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BUILDING CONTRAVENTIONS AND INCIDENCE OF FLOOD IN THE LAGOS METROPOLIS

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ABSTRACT: The urge to satisfy the housing needs of the growing population results in indiscriminate development of urban space, including flood plains and canals, without recourse to urban planning and development guidelines. The consequential effect of this unwholesome practice is incessant flooding in the metropolis. This study carried out spatial analysis of flooded areas in Lagos Metropolis. A complete list of streets where flood incidence was recorded in sixteen metropolitan local government areas was obtained from Drainage Department, Lagos State Ministry of Environment. Visitations were made to each of the 211 flood prone streets to obtain information about the causes of flood. These data were integrated within GIS and delineation of streets prone to flood due to building contraventions and poor urban planning was carried out. The results suggest building contraventions along drainage channels and floodplains were the cause of flood in 48.8% of the streets. This paper contributes to the pragmatic and problem-solving integration of urban planning and development with social advocacy for flood management in the Lagos Coastal Megacity which is part of the objectives of the CCaR Project.

Key Words: Spatial Analysis, Building Contravention, Flood, Geographic Information Systems (GIS)

1. INTRODUCTION

Across the globe, floods have posed tremendous danger to people's lives and properties. Floods are the leading cause of natural disaster deaths worldwide and were responsible for 6.8 million deaths in the 20th century (Doocy *et al*., 2013). According to Etuonovbe (2011), from early 1970s till date, flood has been responsible for building collapse, submerging markets, destroying properties, and affecting more than 300,000 people in Lagos. Akanni and Bilesanmi (2011) reported how a Lagos flood forced communities in Lagos to relocate as a result of heavy rain of 7th and 8th of July, 2011, not knowing there was going to be a more devastating torrential rain that would result in "more disastrous floods in Lagos Metropolis" in the following week (Mordi, 2011; Amaize, 2011). In order to avert casualty after torrential rainfall of Sunday, 10 July, 2011, a public holiday was declared on the following Monday, 11 July for both public and private schools in Lagos State (Akoni *et al.,* 2011). The rate of occurrences of floods in the Lagos Metropolis in recent times has been a great concern and challenge to the people and Governments (Aderogba, 2012a). More importantly, the frequency and areal extent of flood occurrence within the metropolis, with the attendant havocs call for concern and serious attentions (Akanni and Bilesanmi, 2011; and Adegboye, 2011).

Globally, the number of people affected by increasingly frequent hydrological events has doubled over the last 30 years (World Economic Forum 2010). Aderogba (2012b) estimated that about ₦102 million is the cost of loss to floods in Lagos metropolis between 2010 and 2012. Hallegatte et al. (2013) ranked Lagos City 15th among the top 20 cities facing risks of flood losses in the world. According to them, by 2050, the world's 136 largest coastal cities including Lagos could risk combined yearly losses of $1 trillion (750 billion Euros) from floods. However, the current vulnerable population to coastal flooding in Lagos is 357, 000 while estimated exposed population will be 3,229,000 in 2050 (Hallegatte et al., 2013). The rate of influx of people into the city of Lagos has been so high that the pace of settlement development and

housing provision could not accommodate them. Since they must have shelter, all forms of informal procedures are adopted to provide housing (Olokesusi, 2011). This has resulted in non-compliance with physical planning regulations and development control standards (Olokesusi, 2011). The non-compliance to urban planning regulations led to indiscriminate erection of buildings within catchment areas causing impediments to free flow of water and run-off during and after rainfall leading to flooding.

Many researchers have employed climatic parameters (Eckert, 2008; Adelekan, 2009; Ekanade et al., 2011) topographic variables (Ologunorisa, 2009; Fuchs, 2010) economic status (Costanza and Farley, 2007; Parvin and Shaw, 2011; Hallegatte et al., 2013), drainage and demographic characteristics (Oyebande, 1983, 1990 and 2005; Adeaga, 2008; Akpodiogaga and Odjugo, 2010; Ikhile and Olorode, 2011; Aderogba et al., 2012) to determine the causes of floods. Although Aderogba et al., (2012) established urban development from drainage points of view as one of the causes of flooding in Lagos metropolis, buildings developed against urban planning regulations along drainage channels were not spatially analysed. The contributions of building contraventions to flooding in Lagos metropolis cannot be neglected, as they serve as points where water build-up and back-flow up-stream causing flooding. This work, therefore, aims at carrying out spatial analysis of buildings that are contributing to flooding due to contravention of urban planning regulations in Lagos metropolis with a view to mitigating the impacts of flooding.

2. LAGOS METROPOLIS

Lagos metropolis is situated within latitudes $6^{o}23'$N and $6^{o}41'$N and longitudes $2^{o}42'$E and $3^{o}42'$E in Lagos state. The State is bounded in the north and east by Ogun in the west by the Republic of Benin and the south by the Atlantic Ocean/Gulf of Guinea (see Figure 1). The demography of Lagos is steadily increasing with its twin partner- spatial expansion. With a population of about 25,000 in 1866 (Ayeni, 1981), Lagos was one of the smaller settlements in Nigeria, the largest being Sokoto with a population of 120,000 (Mabogunje, 1968). Earlier refugees from slavery and war in the interior, freed slaves from Brazil, and later colonial administrators and traders settled in the port, the population of which reached 40,000 by 1901 and 74,000 by 1911; by 1963 it had reached 665,000 (Abiodun, 1997). In 1975, the population of Lagos was 3.3 million and 4.3 million in 1980 (Lagos State Ministry of Economic Planning and Budget, 2004). The provisional results of the 1991 and 2006 censuses gave Lagos State a population of 5,685,781 and 7,937,932 respectively (The National Population Commission, 1991 and 2006). It is expected that the population of Lagos City will be over 20 million by 2015, making it the world´s third largest city, after Mumbai, with 27.4 million, and Tokyo, with 28.7 million (George, 2010 and Olokesusi, 2011).

Population density of Lagos is extremely high; the city occupies only about 0.4% of Nigerian land area but it harbours 6.43% of the nation's population. The metropolitan area of Lagos has only 37% of the land area of Lagos state but over 80% of the population of the state reside in it (Ogunleye and Alo, 2010).Metropolitan Lagos constitutes about 33% of Lagos State, with 455 sq km of the metropolis being water bodies, wetlands and mangrove swamps (Lagos State Ministry of Economic Planning and Budget, 2004). Lagos has grown spatially from a traditional core settlement of about 3.85 sq km in 1881 (Okude and Ademiluyi, 2006) to a huge metropolis of over 3,577.28 km sq in 2010 (Lagos State Government, 2014). In 1911 it was 46.6 km^2, 52.3 km^2 in 1921, 66.3 km^2 in 1931, 69.9 km^2 in 1952, 69.9 km^2 in 1963, 85.44 km^2 in 1986, 96.53 km^2 in 1990, 103.54 km^2 in 1995 (Abiodun, 1997) and 111.89 km^2 in 2002 (Olokesusi, 2011). These traits have exposed population and assets to the risks of flooding in Lagos City.

Other factors that make the city of Lagos vulnerable to flooding include indiscriminate urban development in hazard-prone areas, inadequate enforcement of building codes whereby many houses were poorly built, located in flood plains and lacked proper utilities, particularly, sanitation facilities. The number of cases of waterborne diseases such as cholera and dysentery reported annually in Lagos has increased over the past two decades (Okpanachi, 2008, and Lagos Water Corporation, 2008) due to frequent floods. Adeloye and Rustum (2011) indicated that climate change is not the culprit but anthropogenic factors such as increased urbanisation, lax planning laws in relation to the erection of buildings in flood plains and the inadequacy of storm drainage facilities in the city are to blame. Aderogba (2012b) identified illegal structures erected on or across drainage channels and torrential rain storms as the major substantive conservative causes of the floods. Aderogba et al. (2012) concluded that run-off resulting from intermittent and torrential rainfall was beyond the capacities of the drainage channels; besides, inadequate planning of the physical environment, wastes dumped in drainage channels and erosion passages, and deliberate or inadvertent physical structures that blocked free flow of water along the drainages were the causes of flood in Lagos metropolis. Olajuyigbe et al. (2012) investigated the causes of flood at *Mile 12* in Lagos and found out that consistent high rainfall and water releases from Oyan dam in the neighbouring state of Ogun, Nigeria were the culprits. Other causes of flood in the study area include blockage of drainage channels by wastes, narrow river channels and construction along floodplain.

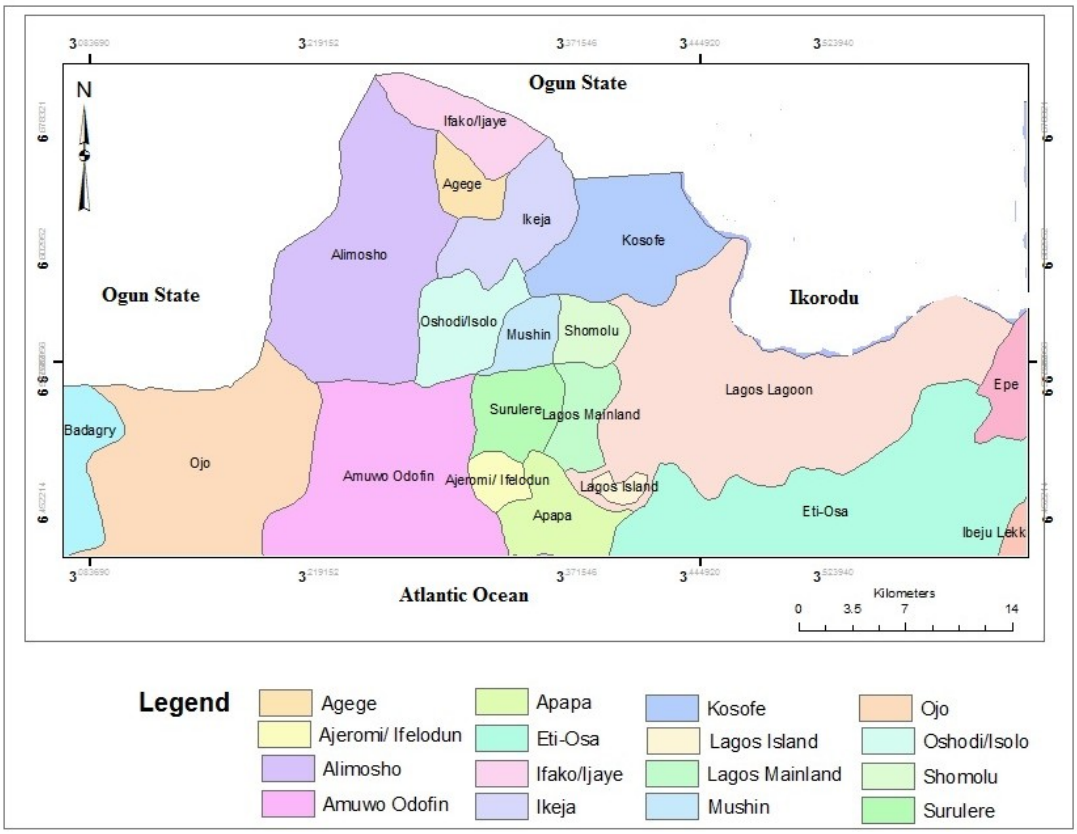

Figure 1: The Lagos Metropolis

Source: Lagos State Ministry of Physical Planning and Urban Development, 2014

2.1 Methodology

The study used both primary and secondary data as presented in Table 1. The causes of flood and distance between structures and drainage channels obtained during ground-truthing of the study area were the primary data. The secondary data is made up of a complete list of streets where flood occurrences had been recorded, number of contraventions detected and number of buildings demolished in 16 LGAs as obtained from Department of Drainage Services, Lagos State Ministry of Environment (DDSLSME). The stipulated set-backs from Ocean (150m), Lagoon (50m), Rivers/Creeks (15m) and Canal/Drainage/Gorge (10m), was obtained from Department of Regional and Master Planning, Lagos State Ministry of Physical Planning and Urban Development. The drainage channels and adjoining buildings in the metropolis were captured on Google Earths and integrated within ArcGIS 9.3. Buffers of stipulated setbacks (50m for lagoon and 10m for canal/gorge) were made along the captured drainage channels in ArcGIS 9.3 environment, converted to Kmz format and exported to Google Earth where buildings erected within statutory setbacks were counted and the sample of the results presented in Figure 2 for a section of the Lagos lagoon at Sheu Area in Amuwo-Odofin LGA.

Table 1; Data types and sources

S/N	Data	Types	Sources
1	Causes of flood	Primary	Fieldwork
2	Distance between structures and drainage channels	Primary	fieldwork
3	Flooded streets in Lagos metropolis	Secondary	DDSLSME
4	Drainage channels in Lagos metropolis	Secondary	Google Earth
5	Contravening structures	Secondary	Google Earth

2.1.1 Results and Discussion

All the 3647 buildings tagged contraventions in Table 2 were built in violation of the statutory 50m and 10m setbacks in areas adjoining lagoon and canal respectively and consequently were being flooded because they were located on flood plains, bank of rivers, lagoon, canals, drainages and within the basement of gorges as presented in Figure 2. In Agege, Ajeromi/Ifelodun, Alimosho, Mushin, Oshodi/Isolo, and Surulere LGAs, all the contraventions detected were built within 3-10m to the bank of the canal. At Sheu Area of Amuwo/Odofin LGA, the buildings were erected 0-5m to the lagoon, while around Lake View Estate/Ist Avenue FESTAC the buildings were 0.5-5m close to the lagoon. Buildings along drainages at Burma/Greek and Abraham Adesanya Road were erected at the brim of the drainage in Apapa LGA, while the maximum distance between buildings and canals along Mobil Rd/Marine Beach Axis and Orile/Sari Iganmu Axis was 3m. At Gaskiya/Jimoh Ojora/Bakare Faro Axis and Ijora/Badia/Makanjuola Axis, the canal had been cleared yet the distance of buildings from the canal was 0m.

The fence of buildings along Canals at Itirin, Ligali Ayorinde, Akin-Adesola, Karimu-Ikotun, Eko Hotel and Sapara Williams had a maximum distance of about 5m from the Canal that connects the lagoon to the Atlantic Ocean. In Ikeja LGA, the maximum distance between buildings and canal at a point was 5m, while at other points adjoining the lagoon, it was 3m. At Ogudu and Ojota (Olorunfunmi Street), buildings were erected directly inside a gorge that is 4m above sea level (ASL) as well as around the brim. At Odo-Iya Alaro by Iyanda Salawu Street near Ojota Old Motor Park, the canal had been filled with refuse giving

room for erection of make-shift bindings. Around Mile 12, Alapere and Agboyi in Kosofe LGA, the least distance between buildings and canal was 0.3m, while buildings at Oworo were about 0m away from the adjoining lagoon. The maximum distance between buildings and canal in flood prone areas in Lagos Island LGA was 7m. The canals were being dredged to provide vertical space for water to drain into the lagoon surrounding the Island. At Ebute-Meta East and Oto in Lagos Mainland LGA, buildings were located 2m away from the canal in some cases, while in most cases; buildings were erected directly on the canal. At Iwaya and Makoko, buildings were located in the lagoon without observing the statutory set-back of 50m.

The flood prone buildings at Idiaraba were 4m away from canal, that of Itire were 5m; the maximum distance between buildings and canal along Oduduwa Street, Mushin was 10m, while that of Lawanson was 8m. Buildings were located in the gorges that are about 4m ASL in Ajangbadi, Ojo LGA. Also at Muwo in Ojo LGA, buildings were erected directly in the lagoon. At Kemberi area, buildings were erected in canal reclaimed by refuse, while buildings were located 0m away from canal at Teddi Area. The flood prone areas identified in Oshodi/Isolo were along the canals are the maximum distance recorded between the canal and the buildings had increased from 0m to 15m in areas where buildings had been removed, while maximum distance of 7m was recorded in others. In Shomolu LGA, the maximum distance recorded between buildings and drainage that flows into canal at Bariga along Onajinmi, Osho, Oreofero, Araromi, Arobadade-Isale, Abeokuta, Odunsi and Olowolagba Streets was 13m. In Surulere LGA, out of 35 buildings erected in the canal at Sari Iganmu, 9 had been removed and that gave room for a distance of about 11m away from the canal, while in those areas where buildings had not been demolished, a distance of 1.5m was recorded. At Iponri and Adeniran Ogunsaya the minimum distance between canal and adjoining buildings was 7m and 1.2m respectively, while maximum of 8m was recorded at Ijesha along the canal. In Ifako/Ijaiye LGA, the gorge at Abule-Iroko was filled to the brim with buildings located indiscriminately with 1.5m wide and 2m deep depression created for water passage into the canal. Maximum distance of 6m was recorded between buildings and drainage channels at Brown Avenue, Folakun-Owode, Olujola, Olisa and Shoyinka Streets.

The demolished buildings, according to Officials at DDSLSME, were those that were erected 2-3m into the canal across the Metropolis. The ground-truthing conducted revealed that the volume of canals and drainages had been vertically increased by dredging in Lagos Island and Surulere LGAs where no building was demolished, while at Ayiga and Arigbanla Streets in Agege LGA, buildings were still 3m away from the canal. The building contraventions in the gorge at Olorunfunmi Street and Odo Iya Alaro by Iyanda Salawu Streets beside old Ojota Motor Park were still intact at the time of survey. All the building contraventions along the Isheri River at Isheri and lagoon at Oworo were also standing. At Oto community in Lagos Mainland LGA, no building was removed from the canal and the buildings were still being flooded each time the canal over flowed. The nature of reinforcement provided by water retaining walls across the buildings, including the door to the main buildings and individual rooms for the boys' quarters indicated the adaptation strategy to flood. The strategy involved a raised-wall-fence ranging from 0.5m to 1m high employed to protect the porch and individual room against flood water. The agonies of flood have become the lot of nearly every community in the metropolis. In various communities that have been experiencing flood across the metropolis, the economic and social disruptions that follow every heavy downpour that lasts more than three to four hours are worrisome. It is more serious when the rain lasts more than four hours, because the capacity of major drainages and canals that should convey excessive run-off into the lagoon had been reduced by buildings either erected directly in or at the brim of the channels. This is peculiar to both residential and industrial areas prone to flood in the Metropolis.

Table 1: Detected contravention and demolished buildings in Lagos Metropolis (2011-2013)

LGA	Area/Street	*No. of Building Contraventions Detected	No. of Buildings Demolished	*Distance from Cana/Lagoon (metre)	
				Minimum	Maximum
Agege	Oko-Oba	102	8	3	10
	Orile-Agege	56	6	2	9
	Abattoir	67	11	0	9
	Ayige Street	14	-	1	10
	Arigbanla Street	16	-	2	7
Sub-total		**255**	**25**		
Ajeromi/Ifelodun	Boundary/Ahcapo/ Berger Mile 2 Axis	108	26	3	7
	Okorogbo/Ugbowankwo/Itire/Alaba Axis	99	15	5	10
	Okoya/Cemetray/ Ezeagu/Mile 2 Axis	105	12	3	8
Sub-total		**253**	**53**		
Alimosho	Taiwo Olaleye/ Afilaka Close/ Pedro Road	101	21	3	8
	Taiwo Olaleye/Peter Egundebi by Isolo Rd	113	17	2	8
	Omoboriowo/Egbe axis	27	7	1	9
Sub-total		**241**	**46**		
Amuwo/Odofin	Sheu Area	139	9	0	3
	Raji Rasaki Road	23	2	0	5
	Lake View Estate/Ist Avenue FESTAC	45	5	0.5	4
Sub-total		**207**	**16**		
Apapa	Burma/Greek Rd	43	9	0	2
	Abraham Adesanya Rd	28	12	0	5
	Orile/Sari Iganmu Axis	56	13	0.8	4
	Gaskiya/Jimoh Ojora/Bakare Faro Axis	78	12	5	12
	Mobil Rd/Marine Beach Axis	31	14	3	10
	Ijora/Badia/Makanjuola Axis	98	21	0	4
Sub-total		**334**	**81**		
Eti-Osa	Itirin Canal	25	7	1	3
	Ligali Ayorinde	14	4	0.5	4
	Akin-Adesola	28	6	0	5

	Karimu Ikotun	33	7	0	3
	Eko Hotel	16	4	0	1.5
	Sapara Williams	5	3	1	2.7
	Sub-total	**121**	**31**		
Ikeja	Ogba/Alen/Opebi Link Axis	19	8	2	5
	Ogudu Area	43	15	1	6
	Ojota (Olorunfunmi Str)	24	-	0	5
	Odo-Iya Alaro by Iyanda Salawu Str	35	-	0	7
	Sub-total	**123**	**23**		
Kosofe	Mile 12	88	8	0.8	6
	Alapere	27	5	0.3	5
	Agboyi	34	3	2	9
	Oworo	58	2	0	7
	Sub-total	**207**	**18**		
Lagos Island	Anikantamo by Adeniji Adele Rd	9	-	1	4
	Olowu by Freeman St	5	-	1	3
	Simpson by Sura Market	12	-	1	6
	Olowogbowo	25	-	1.5	7
	Jankara/Ojo-Giwa/Oroyinyin Axis	15	-	2	6
	Ofin Canal/Alakoro Axis	65	-	2	5
	Sub-total	**131**	**0**		
Lagos Mainland	Makoko Area	517	75	0	5
	Ebute-Meta East	20	3	0	4
	Iwaya	10	6	0	5
	Oto	28	-	0	2
	Sub-total	**575**	**84**		
Mushin	Idi-Araba	69	11	4	8
	Itire	45	7	5	9
	Mushin	13	4	2.5	10
	Lawanson	11	7	2	8
	Sub-total	**141**	**29**		
Ojo	Ajangbadi	69	5	0	7
	Alaba Market	45	3	2	8
	Muwo i	36	4	0	7
	Teddi	39	3	0	5
	Sub-total	**188**	**15**		
Oshodi/Isolo	Mafoluku	59	6	5	13
	Alh. Akanni-Busari	24	2	6	11
	Alh. Agbeke Str.	35	5	5	10
	Enyi-Arinze Str.	43	-	5	10
	Havana Str	25	-	6	9
	Bayo Oyewale Str.	28	4	7	10

	Salau Aliu Str.	24	-	6	15
	Benson Akinyele Str.	22	6	5	11
	Aimasiko Str.	16	6	5	12
Sub-total		**276**	**29**		
Shomolu	Onajinmi Str.	34	9	5	7
	Osho Str.	43	14	4	9
	Oreofero Str.	12	9	5	8
	Araromi Str.	26	10	4	9
	Arobadade-Isale Str.	17	7	5	8
	Abeokuta Str.	33	11	5	9
	Odunsi Isale Str.	23	16	4	10
	Olowolagba Str.	41	16	5	11
	Bariga	30	10	6	13
Sub-total		**285**	**102**		
Surulere	Iponri	21	-	7	13
	Sari Iganmu Area	35	9	1.5	11
	Ijesha	41	4	1	8
	Adeniran Ogunsanya Area	11	-	1.2	11
Sub-total		**141**	**13**		
Ifako/Ijayie	Abule-Iroko	46	3	0	5
	FolakunOwode	13	-	1	7
	Brown Avenue	25	4	2	8
	Olujola Str.	41	-	3	9
	Olisa	26	-	1	7
	Shoyinka Str.	12	-	0	7
Sub-total		**163**	**7**		
Grand-total		**3647**	**578**		

Source: Department of Drainage Services, Lagos State Ministry of Environment, 2013

*Authors' Fieldwork, 2014

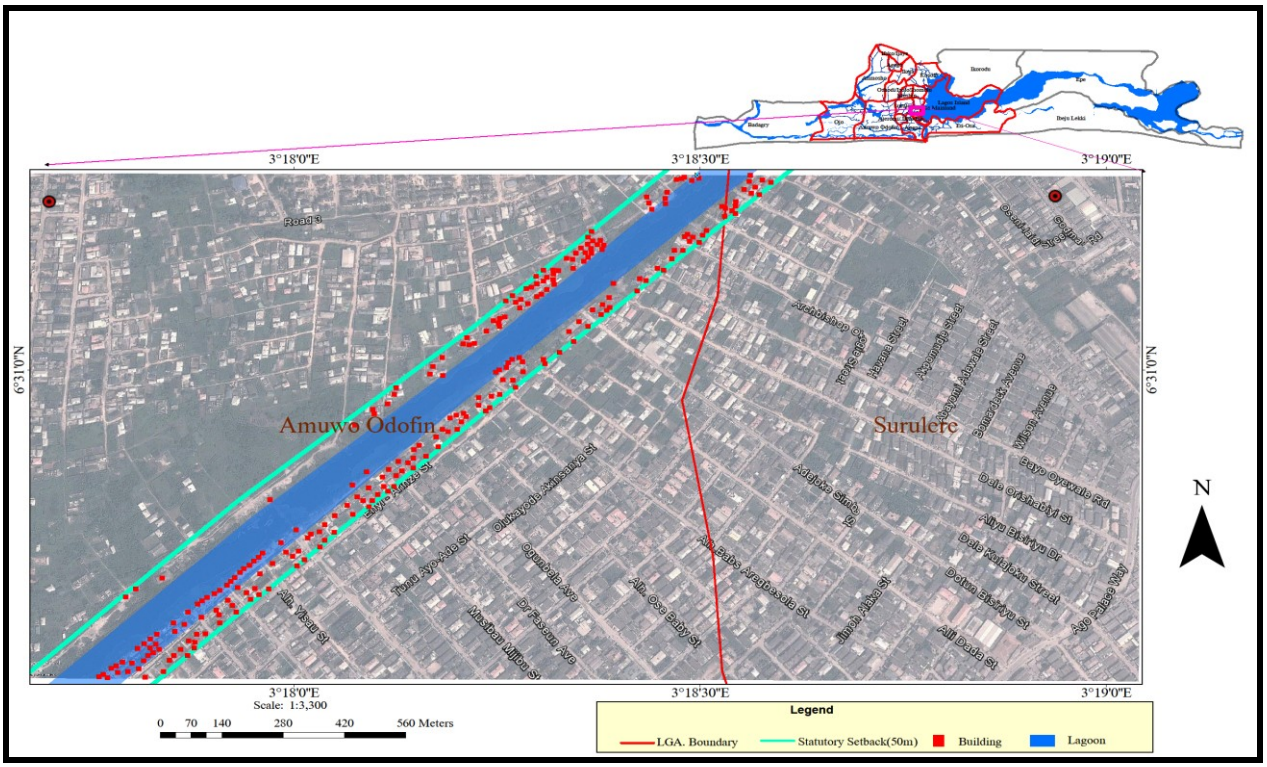

Figure 2: Building contraventions along Lagos lagoon at Sheu Area, Amuwo-Odofin LGA

Source: Authors' fieldwork, 2014

2.2 Conclusion

The Lagos metropolis keeps on experiencing increase in areal extent and population size forcing residents to occupy precarious parts of the environment. The occupation of wetland with buildings causes reduction in the rate of water flow in both natural and man-made drainages; lessens infiltration capacity of the soil, engenders vegetation loss and flooding- excessive destructive water that flows without hindrances in hitherto dry areas- causing loss of lives and property. Floods are caused by a combination of events and processes. In Lagos, apart from the issue of building contravention, indiscriminate solid waste dumping in open spaces and drainage channels, excessive concretisation of surfaces due to urban development contribute significantly to the occurrence of flood in the Metropolis. The existing guidelines for urban development, particularly in areas of building construction and solid waste management require overhauling in the aspects of formulation and particularly enforcement to facilitate functional adherence to the rules and regulations guiding the development of buildings.

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