Optimization of Municipal Solid Waste Management In Ifite, Awka Urban Area, Anambra State, Nigeria

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Abstract- **Owing to a rapid surge in population and urbanization in Ifite, Awka Urban area of Anambra state, problems associated with municipal solid waste management have become a critical issue. Its direct impact on human health and aesthetic values of the environment makes it crucial. The aim of this study is to develop an optimum municipal solid waste collection and disposal system in Ifite, Awka urban area, Anambra state Nigeria through recommending best route for solid waste collection and disposal. From the findings, a collection and disposal plan was developed using GIS tools. ArcGIS 10.2 Network Analyst software was used to optimize solid waste collection and disposal routes for Ifite (scenario 1) as well as to calculate the distance for the scenario. The distance covered for scenario 1 is 12.3km.**

Keywords- Solid waste, Optimization, Arc-GIS, Awka, Environment

I. INTRODUCTION

Wastes can be defined as materials or substances which are regarded un-useful by its producers or holders and therefore discarded. Wastes occur in three different forms; solid, liquid and gaseous. Kalu, Inyama and Nwobi (2017) defined Solid waste as any material which comes from domestic, commercial and industrial sources arising from human activities which has no value to people who possess it and is regarded as useless. Municipal solid waste management (MSWM) is the process of collecting, storing, treatment and disposal of solid waste in such a manner that they are harmless to humans, plants, animals, ecology and the environment in general (Ezerie, Chima, Ogbonna and Chibunna, 2017). Waste generation is continuous and occurs in all places where there are living things. As part of metabolism, living things generate various waste products which are discharged directly to the environment. Uwakwe (2013), notes that other activities of man such as agriculture, food processing, wood work, building and construction as well as others also release various forms of wastes into the environment. In the past, wastes were easily degraded and

decay faster; this is because wastes produced were mainly organic in nature and therefore posed less risk to the environment. Uwakwe (2013) further notes that the era of technological advancement and industrialization has introduced various forms of equipments and facilities into government offices, residential homes, institutions, industries and commercial centres. The use of these gadgets have greatly improved the living conditions of man but have in turn led to higher quantities of waste generation, some of which are non-biodegradable and constitute great danger to the environment. Commenting on the alarming rate of urban population growth, Imam, Mohammed, Wilson, and Cheeseman, (2008) reported that while Nigeria's population increased by about 2.8% per annum, the rate of urban growth is as high as 5.5% per annum.

Ifite, Awka urban area, is densely populated as commercial residences are built haphazardly without proper planning. The area is peopled by staff and students of Nnamdi Azikiwe University as well as public servants who live in and around commissioner's quarters axis due to its proximity to the Anambra state government house as well as the state secretariat. In Ifite and the whole of Anambra state, solid wastes are solely managed by Anambra State Waste Management Agency (ASWAMA), which seems helpless in organizing prompt evacuation of wastes in the face of rapidly increasing population growth. Increase in the population of an area directly means increase in quantities of wastes generated which in turn pollutes the environment and causes health hazards. This reinforces Akanwa (2017) assertion that Nigeria has a population of 150million people and generates wastes ranging from 0.44 to 0.66 kg/capita/day and upto 25 million tonnes per annum, with household and commercial centers contributing 10% of total urban waste burden. The overall aim of this study is to develop an optimum municipal solid waste collection and disposal system in Ifite, Awka urban area, Anambra state Nigeria through recommending best route for solid waste collection and disposal.

Fig. 1 Overflowing dumpsters opposite Joy hostel, Ifite road.

II. MATERIALS AND METHODS

Available data of the study area on existing map was geo-referenced and digitized to define all the geographic datasets in the study area and to create buffer zones for the purpose of defining environmental safe distances and environmental sensitive zones. In this light, ArcGIS 10.2 software was employed to recommend suitable sites for locating dumpsters in order to enhance regular waste evacuation based on convenient distance to households and maximum service coverage. In addition, Q-GIS (version 2.14.2) was employed to enter data obtained from field work. The data was converted to a readable format and exported to ArcGIS 10.2 Network Analyst (NA) software which was finally used to find the best waste collection route to the approved waste dumpsite.

Fig. 2 Indiscriminate waste dump in front of St. Martins lodge, Ifite.

III. RESULTS AND DISCUSSION

In this study, GIS is used to model an optimal routing network that minimizes distance and cost for transporting Municipal Solid Waste (MSW) from a network of collection points to the approved dumpsite at Agu-Awka. The network was developed to inform and optimize collection points for Ifite and environs. Route optimization in this study comprises three phases: phase 1 creates a road network also known as "DATASET" using ArcGIS Network Analyst (NA); phase 2 analyses and calculates the number of arcs along the road network; and phase 3 performs the optimization of Municipal Solid Waste (MSW) collection for best route by applying ArcGIS Network Analyst.

Following the application of Network Analyst to solid waste evacuation and disposal in Ifite, Awka urban area, a scenario of waste management evacuation was produced and analysed below.

Scenario i

Table 1 shows the analysis of driving directions for best route for scenario I. Each of the arcs in this scenario was analysed in terms of direction and distance as well as the total distance covered. The best route details and driving directions for Anambra State Waste Management Agency (ASWAMA) crew are shown below.

Table 1: Best route analysis for scenario I

S/N	Driving Directions	Track Length
1	Start at Graphic Pick 1 (G.P 1)	
2	Go north 0.7 mi	0.7 km
3	Turn right on Umudioka Avenue	0.2 km
4	Turn left	0.7 km
5	Turn left on Esther Obiakor Road	0.4 km
6	Turn right on Ifite Road	0.4 km
7	Turn left	
8	Arrive at Graphic Pick 2, on the right	
9	Depart Graphic Pick 2 (G.P 2)	
10	Go northwest	< 0.1 km
11	Arrive at Graphic Pick 3 (G.P 3), on the right	
12	Depart Graphic Pick 3	
13	Go back southeast	0.2 km
14	Turn left on Ifite Road	0.2 km
15	Turn left	0.2 km
16	Arrive at Graphic Pick 4 (G.P 4), on the right	
17	Depart Graphic Pick 4 (G.P 4)	
18	18: Go back southeast	0.2 km
19	19: Turn right on Ifite Road	0.2 km
20	20: Turn right	0.3 km
21	Turn right	0.1 km
22	Arrive at Graphic Pick 5 (G.P 5), on the right	
23	Depart Graphic Pick 5 (G.P 5)	
24	Go back west	0.1 km
25	Turn left	0.3 km
26	Turn right on Ifite Road	2.7 km
27	Continue on Enugu-Onitsha Express	1.2 km
28	Turn left on Oby-Okoli Street	< 0.1 km
29	Continue on Arthur Eze Road	0.2 km
30	Turn left on Emma Nnaemeka Street	0.4 km
31	Turn left on Emma Nnaemeka Street and immediately turn right	0.2 km
32	Turn left	0.3 km
33	Turn right on Amaku Hospital Road and immediately turn left	0.8 km
34	Make sharp left	0.6 km
35	Turn right	0.7 km
36	Turn right	0.8 km
37	Finish at approved disposal site, on the left	
Driving distance	12.3 km	

In the case of waste evacuation from Ifite, Commissioners quarters and environs to the approved dumpsite at Agu-Awka, the best route from this point is shown in Fig. 3. The route is the quickest, shortest and most scenic route to the approved dumpsite.
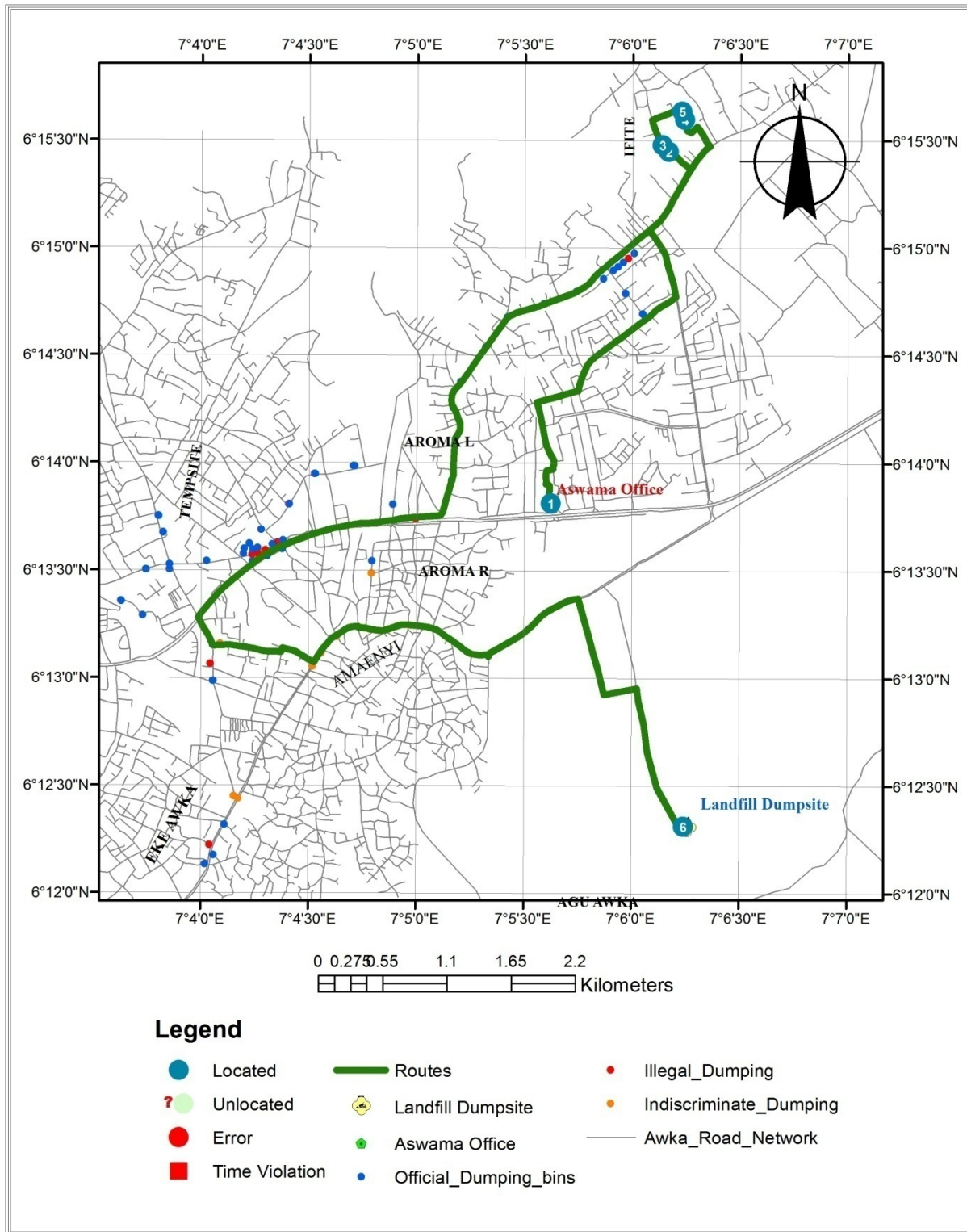
FIG. 3 Ifite, showing best route for waste collection for Scenario I

IV. CONCLUSION

In conclusion, it could be established that waste management in Ifite-Awka is still at rudimentary stage. This is against the backdrop of incessant spate of indiscriminate and illegal refuse dumping around the area without prosecuting the defaulters of environmental laws. This suggests that waste management system in Ifite-Awka is poor and lacks planned evacuation system. This study has further demonstrated the importance of GIS technology as a waste collection optimization tool capable of guiding proper decision making.

ACKNOWLEDGEMENT

REFERENCES

[1]. KALU, E.O, INYAMA, S.C, and NWOBI, F. N. (2017): Mathematical Model of Municipal Solid Waste Management System in Aba Metropolis of Abia State Nigeria. *Journal of Research in Applied Mathematics.* Vol. 3, issue 7, pp. 38-51 ISSN(Online) : 2394-0743 ISSN (Print):2394-0735.

[2]. EZERIE, H.E, CHIMA, G.N, OGBONNA, C.E, and CHIBUNNA, J.B. (2017): Municipalsolid waste management in Aba, Nigeria: Challenges and prospects. *Journal of Environmental Engineering Research.* Vol. 22, No.3, pp. 231-236.

[3]. UWAKWE, F.E (2013): Solid Waste Management in Owerri Municipality and its Immediate Environs. *Academic Journal of Interdisciplinary Studies.* Vol. 2, No. 5, pp.141.

[4]. IMAM, A. MOHAMMED, B. WILSON, D.C and CHEESEMAN, C. R (2008): Solid waste management in Abuja. *Elsevier Journal of waste management.* Vol. 28, pp. 468-472.

[5]. AKANWA, A. O. (2017): Characterization of Leachates from Solid wastedumpsites and its Implication on Sustainable Groundwater Sources in Anambra State, Nigeria. A paper delivered at 2nd International conference on the Environment (FESCON 2017), Chukwuemeka Odumegwu Ojukwu University.

[6]. EZENWAJI, E. E., PHIL-EZE, P. O., ENETE, I. C., and OSUIWU, B. O. (2014): An Analysis of the Cycles and Periodicities of Annual Rainfall over Awka Region, Nigeria. *Atmospheric and Climate Sciences.* Vol. **4**, pp. 665-671.

[7]. EZENWAJI, E.E., PHIL-EZE, P.O., OTTI, V.I., and 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.*Vol.6, No.6, pp. 237-243. ISSN. 2070-1845.

[8]. EZEAH, C.(2010): *Analysis of Barriers and Success Factors affecting the Adoption of Sustainable management of municipal solid waste in Abuja, Nigeria.* A Ph.D thesis submitted to university of Wolverhampton.

[9]. GEOFFREY, I. N. (2005): The Urban Informal Sector in Nigeria: Towards Economic Development, Environmental Health, and Social Harmony. Global Urban Development Magazine . Vol. 1, No. 1.

[10]. HAREESH, K.B., MANJUNATH, N.T., and NAGARAJAPPA D.P. (2015): Route Optimization Model for Municipal Solid Waste Management by a Decentralized System in Davangaree City. *International Journal of Emerging Technology and Advanced Engineering.*Vol. 5, ISSN 2250.

[11]. IGBINOMWANHIA, D. I. (2011). Status of Waste Management. *Journal of Integrated Waste Management* Vol. 2, pp. 11-34.

[12]. IRO, S. I, OKORONDU, U. V, MBANO, E., and Duru, P. (2012): "Implications of Geographic Information System in Mapping Solid Waste Collection Points in New Owerri, Imo State". *An International Journal of Science and Technology Bashir Dar, Ethiopia.* Vol.1, No.1, pp. 60-69.

[13]. KADAFA, A.Y., ABDULLAH, H. O., and SULAIMAN, W.N. (2013): Current Status of Municipal Solid Waste Management Practice in FCT Abuja. *Research Journal of Environmental and Earth Sciences.* Vol.5, No.6, pp. 295-304, ISSN: 2041-0484; e-ISSN: 2041-0492.

[14]. KARADIMAS, N. V., KOLOKATHI, M., DEFTERAIOU, G., & LOUMAS, V. (2007).Municipal Waste Collection of Large Items Optimized with Arc GIS Network Analyst. *21st European Conference on Modeling and Simulation.*

[15]. KARADIMAS, N.V, and LOUMOS, V.G. (2008): GIS- based modeling for the Estimation of Municipal Solid Waste Generation and Collection. *Journal of Waste Management and Research.* Vol. 26, pp. 337-346.

[16]. KANCHANABHAN, T.E., MOHAIDEEN, J.A., SRINIVASAN, S., and SUNDARAM, V., (2010): Optimum Municipal Solid Waste Collection using Geographical Information System (GIS) and Vehicle Tracking for Pallavapuram municipality. *Journal of Waste Management and Research*. Vol.8, No. 6.