CLIMATE AND BUILDING STRUCTURES IN ADO EKITI TOWNSHIP

By

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Abstract

The study examined the impact of climatic elements on building structures in Ado Ekiti Township using two sources of data. Primary data were obtained through questionnaire administration, oral interviews and observation of building structures, while secondary data was abstracted from the archive of the Department of Geography and Planning, University of Ado Ekiti for a period of 12 years (1996 – 2007). Ado Ekiti township was divided into three zones based on population and housing density, these are: the core zone, transition zone and the outskirt zone. A total of 100 questionnaires were administered using the purposive random sampling technique to the three zones on the basis of 50:25:25. Simple percentage score was used to analyse socio-demographic characteristics of respondents, while product moment correlation and chi-square techniques were used to examine relationship between damaged walls, roofs and structural damage/location analysis. Results obtained shows that 68% of the respondents were aged 50 years and above. This indicates a high level of maturity which reflected in the other responses. The mud/cement walling material was observed to have recorded the highest percentage damaged (47.04%). The relationship between damaged walls and rainfall, damaged roofs and rainfall were both positive and strong with correlation coefficient (r) of 0.98 each. Both relationships were significant at the 0.05% confidence level. There was however no relation between structural damage to buildings and location within the township. The research therefore concludes that since the highest number of structural decay occurs within the core zone, the zone should be seriously considered for an urban renewal exercise in order to address congestion problems.

Keywords: *Climatic elements, rainfall, building structures, damages and relationship.*

Introduction

Man and his activities including development and management of infrastructure are vulnerable to climatic variations. Building structures vary according to design and they reflect different land use types (Residential, Religious structures, Educational structures, Recreational structures, Traditional structures and monuments, etc). All building structures are constructed to function as shelters for inhabitants and materials against physical attacks and weather and climate. Building structures are also used to conserve energy efficiently, guaranty safety and ensure aesthetic quality. Thus, there are two broad aspects of the relationship between outdoors construction projects and climate or weather: (1) influences on design and choice of materials (2) Direct effect on construction activities. The design of a given structure must take into account potential stresses impost by temperature extremes and fluctuations, wind force, humidity changes, rainfall or loads of snow and ice. These factors also help determine the selection of materials best suited to climatic extremes because of their inherent strength or resistance of damage by physical of chemical weathering. Qualities such as heat conductivity flexibility or permeability may also be important in a particular structure (Critchfield, 2006).

The issue of climate and development has been in the fore front of discussions. Recently, Michealowa and Michealowa (2007) analysed the interaction of climate and development

policy that has taken place since the early 1990s. They observed increasing dissatisfaction about the result of traditional development cooperation and the appeal of climate policy as a new policy field led to a rapid reorientation of aid flows. Their finding also shows that funds meant for development and management of structures and resources are used for beefing up climate policy as a justified measure on countermeasure against emission. In fact the decision of selecting building structures with respect to the environmental demand is an issue that has been propounded, discussed and supported in most regions of the world. Hassan (2004) argued strongly that climate should be the deciding factor in the selection of materials for wall structure. He advised that decisions should be made on three categories of exterior wall structures: wood, masonry and concrete. Sancho et al (2003) did similar work for the semi arid environment, while Wu et al (2007) and Ergular and Ulusaw (2003) centered their studies in the Polar and Humid clay environments.

The impact of climate on man's activities maybe positive or negative. Climate may also be regarded as a hazard and a resource depending on the time, location and the value and types of climatic parameter involved. For example, rainfall has an appreciable effect on building. The total amount, direction, intensity and incident angle should be considered in structural development. It affects building materials and cause damage to both exterior and interior of buildings. Adefolalu (1988) pointed out that rainfall is highly variable in West Africa both in time and space. They are generally marked by strong winds and rainfall of high intensity at the beginning and end of the rainy season. The rain drops are rather large, discharging high energy load on structures thereby damaging or weakening them. When accompanied by hailstones, glass windows and slate roofs are shattered. Rainstorm leads to flooding which can undermine the foundation of building structures and damage structural materials. Apart from rainfall, other climatic parameters also exert great destructive influence on structures. For example, high temperature promote chemical breakdown of surface coatings and extreme diurnal temperature fluctuations causes thermal movement in materials thus weakening them especially metals (Critchfield, 2006). High humidity often leads to dampness and consequently fungal attack on the building structures as well as metal corrosion. Wind, apart from exerting direct force against the building also helps to blow rain water into crevices of structures and when it is blown against wooden doors and window, the resultant effect is twisting and warping.

Most traditional architectures tend to reflect building designs in response to the prevailing climate, however, cross cultural contact have led to the adoption of house styles and choice of building materials which are not in harmony with the prevailing climatic condition. Fasheun (1991) opined that it is for reasons like this that soon man discovered that building which were supposed to provide safety and controlled atmospheric environment often fail to do so under extreme weather condition. It is against this background that this research is geared towards investigating the influence of climate on building structures in Ado Ekiti township and proffer pro active solutions.

Materials and Methods

Study area

Ado Ekiti is located between latitude 7^0 35' and 7^0 50'N of the equator and between longitude 5^0 11'and 5^0 29'E of the Greenwich meridian. It covers a total land area of about 265 square kilometers comprising of agglomeration of settlements such as Odo Ado, Ijigbo, Okesa, Oke, Ila, etc. Ado Ekiti is 46km north of Akure, 344km from Lagos and 250km south of Abuja the Federal Capital Territory of Nigeria. Ado Ekiti is bounded on the east by Gbonyin LGA, on the west by Ilawe Ekiti, it also share boundary with Kwara and Kogi States to the north and

Ondo State to the south. Ado Ekiti is the capital of Ekiti state and the headquarters of Ado Ekiti local government council.

Ado Ekiti enjoys a typical tropical humid climate with two distinct seasons of wet and dry. The wet season last 7 months, spanning between April to October, while the dry season spans 5 months (November to March). Temperatures are generally high throughout the year with a mean monthly value of 27^{0}C. Annual average rainfall is about 1,450mm. Relative humidity swings with the season, being relatively low during the dry season and high during the wet season. The soils are rich in clay content with abundant humus. The vegetal cover is conspicuously luxuriant in spite of population pressure on the land. Ado Ekiti has an average altitude of about 360meters above sea level and agriculture thrives well in the area.

Data source

The major sources of data for the study are both primary and secondary data. The primary data consist of structured interviews with household heads and direct observations of different forms of damages suffered by building structures in the study area. Secondly, data from structured questionnaires to elucidate required information in the areas of building location, age of building, types of building, materials used for building, climatic problems related to building structures, etc. Secondary data in the form of climatic data was obtained from the archive of the meteorological station of Department of Geography and Planning, University of Ado Ekiti, Ekiti State. The climatic data obtained spans a period of twelve years (1996 to 2007). The oral interview was geared towards obtaining vital information as to whether there has been any major damage to respondents building in the recent past, such as collapsed walls, blown roof tops, floods, etc. for the purpose of questionnaire administration, Ado Ekiti town was divided into three sections. These are the core zone, transition zone and the outskirt zone. A total of one hundred questionnaires were administered using the purposive random sampling technique. The choice of this technique was informed by the fact that the research needs to consider the different types of building structures in Ado Ekiti. Fifty questionnaires were administered in the core zone, while twenty five each were administered in the transition and outskirt zones respectively. The sharing formula was done with consideration of housing density in each zone.

Data analysis

The research adopted the used of both descriptive and inferential statistics in the analysis of data generated. Descriptive statistical tools of mean, median and percentage scores were used to analysed questionnaire response, while product moment correlation analysis was used to test the relationship between rainfall and its related damages to building structures. The research went further to employ the use of chi square test to examine relationship between climatic effects on building and location relative to the three zones.

Results and Discussion

The study restricted its analysis of climatic elements to rainfall alone because its effect is usually quite glaring and is discernable overtly. Unlike the other climatic elements such as temperature (maximum and minimum), relative humidity, pressure, sunshine, etc. whose effect requires more technical expertise in building climatology to understand and interpret over the short period of this study. Rainfall effects can easily be detected through a careful observation of the building structure, especially the conditions of the roofs, walls, windows, doors and the interior of buildings. Out of the one hundred (100) houses investigated and questionnaires administered to, 39 houses were found to be in excellent habitable condition without any form of structural damage attributable to rainfall. The remaining 61 houses were found to suffer one effect or the other as a result of rainfall. This observed findings form the main basis of results presented and discussed below.

Socio-Demographic Characteristics of Respondents

The result of the analysis of socio demographic characteristics of respondents in Ado Ekiti township is presented in table 1.

Table 1; Socio-Demographic characteristics of Respondents

S/No	Variable	Classes	Percentage (%)
1.	Age	30 – 39	10
		40 – 49	22
		50 – 59	37
		60 >	31
2.	Gender	Male	89
		Female	11
3.	Occupation	Civil servant	24
		Self employed	55
		Retired	21
4.	Marital status	Single	2
		Married	81
		Divorce	6
		Widow/widower	11
5.	Monthly Income level (Naira)	10,000 – 19,000	10
		20,000 – 29,000	21
		30,000 – 39,000	29
		40,000 – 49,000	17
		50,000 >	23

(Source: authors field work, 2008)

Table 1 shows that out of the 100 questionnaires administered to 100 household heads, 37% and 31% respectively were within age brackets of 50 – 59 and 60 years and above. This could be attributed to the fact that people in this area are committed to knowledge acquisition and therefore the quest for early marriage may not be the order of the day. In fact, further investigations revealed that the 10% categories aged 30 - 39 years were mostly the eldest son representing their aged parents. The result of socio-demographic analysis also shows a predominance of males heading the house holds (89%). This finding agrees with the widow/widower's percentage (11%) in the married section. Analysis of occupation shows that 55% of the respondents interviewed are self employed in the fields of agriculture, business, artisans and professional practices. This finding attests to the liberating effect of education. Table 1 also reveals that 69% of respondents have monthly earnings above 30,000 naira and therefore could afford to maintain building structures.

Condition of Building Structures in Ado Ekiti Township

Out of the 100 questionnaires administered to household owners in Ado Ekiti township, the types and condition of building occupied by the respondents was closely observed and classed. Ado Ekiti township is dominated mainly by bungalow structures, with a few duplexes and not too many two, three and four storey buildings. The result of building types and condition is presented in table 2.

Table 2; Types and Condition of Building Structure in Ado Ekiti Township

Variables	Number examined	No. with damages	Percentage (%)
Building types	Bungalow (45)	22	36.07
	Duplex (17)	8	13.11
	2-storey (20)	17	27.87
	3-storey (16)	13	21.31
	4-storey (2)	1	1.64
Age of structure	16		16
	20		20
	19		19
	21		21
	24		24
Location of building structure (zone)	Transition (25)	10	16.40
	Outskirt (25)	11	18.03
	Core (50)	40	65.57
Wall materials	Mud (18)	13	21.31
	Concrete block (25)	10	16.39
	Stone block (10)	3	4.92
	Mud/cement (35)	29	47.54
	Reinforced concrete (12)	6	9.84
Roofing material	Corrugated iron (50)	42	68.85
	Slate (24)	9	14.74
	Long span (26)	10	16.40

Source: Author's Field Work, 2008.

From Table 2, it can be seen that bungalow structures constitute the commonest type of building in the study area. Out of the hundred houses sampled randomly, bungalows were 45 in number with 22 of them manifesting one form of climatic damage. The predominance of bungalow type of structure may not be unconnected to the fact that it is the cheapest in term of construction cost compared to the other building structures under study. The 22 bungalows account for 36.07% of total structures under study. The total number of housing types, number damaged and percentage represented for the remaining types of buildings are shown on table 2. Following respondents reply to age of building structures, an age range was developed and building structures grouped accordingly. From table 2, it can be observed that most of the buildings under consideration (24%) are above 21 years in existence and are mostly located in the core zone of the township. While the latest structures aged 1 to 5 years constituting 16% of structures under study are mostly located in the outer zone of the city. Analysis of building location was done to ascertain which part of the township was more prone to structural damage related to climatic factor. Results shows that of the 50 houses studied in the core zone, 40 of them bear climate related damages, while, 10 and 11 structures were observed for the transition and outskirt zones respectively with 25 houses sampled in each zone. Observations

further shows that building structures are not properly planned, this coupled with high population and housing density in the core zone makes climatic elements take heavy toils on building structures.

On the effects of climatic elements on the wall of buildings in Ado Ekiti, it was observed that materials used for wall construction vary. Some of the materials used include mud unrendered, mud block, concrete block, stone block, mud cement rendered and reinforced concrete. The mud cement rendered is the most common wall construction type in Ado Ekiti, especially in the core area. This material seems unstable under pressure from a particular climatic element (rainfall) judging by the number of decaying or collapsed buildings. Results of analysis show that 47.54% of damaged walls are from the mud cement combination. Table 2 gives the results for the other types of materials used for wall construction. Generally, it was observed that because of the high nature of rainfall in the study area, the walls are predominantly wet, weak and loose allowing for increased weathering and decay of structures. Another area where climatic elements (especially rainfall in the tropics) affect buildings is the roofing materials. Observation shows that tree materials are commonly used in Ado Ekiti, these are; corrugated iron sheet (zinc), asbestos sheet (slate) and long span aluminum sheet. Result from table 2 shows that of the 100 houses investigated, 61 houses suffered damage roofs and out of these 61 affected structures, 42 were roofed with corrugated iron sheet. The overwhelming effect of rain on zinc is attributed to the fact that rain water combine with carbon in the air to form carbonic acid which is a weak acid that speed up metallic corrosion. The presence of heavy and constant rain in Ado Ekiti hastens the process of roof damage in the area.

Relationship between Rainfall and Building Structures in Ado Ekiti

In order to validate the research findings, null hypotheses of no significant relationship between damage walls and rainfall in the area, no relationship between damaged roofs and rainfall in the area and no relationship between rainfall damage on buildings and location in Ado Ekiti township were set. The first two hypotheses were tested using product moment correlation analysis while the last was tested using the chi-square test statistics. The monthly rainfall averages for the area was used as the independent variable (x), while the number of structural damages on monthly basis served as the dependent factor (y). The results of correlation analysis for the two variables is presented in table 3.

Table 3; Correlation Result for Damaged Walls, roofs and Rainfall in Ado Ekiti

Variable	r	r^2	Df	t-cal	t-tab	Sig. level
Walls	0.98	0.96	10	15.48	1.812	0.05
Roofs	0.98	0.96	10	15.49	1.812	0.05

The result of correlation analysis between damaged walls and rainfall in Ado Ekiti shows a strong positive correlation with a correlation coefficient of 0.98. The coefficient of determination indicates that 96% of damage walls of houses in Ado Ekiti are as a result of excessive rainfall. This findings agrees with the works of Adefolalu (1988) and Critchfield (2006) who both stated that the nature of tropical rain tend to discharge high energy load on building structures thereby weakening or out rightly damaging them. In fact Hassan (2004) opined that trapping of rain water in the building materials through leaching leads to their detoriation. The most notable of such effects have been observed in marbles commonly used in columns and tombstones. The calcite in the marble is transformed by acid into gypsum, a material which is not only more soluble but also softer and more eroded by rain. Generally, absorption and movement of moisture through porous materials such as bricks and concrete occur under the influence of capillary forces. Rain water may also be driven through joints and

gaps around windows and doors by wind force. Moisture migration through building materials lead to dampness and decay of structure.

The analysis of rainfall effect on roofing materials also reveals a strong positive relationship which is significant at 95% confidence level. The result of the chi-squared test run on building damage in relation to location turned up a chi-square value of 1.458. With a degree of freedom of 6 and a critical value of 12.592, we therefore accept the null hypothesis of there is no significant relationship between climatic damage on building and location of the building. The effect of climatic elements on building structures are quite diverse and varied. Ogunsote (2002) developed software for architectural design with climatic consideration in Nigeria, these programmes are meant for student instruction in building climatology and for practicing architects. Some of the programmes include; Clicomp, Clidata, Coldhot, Klimax, S4S and System stress.

Conclusion

The study has established the strong link between climatic elements and building structures in Ado Ekiti township. It was also observed that the development of Ado Ekiti radiates from an old core settlement characterized by old building structures mostly of the bungalow types and quite void of space and elements of planning. This nucleated core gives way to a less dense settlement classed in this study as transition zone. The periphery of the township here in referred to as the outskirt is sparsely settled and characterized by modern high rise buildings. The effect of a climatic element (rainfall) recorded on monthly basis was used to correlate various forms of building damages and their probable month of occurrence. Finding shows that rainfall as a climatic element exert various forms of damages on building structures, these include damage to walling materials, roofing materials and various building types and their damage figures. These damages were observed to be more within the core zone. This maybe because most buildings here are quite old and the area has a high density of people and structures. The research therefore concludes that in order to minimize the frequent incidences of flood, the core zone of Ado Ekiti should be considered for an urban renewal exercise. This research is by no means exhaustive on the effect of climatic elements on building structures, since it addresses only rainfall as an element. More could still be done on the effect of other climatic elements on building structures.

References

Adefolalu, DO (1988) Weather Hazards in Calabar. Geo Journal, 9(4),

Critchfield, HJ (2006) General Climatology. Prentice-Hall, New Delhi, India.

Ergula, HA and Ulusav, R (2003) Engineering Characteristics and Environmental Impact of the Expansive Ankara Clay: and Swelling Maps for SW Metropolitan area. Environmental Geology, Vol. 44(8), 979 – 992.

Fasheun, TA (1991) The Destructive and Detoriating Effect of Tropical System on Buildings in Nigeria. In Oguntoyinbo, JS et al (Eds) Meteorological Hazards and Development. Kola Okanlawon Pub, Lagos.

Hassan, OAB (2004) Application of value-focus thinking on the Environmental selection of wall structures. Journal of Environmental Management, Vol. 70(2), 181 – 187.

Michealowa, A and Michealowa, K (2007) Climate or Development: is ODA diverting from its original purpose? Climate Change, Vol. 84(1), 5 – 21.

Ogunsote, JS (2002) Climatology and Building Designs in West Africa. West African Urban quarterly.

Sancho, C; Fort, R and Belamonte, A (2003) Weathering Rate of Historic Sandstone structures in Semi arid Environment (Ebro basin, NE Spain).catena, Vol.53(1),53 – 64.

Wu, QB; Dong, XF; liu, YZ and sJin, HJ (2007) Responses of Permafrost on the Qingha-Tibet Plateau, china to Climate Change and Engineering construction. Arctic, Antarctic and Alpine Research. Vol.39(4), 682 – 687.