# EFFECT OF CLIMATE ON TRADITIONAL BUILDING
# (A CASE STUDY OF USHAFA, F.C.T ABUJA.)

**SALAMAT A. AJIKOBI**

PGD/GEO/2002/2001/167

DEPARTMENT OF GEOGRAPHY

F.U.T MINNA

FEBRUARY 2002.

# EFFECT OF CLIMATE ON TRADITIONAL BUILDING A CASE STUDY OF USHAFAM, F.C.T. ABUJA.


**BY**

**SALAMATU A. AJIKOBI**

**PGD/GED/2000/2001/167.**

**DEPARTMENT OF GEOGRAPHY**

**SCHOOL OF SCIENCE AND SCIENCE EDUCATION**

**FEDERAL UNIVERSITY OF TECHNOLOGY**

**MINNA, NIGER STATE.**


**PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR POST GRADUATE DIPLOMA IN ENVIRONMENTAL MANAGEMENT.**

**FEBRUARY 2002.**

## DEDICATION

This project is dedicated to my parents Alhaji Abdul-rahim .B. Ajikobi and Hajiya Khadijat Ajikobi who have been must helpful and caring.

To the late memory of my good friend, course mate and a colleague in the office in person of **Miss MEDEBISE ABIODUN OMOTAYO** who could not live to ripe the fruit of her labour. May her gentle soul rest in peace. Amen.

## ACKNOWLEDGEMENT

My sincere graduate goes to Almighty Allah who guided me with strength and made my way safe. His favour, love and grace are immeasurable

To my family, M'Ka their love and support made me emotionally stable to do this work..

I also wish to express my unreserved appreciation to my supervisor and mentor **Prof. D.O. Adefolalu** who despite his busy schedule, both official and personal, supervised this work with all optimism from the beginning to the point it is now. His contribution towards making the work a reality worth mentioning in recognition. May Allah reward you. I must also thank all members of geography department (Both academic and non academic) for their kind advice few to be mentioned are Dr. Ahamad Sadauki, Dr. Akinyeye, Dr. Apollonian, Dr.A.S Halilu, Mallam Salihu Saidu the course coordinator Mallam Ndagi Patigubagi and host of others. May Allah reward you accordingly.

My appreciation goes to U.B.Umar who also help in making this work a reality and Usman Ajikobi who help in typing the manual script and to all other friends and people who have helped as well as my classmate in the environmental management class whom in one way or the other assisted me during the course.

## ABSTRACT

Climate and tradition vary in every geographical region. It is therefore important to understand the local and spatial variation in the climate because this information is important for any technological advertisement to take place especially in rural areas.

This study focuses on climatic effect on Ushafa traditional building materials particularly on how it makes the place habitable for the populace. The rainfall, temperature evaporation and relative humidity data for the period of eighteen years were used to determine the climate condition of every month of the years.

Findings of this study show that the rural community of Ushafa is changing fast ushering in a spectacular demand for modern structures in which to house their growing families that will be commensurable with their new rise in living standards. The researchers suggested the promotion of traditional building material by; upgrading the suitability and equality on these materials adopting new construction methods. Preferential treatment, training technical assistance, establishes of research and production centers and marketing of promotion efforts will be valuable.

## 1.6 THE STUDY AREA.

Abuja is the federal capital of Nigeria. It is bounded on the North by Kaduna State and on the West by Niger state, on the East and South by Plateau State and on the Southwest by Kogi state. It falls within $7^0$ 25' and $9^0$ 20' North of the equator and Longitude $6^0$ 45 and $7^0$ 39'.

Abuja presently has six area councils namely; Municipal, Abaji, Gwagwalada, Kwali and Bwari.

Ushafa is a village situated in Bwari area council.It has amodern pottery and ceramic complex with an update operating system along side the traditional system. It occupies the northern foot plain of the Aso-Bwari hill range.

The Bwari-Aso hills are an area of extremely rough terrain, which occurs at the northeast part of the FCT.The area is dissected by the valley of the river Usma and its tributaries.

Ushafa experience six (6)month (may-October) exhibiting high rainfall, low temperature, high evaporation and high humidity. The remaining six months November-April is a dry season with high temperature, high evaporation and low humidity.

GENERAL CLIMATE OF ABUJA

It is appropriate to explain the main features of the climate of Ushafa –FCT and the prevailing conditions. For the completeness of this work the following shall be discussed in summary rainfall, humidity, wind, heat condition (radiation), temperature and evaporation.

### 2.2.1 Rainfall:

Precipitation in the FCT-Ushafa like else where in the tropics consists of almost entirely of rainfall. It is the most variable element in the tropical climate. The most important quantitative indicator in this area is the annual total, which differs from year to year and place to place widely.

Rainfall characteristics such as it seasonal and diurnal distribution, intensity, duration and frequency of rainy day, also show important differences in both place and time.

The FCT exemplifies a transitional character as between the zone double rainfall maximum to the south and that of a single maximum to the north.

The rainfall is generally intensive, of shorter duration and stronger location.

Rainfall at about 20th of March on the southern boundary of the territory to about 10th of April at the northern limits. Rainfall cessatran date ranges from 20th October in the north to about 18th November in the south, given a duration of between 190-240 days.

5.2 ~~2.2.2~~ Humidity

Humidity is a general expression relating to the measurement of the water vapour content of the atmosphere. The source of humidity is the earth surface, therefore it is concentrated in the lower atmosphere.

Seasonal variations follows a simple pattern, being control by temperature and air mass characteristics, the diurnal variations are more complex. The daily maximum is usually recorded shortly before sunshine this builds up to a maximum, in the early morning later in the morning, the value decreases to a secondary maximum. After sunset, the amount increases again in the decreased test result in the minimum before sunrise start shortly after midnight.

During the dry season, relative humidity falls in the afternoon. This low relative humidity, coupled with high afternoon temperature accounts for the desiccating effect of dry season, which is also marked by the presence of the Harmattan haze. During the rainy season, which is also marked by the presence of the harmattan haze. During the rainy season, the afternoon

the movement of the earth; its radiation around its axis and its annual orbit around the sun.

2.2.6 Temperature:

The concept of temperature and heat originates in man's sense perception. Temperature can be correlated with the sensation of hot and cold. Beyond certain narrow limits and cannot perceive the difference between cold and colder. Or between hot and hotter.

When making reference to the temperature is referring to the conditions near the ground where man lives.

FCT have a number of characteristics in temperature, which is common. In the four major areas; thermal uniformity, diurnal cycle, effect of elevation and physiological temperature. FCT records the highest temperature during the dry season month, which are generally cloudless. The maximum temperature occurs in the month of March with the amount varying from $37^0$c in the southwest to about $30^0$c in the northeast. This is the period of high diurnal ranges of temperature when drop of as much as 170c may be recorded.

Two distinct season can be defined the hot and the cold season. The temperatures are generally higher in the month of March-October, which compasses the rainy season. Average temperature between about $30^0$c. in the month of November-February, the temperature are generally lower, ranging between $15^0$c-$30^0$c with an average of $22^0$c.

1.4 JUSTFICATION

To achieve maximum comfort for the occupant of building it is important to note the climatic data analysis, which varies in important and relevance in every geographical region.

Analysis of climatologically data is relevant to measure the level of development that an area has undergone. So it is vital to understand the local

and spatial variation in climate in relation to infrastructure facilities.

Prescribe standards based on assessment of materials and their life span is relation to climatic controls.

Understanding of the environment can only be done with adequate and appropriate data in rural area like Ushafa-Abuja. Where such data is not readily available. Nigeria lack environmental awareness and they depend socio-cultural standards and norms. For this attitude to change one to use measurable data enlighten and educate rural communities.

# CHAPTER TWO

## 1.0 LITERATURE REVIEW

### 2,1CLIMATE AND BUILDING

The average weather condition throughout the season over a fairly wide or very extensive area of the earth surface and considered over-many years usually 30-35 years (WMO1968).

Human variety can best served by as a reminder that whatever his accomplishments his sophistication, his artistic pretensions, man owes his over existence to a six – inch layer of top – soil and the fact that it rains (quoted in the COCKLE BUR, COLE 1970). Hear lies the importance of the area of concern in climatology to human existence.

Never in all of his history has man's attention been focused as intently as at present upon

The atmosphere and its weather. Because of its place of weather and climate in man's life a regional study of any place must include its weather and climate.

**BUILDING: -**

Building is primarily design amongst it other functions, to protect man from the direct impact of weather element like rainfall, evaporations, temperature, relative humidity and solar radiation.

The fact that climate is an important factor in the choice of materials and the orientation of building cannot be over-emphasized. Over the years the lack of adequate scientific knowledge about the vagaries of regional climate, the limited technology and the inadequate of other necessary resources have imposed considerable limitations on climatic perfection's of tradition materials.

## 2.2 BAMBOO

Bamboo is one of the oldest building materials used by man to increase comfort and well-being. In today's world of plastics and steel, besides continuing to make its traditional contributions, bamboo is growing in importance. Outstanding varieties of bamboo from throughout the world are being tested to find out how they can contribute to local economies.

As the best species are identified and disseminated, their use will help to improve the live of many. With a few plants of superior bamboos in the back yard, a family will have at hand the wherewithal to fence the garden, build a pigeon or chicken coop or add a room to the house. The family will also be able to increase its daily income by making basket or other specialties for sell or exchange.

Bamboos are prominent element in the natural vegetation of many parts of the tropical, sub-tropical and mild temperate regions of the world, from sea level to altitude of more than 13,000 feet (4000m).Men have widened the distribution of many species of bamboo. But some of the more valuable species have not been distributed as much as they could be. Much remains to be done to make these varieties more generally known available.

Bamboo can be prepared for use in construction with simple tools. Once prepared, bamboo can be used extensively in the construction of houses: In making foundations,frames,floors,walls,partitions,ceilings,doors,windows, roofs, pipes and troughs.

often be more useful in characterizing a climatic state than the mean. The definition also permits further description of a climatic change as the difference between two climatic states, and a climatic anomaly as the difference between acclimate state and the mean state

## 2.4 TRADITIONAL BUILDING MATERIAL IN USHAFA – ABUJA

The Gwari traditional structures are built with available nature materials like clay, grasses and bush wood.

These materials are obtained in their nature state and processed into materials with better qualities for application in the construction. They are not used directly as they were obtained, because as Evans has observed that to build with mud is not possible to use any soil, the mud has to contain the correct proportion of clay and sand to be sufficiently cohesive.

Being aware of this too, the Gwaris employed their own techniques of transforming these materials from their ordinary state into materials that will perform the structural functions expected of building materials.

4.1 MUD

The best soil from the production of clay materials is the type or red earth available in the area. The soil is dug and the top removed. The part below the surface is heavily diluted with water in the pit and thoroughly kneaded underfoot. An admixture of ground nibble from ruins and soil from termite mould, which contain sticky slime from the insect, are added to it and whole content is carefully mixed up. The admixture serves as a binding medium to the content.

It is stored inside the pit to rest and protected from drying up to five days under wet conditions. After this period, chopped accah strew is added tom the content to reinforce the clay materials. The chopped stew also contains some

microorganism that properly effect the release of certain chemical and biological process that promote hardening. Water is sprinkled to the content that trample thoroughly once more until it becomes very grainy and greasy with high degree of plasticity.

GRASS: -

Grasses are also selectively used as convening materials for their special quality. The preparation of the grass is first by cutting it wet at the beginning of dry season, which start from December. They are neatly into bundles and stored on the raised platform till dry.

Care is taken to check termites from attacking it. This material has double advantage: that of retaining water from getting to the build and it also retards heat of radiation from getting into building envelope.

Bush Wood: -

Are used as rafter and purloins for building that not doomed. Preparation of wood is done between November and February. The woods are cut wet and dried before use to prevent roof members from drying crookedly, when they are pilled together on a large rock in horizontal position to dry. By placing heavy loads or log of bush wood on them.

When completely dried they are selected and the good once packed in to bundle to the site ready for use

## 2.5 CONSTRUCTION METHODLOGY

Every man in an African society is an Architect. His orientation is towards the balance of

Model materials and uses the latter usually himself "(OLIVER; 1978, P143) for the construction". The ground on which the house will stand is leveled first and compacted later if necessary. To get the round ahpe a peg is drawn approximately in the centre of this levelly ground. A rope is then tied to the

peg and sharps stick or a metal rod is tied to the free end. The rope is kept is tight as the circle is drawn on the ground. The radius of the house varies between three to four meter (3-4m) measured from toe to toe.

## 2.6 COMARATIVE ANALYSIS OF LOCAL AND MODERN BUILDING MATREIALS TECHNOLOGY

consideration shall be given to some selected building materials that are mostly (frequently)sued and will be cost effective, truly portray the indigenous culture if adopted especially for the rural populace and low income earners. Comparative analysis shall be carried out between earth (mud) and cement sand Crete blocks, thatch roofing and modern roofing properties.

| | |
|---|---|
| ASBESTOS | 0.220 |
| SOIL | 0.440 |
| CONCRETE | 0.156 |
| BRICK | 0.220 |
| GLASS | 0.163 |
| STEEL | 0.117 |

(Source: air conditioning and refrigeration, sevens and fellows).

A comparison between cement block (sand Crete) and local Earth (Mud) is as follows.

COMPARISON OF SANDERETE AND EARTH

| SANDCRETE/CONCRETE | MUD |
|---|---|
| 1. | Expensive |
| | Cheaper |
| 2. | Moderately available |
| | Readily available |
| 3. | Low thermal capacity |
| | High thermal capacity |
| 4. | Less frequent maintenance |
| | More frequent maintenance |
| 5. | Restrict form |
| | Vulnerable to continuous contact with water. |

From the above we deduce that the major problem of mud is its vulnerability to water, which is always improved upon when it is mixed with other materials or modified to the detriment of its high thermal capacity.comparison between thatch and modern roofing material:-

what has changed the physical appearance of settlements more than anything else was the introduction of new building materials from Europe corrugated iron sheeting…. Had perhaps the greatest effect". Susan Denyer, 1980. it is on this statement that modern Gwari roof forms will be defined as attempt by the people to conform with the modern trend through the use modern modern roof construction include corrugated iron sheets and zinc sheets.

| CORRUGATED IRON ZINC SHEET | THATCH |
|---|---|
| 1. | Expensive material |
| | Local material – abundant |
| 2. | Need for skilled handling of construction |
| | Simply erected |
| 3. | Have high fore resistance |
| | Not fire resistant |
| 4. | Less maintenance required over a long period |
| | thatch might be replaced |
| | between 18-24 months |
| 5. | Tendency for rusting and corrosion |
| | But frame might last as |
| | Long as 10-15 years not |
| | Infected by termites |
| 6. | Good conductor of heat |
| | poor conductor of heat |
| 7. | There is the problem of noises during rain |
| | No noise problem during rain |
| 8. | There might be need for numerous fixings (ties) |
| | Roof weight discourage building material |
| | to prevent roof uplifts |
| | roof uplifts |

# CHAPTER THREE

## 3.0 METHODOLOGY

The source of set of data used in this project is by the CLIMATE CHANGE CENTRE F.U .T MINNA.Also by the Mabaogunje A.L (1999) report of the Ecological survey of the Federal Capital Territory Vol.1.

## 3.1 LONG TERM DATA

The long term data is the monthly rainfall, temperature, evaporation and relative humidity data for the F.C.T (Ushafa). This ranges between 1983-2000.

## 3.2 MONTHLY DATA FROM 1983 - 2000

The data from the climatic change center will be used for the studies. This will allow for the discussion of their effect on traditional building materials.

Statistical calculation of means values of climate parameters.

Plotting of graphs to show distribution of climatic elements

Rainfall----------1983-2000

Temperature----------1983-2000

Evaporation----------1983-2000

Relative Humidity----------1983-2000

## CHAPTER FOUR

## RESULT OF ANALYSIS ON THE EFFECT OF CLIMATE ON TABLE 4.1 DISTRIBUTIONS OF CLIMATE VARIABLES OF THE STUDY AREA FROM 1983 – 2002.

| | JAN. | FEB. | MAR. | APRIL | MAY | JUNE | JULY | AUG. | SEP | OCT | NOV | DEC. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RAINFALL | NIL | 3.36 | 24.36 | 65.66 | 154.24 | 185.84 | 224.9 | 311.12 | 246.26 | 141.44 | 152.1 | 2.62 |
| R/H | 39.4 | 34.76 | 46.59 | 62.78 | 74.22 | 78.08 | 84.20 | 85.40 | 83.15 | 78.83 | 58.19 | 46.20 |
| EVAP. | 17.42 | 19.17 | 19.48 | 12.01 | 6.94 | 5.03 | 3.77 | 3.53 | 4 | 5.12 | 9.49 | 13.2 |
| TEMP. | 27.22 | 28.17 | 28.96 | 30.23 | 27.84 | 25.84 | 25.06 | 24.38 | 5.31 | 26.28 | 25.89 | 25.22 |

### TRADITIONAL BUILDING MATERIALS.

Microclimates of a region are product of manmade features and the natural environment and the climate of any settlement cannot be separated from the townscape and landscape.

In order to establish discrepancies between climate and building materials it will be necessary to examine the functions of constructional elements. The elements roof, wall and floor are responsible for the maintenance and regulation of the interior environment of a building.

WALLS: -

It is an enclosure of space which from the building space. A considerable proportion of the heat reaching the interior of a building is transmitted through the external walls. As exposed element of construction they are subjected to the sun's direct impact and the attendant heat loads.

ROOF: -

It has the biggest exposure to the sun and remains unprotected most of the time. An overriding factor for roofing is of course the function of arresting rainwater and channeling it away from the building.

FLOOR

The floor construction, which is the function of arresting moisture dampness and insect getting into the building. Also act as stabilized finish to interior and exterior of building.

EARTH (MUD) CONSTRUCTION

RAINFALL EFFECT: - Rainfall has a serious adverse effect on mud house especially during the peak period of the rainy season in between July – September is heavy. The nature of the soil being used for construction has high tendency to absorb water at slow rate but retain it for a long period. This leads to disintegration of the soil particles. Where appreciable rainfall continuous the surface crumbles. It could also lead to collapsing of the structures. Problems also occur in foundation because of heavy rains, surface water run-off cause erosion and wash off the foundation and floor surroundings, see plate 1and 4 page 24 and 25.

TEMPERATURE EFFECT: - Temperature has adverse effect on the mud construction. The physical and chemical property of the soil being used has significant value for mud construction.

The cohesive soil grains allows the mud house absorb more heat from radiation being released by the sun during the day even though it absorb slowly so also it release slowly. The expansion and contraction later weaken the soil particles and result in crack on walls see plate 1and 2 page 24. Heat absorbed during the day makes the house hot at night and cooler at daytime. The highest temperature is recorded in between the month of June – April but the month of April is usually the peak period while between may to December temperature will fall considerably.

RELATIVE HUMIDITY: - The effect of relative humidity is of significant value in building materials. The moisture dampness condition has adverse effect on building materials.

Mud wall are vulnerable to moisture and this causes dampness on walls. The chemical and physical properties of the soil used are affected causing damage. Thatched roofs are prone to damage as a result of dampness or moisture see plate 1 page 24. Thatch has a capability of retaining moisture which attract fungi and insects thereby causing serious damage.

Relative humidity is lowest in February and it gradually increase until it gets to the peak in August.

EVAPORATION – Moisture is being released from the surface into the atmosphere. This sometimes results in cooling effect and causes contraction or shrinkage when evaporation has fully taken place.

As a result of evaporation on the wet mud walls, the soil particles tend to shrink together. This reduces both the physical and chemical properties of the soil grain as a result weathering set in resulting to crack while the thatch roof gets won out after the wear and tear effect of evaporation see plate 1 and 3 page 24 and 25. The wet thatch roof after wetness and dryness lead to shrinkage. The rate of evaporation is usually highest in March at 19mm and

lowest in August at 3.5mm.

COPARATIVE ANALYSIS OF TRADITIONAL AND MODERN BUILDING MATERIALS.

EARTH: - Earth (mud) is one of the most widely used of all traditional building materials in our local construction industries. For one thing it is the most economical and the most generally available materials. The superior thermal performances of the earth structures, owing to their density and thickness, particularly appealed to the people.

In earth construction transportation is less expensive obtainable and self-help method are available. Period of continuous rain cause the surface of earth construction to crumble. The walls are vulnerable to moisture and require maintenance after each rainy season.

CEMENT AND SANDCRETE BLOCK: - Sandcrete block is increasingly being used for the foundations and wall construction. The block requires more careful attention and construction than is normally necessary for earth (mud) construction. A major problem posed by the sandcrete block is cracking due to shrinkage caused by temperature fluctuations.

The thermal performance is less compared to earth construction. Transportation is more expensive and un obtainable for the rural populace. The sandcrete blocks are less vulnerable to moisture and does not require maintenance every year.

THATCH ROOF: - The thatch roof is widely used because of abundance within the locality. The roof might discourage roof uplift. The thatch roof is not fire resistant, and it is a poor conductor of heat. It also requires frequent replacement of thatch. Termites easily infect the thatch which lead to deterioration of the roof. The thatch roof does however absorb heat.

CORRUGATED IRON OR ZINC SHEET: - This is a modern roofing

material. It has high fire resistance, less maintenance required over a long period. It is a good conductor of heat.

There might be need for numerous fixings to prevent roof uplift due to rainstorms, and noise during rainy season. There is the advantage of les or no leakage of the roof. Rainwater does not enter a building except in a faulty situation.

PLATE 1: SHOWING EFFECT ON ROOF WALL AND FLOOR

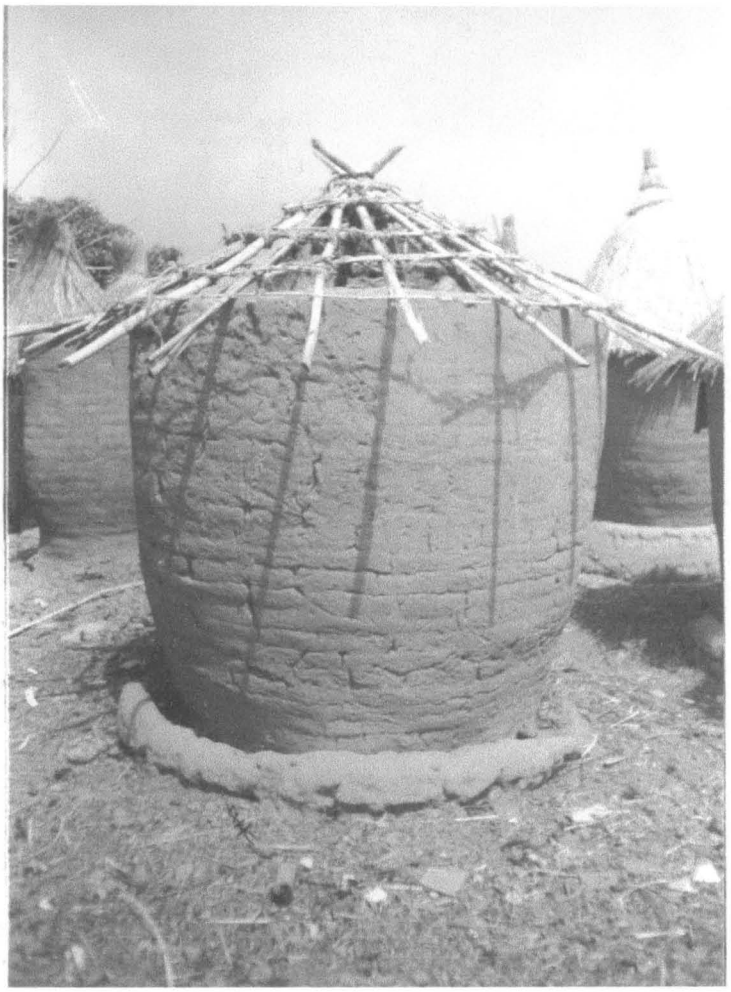

PLATE 2: SHOWING EFFEC ON FOUNDATION, WALL AND ROOF CONSTRUCTION

PLATE 3: SHOWING COMPLETED BUINDING

PLATE 4: SHOING EFFECT ON FLOOR.

# CHAPTER FIVE

## SUMMARY, CONCLUTION AND RECOMMENDATION

### 5.1 CONCLUTION

This project has focused on the effect of climate on traditional building materials. Climate effect of rainfall, temperature, evaporation and relative humidity during the period of 1983-2000.

Today with the wave of alarm and apprehension, over possible environment consequences of global change in climate, another dimension is being introduced into the problem. This is because with scientific ascertainment of climate change, it will be necessary to retailor building materials to take full care of negative consequences of such envisaged change.

When we call for presentation of climatic data in relevance to building materials, this is not abstract guest for scientific perfection but the prerequisite for the adaptation of building to climate now and in the future. But we must also make contemporary materials references and not engineer new techniques. That is what the old master builder did for centuries, working in harmony with communal wisdom.

### 5.2 RECOMMENDATION

In this study, we have been able to show that climatic parameters, such as rainfall, temperature, evaporation and relative humidity are important in the choice of building materials.

The findings are limited in scope because it is based only on physical factors.

The following are recommendations to improve traditional building materials.

1. in the case of mud or clay, walls problem often occur at the foundation level or with the walls because of heavy rains. Foundation can easily be improved by using stabilized earth blocks. Walls can be made resistant to rain by plastering them with fiber-reinforced plaster (FRC).
2. Stabilized clay can be used for bricks by grinding to powder and water added. After hand molding the bricks were shaped in simple manually operated machine, which require training.

   The clay bricks have the advantage of the local clay wall but also an improvement on the effect of rain and other climate parameter.

   The use of overhanging roofs also helps to limit the damage caused by rains.devices such as deep roofs overlays and verandas to protect the external wall surfaces.

   There are so many advantages however, to adapting traditional materials. In order to preserve their advantages, it is necessary to determine the shortcoming and upgrade the suitability and quality of materials by adapting new construction methods.

## REFERENCES


**P.D Dawan:** **Geography of Abuja, F.C.T Pg. 9-2**

**Adefolalu D.O (1986):** **Rainfall trends in Nigeria theor. Climate 37205-219**

**UNEP:** **Climate and Human Settlement (1991)**

**N.I.A. Journal:** **Low-cost construction for the urban Poor. September 1982.**

Susan Denyer **–Traditional Architecture.**

**Mabaogunje Al 1999** Report of the ecological survey of the federal Capital Territory vol. .I

**VITA publication June 1986** Village technology hand book.

**A. Henderson the sellers and K.Mc Guffie (Public Communication 1986)**

The climate is a beautify system exceeding rich in iterconnection and complexies.

**D.O Nigeria A 138 January 1983** Regional Development plan of the Federal Capital Territory.