International Journal of Science, Environment and Technology, Vol. 2, No 6, 2013, 1462 – 1478

ISSN 2278-3687 (O)

BIO-CLIMATIC CHARACTERISTICS OF RESIDENTIAL BUILDING TYPES IN THE TRADITIONAL CORE OF OGBOMOSO, SOUTH WEST NIGERIA

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Abstract: Building is meant to offer protection against harsh outdoor climate, provide both physiological and psychological comforts; healthy indoor environment for the occupants and to conserve energy. However, various residential building types in the traditional core area of Ogbomoso use different bio-climatic elements to address these functions thereby producing different degrees of comfort for the occupants. This paper examines bioclimatic performance of these residential building types with a view to determining the most efficient and sustainable one. In doing this, the study adopted Mahoney Table approach to climate analysis for the determination of design guidelines for comfort in the study area as various residential building typologies were compared using Mahoney recommendations. The indicator Table of Mahoney showed that the core area of Ogbomoso is too warm for comfort by days and in some nights. It also revealed that air movement is highly essential to reduce discomfort. The method produced some design recommendations which include good layout (East – West orientation) for exclusion of solar penetration. Spacing of buildings should be at least 5 times their height and sizes of openings should be between 40 – 80% of north and south walls for effective ventilation in warm humid climate. However four residents building types were identified in the study area with 46.2% being traditional compound system, 30.9% were modified traditional compound, 17.4% were Brazilian rooming house and 5.6% were modern flats or duplex. The comparison of these building types with Mahoney recommendations revealed that 37.6% of these house types were oriented in accordance with Mahoney recommendation while 62.4% were badly oriented. The implication of this is that many of these buildings are exposed to solar penetration which heat up the indoor space causing thermal discomfort. The spacing of buildings and sizes of openings in the study are less than what effectiveness difficult Mahoney recommended; making the ventilation to achieve.

Keywords: Bioclimatic features, Mahoney Tables, Traditional Core and Residential building.

1. INTRODUCTION

Housing is meant to offer protection against harsh outdoor climate, provide bothphysiological and psychological comforts, healthy indoor environment for the occupants and to conserve

*Received Nov 9, 2013 * Published Dec 2, 2013 * www.ijset.net*

energy. To be able to achieve these functions, housing studies have been approached from many different perspectives stemming from Architecture, Psychology, Sociology and Environmental behavioural studies resulting in the formation and design of various residential building types. However in Nigeria, various studies in housing according to Ajibola (1995) have focused on socio- psychological issues while physiological issues such as thermal comfort and ventilation have been taken for granted and such relegated to the background. Physiological issues in buildings are very important; they are the indices of measuring the climatic effects on buildings. The result of which describe the health and comfort of indoor environment (Adunola2006; Ayinla 2011).

Residential buildings in the traditional core of Ogbomoso were expected to attend to these climatic challenges by providing healthy indoor comfort for the occupants. However, these comforts were not adequately achieved as these buildings provide various degrees of comfort which is based on their type. The situation has forced the residents to supplement with the active energy based equipment such as fan and air conditioner. This has proved to be un-economical and expensive because of high cost of equipment, cost of running and maintenance for low income earner of the residents of the core area of Ogbomoso (Adunola 2006).

Since the major source of discomfort in the houses of the traditional core of Ogbomoso emanated from the climate, Mahoney method of climate analysis was therefore applied to analyze the climate of Ogbomoso with a view of providing some design recommendations. The method has been described as a means of determining the human comfort requirements and satisfactory design principles (Alajlan and Sayigh, 1994). The method was also extensively discussed and used in various studies of Komolafe and Agarwal(1987), Ogunsote (1988), Liu (2004) and Ayinla (2011)with success. This study therefore examined bioclimatic performance of these house types with a view to determine the most efficient and climate responsive one.

1.0 THE STUDY CONTEXT : OGBOMOSO

1.1 Physical Characteristics of The core area of Ogbomoso

Ogbomoso, the second largest city in Oyo State, in the southwestern part of Nigeria is situated on the Trunk A highway, a location which positions it as the gateway to the northern part of the country from the south-west. It lies on latitude 8°10¹ North of the equator and longitude 4°10¹ East of the Greenwich Meridian within the derived Savannah region of Nigeria.(Ayinla, 2011; Wikipedia, 2012; World Atlas.com, 2012). The population was approximately 645,000 as of 2011. The majority of the people are members of the Yoruba ethnic group.

Traditionally the core area of Ogbomoso is characterisedby land locked buildings that were compactly built together. These buildings were majorly accessed by footpath and few roads (figure 1). This portion of Ogbomoso according to Afon (1997) is an area in which the planning authority treated as special area because the development control regulations are hardly enforced. Regulations governing housing densities are relaxed resulting in residents sitting their houses anywhere at will and oriented in any direction (Ayinla 2011).

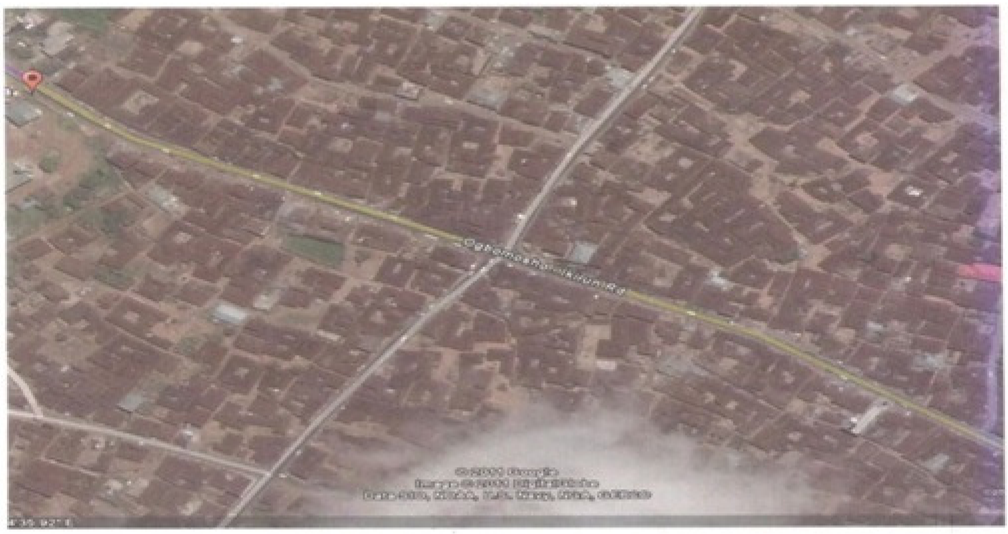

Figure 1. Image of Ogbomoso showing the Physical arrangement central core
Source: Google Earth (November, 2009)

In addition to the prevailing conditions mentioned above, the core area of Ogbomoso could also be described as economically unattractive as it considered as area of marginal economic opportunity (Afon 1997). Despite these squalid and unhealthy conditions which characterized this area, it still houses the highest proportion of the city population especially the low income earners.

The houses in the core area of Ogbomoso are majorly compounds in traditional form and characterized by one or more courtyards. The sizes of the compound vary greatly and it is usually determined by the social status of the family progenitors. It has habitable rooms (sleeping and sitting rooms) arranged linearly with a continuous verandah (passage) erected on square or rectangular courtyard (open space). The courtyard compounds are separated by narrow foot paths. The buildings are of two parts: the row of habitable rooms at the rear and the verandah in front to which they open. Thus, the courtyard compound has three basic elements: The central (inner courtyard, the verandah which abuts it and the outer row of habitable rooms. Example of this compound house is 'Ile kangu' in figure 2.The walls are made of mud construction built in courses each about 450-600mm high which were covered with leaves and left to dry for a few days before the next course was laid. After about five to six courses- each is clearly distinguishable by the marked horizontal layer boundaries (Ososana 2002).

The buildings were normally roofed, using a system of timber members from the coconut palm or other hard wearing, termite resistance wood as rafters, cross beams and purlins, graded in terms of anticipated load. The compounds in the olden days were covered with gablethatched roof but nowadays they were covered with corrugated iron roofing sheet.

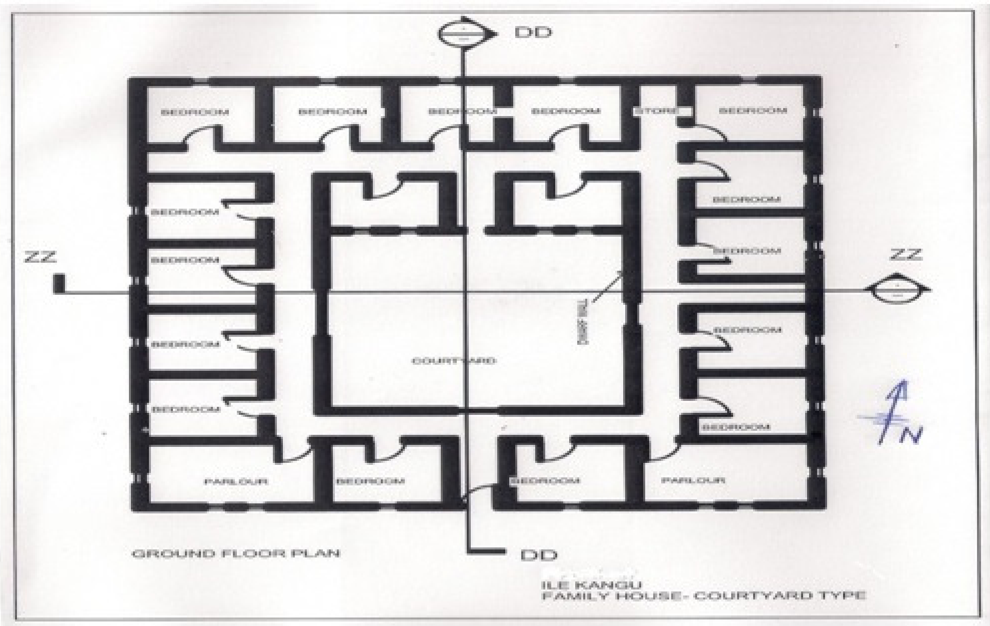

Fig.2 Ile Kangu (Ground floor Plan)
Source: Authors' field survey, Ogbomoso (November 2019)

2.2 Climate of Ogbomoso

Ogbomoso, a typical city in the South Western Nigeria has a climate that is largely independent of the topographical features but varies by the interactions between Two principal wind currents: *The Harmattan* (often appears as a dense fog and covers everything with a layer of fine particles), from the northeast, which is hot and dry and carries dust from the desert; it causes high temperatures during the day and cools at nights. Also, the moist, *South-West Wind* coming off, of the Atlantic Ocean, which brings cloudy and rainy weather.

The interactions between these two air masses play a distinct role in the country's seasons and temperatures (Nationsencyclopedia, 2012; Traveltips, 2012). As such, two major seasons are prevalent in the country as follows;

(i) *Rainy Season:* The climate of Ogbomoso produces an extensive rainy season across the country, with rains beginning early March and travelling north, reaching most areas by late April, with rain lasting through early November. The highest rainfall occurs in September.

(ii) *Dry season*: This season starting Mid November and lasting in early March.It is usually associated with high temperatures and low humidity, the air is always cold and dry with desiccating effect. A second little dry season occurs in August*(August break)*

3 METHODOLOGY

The climate of Ogbomoso was subjected to Mahoney Table approach to climate analysis for the determination of design guidelines for comfort in Ogbomoso while the reconnaissance survey of the core area of Ogbomoso was used to identify the buildings and categorized them in to types.

3.1 Climatic Data for Ogbomoso

The relevant climatic data for Ogbomoso were obtained from Oyo State Water Corporation, Ogbomoso. The data obtained were for a period of five years in line with the recommendations ofOgunsote (1988), Marsh (2001) and Liu Yang (2003) that averages of climate data for a period of between five to ten years is adequate for building design purpose. The data included values of the following climatic elements on a monthly basis from January to December for the years 2004, 2005, 2006, 2007 and 2008 maximum and minimum temperature, maximum and minimum relative humidity, solar radiation, wind speed, and rainfall. Averages of these data were presented in Table 1 and figure 3below.

Table 1: Average Climatic data of years for Ogbomoso (2004 - 2008)

Month	*Temp. °C (max)*	*Temp. °C (min)*	*Temp. °C (Average)*	*RH(am) %*	*RH(pm) %*	*Rainfall (mm)*	*Radiation (mj/m²/day)*	*Wind Speed(m/s)*
January	33.36	19.53	26.45	65.91	40.43	11.76	11.68	1.62
February	34.73	20.70	27.72	68.16	37.20	20.79	12.42	1.68
March	34.16	22.86	28.51	73.27	46.75	82.14	13.34	1.74
April	32.94	22.38	27.66	77.11	60.78	128.51	12.54	1.76
May	31.96	22.23	27.10	80.76	66.03	167.02	11.56	1.68
June	30.77	21.74	26.26	84.66	69.60	187.58	9.72	1.68

July	29.31	21.44	25.38	89.16	72.76	171.87	7.22	1.60
August	28.55	20.87	24.71	85.85	73.27	137.58	7.86	1.52
September	29.41	20.85	25.13	85.51	73.33	237.65	9.10	1.72
October	31.28	19.88	25.58	86.04	68.54	198.03	11.06	1.74
November	32.82	20.69	26.76	83.06	54.26	79.19	13.28	1.92
December	33.16	18.94	26.05	74.23	44.60	13.21	10.90	2.00
Average	31.87	21.01	26.44	79.48	58.96	119.61	10.89	1.72

Source: Adapted from Oyo State Water Corporation, Ogbomoso. (2004 - 2008.)

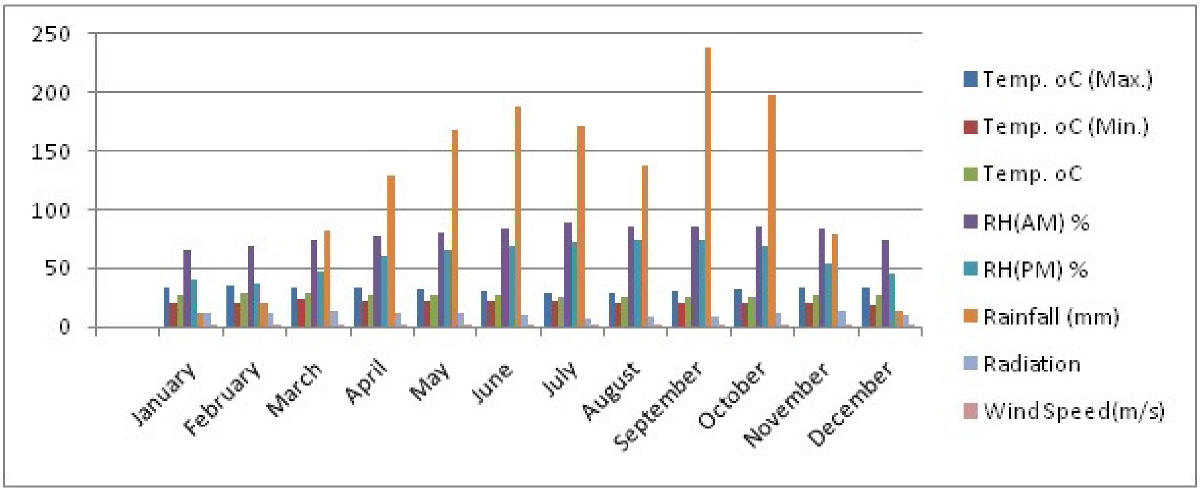

Figure 3: Average Climatic data of Ogbomoso, (2004 - 2008)
Source: Author's analysis, November 2009

Application of Mahoney tables to the climate of Ogbomoso reveals some climatic indicators (Table 2 and Table 3); the indicator table shows that the climate of Ogbomoso is too warm for Comfort by days and in some nights. It also reveals that air movement is highly essential to reduce discomfort (table 3). The Tables produced some design recommendations (table 4.). It is on the basis of these recommendations that the bio-climatic characteristics of the residential buildings in the traditional core of Ogbomoso are based. Some of these recommended are:-

Table 2: Diagnosis Table

		Jan.	*Feb.*	*Mar*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*
Humidity group		*3*	*3*	*3*	*3*	*4*	*4*	*4*	*4*	*4*	*4*	*3*	*3*
Temperature (oC)													
Monthly mean Max.		33.5	34.5	34.0	33.0	32.0	31.0	29.5	28.5	29.5	31.5	33.0	*33.0*
Day Comfort	*Max*	*29*	*29*	*29*	*29*	*27*	*27*	*27*	*27*	*27*	*27*	*29*	*29*
	Min	*23*	*23*	*23*	*23*	*22*	*22*	*22*	*22*	*22*	*22*	*23*	*23*
Monthly mean Min.		19.5	20.5	23.0	22.5	22.0	21.5	21.5	21.0	21.0	20.0	19.0	21.0
Night Comfort	*Max*	*23*	*23*	*23*	*23*	*21*	*21*	*21*	*21*	*21*	*21*	*23*	*23*
	Min	*17*	*17*	*17*	*17*	*17*	*17*	*17*	*17*	*17*	*17*	*17*	*17*
Thermal Stress													
	Day	*H*	*H*	*H*	*H*	*H*	*H*	*H*	*H*	*H*	*H*	*H*	*H*
	Night	*C*	*C*	-	-	*H*	-	-	-	-	*C*	*C*	*C*

Source: Author's analysis, November 2009

Table 3: Indicator Table

	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Total*
Humid													
H1 Air movement (essential)	√	√	√	√	√	√	√	√	√	√	√	√	*12*
H2 Air movement (desirable)													*0*
H3 Rain protection							√		√	√			*3*
Arid													
A1 Thermal storage													*0*
A2 Outdoor sleeping													*0*
A3 cold-season problem													*0*

Source: Author's analysis, November

Table 4: Sketch Design Recommendations

Indicator total from table 3						***Recommendations***
Humid			*Arid*			
H1	*H2*	*H3*	*A1*	*A2*	*A3*	
12	*0*	*3*	*0*	*0*	*0*	
						Layout
			*0 – 10**			*1. Buildings orientated on east-west axis to reduce exposure to sun*
			11- 12		*5 - 12*	
					0 - 4	*2. Compact courtyard planning*
						Spacing
*11 or 12**						*3. Open spacing for breeze penetration*
2 – 10						*4. As A3, but protect from cold hot wind*
0 or 1						*5. Compact planning*
						Air movement
*3 – 12**						*6. Rooms single banked. Permanent provision for air movement*
1 or 2			*0 - 5*			
			6 - 12			*7. Double- banked rooms with temporary provision for air movement.*
0	*2 - 12*					
	0 or 1					*8. No air movement requirement.*
						Openings
			0 to 1		*0**	*9. Large openings, 40 – 80 % of N and S walls*
			11 or 12		*0 or 1*	*10. Very small openings, 10 – 20 %*
			Any other conditions			*11. Medium openings, 20 -40 %*
						Walls
			*0 – 2**			*12. Light walls; short time lag*
			3 – 12			*13. Heavy external and internal walls*
						Roofs
			*0 – 5**			*14. Light insulated roofs*
			6 – 12			*15. Heavy roofs; over 8 hours' time lag*
						Outdoor sleeping
				2 – 12		*16. Space for outdoor sleeping required*
						Rain penetration
		*3- 12**				*17. Protection from heavy rain needed*

*Design recommendations

Source: Author's analysis, November 2009.

3.1.1. Layout: Mahoney tables recommended that the building should be orientated with longer sides on east- west axis. However, orientation of buildings in the core area of Ogbomoso (table 5) reveals that out of 340 residential buildings surveyed, 211 representing

62.1% are orientated with longer sides in north-south axis, while 72 houses representing 21.2% are orientated with longer sides on east-west axis, 37 houses representing 10.9% are orientated northwest-southeast axis, and 20 houses representing 5.9% are orientated northeast-southwest axis. In all 129 houses representing 38.0% (northwest-southeast) + (northeast- southwest) + (east-west) orientations are orientated in accordance with Mahoney recommendation while 213 houses representing 62.0% are badly orientated. The implication of this is that many of these buildings are exposed to solar penetration which heat up the indoor spaces, causing thermal discomfort to the occupants.

Table 5: Building orientation in the Traditional core of Ogbomoso

Orientation	Frequency	Percent	Valid Percent
north-south	211	62.1	62.1
east-west	72	21.2	21.2
northwest-southeast	37	10.9	10.9
northeast-southwest	20	5.9	5.9
Total	340	100.0	100.0

Source: Author's field survey, November 2009.

3.1.2 Spacing: Mahoney table, for breeze penetration recommended that the buildings should be spaced five times their height. Reconnaissance survey of the core area of Ogbomoso reveals that the buildings are closely built with narrow foot paths separating buildings. Depending on the house types, the distance between each building is less than 2.4m especially in the Traditional compound house types, but in the Brazilian rooming house, the minimum distance is on the average of 3.0m. The situation generally in the study area is that the spacing of buildings is less than what the Mahoney recommended.

3.1.3 Air Movement: For effective air movement, the table recommended that the room should be single-banked with windows in the north and south walls. The nature of rooms and position of windows of the houses in the study area largely depend on the house types and orientation. Although most of the rooms in all the house types are single-banked but windows were haphazardly placed, not minding the orientation of the walls to which these windows are located. The implication of this is that only the windows that are placed in the windward (north and south walls) direction will aid air movement and exclude solar penetration which is more pronounced in west and east walls.

3.1.4 Size of Openings: Mahoney tables recommended that large openings between 40-80 percent of north and south walls should be provided for adequate and effective ventilation in warm humid climate of Ogbomoso.Window size determines the average wind speed flowing through the room and that this effect varies, depending on whether the room is cross ventilated. In ventilated room, increase in the size of windows has a greater effect on average indoor air. Various guidelines for the determination of window sizes in warm humid climate have been proposed; Energy Research for the Building code of Australia Vol.1 have prescribed the minimum opening (window) for natural ventilation in warm humid climate to be 15% of the floor area. Chand (1976), have also recommended that the opening should be between 30 - 50% of the exposed wall area and between 20 – 30% of the floor area of the room. However, the ratio of sizes of Openings (windows) to corresponding walls and floors are presented in table 6. The table` shows the calculated window/ floor area and window/ wall area ratio of the core area of Ogbomoso. Using Chand's recommendations, none of the spaces in all the house types attained the required value of 20 –30% of the floor area except the kitchens in house type D (flat/duplex) with the value 23.79%; the lowest is the bedrooms in house type A (traditional compound system) with the value of 3.02 %.

The table 6 also reveals that none, except the living rooms of the house type C (Brazilian rooming house) of the spaces, satisfy the condition of 30 – 50% of the window to exposed wall area. The highest value is 28.08% in the living room of the residential building type C (Brazilian rooming house) which is very close to the lowest value of the condition, i.e. 30%. The lowest value is 2.98% in the bedroom of the residential building type A (Traditional Compound System). The implication of this is that only the living room in the residential building type C (Brazilian rooming house) would enjoy appreciable air movement.

Table 6: Window/wall area ratio and Window/ floor area ratio

House Types	*Type A (Traditional Compound System.)*			*Type B (Modified Traditional compound System.)*			*Type C (Brazilian rooming house)*			*Type (flat/ Duplex)*		
	L/Rm.	B/Rm.	Kit.	L/Rm.	B/Rm.	Kit.	L/Rm.	B/Rm.	Kit.	L/Rm.	B/Rm.	Kit.
Window/Wall Area ratio (%)	16.01	2.98	7.12	22.74	6.93	7.69	28.08	18.13	7.03	17.53	15.44	19.3
Window/floor area ratio (%)	13.13	3.02	8.39	14.42	6.22	9.38	23.30	14.82	7.96	12.76	14.07	23.79

Source: Author's field survey, November 2009.

Other Mahoney recommendations for climate of Ogbomoso include heavy external and internal walls, heavy roofs, Space for Outdoor sleeping and protection from heavy rain

2.2 Residential Building Types in the Traditional core of Ogbomoso

A reconnaissance survey of the core area of Ogbomoso revealed that the area is concentric in shape and it can be conveniently divided in to four quadrants using the two major roads in the study area that intersect at the centre of the town (Okelerin junction) see (Figure 4). The essence of this this reconnaissance survey was to identify different residential building types and their spatial characteristics. These residential buildings were then categorized into types by form and space organization (Architectural Composition). The status of these buildings in terms of orientation, types and sizes of openings (windows) were also considered because of their relevance to indoor comfort. The distributions of these residential building types among the four quadrants were empirically explained in table 7.

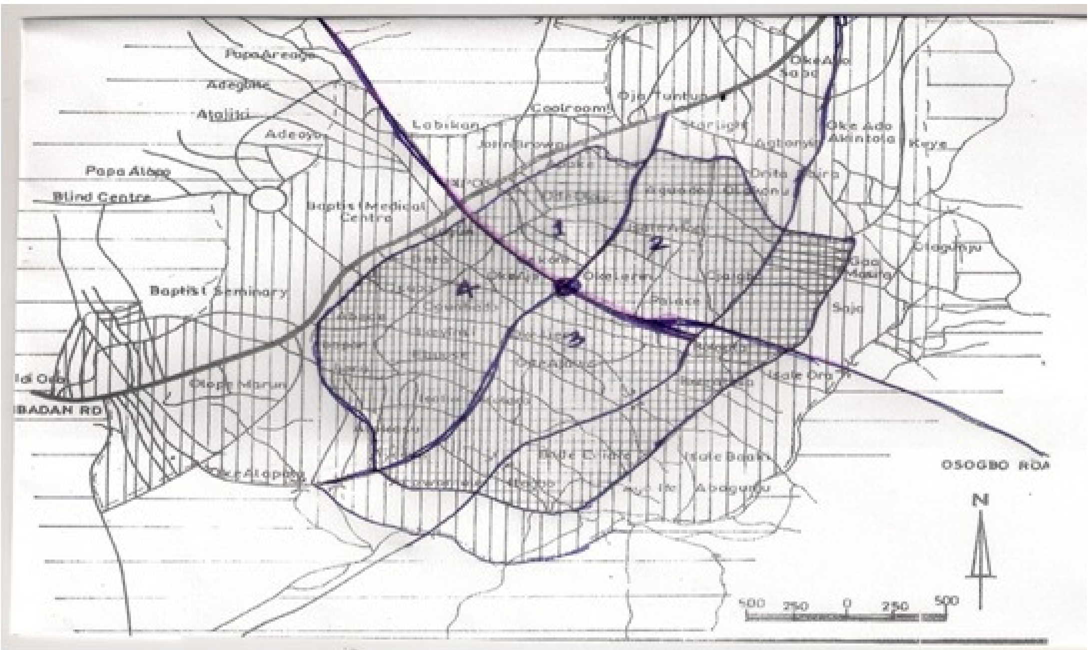

Figure 4: Map of Ogbomoso showing the traditional core and the four quadrants
Source: URP Dept. Lautech. Ogbomoso (2009).

The residential building types identified are Traditional Compound, Modified Traditional Compound, Brazilian rooming house and Flat/Duplex.

Table 7: The distribution of residential building types in the Traditional Core of Ogbomoso

S/no	*Residential Building types*	*Quadrant 1*	*Quadrant 2*	*Quadrant 3*	*Quadrant 4*	*Total*	*Percentage (%)*
1	Type 'A' Traditional Compound System	34	45	39	39	157	46.2
2	Type 'B' Modified Traditional Compound System	29	26	27	23	105	30.9
3	Type 'C' Brazilian Rooming House.	17	15	12	15	59	17.4
4	Type 'D' Flat/Duplex	04	06	05	04	19	5.6
	Total	84	92	83	81	340	100

Source: *Author's field survey, November 2009.*

Table 7.reveals the distribution of residential building types and the quadrants to which these building types are found. 157 out of the 340 houses, representing 46.2%, were traditional compound system. 105 houses representing 30.9% were modified traditional compound, 59 houses (17.4%) were Brazilian rooming house, while 19 houses, representing 5.6%, were either flat or duplex.

2.1.1.1. TYPE A -Traditional Compound

This type is commonly referred to as the family house; it is associated with the extended family and by implication, it is a house occupied by persons who's right of residence is derived directly from common ancestry. This house types accommodates large number of rooms commonly arranged rectilinearly along one or more courtyards with verandas overlooking these courtyards. These courtyards perform functions of privacy and offer climatically open air environment, serves as venue for communal meetings and other social gatherings. A typical example of this house type is "*Ile Akogun*". The floor Plan, elevation and section are shown in figure 5.

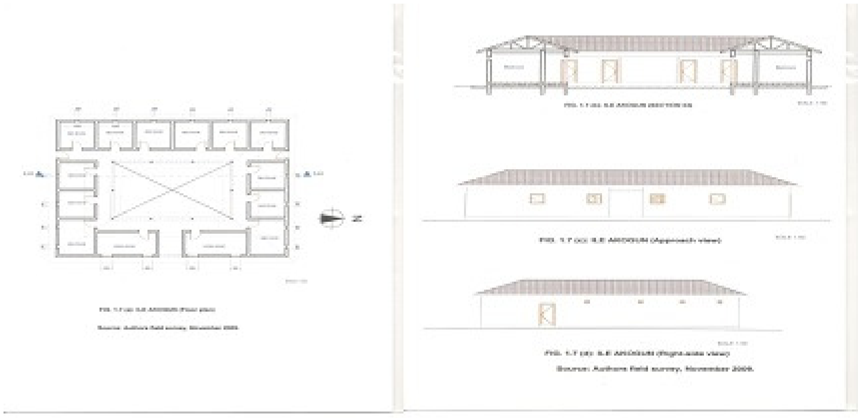

Figure 5.TYPE A -Traditional Compound.

2.1.1.2 TYPE B – Modified Traditional Compound

This residential building type become prominent during 1930's when earnings from cocoa, palm oil, etc. allowed a relatively young man who inherited a share in the family compound to build his own house. This type of residential building consists of a set of rooms arranged along an opening, off a central hall. The hall serves an important function in the running of the house and provides space for sitting (living) and also serves as accommodation for visitors. The back of the house generally contains a kitchen, latrine and general service area. *"KaaIgbogila in Okunmeibo CompoundOgbomoso"* is a typical example of this house types, the plan, and elevations are shown in figure 6.

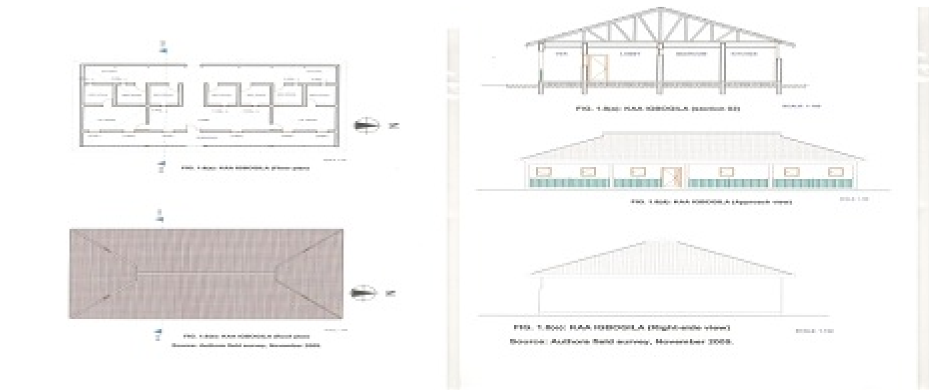

Figure 6: Type B – Modified Traditional Compound

2.1.1.3 TYPE C – Brazilian Rooming House

This residential house type, according to Okeyinka (2007) was developed from Brazilian house types brought about by the influence of the freed slaves who brought new building practices and styles. It does not derive from the traditional Yoruba model but from successive modification of the Portuguese colonial residence in Brazil. This building type characteristically is a building which is divided into separate rooms, for rentage by individual tenants. In the entire urban centre and the villages in Nigeria, this house type has become a dominant type especially in semi core areas. The reason for this, according to Okeyinka (2007), is that it provides rental accommodation at reasonable costs for the large immigrants in the rapidly expanding cities.

This residential building type in its common form, have numerous rooms arranged in a linear form on both sides of an access corridor, hence, in south western Nigeria, it is popularly called 'face-me-I- face-you' (since the doors to the room on opposite sides of the corridor often face one another). Example of this house type ranges from six bedroom bungalow with services in the backyard to two, three and four storey building with numerous rooms with cooking and sanitary services on each floor. A typical Brazilian rooming house has all the rooms treated alike, a bedroom as the same as parlor. The passage or the corridor is as wide as 1.5m to 2.4m, and this enhances its potential for multiple uses (Figure 7).

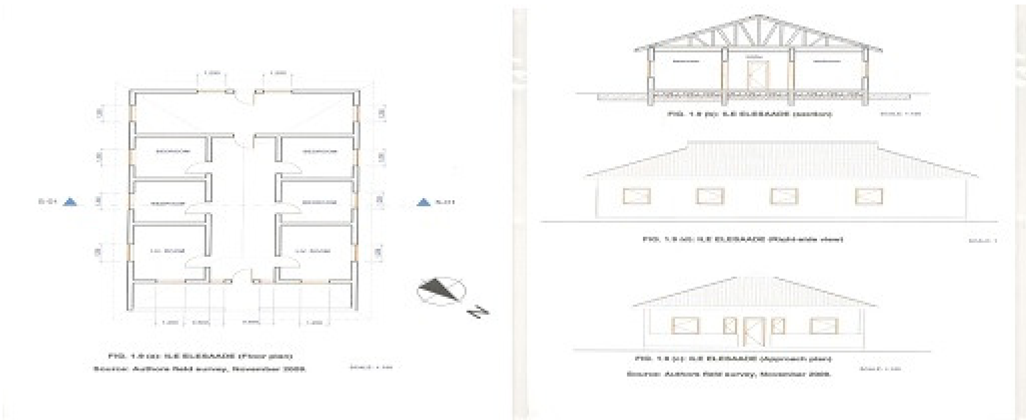

Figure 7: Type C – Brazilian Rooming House.

2.1.1.4 TYPE D- Flat/ Duplex

This residential building type is a complete departure from the traditional house form; privacy is enhanced by the arrangement of rooms better than all other house types. The flat/duplex is a development over the other house types to cater for the educated elite in terms of privacy and access to services within the house. It is common among the educated. In this residential building type, rooms are differentiated with each of this room for specific activity, where as in other building types, almost any activity may occur in nearly any room. Differentiation of course, is partly a function of wealth and privacy.

A flat/duplex may be of two, three, four or five bedrooms with its kitchen and conveniences. The number of bedrooms in this house type is used to denote the apartment. The rooms are arranged in such a way that they either open into lobby or the main sitting room. The sitting room is where the guests or visitors are attended to, and in most cases adjoins with the dining spaces (Figure 8). This house type is not common in the core area.

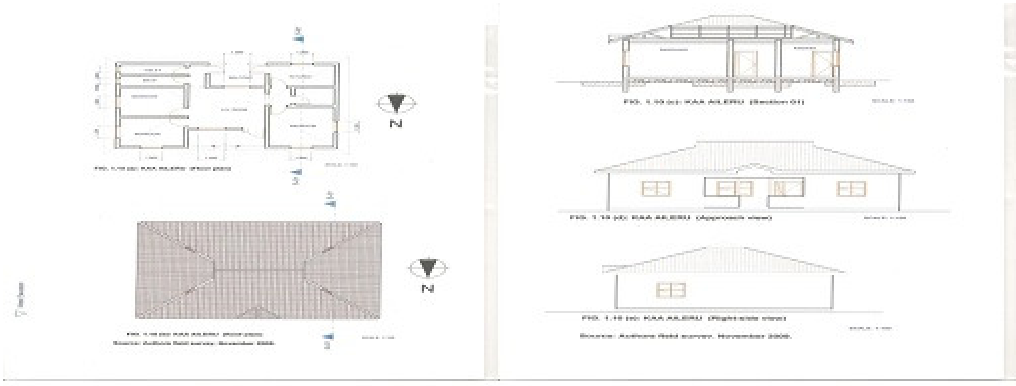

Figure 8: Type D- Flat/ Duplex

4.0 CONCLUTIONS

Reconnaissance survey of the cone area of Ogbomoso shows that it can be divided in to four quadrants with the radial point at Okelerin. The residential buildings in the four identified quadrants can be categorized into four which are: Traditional compound system (46.2%), Modified traditional compounds (30.9%), Brazilian Rooming House type (17.4%), and flat/duplex (5.6%).

Mahoney tables revealed that Ogbomoso is too warm for comfort by day and in some nights, and that air movement is highly essential to reduce discomfort. The tables further provides some design recommendation which include: good layout (longer sides on east – west axis), adequate spacing for breeze penetration (buildings should be spaced five times their height), adequate air movement (rooms should be single banked with windows in the north – south walls) and size of openings should be 40 – 80% of the north and south walls.

However, the situation in the study area did not conform to the Mahoney recommendation, in terms of layout, only 38% of the buildings are properly oriented in accordance with the recommendation. Reconnaissance survey revealed that buildings are closely built, with narrow foot paths separating the buildings; the distance between each building is not more than one fifth of the Mahoney recommendation. In terms of effective air movement, most of the rooms in all the house types are single banked, but are haphazardly placed, not minding the orientation of the walls to which these windows are located. The ratio of the sizes of these windows to wall is less than Mahoney recommendation, the highest being 28.8% in Brazilian Rooming House type, while the lowest is 2.98% in the traditional compound system.

5.0 RECOMMENDATION

Orientation was found to be a major influencing factor in indoor comfort in warm humid climate; it is recommended that windows should not be exposed to the East- West sun path to reduce isolation. The building should be orientated with longer external walls facing north and south directions. Natural ventilated buildings are recommended for the attainment of indoor comfort. The study has shown that the buildings with well-ventilated spaces offer sufficient comfort for the occupants. To achieve this ventilation level, however, windows should be wide enough (at least 40% of the exposed wall area).

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*Received Nov 9, 2013 * Published Dec 2, 2013 * www.ijset.net*