari, 2016). Data collection was achieved using questionnaires, field observations, camera and the Global Positioning System (GPS) - these formed the primary data, while information from published sources formed the secondary data. Two hundred copies of a set questionnaire were equally divided between Eke Awka and Nkwo Amaenyi. These two aforementioned neighbourhoods were purposively selected because they host the two major markets in Awka urban. Residents of the neighbourhoods were randomly selected for interviews and questionnaire administration. Data obtained from questionnaire was described in bar charts, pie chart and histogram, while ArcGIS 10.3Network Analyst software was employed to create optimized waste collection and disposal routes to the approved waste dumpsite at Agu Awka.

Plate 4: Indiscriminate waste disposal on road divide along Eke Awka roundabout, Zik Avenue.
Source: Fieldwork, 2019

RESULTS

i. Socio-Demographic characteristics of Respondents

Table 1 shows the socio-demographic characteristics of respondents. Our findings reveal that more males (56%) were sampled in the study. The result also indicated that vast majority (65%) of the respondents are in the 40-59 years age brackets; and that most respondents (57%) are married and had at least primary education.

Table 1: Socio demographic characteristics of respondents

Socio-demographic variables	Frequency	Percent
Gender		
Male	112	56%
Female	88	44%
Total	200	100%
Age		
20-29	22	11%
30-39	34	17%
40-49	68	34%
50-59	62	31%
60above	14	7%
Total	**200**	**100%**

Marital status		
Married	114	57%
Single	86	43%
Total	**200**	**100%**
Educational Qualification		
Primary	22	11%
Secondary	72	36%
Tertiary	106	53%
Total	**200**	**100%**

ii. Availability of Dumpsters in Market Neighbourhoods

Dumpsters in Awka urban are of two types; large dumpsters, usually orange coloured and the medium sized dumpsters, which are mostly green in colour. They are all metal and designed to be hoisted by a waste collection truck for disposal. The analysis of responses from residents in Eke-Awka neighbourhood reveals that 83% indicated unavailability of dumpsters in their neighbourhoods while 17% of respondents were of the opinion that there are indeed dumpsters in their neighbourhoods. Similarly, 94% of residents in Nkwo-Amaenyi neighbourhood indicated absence of dumpsters while 6% indicated availability of dumpsters in their neighbourhoods.

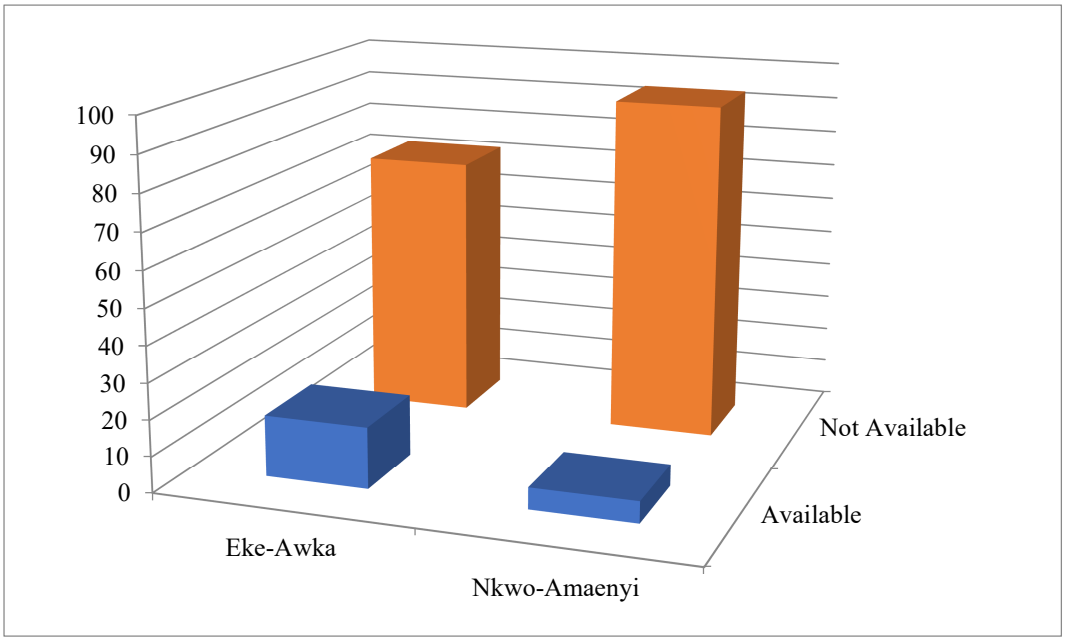

Figure3: Availability of dumpsters in neighbourhoods

iii. Frequency of Solid Waste Evacuation

In Anambra state, solid waste management is the sole responsibility of Anambra State Waste Management Agency (ASWAMA). The agency, which is a department in the state ministry of environment, is saddled with the responsibility of managing the massive solid waste 'mountains' in the entire state. Figure 4 shows the analysis of frequency of solid waste evacuation from market neighbourhoods. The analysis indicates that in Eke-Awka, majority of respondents (63%) indicated that wastes are evacuated twice a week, while 23% and 15% of the respondents were of the opinion that wastes are evacuated daily and once a week respectively. Similarly, majority of residents in Amaenyi (54%) claimed that wastes are evacuated once a week while34%, 10% and 2% of respondents indicated that wastes are evacuated twice a week, every day and once a month respectively.

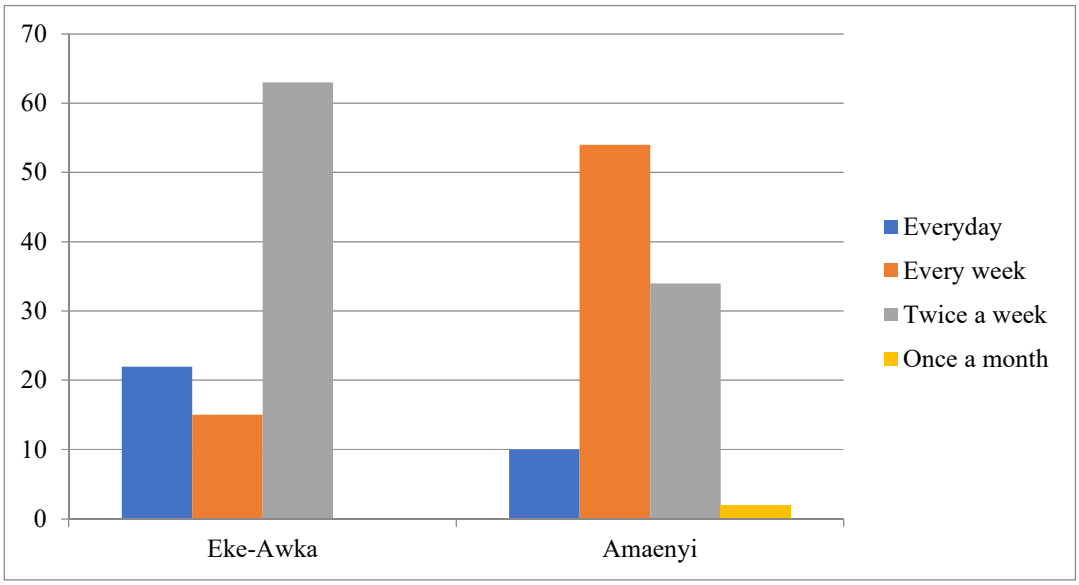

Figure4: Frequency of Waste Evacuation

ArcGIS 10.3 Network Analyst (NA) software was employed to create shorter and faster solid waste evacuation routes to enhance efficiency. In this study, GIS techniques were used to model an optimal routing network that minimizes distances from a network of collection points to the approved dumpsite at Agu-Awka. The model in this study comprises 3 phases; phase 1 creates a road network also known as "dataset" using ArcGIS Network Analyst; phase 2 analyses and calculates the number of arcs along the road networks leading to the two major markets; and phase 3 performs the optimization of solid waste collection for best route by applying ArcGIS NA. For ease of analysis, the two market neighbourhoods were assessed in two distinct scenarios as: Scenario 1 focused on Eke-Awka and environs while scenario 2 covered Nkwo Amaenyi and its environs too. The model is designed to evacuate waste from available dumpsters within the neighbourhoods of the two markets; therefore, the coordinates of all existing dumpsters in the

two areas were collected using a GPS. The data from the GPS was converted into readable format with the aid of Q-GIS software. The converted data was finally exported to ArcGIS NA for further analysis.

Scenario I: There is need to evacuate solid waste regularly from Eke-Awka and environs due to the presence of the Eke-Awka market and the busy nature of the area. Figure5 shows the best route to be taken by ASWAMA crew linking Eke-Awka, Dike Park, parts of Zik Avenue as well as other neighbourhoods while Table 2 describes the route analysis.

Table 2: Best Route Analysis for Scenario I

S/N	Driving Directions	Track Length
1	Start at Graphic Pick 1 (G. P 1)	
2	Go west	0.4 km
3	Bear right on Enugu-Onitsha Express	1.7 km
4	Turn left on Oby-Okoli Street	< 0.1 km
5	Continue on Arthur Eze Road	1 km
6	Continue	< 0.1 km
7	Turn left	< 0.1 km
8	Arrive at Graphic Pick 2 (G.P 2), on the left	
9	Depart Graphic Pick 2 (G.P 2)	
10	Continue northeast	1.1 km
11	Turn right on Amaku Hospital Road and immediately turn right	1.3 km
12	Turn left	< 0.1 km
13	Arrive at Graphic Pick 3 (G.P 3), on the left	
14	Depart Graphic Pick 3 (G.P 3)	
15	Go back northwest	< 0.1 km
16	Turn right	1.3 km
17	Turn left on Amaku Hospital Road and immediately turn left	1.2 km
18	Turn left	0.3 km
19	Turn right	< 0.1 km
20	Arrive at Graphic Pick 4 (G.P 4) , on the right	
21	Depart Graphic Pick 4	
22	Go back southeast	< 0.1 km
23	Turn left	0.3 km
24	Turn right	1.2 km
25	Turn right on Amaku Hospital Road and immediately turn right	1.5 km
26	Turn left	< 0.1 km
27	Arrive at Graphic Pick 5 (G.P 5), on the left	
28	Depart Graphic Pick 5 (G.P 5)	
29	Go back northwest	< 0.1 km
30	Turn right	1.5 km
31	Turn left on Amaku Hospital Road and immediately turn left	1.2 km
32	Turn left	0.4 km

33	Turn right	< 0.1 km
34	Arrive at Graphic Pick 6 (G.P 6), on the left	
35	Depart Graphic Pick 6 (G.P 6)	
36	Go back east	< 0.1 km
37	Turn left	0.4 km
38	Turn right	1.2 km
39	Turn right on Amaku Hospital Road and immediately turn left	0.8 km
40	Make sharp left	0.6 km
41	Turn right	0.7 km
42	Turn right	0.8 km
43	Finish at approved disposal site, on the left	
Driving distance		**18.8 km**

Table 2 shows the analysis of driving directions and distances for the best route network for evacuating waste around Eke-Awka and environs to the final deposition site at Agu-Awka. The total distance for the best route is 18.8km.

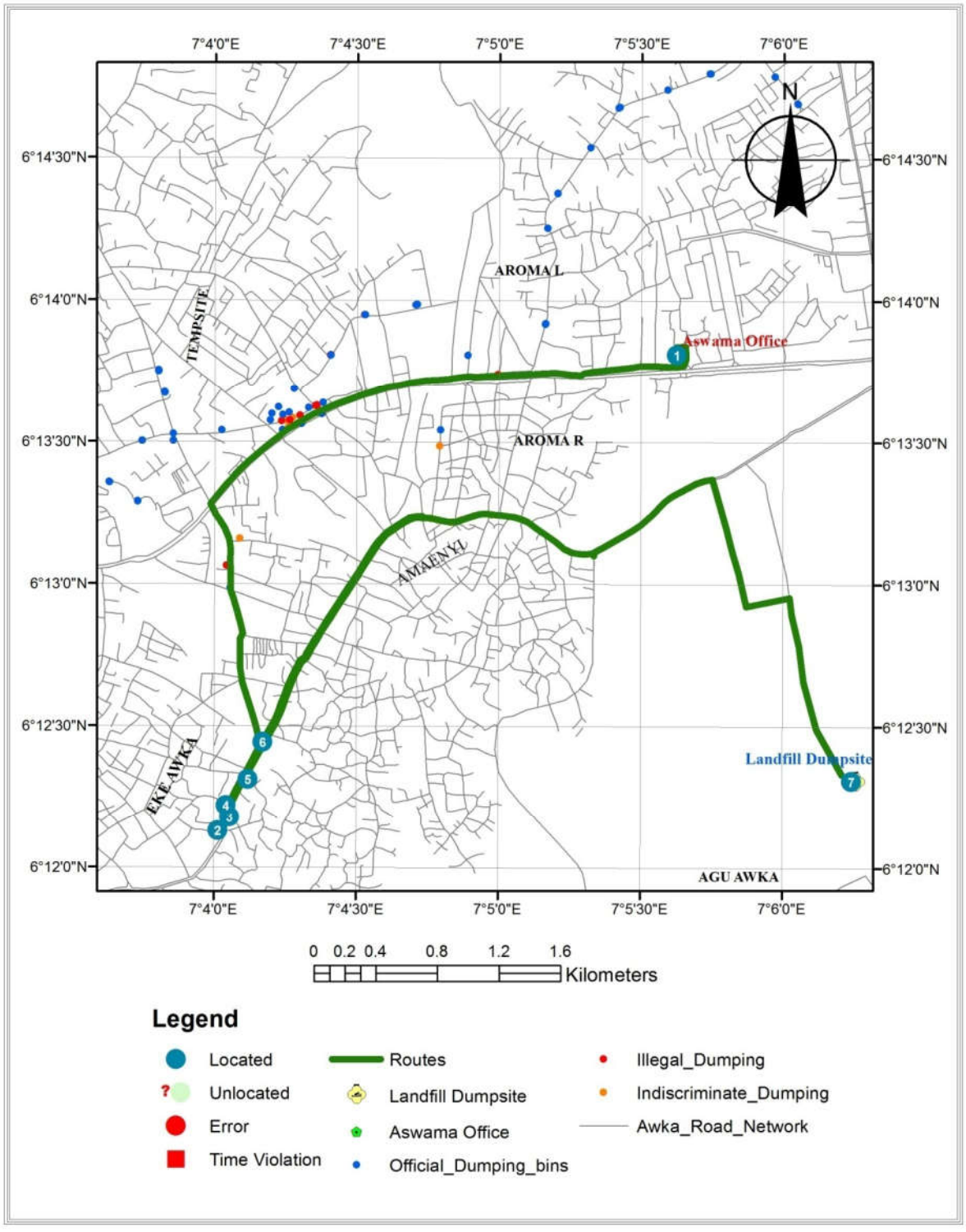

Figure5: Awka showing best route for waste collection for scenario I (Eke-Awka)

Scenario 2: Table 3 shows the best route details and directions for evacuating wastes from locations in Amaenyi axis, the best route was optimized for easy transfer of waste. Figure6 shows the best route to be taken by ASWAMA crew linking locations along the Nkwo-Amaenyi market and environs.

Table 3: Best route analysis for Scenario 2

S/N	Driving Directions	Track Length
1	Start at Graphic Pick 1 (G.P 1)	
2	Go east	< 0.1 km
3	Turn right	0.5 km
4	Bear right on Enugu-Onitsha Express	1.7 km
5	**Turn left on Oby-Okoli Street and immediately make sharp left on Enugu-Onitsha Express**	**0.6 km**
6	Arrive at Graphic Pick 2(G.P 2) , on the left	
7	Depart Graphic Pick 2 (G.P 2)	
8	Go back southwest on Enugu-Onitsha Express	< 0.1 km
9	Arrive at Graphic Pick 3 (G.P 3) , on the right	
10	Depart Graphic Pick 3 (G.P 3)	
11	Continue southwest on Enugu-Onitsha Express	0.5 km
12	Make sharp right on Oby-Okoli Street and immediately turn right on Enugu-Onitsha Express	0.5 km
13	Arrive at Graphic Pick 4 (G.P 4), on the left	
14	Depart Graphic Pick 4 (G.P 4)	
15	Go back southwest on Enugu-Onitsha Express	< 0.1 km
16	Arrive at Graphic Pick 5 (G.P 5), on the right	
17	Depart Graphic Pick 5 (G.P 5)	
18	Continue southwest on Enugu-Onitsha Express	0.4 km
19	Turn left on Oby-Okoli Street	< 0.1 km
20	Continue on Arthur Eze Road	0.2 km
21	Turn left on Emma Nnaemeka Street	< 0.1 km
22	Arrive at Graphic Pick 6, on the left	
23	Depart Graphic Pick 6	
24	Go back west on Emma Nnaemeka Street	< 0.1 km
25	Turn left on Arthur Eze Road	< 0.1 km
26	Arrive at Graphic Pick 7, on the right	
27	Depart Graphic Pick 7	
28	Continue south on Arthur Eze Road	< 0.1 km
29	Arrive at Graphic Pick 8, on the right	
30	Depart Graphic Pick 8	
31	Continue south on Arthur Eze Road	< 0.1 km
32	Turn left on Ezeudu Street	0.4 km
33	Turn left	0.6 km
34	Turn right on Amaku Hospital Road and immediately turn right	0.3 km

35	Arrive at Graphic Pick 9, on the left	
36	Depart Graphic Pick 9	
37	Go back northeast	< 0.1 km
38	Arrive at Graphic Pick 10, on the left	
39	Depart Graphic Pick 10	
40	Continue northeast	0.1 km
41	Turn right	< 0.1 km
42	Arrive at Graphic Pick 11, on the right	
43	Depart Graphic Pick 11	
44	Go back northwest	< 0.1 km
45	Turn right	0.1 km
46	Turn left on Amaku Hospital Road and immediately turn right on Amaku Hospital Road	< 0.1 km
47	Arrive at Graphic Pick 12, on the right	
48	Depart Graphic Pick 12	
49	Go back west on Amaku Hospital Road	< 0.1 km
50	Turn left on Amaku Hospital Road and immediately turn left	< 0.1 km
51	Arrive at Graphic Pick 13, on the right	
52	Depart Graphic Pick 13	
53	Go back west	< 0.1 km
54	Turn right on Amaku Hospital Road and immediately turn right	0.1 km
55	Arrive at Graphic Pick 14, on the right	
56	Depart Graphic Pick 14	
57	Go back west	0.1 km
58	Turn left on Amaku Hospital Road and immediately turn left	0.2 km
59	Arrive at Graphic Pick 15, on the right	
60	Depart Graphic Pick 15	
61	Continue east	< 0.1 km
62	Arrive at Graphic Pick 16, on the right	
63	Depart Graphic Pick 16	
64	Go east	< 0.1 km
65	Arrive at Graphic Pick 17, on the right	
66	Depart Graphic Pick 17	
67	Continue east	0.5 km
68	Make sharp left	0.6 km
69	Turn right	0.7 km
70	Turn right	0.8 km
71	Finish at Graphic Pick 18, on the left	
Driving distance		**9.7 km**

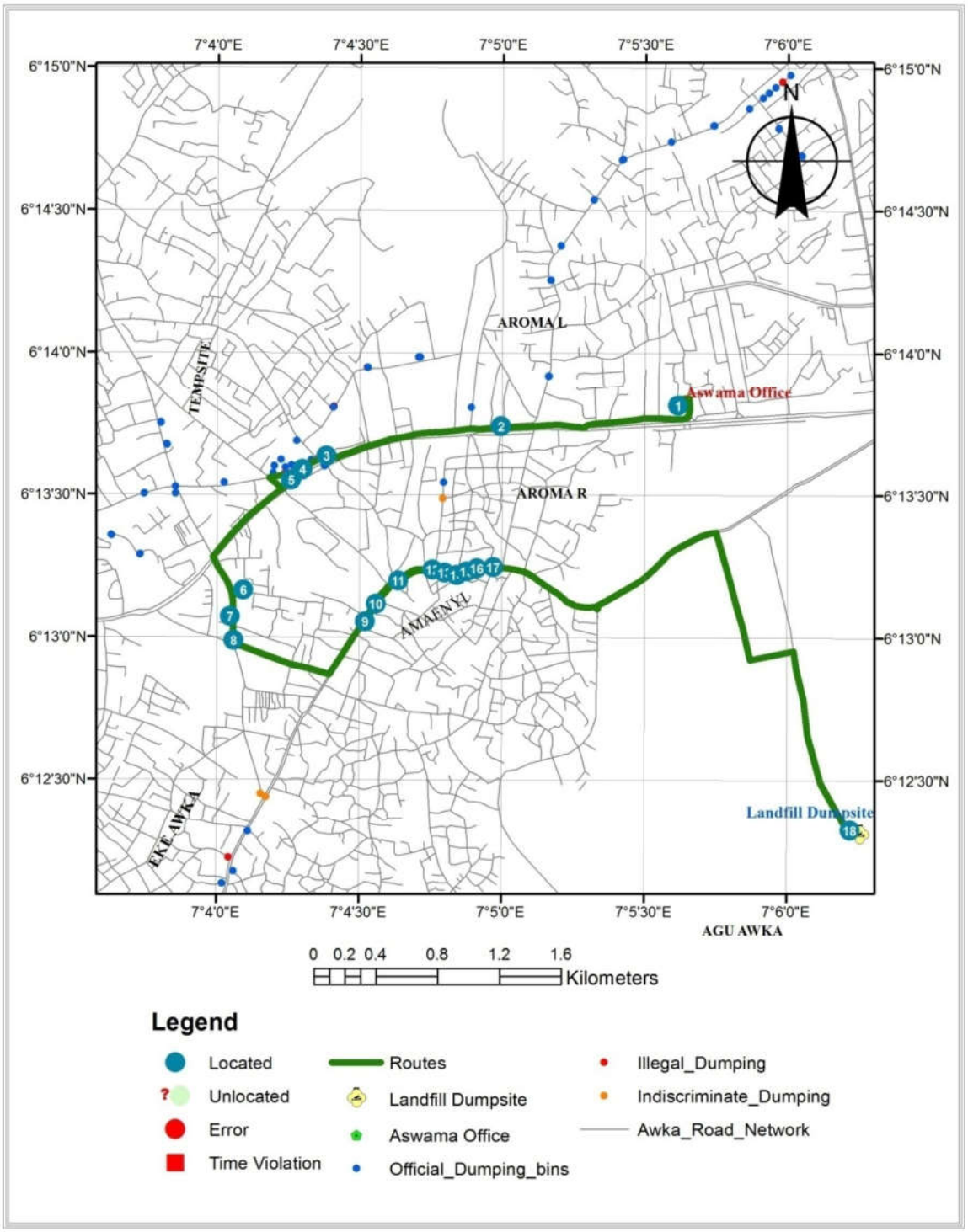

Figure6: Awka showing Best route for waste collection for Scenario 2 (Amaenyi)

CONCLUSION

Despite clear government policies on illegal waste disposal, heaps of uncollected wastes which portend health hazards still litter various neighbourhoods in Awka Town. Just like every other African market neighbourhood, Awka urban market neighbourhoods still grapples with increasing waste stream, overflowing dumpsters as well as inappropriate disposal methods. The conventional waste management methods in Awka urban which include open burning, landfilling and burying, which are mainly implemented have failed. This study therefore submits that solid waste management around the market areas in Awka is still rudimentary and have not reached acceptable standards for orderly disposal, storage, evacuation and final disposal. To improve efficiency in solid waste evacuation, this study therefore recommends that:

1. More dumpsters should be provided and strategically located within and outside the various markets to avoid the heaps of market wastes littering most neighbourhoods
2. Large dumpsters should also be provided and strategically located in market neighbourhoods to avoid illegal disposal of wastes on road divides, water channels and open spaces. The dumpsters should be within acceptable distances for residents to deposit there wastes
3. ASWAMA should be well equipped with modern equipment for waste evacuation. Researcher's field observations pointed to the fact that ASWAMA staff made use of crude implements such as brooms, sticks and rakes for waste evacuation.
4. Proper monitoring system should be implemented to ensure strict adherence to solid waste management regulations.

REFERENCES

Abdulrasoul, A. A. & Bakari, S.S. (2016). Challenges and Problems of Solid Waste Management in Three Main Markets in Zanzibar. *Advances in Recycling and Waste Management* ***1***(2), 2-9.

Amasuomo, E. & Baird, J. (2016). The Concept of Waste and Waste Management. *Journal of Management and Sustainability****6***(4), 88-96.

Butu, A. W. & Mshelia, S.S. (2014). Municipal Solid Waste Disposal and Environmental Issues in Kano Metropolis, Nigeria. *British Journal of Environmental Sciences 2*(2), 10-26.

Eze, B. U. (2014).The Adverse Impacts of Population Pressure and Agricultural Change on the Environment of South Eastern Nigeria: A Review. *World Engineering and Applied Sciences Journal 5*(2), 30-35.

Ezenwaji, E.E., Phil-Eze, P.O., Otti, V.I. & Eduputa, B.M. (2013). Household Water Demand in the Peri-Urban Communities of Awka Capital of Anambra State, Nigeria. *Journal of geography and Regional Planning 6*(6), 237-243.

Nwagwu, O. J., Madubuike, O. N., Okereke, C.D., Wole, R. & Chilakpu, K. O. (2018). Assessing the Vulnerability of Awka South Soil to Gully Erosion. *FUTO Journal Series4*(1), 316-325.

Omololu, F.O. & Lawal, A.S. (2014). Population Growth and Waste Management in Lagos. *The Nigerian Journal of Sociology and Anthropology, 1*(1), 83-100

Remigios, V. M., & Wiseman, M. (2012). The Management, Practice and Environmental Health Implications of the Municipal Waste Dumpsite in Alice, South Africa. *Journal of Social Sciences Research, 1*(5), 125-131.

Tahir, M., Hussain, T. & Behaylu, A. (2015). Scenario of Present and Future of Solid Waste Generation in India: A Case Study of Delhi Mega City. *Journal of Environment and Earth Science, 5*(8), 83-91