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Building Orientation Pattern for Microclimate Comfort along Slopes in Okigwe Zone, Southeastern Nigeria

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ABSTRACT

The research scope is on building orientation pattern for microclimate comfort along slopes. The findings determined the mean daily maximum temperature of Okigwe Zone to vary between 33oC in January to 28oC in July; while the mean daily minimum temperature varies between 20oC in January to 22oC in March. The purpose of the study include: (1) To encourage building orientation through responsive concepts to immediate slope microclimate (2) To maximize the cooling efficiency and thermal comfort of buildings along slopes. The methodology utilized reconnaissance survey; and secondary data collection involving Okigwe Zone contour map profiling; and the analyses of the profiles of slopes in the Zone. The results identified peculiar site conditions that influence buildings microclimate along slopes to comprise; the site orientation, slope profile orientation, topography, and landscaping. The conclusion classified the analyses of these factors as key to best practice building orientation pattern for microclimate comfort along slopes.

Keywords: *Building orientation, Microclimate, Slopes profile, Wind direction, Sun direction, Topography.*

INTRODUCTION

Building orientation on site is the positioning of a building in relation to seasonal variations in the sun's path as well as prevailing wind directions. Building orientation pattern for microclimate comfort along slopes in Okigwe Zone spells out good orientation considerations that maximize the energy and cooling efficiency of houses along slopes, rendering them more comfortable and cheaper to live in. The influences of slopes and valleys in distorting the thermal comfort of internal room spaces in buildings require an equal professional input, such as this work, in determining factors for analyses in building orientation for thermal comfort. The work utilized modern techniques of research findings and results presentation in the built environment.

The relative position of the sun, in relation to the building site at different times of the day, is a major factor for analysis in building design, zoning of internal spaces, location of outdoor uses, and the building orientation for comfort. The influences of slopes and slopes profile orientation in altering the natural sun shade and wind directions makes it imperative that appropriate orientation analyses be carried out before a building is sited along the slopes profiles and undulating terrain of Okigwe Zone. A building site comprises a multitude of microclimates, each different from the others. The microclimate of any site potentially affects a number of design elements which should be considered when deciding where to place different functions and outdoor uses. According to John *et al.* (2016), functions that require sun exposure should be located in the sunniest places of the site while uses that require minimum air flow should be located where they are protected from the wind. Areas that are to be frequently used by people should be carefully placed for microclimate so that they are

comfortable and more enjoyably used for longer periods of time.

Each site has its own microclimate that result from the particular site conditions, including site orientation, house location, house orientation, house size/configuration, topography, drainage pattern, amount and location of existing plant materials and pavement (Uji, 2017). This study however, identified the peculiar site conditions that influence buildings microclimate and orientation in Okigwe Zone to consist mainly of the site orientation, slope profile orientation, and topography. The impact of landscaping in creating good architecture with microclimate comfort along slopes was emphasized by Chaira and Koppelman (2018) and Cartilidge (2016) when they stated that an urban house erected on hills (slopes) without gardens and vegetation, where the only open spaces are roads, pavements and courtyards, is likely to be soulless, monotonous and hot. This is simply an expression of the importance of landscaping in improving the microclimate comfort of badly oriented buildings, and buildings with limited environmental allowances for good orientation. Ogunkoya (2018) stated that, for the enhancement of the orientation of any piece of architecture into the environment, the landscape elements and design must be simultaneously thought of, alongside the development of the building design.

THE IMPORTANCE OF THE STUDY

General orientation consideration and analyses affects the concept and planning of interior spaces and zoning of functions in any building design. This is an important design factor to be considered as the building is being planned. Orientation influences the location of rooms on the plan as well as the positioning of the building on the site (Philip *et al*, 2016).

Orientation involves a consideration not only of prevailing winds, views, and privacy, but also of the sun. Each of these environmental components affects the comfort and form of the house. Generally, it is not possible to incorporate all the best orientation elements involved, but each should be considered, and some provisions made to help ease bad situations. For example, if the hot southwesterly sun will bear on the bedrooms wing in the evening, and if it is not possible to orient these rooms to face east, then some provisions must be made ready for sheltering this area. A large overhang, trees, a fence, or some such devices should be planned to break the sun rays and heat. Such design and planning will help overcome disagreeable factors caused by unfortunate orientation (Singh and Singh, 2017).

The comfort of a house depends a great deal upon a careful orientation of the building design to the sun. During the dry season, the sun can make a poorly oriented house unbearably hot. But in the wet season, a poorly oriented house could lose the benefit of free solar heat (Lawal, 2016). Two air masses control rainfall in Okigwe Zone, as in the whole of Nigeria – moist, northward moving maritime air coming from the Atlantic Ocean, and dry continental air coming towards south from the northern landmass. In Oklgwe Zone, rainy season usually begins in March as moist Atlantic air, known as the southwest monsoon, invades the zone. The beginning of the rain is usually marked by the incidence of high winds and heavy but scattered squalls. However, the topography and presence of steep slopes and valleys alters the natural order of sun shade and wind directions in the study area. The topography of Okigwe Zone is hilly and undulating compared to the rest of Imo State in southeastern Nigeria, with relatively flat and low-lying relief. Few hilltops around Okigwe Zone reach 300m, while the average height of the crest lies between 120m and 180m above sea level.

The incidences of sun and wind on steep slopes with unfavorable profile orientation can cause an appropriately oriented building to receive only wind eddies for cooling, and cause areas oriented for thermal comfort to be continually damp throughout the seasons. This premise lends credence to the importance of this work which recommends absolute appraisal and analyses of the presence and influence of slopes in buildings orientation for microclimate comfort. Before pen is put on paper in the design of any building to be sited in Okigwe Zone, or in other areas with steep slopes, a study of the slopes profiles orientation, angles, gradient and influence on the immediate site microclimate should be of paramount importance. The importance of this work therefore includes:

- The need to bring man closer to the natural environment – visibly manifest in the form of slopes and similar topography – by an interplay with man-made developments and

yet, maintaining minimal distortion of the natural elements and order.

- The work provides parameters for requisite architectural interior and outdoor space zoning, and building orientation for microclimate comfort of housing developments along slopes.
- The results of the work will serve as a handbook to Architects and land-use planners; and could equally be enshrined in the building regulation policies of local government areas with undulating slopes for good building orientation.

STUDY OBJECTIVES

Mbanugo (2016) pointed out that every architectural scheme is an infringement on the natural environment. Even though an architectural concept for a particular scheme is initiated by an Architect or group of Architects, its implementation is always with an environmental impact which must be identified and recognized at the conceptual stage of the design scheme. Some of the identified environmental impacts associated with architectural schemes, according to Mbanugo (2016), are categorized under; Topography, Microclimate, and Building Orientation. Against this background, the objectives of this study are:

- To identify factors worth analyzing for building orientation at the conceptual stage of architectural design of buildings to be sited along slopes.
- To analyze two of the slopes profiles cut across the Okigwe Zone contour map for building orientation and microclimate comfort.
- To appraise the impact of landscaping in remediating the effects of inhibited building orientation along slopes.

THE STUDY AREA

Okigwe Zone is one of the three Senatorial zones in Imo State, Nigeria. It comprises six Local Government Areas all of which have topographic slopes and undulating terrain. The local government areas are;

- Ehime – Mbano L.G.A, with Headquarters at Ehime
- Ihitte Uboma L.G.A, with Headquarters at Isinweke
- Isiala – Mbano L.G.A, with Headquarters at Umuelemai
- Obowo L.G.A, with Headquarters at Otoko
- Okigwe L.G.A, with Headquarters at Okigwe
- Onuimo L.G.A, with Headquarters at Okwe

Figure1. Shows map of the study area location in Nigeria, Imo State, and Okigwe Zone.

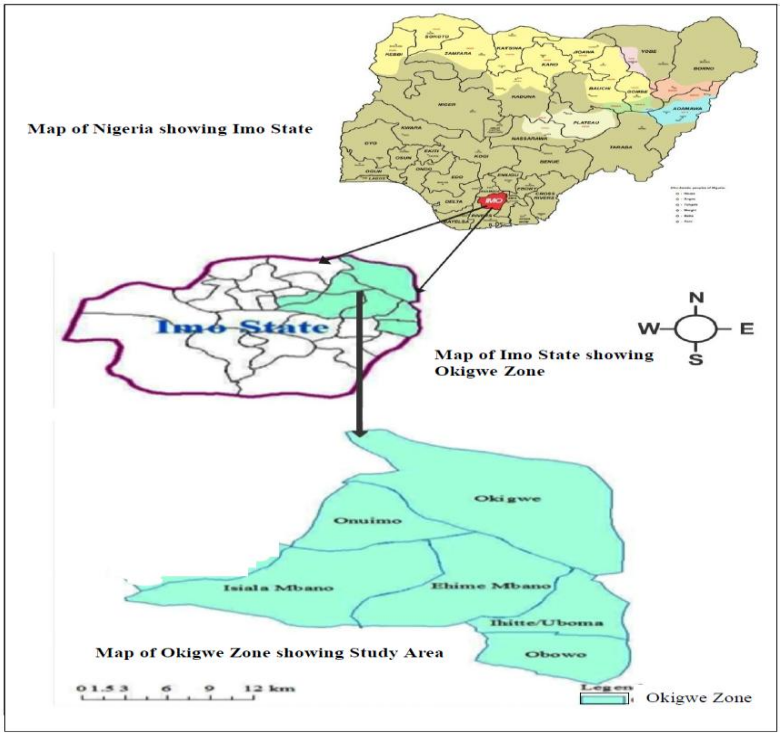

Figure1. *Map of Nigeria, Imo State, and Okigwe Zone showing Study Area*

Okigwe Zone is the study area. It lies between latitude 5^{o} 30' – 5^{o} 57' N and longitude 7^{o} 04' – 7^{o} 26' E covering a land area of about 952.3 sq.km. Okigwe as a zone is strategically located in the heart of the Eastern Region as shown in Figure 1. It is bounded on the East by Abia State, on the West by Orlu Zone, and on the North by Enugu State, while Owerri Zone lies to the south. The Okigwe Zone total population, according to the 2006 population census, stood at 799,556. The inhabitants of Okigwe Zone are Igbos, a culturally homogenous group. The Igbo language is spoken throughout the zone with minor differences in dialects. The official language of the zone, however, is English. Okigwe Zone has very rich cultural heritage with abundant agro and mineral based raw material resources. The occupations of the people are mainly farming, pottery, and carving. (Imo State Ministry of Information, 2018).

Climate of Okigwe Zone

The term "climate" refers to the scientific study of weather conditions of an area over a considerable time. The two major climatic seasons experienced in Okigwe Zone and around Imo State are the rainy season (April to September) and the dry season (October to March). A temporary cessation of rain known as "August break" separates a maximum rainfall regime from a minimum and is experienced between the last week of July and first week of August. A period of dry, cold, dusty wind known as "Harmattan" occurs between December and January. Heaviest rainfall occurs in July and September while the month of March records the hottest weather, and December, the driest month (Department of Meteorological Services of Nigeria, Owerri, 2018).

The mean annual rainfall in Okigwe Zone is between 2000 and 2200mm. The rain falls in heavy showers with great erosive force. Mean daily maximum temperature varies from 33^{oC} in January to 28^{oC} in July; mean daily minimum temperature varies from 20^{oC} in January to 22^{oC} in March (Department of Meteorological Services of Nigeria, Owerri, 2018).

The monthly average, maximum and minimum temperature (^{o}C) by year 2018 at the weather station in Ihitte-Uboma in Okigwe Zone, measured 31.7^{oC} and 21.5^{oC} respectively. The only weather station in the whole of Okigwe Zone is in Ihitte Uboma, so that its results are generalized to cover the entire zone (Imo State Ministry of Agriculture and Environment Owerri, 2018). The understanding of these elements of climate such as rainfall, temperature, humidity, wind and radiation, the interaction between them, and with other aspects of the slope environment, gave insight to this research about the processes that generate change in buildings microclimatic conditions in Okigwe Zone. The inventory of these factors enabled the precise analysis of the Okigwe Zone contour profiles with respect to building orientation.

Related Literature

Architecture is perhaps one of the most potent forms of artistic expression in the building industry that encapsulates many forces of a geographical region. The natural forces of environment like climate and abundant materials for construction; the socio-cultural forces like ethnicity, faith, folklores; economic factors like labour and materials; technological forces as various modes of energy and building systems, all affect and reflect in architecture (Gary and Aura 2017; Gilmer, 2016).

Booth and Hiss (2018); Lawson (2016); and Onyeador (2016) stated that numerous items of information identified and catalogued during site inventory, forms the basis of the building orientation concept. Some site information such as prevailing wind directions and sun angles, are bound to influence the internal location of spaces and the orientation of the building on site. Topography is therefore one factor bound to influence building orientation for microclimate comfort.

The physical environment is also affected during and at the end of the construction process. Consequently, it is critical that buildings be conceived and designed with the utmost care and sensitivity peculiar to the site so it indeed fulfils its vital role in the overall environment. The challenge to the Architects of today is to shape buildings and cities that give people who use them a sense of comfort, natural proportion, and aesthetic delight (Houghton and Woodwell, 2016; Barry, 2017; Chaira and Koppelman, 2018; Fadamiro and Ogunsemi, 2017).

Ahmadu (2016); Olgyay (2017) and Sagada (2015) stated that, before the plans of any building can be drafted, the design of the building components and their relationship to one another and to the environment must be

determined. These include decisions about the concept of the house, zoning of internal and outdoor spaces as well as the building orientation in relation to the environment and information on temperature, wind and humidity.

METHODOLOGY

Data analyses with respect to Okigwe Zone area slopes centered on the Okigwe Zone contours, topography, slopes gradient and profile drawings. Topographic profiles cut across the Okigwe Zone contours in different axes recognizing the North arrow, enabled this study to determine the slopes orientation, gradient and angle, as well as gave insight into existing buildings orientation with respect to wind and sun directions.

In order to procure reliable data for this research, three principal techniques and sources of data were utilized. However, the methodology of data collection used can be summarized into three broad headings: (1) Reconnaissance Survey (2) Secondary data collection (a) Okigwe Zone Contour Map Profiling. (b) Analysis of the Profiles of Slopes in Okigwe Zone.

Reconnaissance Survey

This is the whole observation and feasibility study of the Okigwe Zone to examine the general character of the slopes for the purpose of inventory and inventory analysis of the gathered report. The reconnaissance survey involved a preliminary examination of the topographic angle of elevation and gradients of the Okigwe Zone slopes; types of vegetative covering; existing pattern of building orientation, and availability of public amenities like access roads, water supply network, electricity lines, telecommunication lines, and safety systems. This was done in order to get acquainted with the Okigwe Zone slopes features and acquire insight into the task required for good building orientation for microclimate comfort in the zone.

Consideration for Sun

Peter (2016); Singh and Singh (2017); Olgyay (2017) posited that the sun is one factor that needs consideration to make a building comfortable and environmentally responsive to the site. Its presence affects air temperatures and shadow patterns which in turn directly influences human comfort. Before being able to effectively orient a building for comfort with respect to the sun, it is necessary to understand the movement of the sun throughout the day and at different seasons of the year in the area for the building location. The sun's relative position in the sky, as shown in Figure 2, is constantly changing in its plan direction as well as its angle above the horizon. This study used the information gathered during reconnaissance survey about the movement of the sun in Okigwe Zone to; construct shadow patterns around a house sitting on a plain site to show where the sunniest and shadiest zones are, as well as the associated microclimates under normal circumstance.

Figure 3 and 4 below illustrates the normal microclimate zones and location of spaces around a house. The need for this analysis became imperative when Atkinson (2016); Helen (2017); Holtz and Kovacs (2018); and Peter (2016) stated that similar conclusions can be drawn about shadow patterns for different slopes orientations on a building site. A south-facing slope, like the south side of a house, receives the most sun throughout the year and is the warmest of all during the winter season. An east-facing slope experiences moderate temperature while a west-facing slope is the hottest and driest of all slopes during the summer months. Similar analysis in the tropical zone of Okigwe with only two extreme seasons, proved indeed, some differences between the temperate and the tropical climate conditions. With slope shadow cast interference, the microclimate around any house adjourning a slope changes drastically.

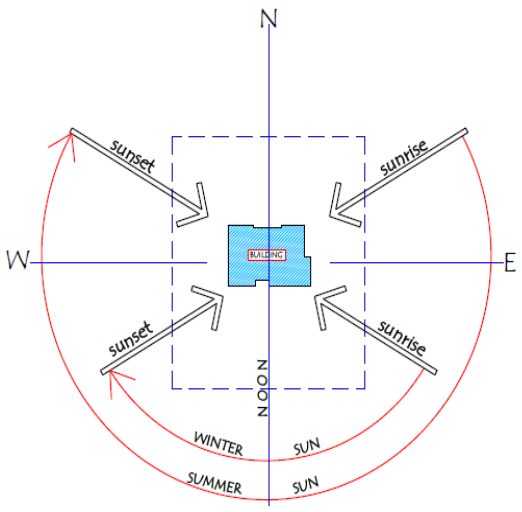

Figure2. *Sun Direction at Different Times of the Day*

Source: *Generated by the Researcher*

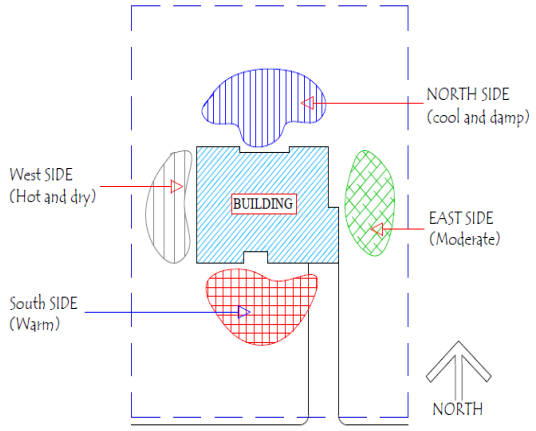

Figure3. *Normal Microclimate zones around a House*

Source: *Generated by the Researcher*

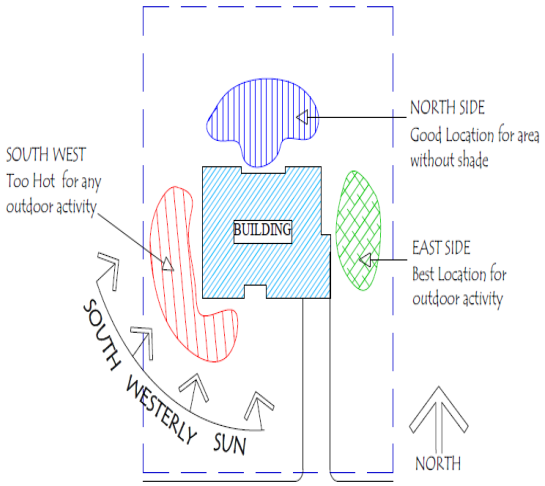

Figure4. *Location for Outdoor Spaces during the Dry Season*

Source: *Generated by the Researcher*

Consideration for Wind

Wind is another important climatic factor that needs to be considered when designing a house for microclimate comfort. Wind affects both human comfort and energy consumption of the house itself. Wind cools the body by increasing the amount of moisture evaporated at the skin's surface. This is desired when air temperatures exceed the comfort range of 70 to 78° F. On the other hand, wind exposure is not desired when air temperatures drop below 70°F (Gilmer, 2016)

Unlike sun, wind is not as precisely predictable in terms of the seasons and directions from which it blows. Wind is more variable on a daily basis than sun, but does hold some generalized patterns based on season and weather fronts. In broad terms, wind blows from all compass direction during all seasons of the year. However, wind blows commonly from a westerly direction throughout Nigeria (Department of Meteorological Services of Nigeria, Owerri, 2018). In the harmattan season, as illustrated in Figure 5, the tropical harmattan wind blows from the North-east direction, while during the wet and dry seasons the Southwesterly wind prevails.

In the United States, the wind direction is different. In the summer, the prevailing wind is from the south and southwest, while during the cool season it shifts more to the west and northwest following the passage of cold front as illustrated in Figure 6. Nevertheless some similarities exist between wind directions in Nigeria and the United States in that, the south, southwest, and west sides of the house receive the most constant wind on a yearly basis. (Armor and Snell, 2016).

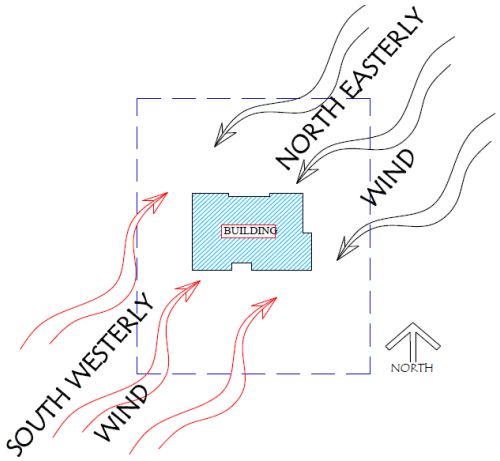

Figure5. *Prevailing Wind Directions in Nigeria*

Source: *Generated by the Researcher*

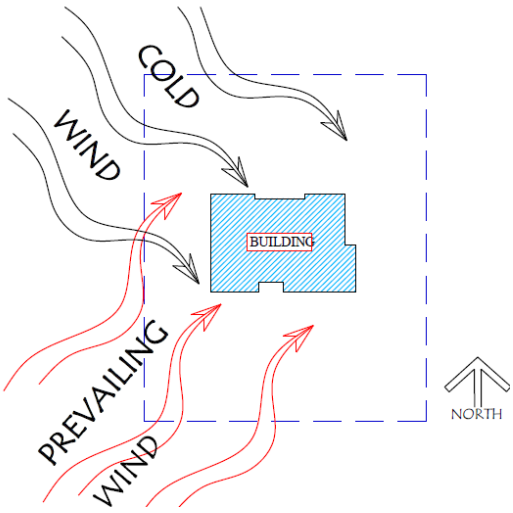

Figure6. *Prevailing Wind Directions in the United States*

Source: *Generated by the Researcher*

Okigwe Zone Contour Map Profiling

The analysis of slopes profiles in Okigwe Zone was carried out using the technique of topographic map profiling of the Okigwe Zone contour map. Topographic map profiling is a graphical technique of determining slopes gradients and angles using cross-section lines that are cut across the contour lines with respect to elevations and features to be captured for analyses. As clearly illustrated in Figure 7 below, five cross-section profiles were cut across the Okigwe Zone contour map with nomenclature and graphical identification letters as follows: Slopes Profile A-A; Slopes Profile B-B; Slopes Profile C-C; Slopes Profile D-D; and Slopes Profile E-E. These slopes profiles were instrumental to the determination and analyses of the slopes profiles orientation, angles, and their influences on buildings orientation with respect to sun position, wind direction, and rainfall. The outcome of these analyses guided the recommendations of the research for proper buildings orientation along slopes in Okigwe Zone. Nevertheless, for lack of space, only profile A-A and profile B-B were analyzed to give insight to the expected profiles results.

Analyses of the Profiles of Slopes in Okigwe Zone

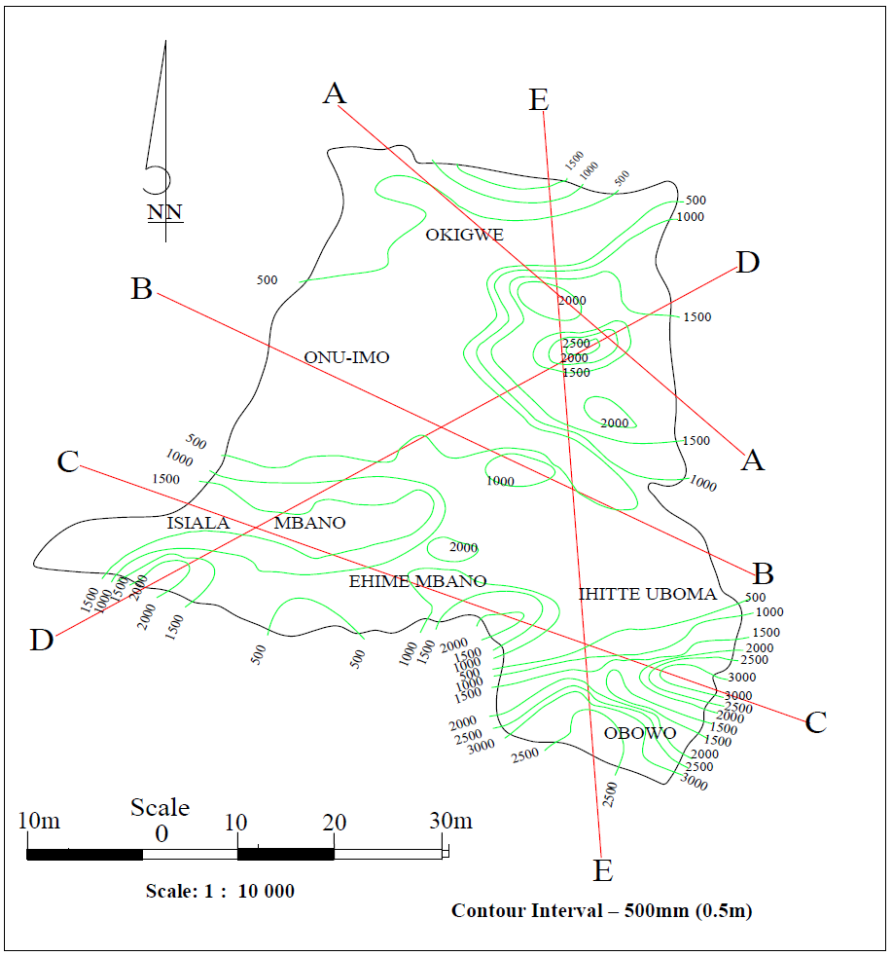

Figure7. *Okigwe Zone Topography Map Showing Contours and Profile Lines*

RESULTS AND DISCUSSION

Analysis of Slopes Profile A-A (Through Okigwe LGA Only)

Slopes profile A-A, as shown in Figure 8, cuts across the high and low lying elevation points in Okigwe Local Government Area to capture the gradient and area profile of the slopes as it exists. The topographic angle of elevation of the slope is 69^{o,} whereas the slope profile is oriented at 47^{o} to the east of the North arrow. As shown in the slopes profile, the plain land area is the axes accommodating the Okigwe town, whiles the hill summits as represented in the slopes profile, covers the area from Okigwe town towards Uturu, where steep slopes and gullies are the area features. There is virtually no development around the steep slope area in the exception of a radio station mast standing on one of the slopes, and some skeletal settlements.

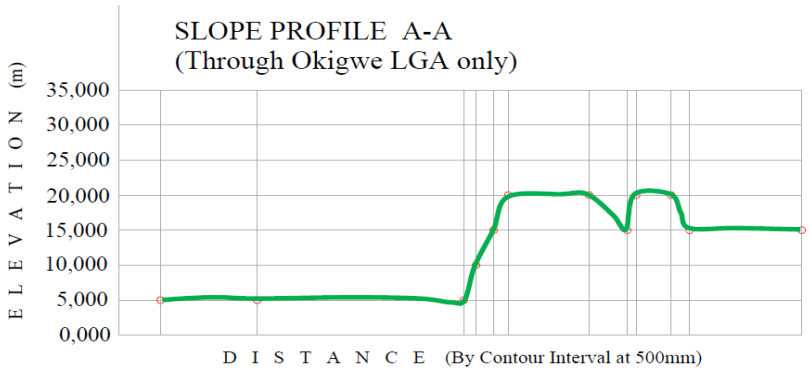

Figure8. *Slopes Profile A-A (through Okigwe Local Government Area only)*

Source: *Generated by the Researcher*

Analysis of Slopes Profile A-A With Respect To Wind

Houses located at the east side of this slopes profile, but directly behind the slopes, will always receive high measures of the northeast (harmattan) wind alongside the dust haze that comes with it, and the resultant effect of building materials damage in the form of rust, wood cuppling, bending, and expansion of weak materials. It is about the same experience for houses located on the west side of the slopes profile as they will throughout the year enjoy the cool southwesterly wind. Houses on the west side of the slope profile lies on the southwest windward side, and receives direct southwest wind effect, while the houses on the east side receives direct northeast (harmattan) wind because they lie on the northeast windward side as illustrated in Figure 9. Both sides will receive eddies of the respective wind directions in the different seasons of the year, that is, the rainy and dry seasons respectively. Figure 10 shows an illustration of the effects of eddies along slopes profiles, as Figure 11 and Figure 12 also illustrates eddies effect on buildings along slopes using graphical expression. The houses on the east side of the slopes profile orientation will tend to be hot almost throughout the year until towards the month of November when harmattan sets in. These houses should be designed, oriented and integrated along the slopes with adequate consideration for landscaping and the use of evergreen trees like Melina, dogonyaro (neem tree), and cashew to serve as shades and wind breakers against the harmattan dust haze. Durable materials and seasoned wood should be used for buildings construction on this side of the slopes profile orientation. The plain area receives both the southwest wind and the northeast wind equally in their respective seasons. The houses here are bound to be cool throughout the year. This slope profile orientation is well positioned for balanced microclimate orientation, but buildings that are 10m to 20m closer to the steep slopes should use large window openings and more balconies to take advantage of the only available wind flow – that is the wind eddies.

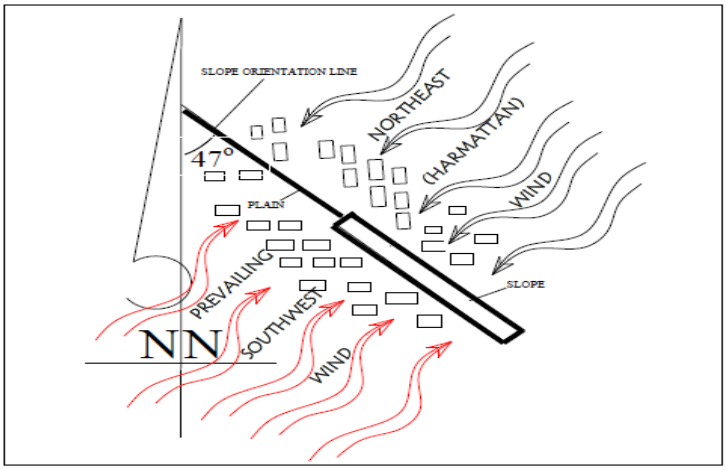

Figure9. *Wind Directions and Impact on Buildings along Slope Profile A-A*

Source: *Generated by the Researcher*

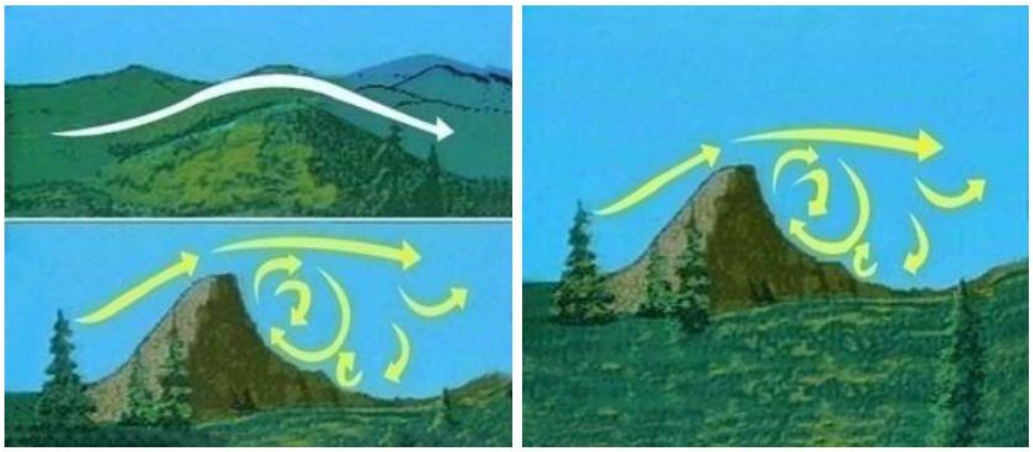

Figure10. *Wind Eddies and effects on Lee sides of Slopes*

Source: *www.google.com*

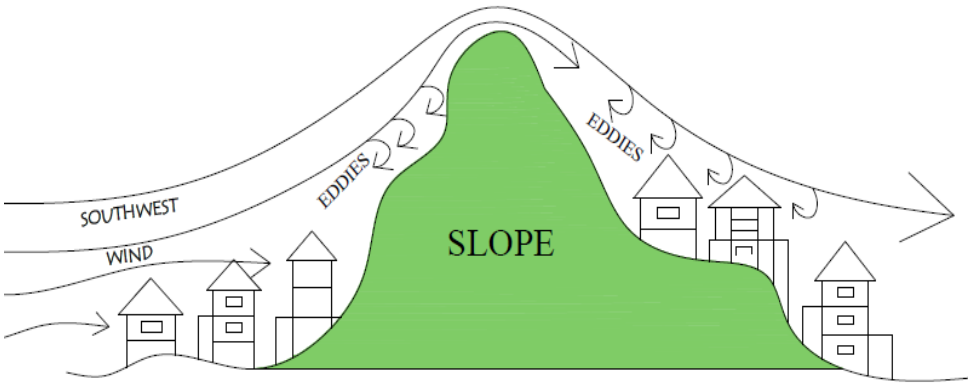

Figure11. *Southwest wind and Eddies Effect on the Lee side*

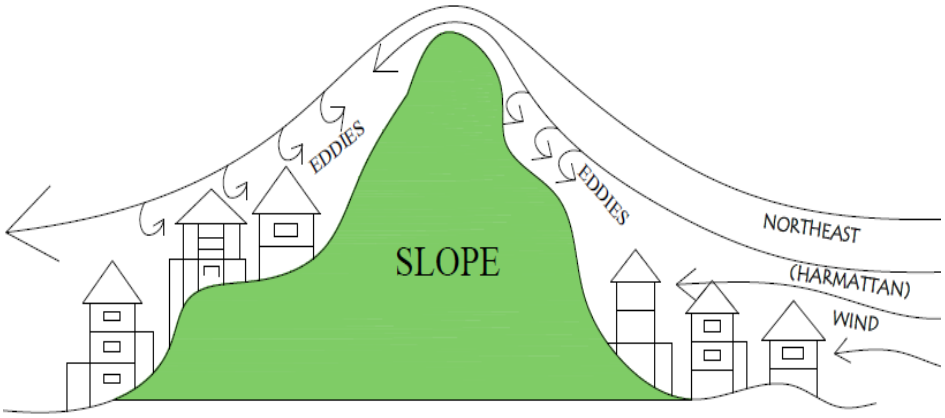

Figure12. *Northeast Wind and Eddies Effect on the Lee Side*

Analysis of Slopes Profile A-A With Respect to Sun

Before being able to orient and integrate a building along slopes in Okigwe Zone with respect to the sun, it is necessary to understand the movement of the sun throughout the day. The sun's relative position in the sky is constantly changing in its direction as well as its angle above the horizon. The sun rises in the east and moves in a clockwise direction through the south, sets in the west and goes down in the north. The orientation of the slope, relative to slopes profile A-A at angle 47^{o} east of the North arrow, spells harsh southwest solar radiation on buildings and settlements on the west side of the slope. Only proper orientation of buildings on this side, usually away from the southwest heat, and the use of landscaping incorporating evergreen trees for sun breakers, can bring about the cooling effect required in the interior spaces

of buildings on the west side. Spaces requiring dryness like the toilet, shower, laundry, and kitchen should be oriented to the southwest direction, while comfort zones like bedrooms, lounges, and study should be oriented away from the southwest sun direction. For microclimate comfort, the shorter sides of the building form should face the southwest and northeast, while the longer sides should face southeast and northwest. At another instance, the buildings on the east side of this slopes profile orientation will always be cool and damp because of the shade and shadow cast effect of the slope over the buildings by the west and southwest sun directions, alongside the sun break effect of the slope over the entire area. This analysis is another coherent proof why Okigwe town is the city center, more developed, and continues to spread in the western direction.

Analysis of Slopes Profile B-B (Through Onuimo and Ihitte-Uboma Lgas)

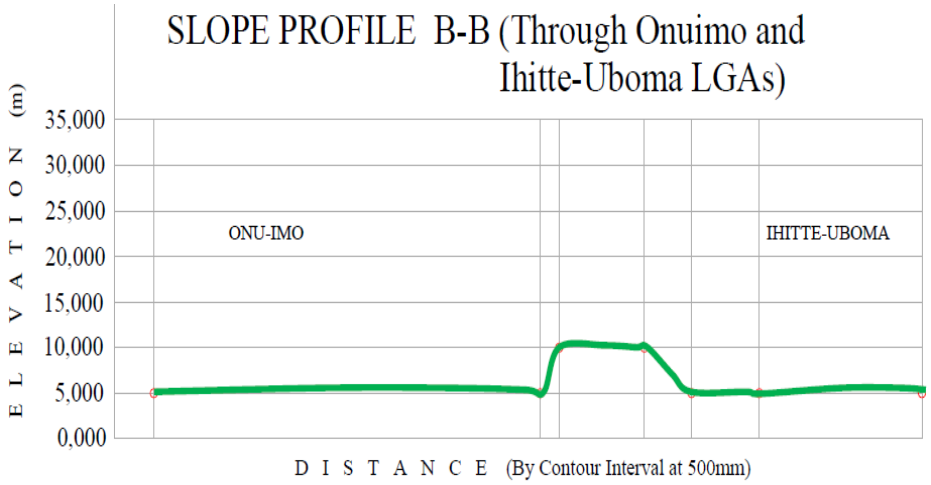

Figure13. *Slopes Profile B-B (through Onuimo and Ihitte- Uboma LGAs)*

Source: *Generated by the Researcher*

Slope profile B-B as illustrated in Figure 13, cuts across the high and low lying elevation points through Onuimo and Ihitte-Uboma Local Government Areas to capture the gradient and profile of the area as it exists. The topographic angle of elevation of the slope is 63^{o,} whereas the slope profile is also oriented at angle 63^{o} to the east of the North arrow as illustrated in Figure 14. As shown in the slopes profile, the plain land area is the axes accommodating Okwe town, the Headquarters and more developed center in Onuimo local government area, while the gentle slope and adjoining plain land area to the east accommodates Etiti, the Headquarters of Ihitte-Uboma local government area.

Analysis of Slopes Profile B-B With Respect to Wind

Slope profile B-B at an angle 63o with the North arrow, does not make much difference in orientation with slopes profile A-A. At this angle, and by virtue of the mostly level land areas, the southwest prevailing wind and the northeast harmattan wind, as illustrated in Figure 14, impacts the buildings and settlements in this area with ease. This slope profile does not make any distinction between a west side and an east side by the demarcation of high topography slopes, except for the small gentle slope close to the middle of the profile. Further analysis of this slope profile through Onuimo and Ihitte-Uboma with respect to wind, indicates that throughout the year, these areas will always enjoy the cooling effect of the southwest monsoon which comes mostly during the rainy season, and without any slope alteration which produces eddies. In the same vein, the northeast harmattan wind with its associated dust haze, will also impact the Onuimo and Ihitte-Uboma axes during the harmattan season between the months of November and January each year. Perfect orientation of buildings to provide the much needed comfort in the interior and exterior spaces in these areas is very important for adaptability; and where buildings cannot be oriented away from the harsh wind directions of southwest and northeast, evergreen trees should be planted to serve as wind breakers. In buildings construction and finishes specification, making the right choice of durable materials that will always withstand the destructive effect of harmmatan in these areas, is very vital.

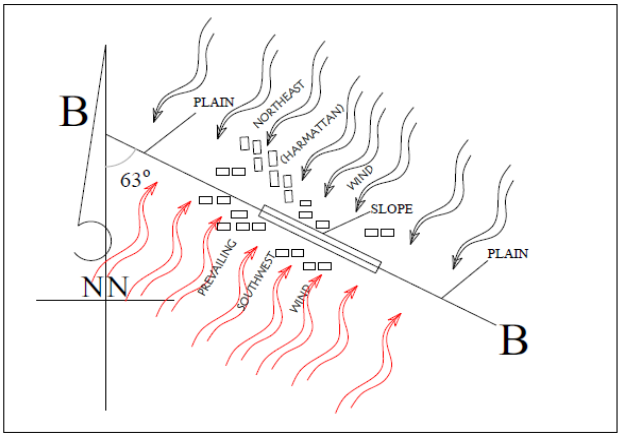

Figure14. *Wind Directions and Impact on Buildings along Slopes Profile B-B*

Source: *Generated by the Researcher*

Analysis of Slope Profile B-B With Respect to Sun

By the orientation of slope profile B-B to the southeast and northwest directions as illustrated in Figure 14, the implication is that the heat of the southwest sun will impact heavily and equally on all settlements and buildings in the Onuimo and Ihitte-Uboma axes. It has been stated that the position of the sun changes at different times of the day and year as it rises from the east. The longest lasting position of the sun and the hottest is the southwest. Buildings and settlements in these areas are bound to be hot by the day except by proper orientation away from the southwest heat, and by planting of trees to create shade and cooling effect. The Ihitte-Uboma weather station in Imo State put the annual minimum and maximum temperature (oC) of Okigwe Zone in 2018 at 21.5 oC (Min) and 31.7oC (Max), as shown in Table 2. The study also noted that the mean daily maximum temperature in Okigwe Zone varies from 33oC in January to 28oC in July; while the mean daily minimum temperature varies from 20oC in January to 22oC in March. In the light of this high maximum temperature of Okigwe Zone, spaces requiring dryness in the interior of building designs should be zoned to the southwest/northeast axes. However, landscaping and evergreen trees planted on both southwest and northeast sides will provide the much desired microclimate comfort around buildings and settlements in Onuimo and Ihitte-Uboma local government areas. The use of evergreen trees as Melina - a quick growing tree; dogonyaro (neem tree), cashew etc, is highly recommended for use as sun breakers in the Onuimo and Ihitte-Uboma slopes profile axes.

MONTHLY MINIMUM AND MAXIMUM WEATHER CONDITIONS AT THE IHITTE-UBOMA WEATHER STATION IN IMO STATE BY YEAR (2015 – 2018).

Table1. *Monthly Minimum and Maximum Temperature (2015 – 2018)*

MONTHS	IHITTE-UBOMA							
	2015		2016		2017		2018	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
January	18.3	33.0	17.2	33.3	18.2	33.1	21.8	32.2
February	18.2	34.0	20.8	35.5	20.3	34.9	23.0	32.9
March	18.1	32.9	20.3	32.9	20.7	32.3	22.7	35.1
April	17.5	33.1	20.6	33.0	20.5	35.0	22.3	33.2
May	17.5	32.2	20.0	32.8	20.0	34.0	21.8	32.6
June	17.0	31.2	20.1	32.0	19.0	33.0	21.4	32.3
July	16.7	29.7	19.5	30.6	19.0	31.0	20.9	30.9
August	20.0	29.0	21.0	29.5	19.5	29.5	20.9	30.5
September	17.0	30.0	20.0	30.0	20.2	30.2	20.5	29.7
October	17.0	31.0	20.0	31.2	20.6	30.9	20.6	29.8
November	16.0	33.0	19.0	32.3	21.0	32.3	21.3	31.2
December	17.2	33.8	19.5	32.6	20.0	31.8	21.2	31.7

Source: *Ministry of Agriculture and Environment Owerri, 2018.*

Table 1 shows the monthly minimum and maximum temperature at the Ihitte-Uboma weather station in Imo State between 2015 and 2018, while Table 2 shows the annual average minimum and maximum temperature between the same space of 2015 and 2018

Table2. *Annual Average Minimum and Maximum Temperature (2015 – 2018)*

YEAR	IHITTE-UBOMA	
	MIN	MAX
2011	17.5	32.0
2012	19.8	32.0
2013	20.1	32.6
2014	21.5	31.7

Source: *Ministry of Agriculture and Environment Owerri, 2018.*

Table 3 shows the annual total and average rainfall in Okigwe Zone from year 2015 to 2018. The mean annual rainfall in Okigwe Zone is between 2000 and 2200mm. Rainfall and rainy season generally increases the run and intensity of the prevailing southwest wind which is also characterized with cold weather conditions. This is yet another consideration for good building orientation on site.

Table3. *Annual Total / Average Rainfall (mm) (2015 – 2018)*

YEAR	IHITTE-UBOMA	
	TOTAL	AVERAGE
2015	2500.2	277.3
2016	1965.5	163.9
2017	1892.6	157.7
2018	2632.9	239.4

Source: *Ministry of Agriculture and Environment Owerri, 2018.*

CONCLUSION

The site surrounding a building is a most important environment. It serves numerous utilitarian, aesthetic and psychological functions for the users as well as for visitors, neighbours, and passersby. As a setting for the building, the site is the context or surroundings within which one views the architecture of the building concept. Building orientation along slopes simply means concept, zoning of spaces (functions), design and integration of buildings along the slopes profile.

Consequently, it is critical that slopes buildings orientation be conceived with utmost care and sensitivity peculiar to the slope profile so it indeed fulfills its vital role in the overall environment. This study identified some environmental considerations associated with good building orientation to include topography, slope profile, wind directions and sun positions at different times of the day and seasons. It is however, evident that there are numerous orientation patterns that can be employed for making a building responsive to nature and the natural processes of slopes. Whatever orientation pattern employed should give particular consideration to the site location with reference to the area slope profile orientation, slope steepness, wind directions, sun's position, and desirable landscaping materials. These are prerequisites for good building orientation and comfort along slopes because of the environmental consequences, as well as the potential economic and functional benefits, as outlined in the importance of the study. Building orientation along slopes require insight in carrying out all feasibility studies and making sure the design process is carried out with utmost care and sensitivity to the broader and ever present natural processes of slopes.

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