RESEARCH ARTICLE

ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF SOLID WASTE DUMPING AND BURNING ON THE MAJOR MOTORWAYS IN DEVELOPING COUNTRIES

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ARTICLE INFO

ABSTRACT

Population growth, increase urbanization and more demand for goods and services have caused the persistent rise in the volumes of solid wastes generation in the developing countries. This has posed threats to the environment and socio-economic indices. It is challenging that the management is becoming cumbersome as the dumpsites have been on rapid accumulation along major roadsides in Nigeria. This study assessed the environmental and socio-economic impacts of the roadside solid waste dumping and burning vis-à-vis the perceptions of the various groups of road users. Primary data were collected through field observations and interviews from 10% of the major motorways. Secondary data from the relevant literatures were integrated to consolidate the research findings. The participants were categorized into three different groups based on their forms of road usage. At P-values 0.33, 0.30 and 0.19 it was concluded that there was no significant mean differences between the perceptions of the people on the environmental and socio-economic impacts of the roadside municipal solid waste dumping and burning. The study concluded that municipal solid waste is a cankerworm which is speedily affecting the human and natural ecosystems. It was recommended that improved management strategies be introduced to ameliorate the environmental and socioeconomic nuisance.

INTRODUCTION

Solid waste is any unwanted or discarded material that is not liquid or gas. It consist of day-to-day consumed and discarded items such as food wastes, containers, product packaging and other miscellaneous such as residential, commercial, electronic wastes, institutional and industries sources (Njoku *et al*., 2015; Miller, 1997). The pollution of the environment through human activities is globally known to have negative impacts on the ecosystems. The disposal and management of municipal solid waste is a challenging issue especially in developing countries because of the associated ecological, social and economic consequences (Butu *et al*., 2013). The growth in population and urbanization poses serious constraints to the provision of solid waste management services by the government which lack funds, deficient in institutional organization and interest, have poor equipment for waste collection, and lack urban planning (Parrot *et al*., 2009). Poor solid waste management also directly affects environmental sanitation (David *et al*., 2014).

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In the developed countries, waste storage, collection and sanitary disposal and the technology of waste cycling and landfilling are of standards. The developed countries have established regulated schemes for the disposal and management of solid wastes. On the contrary, developing countries have weak programs and have typically continued to apply unsophisticated approaches such as open dumps (Berkun *et al*., 2005). Generally, in the less economically developed nations, there has been lack of institutional framework and planning in solid waste management majorly because of economic backwardness and inadequate regulatory information (Al-Khatiba *et al*. 2003; Tiynmaz and Demir, 2006; Vesilind *et al*., 2002). The accumulation of the wastes does not take much time. For example, in the city, a little increase in the individual income can lead to one's change in consumption patterns to higher grade which consequently increases waste outputs (Medina, 1997). This therefore, gives more challenges for the municipalities to manage. For instance, a 49% population increase in India was concluded to have at the same period led to 67% municipal solid waste rise (UNEP, 2001c). However, developed and developing countries do not differ in waste generation fortunately, the former have devised sustainable management measures (Figure 2).
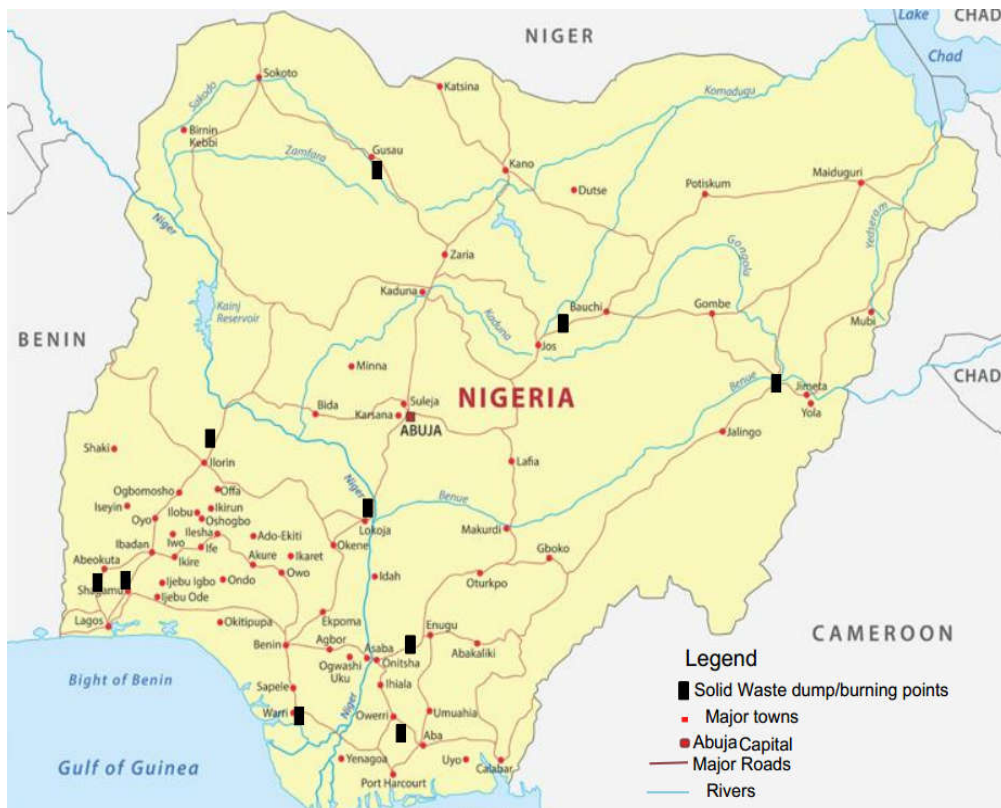
Figure 1. Nigeria map showing major motorways with roadside solid waste dumping and burning locations
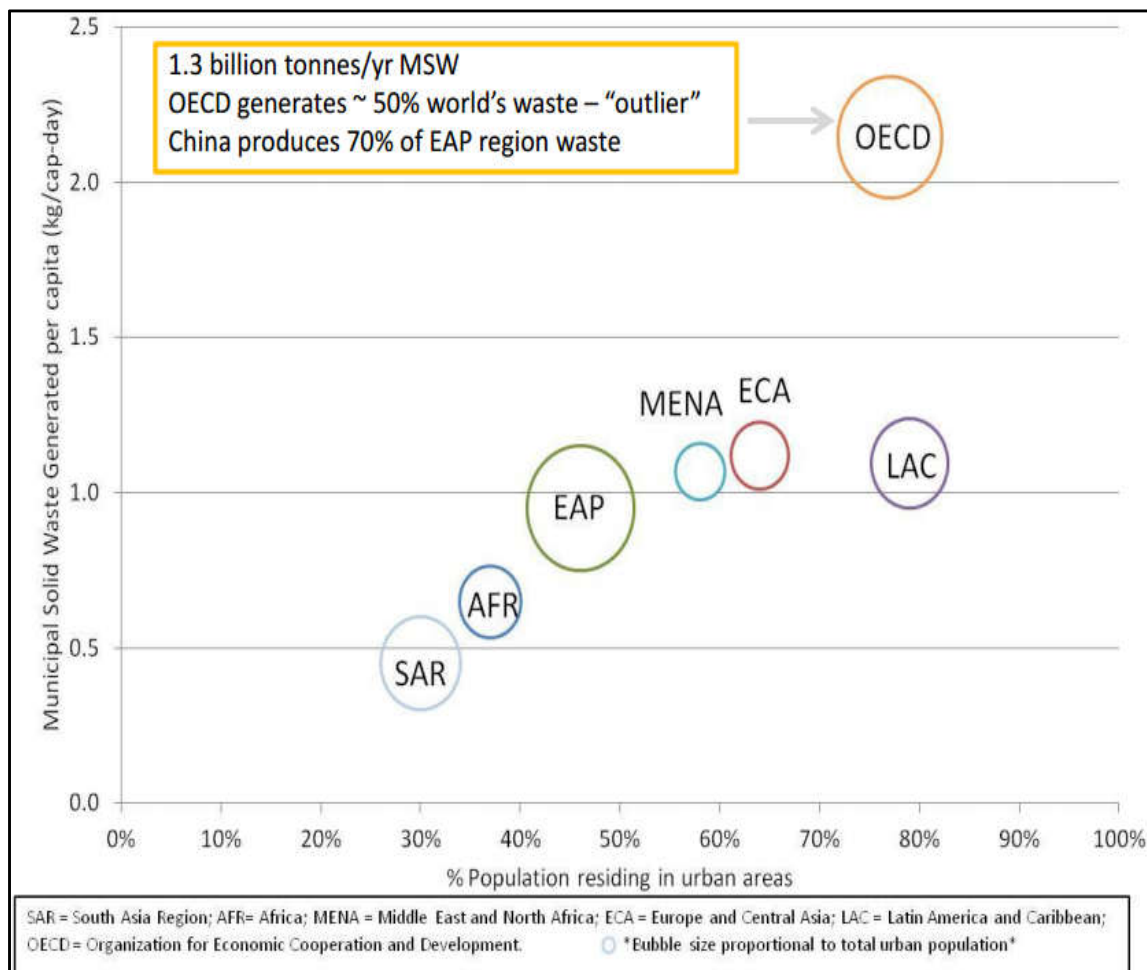

Figure 2. Current Waste Generation by Region (After Dan Hoornweg, 2013)
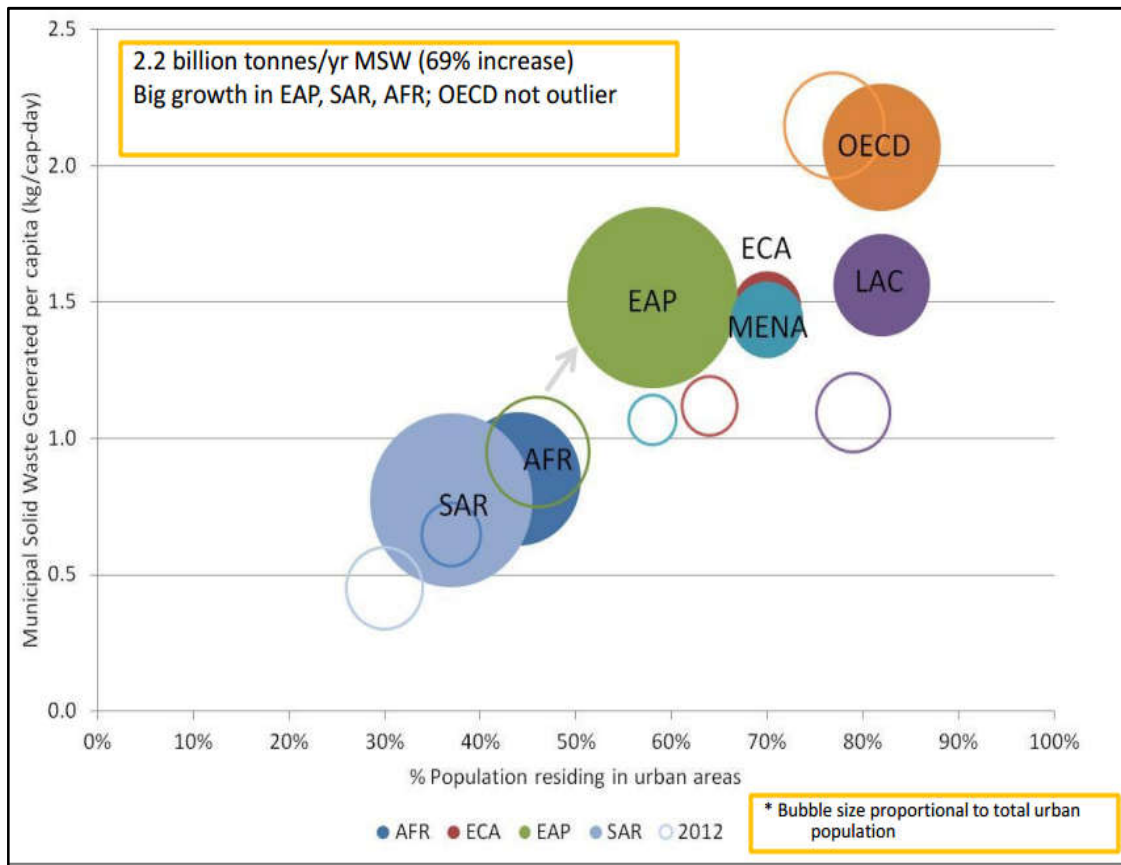
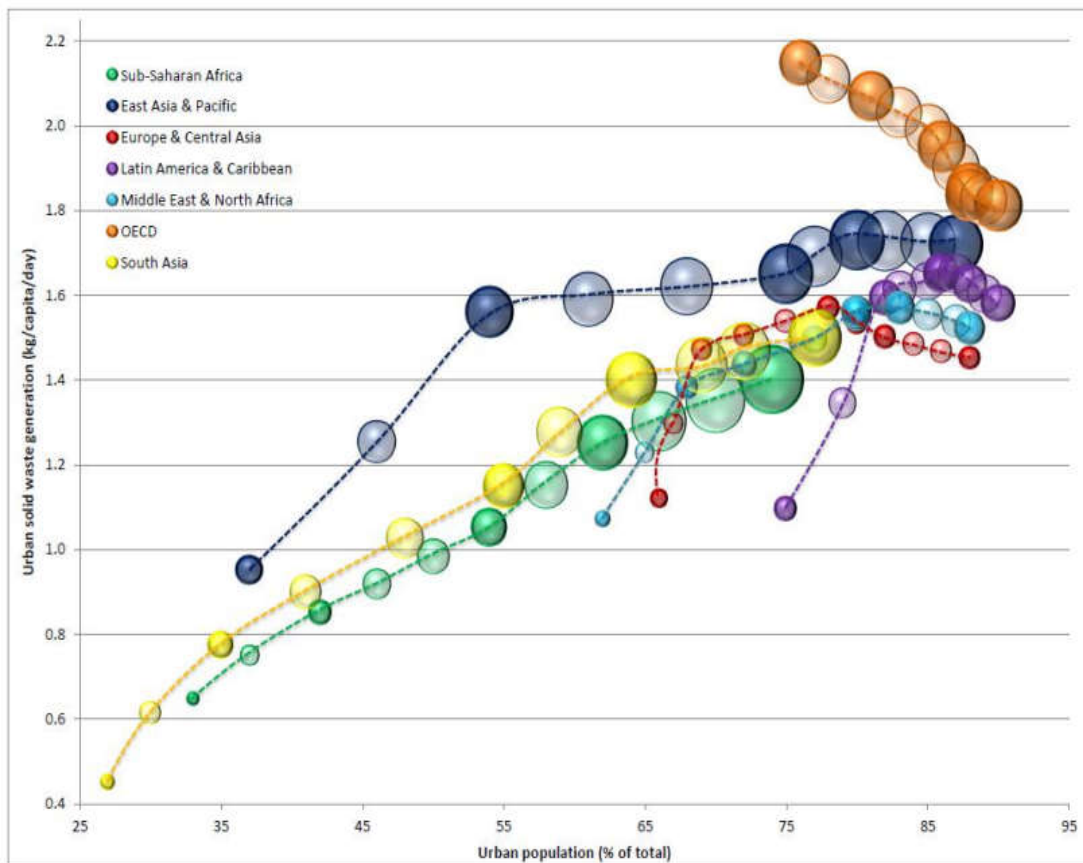**Figure 3. Waste Generation-currently and 2025 projection (After Dan Hoornweg, 2013)**

Figure 4. Waste Generation and Urban projection for 2100 (After Dan Hoornweg et. al, 2013)

Figure 5. Roadsides Solid Waste Dumps and Burnt Sites in the Major motorways in Nigeria
(Authors' Field Survey, 2014)

Which has turned the wastes to economic gain instead of environmental nuisance. According to UNEP (2001e), 'the increasing volumes of waste being generated would not be a problem if waste was viewed as a resource and managed properly' (Figure 3). The recent global Waste Generation and Urban projection for 2100 clearly indicated that the developing countries never produced wastes more than the developed nations (Figure 4), but technological advancement in the management makes the difference.

Meanwhile several studies have documented that various parameters directly affect the quantity of waste generated in developing countries. These include; the income level and lifestyle (World Bank, 2003a; Fehr *et al*., 2000) and household number (Bolaane and Ali, 2004). Other studies have revealed that low standard of living, poor Socio-economic development and low degree of industrialization can partly reduce solid waste generation (World Bank, 2001); yet inadequate waste management has left the heaps still on the major roadsides of the African continent.

In Nigeria, proliferation of Solid waste especially along the major motorways has recently been one of the three major environmental and social issues, including flooding and desertification (Ayuba *et al* (2013). This study aimed at assessing the environmental and socio-economic impacts of the roadside solid waste dumping and burning as well as the perceptions of the various groups of road users. Several studies have been documented on the environmental and socio-economic impacts of municipal solid waste but it is rare to find any on the roadsides dumping and burning in this region.

MATERIALS AND METHODS

Study Area

The research was conducted in Nigeria, a developing country in West Africa. She is located between 4^0N and 14^0N of the Equator and 3^0E and 15^0E of the Greenwich meridian. Cameroun, Niger, Chad and Benin Republics bordered Nigeria Eastward, Northward, North-East and Westward respectively with the Atlantic Ocean in the south. Nigeria has a land area of $923,768km^2$ with atleast 50 major roads and nodes connecting the major cities (Figure 1). She is the most populous country in Africa with the population of ca. 160 million people (NPC, 2006).

Nigeria came into existence in 1914 after amalgamation of North and South protectorates, and became independent in 1960 with three regions (North, East and West) while the 4th region-the Mid-West was created in 1963 after her Republic. She has got 12, 19, 21, and 36 states in 1967, 1976, 1987 and 1991 respectively. Nigeria has lowland and highland areas. The Niger-Delta/Coastal plain region formed the lowest topography (0-100m) while the highest altitude is Adamawa Mountain(1800-2400m) with Jos Plateau(200-1500m) as the coldest place.

Nigeria experiences two different climate seasons such as, wet season (March-November) and dry season with Harmattan (November – February). Temperature ranges between about 23 – 40^0C (from the South to the Northern part). Average annual rainfall ranges between ca. 500mm-3000mm (from the North to the South).

She has six vegetation types (mangrove, Fresh-water swamp, Rainforest, Guinea Savanna, Sudan Savanna and Sahel Savanna which are grouped into three major zones (Forest, Savanna and Montane (Highland) Vegetation (Iwena, 2000; Nwaogu *et al*., 2015).

Research Hypotheses

The following hypotheses were formulated for this study in line with the main objective:

First Hypothesis (H0): No significant mean differences between the perceptions of the Stationary and Mobile groups of the road users on the environmental and socio-economic impacts of roadside solid waste dumping and burning.

Second Hypothesis (H0): There is NO significant mean differences existing between the views of the Stationary and Stationary-Mobile groups of the road users on the environmental and socio-economic impacts of roadside solid waste dumping and burning.

Third Hypothesis (H0): The reports of the Mobile and Stationary-Mobile groups of the road users on the environmental and socio-economic impacts of roadside solid waste dumping and burning NEVER revealed any significant mean differences.

Data Collection

The data for this research included the primary and secondary sources. The primary data were those data obtained through field survey; these include observation, use of structured questionnaire and oral interview. Secondary sources consisted of the documentaries, text books, journals articles, newspapers and internets. A set of structured questionnaire was designed to explore information concerning the environmental and socio-economic implications of roadside solid waste dumping and burning. A stratified-random sampling was conducted based on the existing literature and records on the anthropogenic activities which accumulate solid wastes in the selected states and roads.

Therefore states and roads which has the highest records of socioeconomic activities and dumps were chosen. Approximately 10% of the total number of main roads with heavy human activities were surveyed (Figure 1). The sampled roads were Ilorin-Abuja, Abeokuta-Ilaro, Enugu-Onitsha, Aba-Owerri, Ibadan-Lagos, Zaria-Sokoto, Bauchi-Jos, Lokoja-Abuja, Yola-Makurdi, and Port Harcourt-Benin City (Figures 5A-J). The participants were classified into three primary groups based on the forms in which they make use of the roads. The groups included; the Stationary group, the Mobile group, and the Stationary-Mobile group. The Stationary group involved the roadside hawkers, shop owners and other kinds of stationed activities.

The Mobile group included the pedestrians, motorists and cyclists while, Stationary-Mobile group consisted of the commercial vehicle operators who created legal or illegal parks within the roadsides waste dumpsites. The slow flow of traffic by the dumpsites and the existing roadside motor parks helped in interviewing the Mobile group. Ten (10) roadside solid waste dump and burnt sites were visited as the sampling units.

Sixty (60) respondents were interviewed from each sampling unit. In all, 600 participants were covered with 200 of them from each of the three groups of road users. Apart from their bio-data (age, educational level, occupation, states of origin, income) questions relevant to the research issue were ask. These included; their feelings regarding the presence of the roadside solid waste dump/burning and, their opinions and rating in respect to the environmental and socioeconomic impacts. A likert-scale of 0-2 was used. 0 represented Zero or positive impacts; 1 denoted moderately negative impacts, while 2 indicated significantly negative impacts. This did not only make it possible for swift comprehension by the participants but also for easier and valid quantitative analysis. The results gathered were used for qualitative and quantitative analyses (Table1- 4). These findings were presented in percentages and mean values. In addition, correlation and t-tests were conducted to find the relationships and the mean differences between the perceptions of the various groups involved.

RESULTS AND DISCUSSION

Eighty-five percent of the total sampled population revealed that they felt bad regarding the incessant dumping and burning of the solid wastes by the roadsides. Only 4% felt good and this minority was discovered to be those who were undoubtedly myopic of the possible dangers from menace. The Stationary group of road users accounted for 27.5% of the 85% who were uncomfortable with the degradation act of dumping and burning. Similarly, the Mobile group (that is the passersby) and the Stationary-Mobile group recorded 39.2% and 33.3% respectively for the remaining percentages who frowned at the process. Remarkably, all the participants in the Mobile group of road users felt bad while the other groups have few numbers whose feelings were either neutral or good with the waste dumping and burning. However, in terms of the environmental and socio-economic effects, all the respondents affirmed that the waste dumping and burning have impacts (Table 1).

Table 1. Participants responses on how they feel about the road side solid waste dumping and burning

| | Each classified Road user group sampled | | | |
	Stationary	Mobile	Stationary-Mobile	TOTAL
Bad	140 (70%)	200(100%)	170 (85%)	510(85%)
Neutral	38 (19%)	0	25 (12.5%)	63(11%)
Good	22 (11%)	0	5 (2.5%)	27 (4%)
TOTAL	200	200	200	600

Do you think the environment and socio-economics are affected?

YES	200	200	200	600 (100%)
NO	0	0	0	0

Eleven (11) impacts assessment variables including six (6) for environmental and five (5) for socio-economics were structured for the evaluation. The rating value '2' (representing significant negative impact) has the highest percentages of all the rating values. Impacts of the solid mate dumping and burning on the soil (94%), water (85%), Air (99%), flora (85%) while, impacts on the animals and micro-organisms was 99.6% with burning (Table 2). In contrast, it was discovered that the solid waste heaps favored the animals and micro-organisms which live, feed, mate and reproduce there when left without burning.

Table 2. Number and % of participants and ranking for each impacts assessment variables

Impacts assessment variables	Number /(%)of Respondents who ranked for each value		
	Rating Values		
ENVIRONMENTAL	0	1	2
Soil	4 (1%)	31 (5%)	565 (94%)
Water(groundwater and/or surface)	23 (4%)	68 (11%)	509 (85%)
Air	0 (0)	7 (1%)	593 (99%)
Vegetation(Flora)	19 (3%)	70 (12%)	511 (85%)
Dump without burning on Animals/Microorganisms	302(50%)	217(36%)	81 (14%)
Dump with burning on Animals/Microorganisms	0 (0)	2 (0.4%)	598(99.6%)
SOCIO-ECONOMICS			
Human Health	0 (0)	0 (0)	600(100%)
Safety(Road accidents on animals/peoples)	1 (1%)	9 (2%)	590 (97%)
Trading/Market/Economic Transactions	228(38%)	264(44%)	108 (18%)
Income/Revenue Generation	204(34%)	196(33%)	200 (33%)
Peoples movement	6 (1%)	41 (7%)	553 (92%)

Table 3. Mean Values information for individual group categories of the road users derived from their accumulated ranking (between 0, 1 or 2) regarding the impacts of the road side waste dumping/burning

Impacts assessment variables	Mean value* of each group on impact assessment fields		
	Categorical Groups		
	Stationary	Mobile	StationaryMobile
ENVIRONMENTAL			
Soil	1.52	1.98	2
Water(groundwater and/or surface)	1.69	2	1.92
Air	2	1.95	1.7
Vegetation(Flora)	1.89	2	1.97
Dump without burning on Animals/Microorganisms	0.65	0.44	0.78
Dump with burning on Animals/Microorganisms	1.99	2	2
SOCIO-ECONOMICS			
Human Health	2	2	2
Safety(Road accidents on animals/peoples)	2	1.99	2
Trading/Market/Economic Transactions	0.56	0.82	0.72
Income/Revenue Generation	0.88	0.64	0.53
Peoples movement	2	2	1.98

*Mean value=S/T [where S=Sum of all individual group responses, T=Total number of sampled population for each classified group]

Half of the sampled population revealed that the roadsides solid waste dumps have no negative effects on the fauna instead most of the animals such as dogs, rodents, snakes, birds, worms, millipedes and other invertebrates benefit from the wastes heaps if allowed unburnt. This supported the past documentation that many domestic and wild animals including vultures, rabbits, scorpions, crickets and others use the waste depots as habitats (Onwughara, 2010). On the other, the health of some higher animals including man was reportedly to be significantly at risk with the presence of the solid wastes and the act of burning them (Oyeniyi, 2011; Atiemo *et al.*, 2012; Ogwo *et al.*, 2013).

Reports on flooding have been proved to be partly connected with solid wastes blocking the drainage systems (Lamond *et al.,* 2012; Toyobo *et al.,* 2013) and production of toxic chemicals that destroy tarred roads and pavements (Butu *et al.*, 2013). To most of the hawkers, the solid waste dumps serve as traffic check-points delaying the flow of vehicles consequently, promoting their sales. Therefore 228 respondents out of 600 indicated that the solid wastes have either positive or zero impacts to their businesses. In addition, the waste heaps help them generate more income as confirmed by 204 participants which represented 34% of the total sampled population.

Although the negative impacts of causing road accidents and obstruction of the peoples' movement cannot be under-rated. 590 respondents which represented 97% never hid their feelings about the socioeconomic nuisance of the roadside solid waste dumping and burning (Table 2). Solid wastes cause the pollution of both the ground and surface water (Farouk, 1987; Lamond *et al.*, 2012; Dodman *et al.*, 2011).

The rating of the impacts on the environment and socio-economics was relatively similar among the three classified groups of the road users-hawkers (Stationary), Passersby (Mobile), and Commercial Vehicle operators (Stationary-Mobile). All the groups ranked impacts on the human health very significant. The Stationary group rated effects on the air, road accident and peoples movement the highest. The Mobile group conceived impacts on water and vegetation as paramount.

The influence on the soil and fauna were opined to be most vulnerable by the Stationary-Mobile group (Table 3). High correlation was shown between the groups. Mobile and Stationary-Mobile (0.98). Stationary and Stationary-Mobile (0.93), while the Stationary and Mobile group was 0.94 (Table 4).

Table 4. Statistical tests of the mean differences and relationships between the perceptions of the various group road users on the environmental and socioeconomic impacts of roadside solid waste dumping and burning

Mobile and stationary-Mobile groups		
	Groups	
	Mobile	*Stationary-Mobile*
Mean	1.62	1.60
Variance	0.41	0.36
Pearson Correlation	0.98*	
df	199	
t Stat	0.46	
P(T<=t) one-tail	0.33[a]	
t Critical one-tail	1.81	
P(T<=t) two-tail	0.65[a1]	
t Critical two-tail	2.23	
Stationary and Stationary-Mobile groups		
	Stationary	*Stationary-Mobile*
Mean	1.56	1.60
Variance	0.34	0.36
Pearson Correlation	0.93*	
df	199	
t Stat	-0.55	
P(T<=t) one-tail	0.30[b]	
t Critical one-tail	1.81	
P(T<=t) two-tail	0.59[b1]	
t Critical two-tail	2.23	
Stationary and Mobile groups		
	Stationary	*Mobile*
Mean	1.56	1.62
Variance	0.34	0.41
Pearson Correlation	0.94*	
df	199	
t Stat	-0.91	
P(T<=t) one-tail	0.19[c]	
t Critical one-tail	1.81	
P(T<=t) two-tail	0.39[c1]	
t Critical two-tail	2.23	

*Correlation R; while a, a1, b, b1, c, c1= P values of one-tail and two-tail @ 0.05

The P-values for both one-tail and two-tail t-tests were higher than 0.05 level of significance. Tests on the mean differences between the participants' perceptions on the environmental and socioeconomic impacts of the roadsides solid wastes dumping and burning were 0.33, 0.30, and 0.19 for one-tail test and 0.65, 0.59 and 0.39 for the two-tail test (Table 4).

Table 5. Urban Solid Waste Generation in major cities, Nigeria

City	Population	Agencies	Tonnage (monthly)	Density (Kg/m³)	Kg/capita/ day
Lagos	8,029,200	Lagos Waste Management Authority	255,556	294	0.63
Kano	3,248,700	Kano State Environmental Protection Agency	156, 676	290	0.56
Ibadan	307, 840	Oyo State Environmental Protection Commission	135,391	330	0.51
Kaduna	1,458, 900	Kaduna State Environmental Protection Agency	114, 433	320	0.58
Port Harcourt	1, 053, 900	Rivers State Environmental Protection Agency	117, 825	300	0.60
Makurdi	249,000	Urban Development Board	24, 242	340	0.48
Onitsha	509, 500	Anambra State Environmental Protection Agency	84, 137	310	0.53
Nsukka	100, 700	Enugu State Environmental Protection Agency	12,000	370	0.44
Abuja	159, 900	Abuja Environmental Protection Agency	14, 785	280	0.66

Modified After: Njoku, 2015; Ogwueleka, 2009

In summary, no significant mean differences were discovered between all the groups regarding their view on the solid waste and prevailing impacts. Several studies have postulated the effects of the municipal solid wastes on the environment. Scientific documentations have emphasized that they cause negative health effects on children (Kogers *et al.,* 2005), health of adults (Obirri *et al.,* 2010) and loss of flora (Shagal *et al.,* 2012). Furthermore, there have been records that the air released by the burning of the wastes has tremendous adverse effects to human respiratory systems (Njoku *et al.,* 2015).

The toxic gases such as NO and SO_2 are released into the atmosphere through the burning which consequently fall as acid rain (Nwaogu, 2014; Kram *et al.,* 2014). Several kinds of human cancer and birth defects have been reported to be associated with burning of municipal solid wastes (Onwughara, 2010). The volumes of the municipal solid waste generated in the major cities of Nigeria have been shown to be remarkably high. According to Njoku (2015), the Federal and States Environmental Protection Agencies in Nigeria revealed that the quantity of Solid Wastes increases with increase in the population. In other words, the higher the number of people the more the waste tons (Table 5).

Conclusion and Recommendation

Dumping and burning of solid wastes along the roadsides of the major highways have several environmental and socio-economic impacts. The soils, nearby water bodies, the plants and human health are significantly affected. The animals and the micro-organisms were also affected but these tend to be marginally favored if the waste dumps are not subjected to fire. Notwithstanding, many of them are killed by passersby and motorist while they attempt crossing the roads. Economically, the stationary group of the road users including the hawkers, shop-owners and vulcanizers make more profits because of the heaps.

The movements of the motorists, cyclists and pedestrians were delayed due to the waste dumps and smokes from the burning. In summary, there was no mean differences between the perceptions of the three various groups of the road users surveyed. Even though some were of the opinion that the impact of the wastes was relative for the environmental and socio-economic parameters assessed. To ameliorate this environmental challenge, it has been recommended that environmental education and environmental laws be strongly established for the general public. In as much as more funding is needed, proper and improved waste management systems need be integrated with the available resources. Government should make provisions for necessary facilities to enhance house to house, street to street and shop to shop collections of solid wastes; and residents and shop owners should be taxed. Furthermore, recycling projects and programs should be introduced as this will make it more economically beneficial. It is high time the private organization be given legal opportunity to support the government in disposal and management of the wastes.

Acknowledgement

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