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Application of Geographic Information Systems to Management of Municipal Solid Waste Depots in Lagos Island Local Government Area of Lagos State

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Abstract

The nature of socio-economic transactions taking place in Lagos Island every day makes solid waste management challenges more acute. These transactions generate large volume of waste which has become an environmental challenge because of poor refuse management strategies which do not match the rate of refuse generation. This study examines the underlying factors militating against efficient control of solid waste collection in Lagos Island by applying geographic information systems and conventional qualitative and quantitative research techniques to proffer possible solutions. A set of structured questionnaire was administered on 240 households in the six wards in Lagos Island that had waste depots to collect information on the mode of storage, transportation to communal waste depots and methods of disposal of solid waste in the area. However, only 215 copies (89%) of the questionnaire were retrieved for analysis. Digital analyses such as nearest neighbour, buffering, overlay and distance measurement were carried out with the aid of ArcMap 9.3 to reveal the geographical locations of solid waste depots, the spatial pattern of distribution, and distances covered by residents and traders to dispose solid waste. The existing 13 designated refuse depots were found to be grossly inadequate to facilitate effective evacuation of solid waste in Wards A, B, and C, while D, E, and F and G did not have waste bins. In the three wards where waste bins were provided, the distances of more than 200m between respondents' residences and waste depots, as well as the complete absence of waste depots in others, encouraged patronage of illegal refuse collectors who disposed refuse indiscriminately. It is recommended that public awareness campaign be heightened and sustained and additional communal solid waste depots provided in Lagos Island to facilitate accessibility and reduce the distance usually covered by residents and traders to dispose refuse. This will promote prompt and healthy disposal of solid waste in Lagos Island and prevent possible incidence of enteric ailments.

1.0 Introduction

Waste generation as an activity is not problematic per se, but subsequent phenomenal collection, storage, and disposal, in the face of rapid and uncontrollable urbanisation, pose challenges in many cities in Nigeria. In spite of the obvious solid waste management revolution in Lagos State, municipal solid wastes of all descriptions are on daily basis, deposited indiscriminately in public places. It is amazing that public drains, undeveloped land, verges of major roads and streets; canals, lagoon, and air spaces of residential and commercial buildings are receptacles of municipal solid wastes in many parts of Lagos City, particularly in Lagos Island.

Municipal or urban solid waste is refuse that includes predominantly household wastes, with sometimes the addition of commercial waste, collected by a municipality within a given area. They are in solid or semisolid form and generally exclude industrial hazardous wastes. Municipal solid waste is a useless or an unwanted material discharge that resulted from human or animal activities. It comprises garbage or food wastes: rubbish, including glass, tin cans, paper, and fresh / garden wastes (which include larger items like tree limbs), and old appliances among others. Most commonly, it is solids, semi solids, or liquids in containers thrown out of houses, commercial or industrial premises (Morgan, 1979).

Waste, either solid or liquid, is an integral part of human activities (Ojolowo & Wahab 2011). Its generation, regardless of the quantity involved, does not automatically breed environmental nuisance. However, sanitary storage, regular and efficient evacuation and disposal of waste that is abreast of rate of generation may help eliminate any known form of environmental harm. Environmental nuisance ensues when evacuation and disposal of waste perpetually lag behind the rate of generation. Waste management is a coordinated and systemic control of waste through a sequence of actions to mitigate public health and environmental risks associated with insanitary waste management. Functional municipal waste management cannot be achieved without deciphering the socio-economic and environmental influence underpinning waste generation, storage, collection, and disposal.

Lagos Island, though one of the smallest in terms of land area, is one of the major and oldest commercial centers in Nigeria. The commercial and domestic activities generate wastes of all descriptions (both solid and liquid). Out of these, solid waste is posing an evergreen problem because of the quantity involved. The addition of solid waste generated from commercial activities to that of the households in Lagos Island is no doubt a serious environmental problem, particularly concerning effective storage and disposal. One major cause of this challenge in Lagos Island, is the rapid rate of per capital generation of waste, which is increasing geometrically, because of the rapid rate of urbanization and subsequent population growth.

The problem is aggravated by lack of adequate communal solid waste depots in Lagos Island. Communal Solid Waste Depot (CSWD) is the first point where all types of waste are deposited by residents and traders alike (after storage in either paper, plastic, rubber or nylon containers) prior to removal and subsequent transportation to landfill sites by agents of the Lagos State Waste Management Authority. In the absence of enough CSWD, waste of all descriptions are deposited indiscriminately anywhere thereby creating nuisances that are detrimental to public health.

The state of municipal solid waste management in Lagos Island is a serious concern. The problem is even worst with respect to non-solid wastes since no city in Nigeria has a sewage system worth its name (Lagos State Ministry of Economic Planning and Budget 2004). Wastes of all descriptions find their ways into public places such as open space, drainage channels, lagoon, and road verges. Many households and business outfits do not use waste bins or bags to store and dispose wastes at designated communal waste depots; rather they throw it in the drains, canals, roadside, or in any available open spaces . In addition, and on many occasions, residents contracted cart-pushers and waste porters to discard loose wastes. The cart-pushers and waste porters themselves also, either dump the unkempt waste in illegal dumpsites or in public drains, lagoon etc. Besides the health

hazards associated with waste, solid wastes clog both the drainage systems and hydraulic structures, thereby facilitating urban flooding which sometime can ignite outbreak of diseases.

In Lagos Island, over 307.15 tons of trash, garbage, scraps and other debris were estimated to be generated in 2008 by 122,862 households alone (LAWMA, 2010). The rate of municipal solid waste generation in Lagos Island is geometric. The inadequacy of waste collection sites and the skewed location of the available ones encourage indiscriminate deposition of waste of all types onto every available space, including the rooftops in the study area. The analog methodologies in use by Lagos State Waste Management Authority (LAWMA) in capturing waste generation, deposition, removal and disposal is far loosing efficacy. This paper argues that the employment of the digital techniques of Geographic Information Systems (GIS) to locate municipal solid waste depots is capable of revealing, at a glance, the adequacy or otherwise of refuse deposition sites. The provision of sufficient refuse depots is a healthy and sustainable strategy to avert indiscriminate deposition of waste in public places.

The main thrust of this paper is to apply GIS techniques to map communal solid waste depots in Lagos Island Local Government Area of Lagos State. It also examines the present waste management strategies in Lagos Island, and analyses the urban land use in the Local Government Area using remote sensing and GIS technology. The paper finally generates the pattern of location and the distance matrix of existing communal waste depots. It recommends the provision of adequate communal solid waste depots, and suggests possible reallocation of existing ones in the study area using GIS technology.

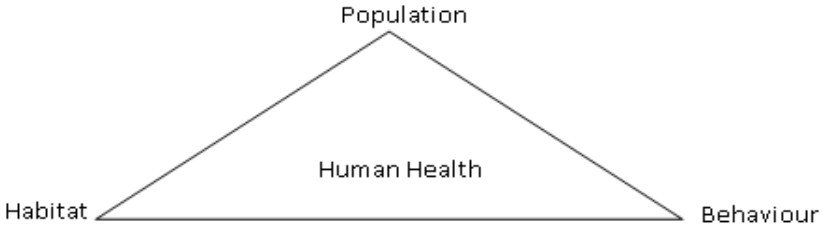
2. Conceptual Framework

2.1 The Triangle of Human Ecology

Melinda et al. (1998) developed the concept of triangle of human ecology. They theorized that the *human ecology* of disease is hinged on the ways human behaviour, in its cultural and socio-economic context, interacts with environmental conditions to produce or prevent diseases among susceptible people. The theory is based on a tripod that forms its triangle- habitat, population, and behaviour (see Fig. 1). This tripod determines the state of human health. The thrust of the concept is the interactions that exist among naturally occurring biotic and physical phenomena of the habitat, populations, and behaviour.

Habitat is a place or the environment within which people live, that which directly affects them (Melinda et al., 1998). Houses and workplaces, settlement patterns, naturally occurring biotic and physical phenomena, health care services, transportation systems, and government are parts of the habitat. The type of houses, the presence of domestic animals, and the kinds of pens and buildings within which they are confined are all of consequence to health. Population is concerned with humans as organisms, as the potential hosts of disease. The ability of a population to cope with health challenges depends on its genetic susceptibility or resistance, its nutritional status, its immunological status, and its immediate physiological status. Through their behaviour, people create habitat conditions, expose themselves to, or protect themselves from habitat conditions, and move elements of the habitat from place to place. The habitat presents opportunities and hazards to the population, which can modify its behaviour.

Fig. 1: The Triangle of Human Ecology



Source: Melinda et al. (1998)

2.2 The Concept of Geographic Information System (GIS)

Rhind, (1989:4) defines GIS as "a computer system for collecting, checking, integrating and analyzing information related to the earth surface''. Other definitions (Pickles, 1991; DeMers, 2000; and Chang 2008) give clearer insight into what GIS really is. Burrough, (1986) describes GIS as a powerful set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from the real world. GIS is also a decision support system involving the integration of spatially referenced data in a problem-solving environment (Chang, 2008). The definition by DeMers, (2000) is adopted in this paper. He defines GIS as the "tools and procedures for gathering, colleting, storing, managing, analyzing and integrating spatially referenced data for decision making in a problem solving environment" (DeMers, 2000:3). This activity is also referred to as Spatial Decision Support System (SDSS). Geographic Information Systems can be viewed as a holistic integration of computer hardware, software, data, and people. Fabiyi (2001) identified a number of elements that are essential for an effective GIS. These include: (1) Institution, (2) People, (3) Organizational structure, (4) Software, (5) Computer hardware, (6) Graphically referenced data, and (7) Procedural techniques/analysis.

3.0 Literature Review

The perceived significant impacts of waste on the constituents of the environment, particularly human, have spurred a number of studies (Wahab & Sridhar, 2009; Wahab, 2004; Sridhar, 1999; UN-Habitat, 1999; Sridhar, et al. 1985; Egunjobi, 1986). There is increased solid waste generation resulting from the ever increasing urban population which exerts an overwhelming influence on the ability of municipal authorities to manage and this results in degraded environments and an increase in health risks (UN-HABITAT, 2010; Ajadike, 2001). NISER (1984) cited by Ajadike (2001), observed that most city residents dispose of their refuse either in open gutters, rivers, streets and open dumps, without regard to the environment and associated health hazards.

Of all the costs of urban environmental degradation, damage to human health is by far the highest (Wahab and Sridhar, 2009; Adelegan, 2004; Obire and Aguda, 2002; Health Stream, 1996). The report released by the World Health Organisation in May 1996, estimated that of the 51.9 million worldwide deaths in 1995, about 17.3 million (33%) were due to infectious diseases. In this group of diseases, about 22% (3.75 million deaths) were due to food, water, and soil borne agents (Health Stream, 1996). Joshi (2001) also asserted that improper waste disposal leads to human health problems, contamination of water supplies, environmental degradation, loss of livelihoods, and unsightly surroundings.

The literature suggests that countries around the world have successfully applied GIS to their urban waste management planning process. Remote sensing data can be an aid in the identification and location of garbage dumping sites and in monitoring the changes in land use within and near hazardous waste and sanitary landfills (Radhakrishnan and Adiga 1996; Amusan, 1998). As Rahman et al. (2009) inform us, an attempt has been made to assess some of the urban environmental issues which Delhi is currently facing with the help of geo-spatial tools, i.e. remote sensing (RS), geographic information system (GIS), and global positioning system (GPS). Rajeshwari (2006) and Verma et al. (2008) combined IKONOS Multi-Spectral and PAN images to analyze location of

infrastructures in Dehradun Municipality, India and determined land-use and land cover change for better management of urban environment.

Rahman and Rahman (2011) used ArcGIS 9.2 with its network analyst extension to recommend efficient waste management options through existing and proposed number of waste bins and containers in Dhaka City. In 2006, Anjonrin-Ohu used Geographic Information System to develop a methodological approach that could facilitate the selection of appropriate site for collecting city wastes in Oyo West, Oyo East, Atiba, and Afijio Local Government Areas of Oyo State, Nigeria. He found that there was significant correlation between the use of GIS and selecting appropriate site for management of municipal waste and suggested further research into the challenges likely to hinder the implementation of GIS-related programmes and policies of the concerned authorities.

Bhambulkar (2011), Kardimas (2007) and Andrukonayte (2008), employed ArcGis network analyst to optimize municipal solid waste collection routes in Nagpur City, India. Estimation and allocation of solid waste bin with the use of geographic information system were successfully carried out in Asansol municipality in West Bengal, India (Vijay, 2008). GIS is highly efficient in coordinating solid waste collection (Kyesski, 2009). The ability to effectively carry out solid waste collection rests solely on the available techniques (Indeglia, 2006).

4.0 Study Area

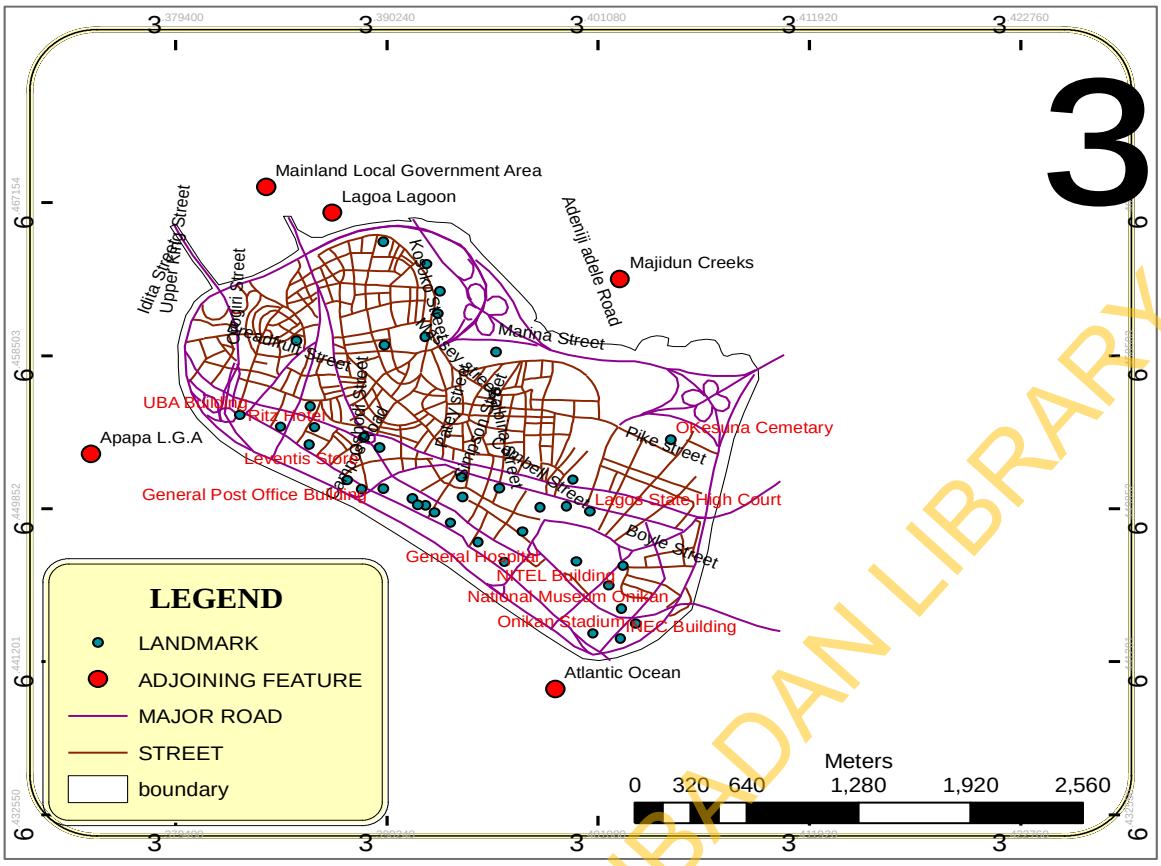
Lagos Island is located approximately between Latitude $6^{0}\ 24^{1}$ and $6^{0}\ 27^{1}$, and Longitude $3^{0}\ 21^{1}$ and $3^{0}\ 25^{1}$ within Lagos State (Fig. 2). It is bounded in the South by the Atlantic Ocean, in the North by Lagos Lagoon and the Lagos Mainland Local Government Area, in the East by Majidun Creeks and in the West by Apapa Local Government Area. It is one of the fifteen local governments created in November 1991. Its existence is dated back to 1660 when

Yoruba farmers and migrants anglers from Isheri, a settlement about 16 kilometers north of Lagos Island, inhabited the settlement. It is the oldest and currently having the old colony of Lagos within its area. Its land area is 8.7 km^2 with a population of 209,437 people, and density of 24,182 inhabitants per km^2 (Wikipedia, 2012; Lagos State, 2004).

5.0 Methodology

A combination of stratified, systematic, and random sampling techniques was adopted in this research to distribute questionnaires used for the collection of socio-economic data from inhabitants of Lagos Island. Lagos Island is re-classified into six (6) wards (A, B, C, D, E, and F&G.). The first three wards (A, B, and C) had communal waste bins located within their area of jurisdiction, while the last three (D, E, and F&G) did not have. About 48 streets (8.9% of 537) and 240 buildings were systematically sampled in the study area based on the number of streets per ward (Table 1). The two hundred and forty (240) questionnaires administered on household heads randomly selected from sampled buildings were analysed.

Fig. 2: Lagos Island Local Government



Source: Surveyor General's Office, Lagos State Secretariat, Alausa, Ikeja, 2010.

Table 1: Sample Frame, Sample Size and Questionnaire Allocation

WARD	NUMBER OF STREET PER WARD	NUMBER OF SELECTED STREET PER WARD	NUMBER OF SELECTED BUILDING PER STREET	NUMBER Of QUESTIONNAIRE RETRIEVED PER WARD
A	125	11	55	50
B	109	10	50	43
C	67	6	30	29
D	47	5	25	22
E	81	7	35	33
F&G	108	9	45	38
Total	537	48	240	215

Source: Author's fieldwork, 2010.

The secondary data used for this study include information about the locations, conditions and records of existing communal refuse depot sites. These were collected from Lagos Waste Management Authority (LAWMA) at Ijora. Also, topographical and land-use maps of Lagos Island were collected from the Surveyor General's Office, Lagos State Secretariat, Alausa, Ikeja, while the number of streets and buildings in each ward was collected from the Information Unit, Lagos Island Local Government Secretariat, 64, Freeman Street, Lagos. The 2010 image of Lagos Island Local government was obtained from Google Earth.

The map of Lagos Island collected from the Surveyor General's Office, Lagos State Secretariat, Alausa, Ikeja, and the image downloaded from Google Earth were geo-referenced and

digitized in ArcGis 9.3 environment. The area of interest was extracted from the Google imagery after which the digitized vector layer was overlaid on the Google imagery. Field verification was undertaken to cross-verify the Google interpretation. This facilitated aptly mapping of various land uses in the study area. Information about the locations of communal waste depots was obtained from LAWMA at Ijora. Geographic coordinates of the locations were generated with the aid of Global Positioning System (GPS) (Garmin 76) and subsequently geo-referenced. Buffering of 200m was made around the locations of the depots to reveal the distance among them. The major road networks, commercial areas, residential areas, and institutional land uses were marked.

6.0 Results and Discussions

6.1 Existing Waste Management Strategies in Lagos Island

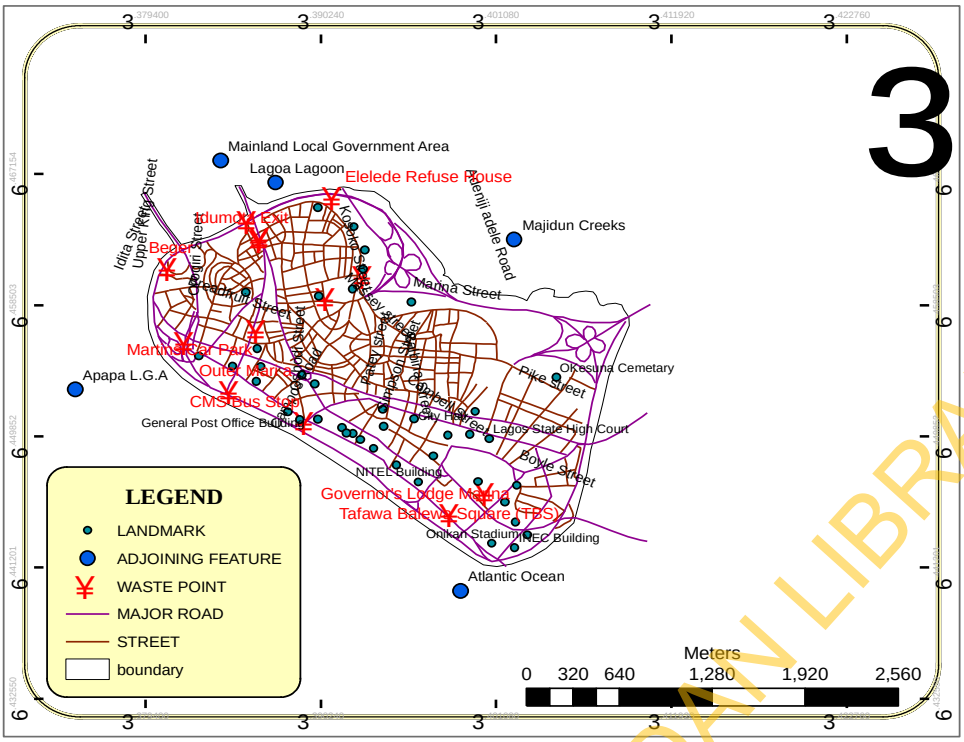
Thirteen communal solid waste depots were found in Wards A, B, and C in Lagos Island at the time of survey (see Fig. 4). The yardstick employed by the Lagos State Waste Management Authority in selecting sites for communal solid waste depots (CSWD) was the type of landuse activities taking place in Lagos Island (see Fig. 5). The study found that CSWDs were located in areas where there were buying and selling of both consumable and non-consumable goods. For instance, two waste depots, with two bins that were less than 200m apart were sited under the Carter Bridge at Idumota. Another two depots with similar characteristics were located at Jankara Market and Idumagbo Avenue, while another depot at Adeniji Adele Road by Pelewura Market was more than 200m away. The refuse depots at Berger, Apongbon, and Martins Streets were more than 200m apart, and were servicing the traders, while the depots at Outer Marina and Odunlami Street very close to CMS Bus stop, were also more than 200m apart, but servicing banks and other tertiary activities. The refuse depot at Tafawa Balewa Square (TBS) was less than 200m away from the one in front of the Governor's lodge at Marina (see Fig 5) and they were both servicing government facilities in the area.

Discussions with officials of Lagos State Waste Management Authority (LAWMA) revealed that Mobile Waste Collection System (MWCS) was adopted for residential areas. Mobile Waste Collection System is a way by which itinerant refuse conveyances move from street-to-street collecting refuse from residents for onward disposal to Adeniji Adele Refuse Loading Station. About 206 (96%) of the respondents indicated that the itinerant refuse collectors had not being coming to their areas to collect refuse. Consequently, the use of cart pushers and solid waste porters for waste disposal became the last resort for the residents. Those respondents who indicated that they patronized cart pushers were 185 (86%), 20 (9%) signified the engagement of porters, while the remaining 10 (5%) traveled more than 200m to discard refuse at designated refuse

depots. All other means of waste disposal (cart pushers and refuse porters) indicated by the respondents apart from designated refuse depots had been out-lawed in Lagos State. Therefore, the cart pushers and solid waste porters can be described as illicit solid waste collectors, which is why they found it difficult to dispose waste at designated places. The consequences of this action are not farfetched; refuse of all descriptions were dumped indiscriminately in public drains, undeveloped land, in the lagoon and road verges.

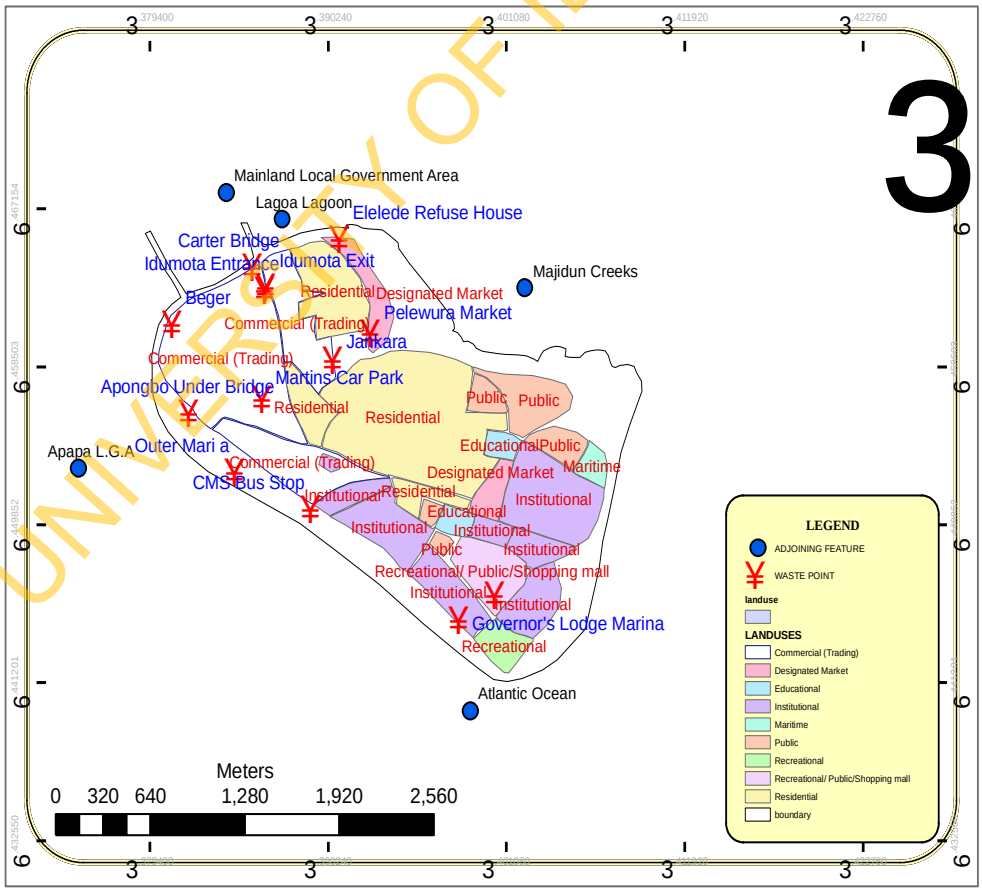
A buffer of 200m was created around the CSWDs as shown in fig.6 and overlaid on the major roads and streets layer to reveal how far the waste depots were from one another. The result showed that seven refuse depots were less than 200m away from one another (Idumota Entrance, under the Carter bridge, and Idumota Exit; Tafawa Balewa Square and Governor's Lodge Marina; Jankara and Pelewura); while the remaining six were more than 200m away from one another. These were those around Odunlami/CMS bus stop, Outer Marina, Apongbon under bridge, Berger, and Adeniji Adele Road by Pelewura Market (see Fig. 6).

Fig.3: Locations of Communal Waste Depots in Lagos Island Local Government Area



Source: Author's Fieldwork, 2010.

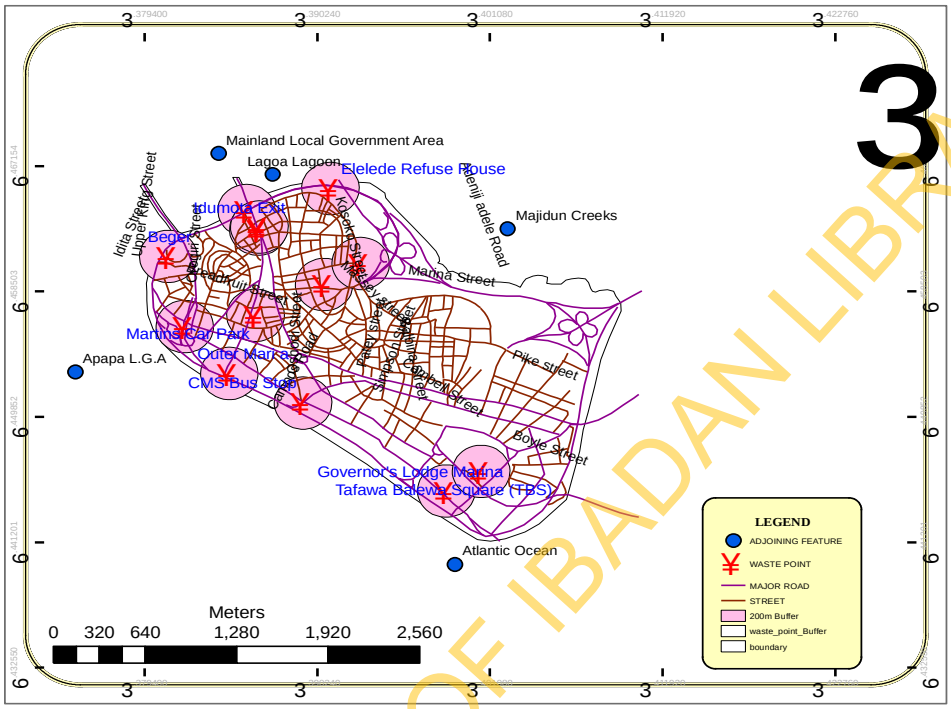
Fig.4: Land use and Locations of Communal Solid Waste Depots in Lagos Island Local Government Area



Source: Author's Fieldwork, 2010.

The implications of the varying distances are that each time people intended to dispose refuse, they would cover less than 200m to dispose waste in places where waste depots were less than 200m. However, in areas where refuse depots were more than 200m, residents had to trek more than 200m to discard refuse. This could make some people to want to dispose their waste anywhere nearby rather than cover the perceived "long distance" of over 200m to designated waste depot. The consequence is unhealthy and unsightly living and working environment.

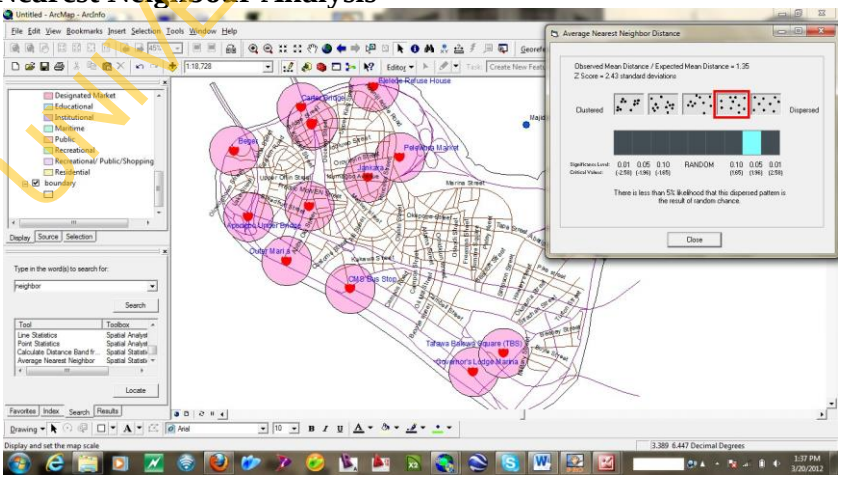
Fig.5: 200m Buffering around Communal Solid Waste Depots in Lagos Island Local Government Area.



Source: Author's Fieldwork, 2010.

The result of the nearest neighbour analysis carried out in ArcGIS 9.3 environment depicted the value of **R** as 1.35 (Fig.7), that is, the spatial distribution of communal solid waste depots in Lagos Island is tending towards dispersal, which shows that CSWDs were not evenly distributed in Lagos Island. In addition, the distance matrix analysis executed in ArcGis environment showed clearly the distance of the CSWD from one another (see Table 2).

Fig.6: Nearest Neighbour Analysis



Source: Authors' Analysis, 2010.

Table 2: Distance Matrix Analysis.

ID	1	2	3	4	9	12	10	13	7	8	11	6	5
1	0	285.0412	1199.993	1753.287	1789.095	1835.398	1884.158	2207.034	2386.894	2395.668	2444.197	2549.524	2631.816
2	285.0412	0	1341.866	1901.259	1794.216	1793.133	1967.018	2335.457	2410.287	2417.239	2398.049	2570.766	2721.044
3	1199.993	1341.866	0	559.4406	914.8843	1137.333	745.5774	1007.177	1362.463	1375.811	1647.108	1519.349	1457.465
4	1753.287	1901.259	559.4406	0	944.5013	1239.44	479.3706	472.6067	1119.285	1135.911	1575.673	1248.375	987.532
5	2631.816	2721.044	1457.465	987.532	1102.49	1336.805	754.0694	547.0329	658.7604	671.1208	1239.314	647.125	0
6	2549.524	2570.766	1519.349	1248.375	779.6787	888.6091	801.647	984.4241	162.9043	153.9707	605.4081	0	647.125
7	2386.894	2410.287	1362.463	1119.285	622.7485	757.7345	658.0208	902.4863	0	17.30417	588.8239	162.9043	658.7604
8	2395.668	2417.239	1375.811	1135.911	627.8143	756.0184	673.7516	919.6291	17.30417	0	574.1758	153.9707	671.1208
9	1789.095	1794.216	914.8843	944.5013	0	301.2145	530.0968	1019.27	622.7485	627.8143	734.2578	779.6787	1102.49
10	1884.158	1967.018	745.5774	479.3706	530.0968	830.2009	0	499.5625	658.0208	673.7516	1098.057	801.647	754.0694
11	2444.197	2398.049	1647.108	1575.673	734.2578	608.9181	1098.057	1460.668	588.8239	574.1758	0	605.4081	1239.314
12	1835.398	1793.133	1137.333	1239.44	301.2145	0	830.2009	1313.492	757.7345	756.0184	608.9181	888.6091	1336.805
13	2207.034	2335.457	1007.177	472.6067	1019.27	1313.492	499.5625	0	902.4863	919.6291	1460.668	984.4241	547.0329

Source: Authors' Analysis, 2010.

Note: CSWD 1= Governor's Lodge at Marina. **2=** Tafawabalewa Square. **3=** CMS Bus stop. **4=** Outer Marina. **5=** Berger. **6=** Under Carter Bridge at Idumota. **7=** Idumota Entrance. **8=** Idumota exit. **9=** Jankara Market. **10=** Martins Car park. **11=** Elelede Refuse House. **12=** Pelewura Market. **13=** Apongbon under bridge.

6.2 Discussions

Sequel to the spatial analysis carried out on the locations of communal solid wastes depots in Lagos Island Local Government Area, the depots are considered inadequate (Fig. 4) to service the entire Island. Majority (85%) of the refuse depots were concentrated haphazardly in areas where higher proportions of commercial activities were taking place (Fig. 4.5). The result of the buffering also revealed that traders and residents alike had to trek for more than 200m to discard solid waste. On interrogation during fieldwork, the traders affirmed that due to unavailability of time and the long distance to waste depots, they patronised cart pushers and solid waste porters who, unknown to them, disposed of refuse indiscriminately and illegally in nearby public spaces and facilities. They engaged themselves in illegal waste collection and could not access or approach legally designated places to discard waste; because the State Government had barred them from collecting refuse in Lagos State.

Communal solid waste depots were conspicuously absent in Wards D, E, and F&G (fig.5). These Wards were not devoid of serious commercial activities, as each building in the Wards had at least six shops on the average. This implies that two types of solid wastes (domestic and commercial) were generated on daily bases there, yet there was no single waste depot. The result is that, rather than have LAWMA or the Private Refuse Contractors (PRCs) collecting waste in the area, the activity was being undertaken by the itinerant refuse collectors whose visitations were not regular. Therefore, the residents were susceptible to disposing refuse indiscriminately in public drains, road verges, uncompleted buildings, open spaces and within building air spaces. One of the major consequences of this attitude is flooding in Lagos arising from the blockage of drainage channels and hydraulic structures by the solid waste that people dumped indiscriminately on daily basis.

7. Summary, Conclusion, and Recommendations

7.1. Summary

Majority (95%) of the respondents in Lagos Island Local government area were fond of contracting refuse disposal to cart pushers and waste porters. This is contrary to the statutory waste disposal strategies adopted by Lagos State Waste Management Authority, which barred cart pushers and waste porters from disposing refuse at designated waste depots. Hiding under the self-employment and economic survival strategies, the cart pushers and waste porters found easy patronage from many residents who had no time but willing to pay little for waste collection services and, therefore, continued to collect waste and discard in any available places.

From the spatial analyses carried out, it is obvious that the thirteen communal solid waste depots provided by Lagos State Waste Management Authority are grossly inadequate to service the entire Lagos Island (Fig.4). The outcome of the nearest neigbour analysis showed that the CSWDs are dispersed (R=1.35), which is against the principle of even distribution in space; more so, there is hardly any part of the Island where both commercial and residential chores are not being carried out on daily basis. Besides the inadequateness of the CSWDs, the thirteen depots provided are not evenly distributed over space, because six out of the twelve refuse depots are more than two hundred meters apart (Fig.5). Unarguably, this is one of the major causes of indiscriminate and unhealthy dumping of waste particularly in residential and market places where solid waste depots were not provided.

7.2 Conclusion

The yardsticks employed by Lagos State Waste Management Authority in selecting locations for communal solid waste depots in Lagos Island are not scientific. Adequate communal solid waste depots are supposed to be located in all parts of Lagos Island to accommodate the volume of waste generated by mixed land use activities going on therein. There is no exclusive landuse pattern that can be assigned to a particular part of the Island because trading and residential activities are taking place concurrently and in a mixed form everywhere. Both landuses are known to rapidly generate solid waste of all descriptions that causes environmental pollution.

The indiscriminate manner in which solid wastes are dumped in Lagos Island appears to pose a high risk to public health and the environment in general. There is urgent need for the Lagos State Waste Management Authority to respond by adopting acceptable scientific methodology in sitting communal solid waste depots at appropriate places in Lagos City, and Lagos Island in particular to avert indiscriminate solid waste deposition and its attendant environmental health consequences.

7.3 Recommendations

Considering the landuse pattern of Lagos Island local government area, it is imperative to provide solid waste depots that are not more than two hundred meters apart. Two giant waste bins should be provided in each market place, and single bins for residential areas. Public awareness campaign on the negative consequences of insanitary disposal of solid waste needs to be heightened and sustained to correct the poor attitude of residents of Lagos Island towards organised waste dumping. Government should empower and adequately equip Environmental Health Officers to facilitate proper monitoring of the environment in order to curb indiscriminate dumping of wastes. It is strongly recommended that LAWMA should integrate Remote Sensing and GIS into waste management strategies to allow for even allocation, efficient location, and adequate and regular monitoring of performance of waste management facilities and particularly the stakeholders.

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