IMPACT OF TEMPERATURE AND RAINFALL DISPARITY ON HUMAN COMFORT INDEX IN ENUGU URBAN ENVIRONMENT, ENUGU STATE, NIGERIA

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ABSTRACT

The rate of changes in temperature and rainfall disparity constitutes severe impact on human comfort index in Enugu Urban Environment. The area is characterized with built-up structures, little or no vegetation cover and high urban heat island which affect temperature and rainfall distributions adversely. This study then becomes indispensable because of the continuous increase in the rate of changes in temperature and rainfall disparity over the years. Temperature, rainfall and human comfort index data for the period of 1970-2005 were collected for the purpose of establishing the rate of temperature and rainfall disparity as well as its impact on human comfort index within Enugu urban environment. Results show among others that temperature and rainfall over the years fluctuates wildly and has grave impact on human comfort index. The study established that the consequences of temperature and rainfall disparity are severe biodiversity and vegetation loss which affects human comfort index adversely. In that light, it then becomes expedient to promote Urban Planning-Meteorological Advisory Services, substantial planting of trees, adaptation measures and Specialized Research Programmes (S.R.P) in the area.

Keywords: *Temperature, Rainfall, Human comfort index, heat, Urban environment*

INTRODUCTION

Temperature and rainfall disparity are sensitive environmental problems that are attributed to our mismanagement of environmental resource and ozone depletion. The Enugu urban environment is characterized by built-up structures, industrial/ transportation activities, exchange of chlorofluorocarbons, methane gases among others. These result to acid rain. Temperature and rainfall trends keep on changing adversely thereby affecting human comfort index. Mcbride and Buiting (1971), maintained that the apparatus for measuring and indicating the comfort index of an ambient atmospheric environment is subject to variations in dewpoint and dry bulb temperature. A heat source is provided which includes means for maintaining it at a temperature which varies as a substantially linear function of the dewpoint. The temperature indicated thereby is the measured comfort index.

In this study, Human Comfort Index (HCM) is defined as maximum changes in temperature and rainfall (atmospheric condition) which support human comfort. Barradax (1991) agues that during the process of transpiration plants release water vapour to the surrounding, making humidity increase and temperature decrease. He also maintained that Typical rates of heat loss by evaporation in arid environment with good irrigation range from 24.5 to 29.5 MJ/m^2 per a day whereas, in temperate climates, rates range from less than 0.7 (winter) to 7.4 MJ/m^2 per a day (summer). The release of water vapour corresponding to these heat loss values ranges from 12 to 0.281/m^2 per day. Fukazawa and Havenith (2009) and USDA (2009), established that urban vegetation plays an important role in urban climate regulation. City parks thus become small Islands which are cooler, more humid and produce hotter and drier environment. This effect of increasing humidity and decreasing temperature of vegetation also change thermal comfort index, making city parks more comfortable compare to the surrounding urban environment. Urban heat Island (UHI) is the name given to the characteristic warmth of both the atmosphere and the lithosphere in cities (urban areas) compared to their rural (non-urbanized) surroundings (Voogt, 2004). UHI may be up to 10 - 15^{o}C under optimum conditions (Oke, 1982). For almost 200 years, climatic differences between urban and rural environments have been recognized (Taha, 1997). Of these, temperature is the most obvious, thus affecting human comfort index adversely (Unger *et al.*, 2001).

Wei-wu, et al (2004), opined that Urban human thermal comfort (UHTC) is affected by the interaction of weather condition and underlying surface framework of urban area. USDA(2009) maintained that Greenhouse gases, especially carbon dioxide (CO_2) are increasing in our atmosphere at an unprecedented rate because of fossil fuel burning and global deforestation. The increase in these gases is warming our climate and impacting on life and human comfort index. Forests store carbon when they grow by taking up the carbon dioxide in the atmosphere and using it to sustain plants. Hence, by increasing the storage of carbon in trees, we can reduce the impacts of CO_2 in the atmosphere. Forests are managed for many reasons including wildlife, recreation, timber and maintenance of human comfort index.

Yuk yee and Oliver (1995) opined that a number of indices have been devised to assess human comfort under a variety of atmospheric conditions. In the USA the most widely used, particularly by the broadcast media, are wind-chill for cold conditions and the Heat Index for hot. Both provide measures of instantaneous conditions and are useful as weather stress guides. Thereafter, the CLO (a measure of comfort that provides an indication of the clothing required under a given set of conditions) is examined as a potential alternative comfort index to those in current use. Derived many years ago, the CLO expresses the resistance to heat transfer by clothing and is expressed relative to units of thermal insulation. Derived CLO values are compared with values of Heat Index and wind-chill for the same data sets at a selected station and significant relationships are obtained. The results indicate that the CLO value could be used as an alternative to the current weather stress indices. The CLO, however, may also be used as a guide to relative comfort representing long-term average as well as extreme, instantaneous atmospheric conditions. It serves as a climatic index by providing a seasonal clothing index.

Heisler and Wang (2002) opined that trees modify air temperature, solar and thermal radiation exchanges, wind, and humidity of the air, and all of these influence human comfort. For urban forest planning, the tree influences on comfort and health of people should be taken into account. Because trees interact with the physical environment in so many ways, the assessment of tree influences on human comfort and health is complex. It is especially difficult to predict tree influences over the course of a season with a typical weather pattern. Such predictions could be possible with computer programs to calculate the influence of trees on environmental factors and the effect of these factors on human comfort. Such computer programs should be easily understood and straight forward to use so that they would be helpful for urban foresters and other planning professionals. Anyadike (2002) opined that the Location of Enugu puts it firmly within the tropics and as such solar radiation is high all year round thus influencing human comfort index.

The conceptual framework that forms the basis for this study is the system concept, system thinking and climate system. A system may be a complex of interacting elements, together with their attributes and relationship. A system with its environment constitutes the universe of phenomena which is of interest in a given context. System can be classified into three; first, the isolated systems which exchange neither 'matter' nor 'energy' within the environment; second, the closed systems which exchange 'energy' but no 'matter'; third, the open systems which exchange both 'energy' and 'matter.' The distinction between the categories, however, is largely on a scale and depends on which elements are regarded as belonging to the system and which to the environment. Thus, if the scale was reduced significantly, an open system could become an isolated system (Mabogunje 1972). Consequently, the concepts of Science systems thinkers consider that: a system is a dynamic and complex whole, interacting as a structured functional unit; energy, material and information flow among the different elements that compose the system; a system is a community situated within an environment; energy, material and information flow to and fro the surrounding environment via semi-permeable membranes or boundaries;

Systems are often composed of entities seeking equilibrium but can exhibit oscillating, chaotic, or exponential behaviour. A system in the context of this study, can also be defined as a set of components such that each component influences, and is influenced by, all the other components. The climate system consists of atmosphere, ocean, biosphere, cryosphere (ice and snow), and lithosphere (Earth's crust). Each of these components influences, and is influenced by, all of the others, so they form part of single system. The sun, in contrast, is not part of climate system because the climate cannot affect the sun. Rather, the sun is said to be an external force. Volcanic eruption, although originating from inside the Earth and its atmospheric envelope, also external forces because they are external in a system sense. They influence, but are not influenced by the climate system. Volcanic eruptions influence climate through the injection of sulphuric gas into the stratosphere, which are transformed chemically into sulphate aerosols that have a cooling effect on climate and through the emission of CO_2.

Hence, this confirmed that temperature, rainfall disparity and human comfort index are being studied and attributed as a system. The disparity in temperature and rainfall is a function of human comfort index in the study area. In other words, temperature and rainfall characteristics are the major determinant of human comfort index in the area. This is aligned to the concept of system model as presented in fig. 1.

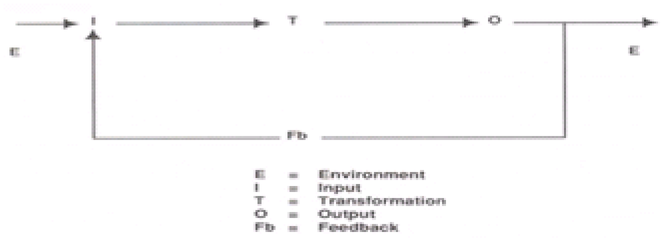


Fig 1: Conceptualized Simple System Model (***Source:*** Littlejohn, 2001)

Study Area: Enugu urban is located on the Eastern fringe of Udi escarpment at an altitude of about 223 m and lies between latitude 60201 and 60301N and longitude 70251 and 70301E (Government of Anambra State, 1978) (fig 1). Its origin dates back to 1909 when Mr. Kitson, a British Minning Engineer together with British Geological Exploration Team discovered coal at the foot of Udi escarpment (Nnamani, 2002). The growth of the city is evident from the various population census figures from 1952 to 2006. It recorded a population of 62,764 in 1952; the 1991 census puts the population figure of Enugu to be 464, 514, accommodated in 28 residential Layouts. The 2006 census records the population of Enugu to be 722, 664 (NPC, 2006).

Enugu has since 1929 remained an administrative headquarter. It served as the capital of southern provinces (1929 - 1938), capital of eastern provinces (1939 - 1950), capital of eastern region (1951 - 1966), capital of defunct republic of Biafra (1967 - 1970), capital of east central States (1970 - 1975), capital of old Anambra state (1976 - 1990) and capital of Enugu state from 1991 - till date. Rainfall and temperature in the zone are largely seasonal and varies highly from year to year. The annual rainfall ranges between 937.2mm to 2243.3mm, while mean temperature range is usually between 26.8 0C to 32.5 0C over the year (NIMET 2008). Two distinct seasons are observed, dry and wet. The dry season extends over a period of about 6 to 7 months, from October to March or April while the wet season extends over a period of about 5 to 6 months, from May to September. However, these meteorological conditions vary wildly and this is a factor of the present global climate change, which awakened the interest of this study.

METHOD

Data on rainfall and temperature (for the period of 1970-2005) were collected from the archives of the Nigerian Meteorological Services, Oshodi Lagos, Enugu airport and ESUT weather observatory. The data obtained included: total volume of rainfall (mm) per annum (1970-2005), minimum, maximum, and average yearly temperature (^{o}C) 1970-2005. The Nigeria Meteorological Services used the Dines, Tilting and the British Standard rainguages to collect the rainfall data used in this study. The positions of these rainguages have not been tainted since the commencement of the record keeping. Therefore, rainfall data may not have suffered from non-homogeneity. Data on human comfort index was also generated through oral interview and personal observations in the field.

Multiple Linear Regression analysis estimates the coefficients of the linear equation, involving one or more independent variables, which best predict the value of the dependent variable. For the purpose of this multiple linear regression analysis; rainfall, maximum temperature, minimum temperature and average temperature are the independent variables while human comfort index is the dependent variable. Multiple linear regression was applied to determine the level of relationship between climatic data and human comfort index over the years of analyses (1970-2005). It can be express mathematically as:

$$b = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{n\sum x^2 - \left(\sum x\right)^2} \quad \text{---------------------} \quad (1)$$

Where: n = number of years of analysis (34 yrs)

y = independent variables (rainfall, maximum temp, minimum temp, and average temp)

x = dependent variable (human comfort index)

$\sum$ = summation of data

Source: Holden *et al* (1993) and SPSS (1990).

Statistical package for social sciences (SPSS) was applied to plot sequence of temperature and rainfall 1970-2004. This establishes sequence of rainfall, temperature (minimum, maximum and average) over the year in graphical form. It is important to note that rainfall and temperature are the dominant meteorological parameter within the tropical environment (Bhalme, 1999 and Ogbuene 2007). This enables the study to determine how changes in temperature and rainfall each year affects human comfort index over the years of analyses. The result of Anova was also utilized to determine if rainfall and temperature (minimum, maximum, and average) were the only meteorological parameter that influence human comfort index in the area.

RESULTS AND DISCUSSION

The result of various correlation variables that disclosed high, moderate and low correlation values from the multiple linear regression analyses in appendix 2, were selected and presented on table 1 below. The correlation variables of Temp max and Temp Ave scored "0.946" in the regression analyses result above. The implication is that temperature maximum and average temperature exhibit near perfect positive correlation in the study. This implies that human comfort index is directly related to the condition of maximum and average temperature in the area. In addition, the correlation variables of Temp Min and Temp Ave also scored "0.495" on table 1. This also implies that minimum and average temperature have impact on human comfort index in the area. Hence, the study proved that slight increase or reduction in current maximum, minimum and average temperature will constitutes a grave hazard on human comfort index in Enugu urban environment. The correlation variables of Temp max and Temp Ave scored "0.946" in the regression analysis results (table 1). The implication is that temperature maximum and average temperature exhibit near perfect positive correlation in the study. This implies that human comfort index is directly related to the condition of maximum and average temperature in the area. In addition, the correlation variables of Temp Min and Temp Ave also scored "0.495" on table 1. This also implies that minimum and average temperature have impact on human comfort index in the area. Hence, the study proved that slight increase or reduction in current maximum, minimum and average temperature will constitutes a grave hazard on human comfort index in Enugu urban environment. Moreover, correlation variables result of rainfall and temperature maximum scored "0.291", while rainfall and temperature average scored "0.271". These results indicate moderate impact on human comfort index in the area. The histogram below disclosed series of variation in rainfall and temperature which affect human comfort index in Enugu urban environment. The line in the graph clearly shows the combination of normal distribution of climatic parameter and human comfort index in the area over the year of analyses.

The result of ANOVA was also utilized to determine if rainfall and temperature (minimum, maximum, and average) were the only meteorological parameter that influence human comfort index in the area. The calculated F ratio result = 0.742, and the table value of F ratio = 5.725 (Table 2). Since calculated F ratio result is less than F ratio table value, we established that rainfall and temperature (minimum, maximum, and average) are not the only the meteorological parameter that influence human comfort index in the area. The result and interpretation above indicate that other meteorological parameters such as solar radiation, percentage relative humidity, atmospheric pressure, urban heat island, Industrial emission, transportation and other human activities can also contribute so much to human comfort index in the area.

Results of Sequence of Climatic parameter over Human Comfort Index: The result enables the study to determine how changes in Climatic parameter (temperature and rainfall) affects human comfort index over the years of analyses. The Sequence of temperature and rainfall variability is not static, thus exposing the area to temperature and rainfall disparity. The area thus experience insufficient rainfall and excess rainfall, thus resulting to different associated environmental consequences.

Impact of Temperature and Rainfall Disparity on human comfort index: The result of regression analysis clearly indicates that rainfall and temperature have a severe impact on human comfort index. Hence, the study proved that slight increase or reduction in current temperature will constitutes a grave hazard on human comfort index in Enugu urban environment. The continuous incidences of changes in temperature and rainfall disparity has affected human comfort index in diverse ways; such as heat or cold as the case may be. Diseases like heat rash and pneumonia among other, are on the increase due to disparity in temperature and rainfall. The urban environment is currently characterized with built up structures, paved road and compounds, without vegetation cover nor functional city parks. This triggers off temperature disparity. The various results of analyses in this study establish that temperature and rainfall are not static in the area, thus leading to flash flood or seasonal drought. Temperature and rainfall disparity constitute serious environmental and socio-economic problems which needs urgent attention. Environmental problems such as flood, gully erosion, seasonal drought and desertification are on the increase due to temperature and rainfall disparity. These have grave impact on biodiversity loss and human comfort index in the area (Anyadike, 2009 and Bhalme, 1999).

Incessant gully erosion expansion due to temperature and rainfall disparity constitutes a serious threat to human comfort index in the area. On the other hand, temperature and rainfall disparity can either expose the environment to excessive rainfall leading to flood or insufficient rainfall resulting to seasonal drought and its associated loss of soil moisture. The rate of variability has a grave impact on human comfort index which could also be trace to loss of houses, economics trees, farmlands, crops, road among others. More importantly, it constitutes psychological tremor to the people. In mid - September, forty-two communities in Anambra West and East Local Government Area, were hit by the floods which displaced an estimated 22,000 persons. Some were reported to have been drowned. Schools, houses, health centres and churches were submerged by the flood. The high waters made it particularly difficult for emergency services to reach the large number of people that were affected. Farmlands were destroyed and only few tubers of yam and potatoes were salvaged. These result in severe food shortage and psychological tremor in the area (UNCF, 2007).

Ojo (1977), Anyadike (2002) and Ogbuene (2010) opined that meteorological conditions vary outrageously and this is a factor of the present global climate change which results into environmental degradation such as loss of soil moisture, acid rain, ecosystem deterioration, biodiversity loss, extinction of threatened species among others. Presently, increasing carbon emission, industrialization, urbanization, transportation, and deforestation has compounded environmental problems and quality of rainfall in the area. The consequences includes: human discomfort, high incidence of skin cancer, high blood pressure, restlessness, low fertility, heat rash and pneumonia. Myers (1991) opined that extinction is a natural process that has occurred for millions of years so why does it deserve so much attention now? The problem is that the rate of extinction has increased dramatically in recent years due to human impact on the environment. The rate of change is perhaps as damaging as the effects of the changes. There is no time for organisms to adapt to their constantly-changing environment. It is currently estimated that if current environmental practices are not changed, we may lose 50% of all species globally. Also animals and human that inhabit an area may alter the surviving conditions by factors assimilated by climate. Increase in temperature and rainfall variability relate to global climate change and its impacts on ecosystems are greater than previously anticipated. It has a serious impact on human comfort index, loss of wetland, soil-water-recharge, and inability for crops to thrive in the affected areas.

Reduction in crop yield constitutes more predicaments and stress thus compounding human comfort index. Blair (2002), reported the results from scientific studies founded by the National Science Foundation (NSF) on crop yield. The study has it that rainfall variability resulting from global climate change reduces productivity and alters the composition of plants. Although, the diversity of plants species are increased in this scenario, the most important or dominant plants were more water-stressed and their growth was reduced. Carbon dioxide release by roots and microbes in the soil also was reduced. Knapp et al (2008) got similar results from experiments conducted at NSF's Konza Prairie Long Term Ecological Research (LTER) site. The study established that insufficient rainfall constitutes a serious deterioration in crops yield and environmental degradation, thus affecting human comfort index. Fay (2000) also observed that more extreme swings in rainfall patterns, without any change in total amount of rainfall received in a growing season, reduced the biomass of plants but increased the variety of species able to live in a particular experimental plot of land. It could be noted that increase in rainfall variability combined with projected high temperature and decrease rainfall amount may lead to grave negative impact on human comfort index, crops yield and the entire ecosystem. Adinna *et al* (2009) maintained that the result of the processed imagery of Enugu urban in fig 9 shows clearly that commercial and industrial areas exhibited the highest temperature, followed by residential areas. The lowest temperature was observed in forest zones followed by farmlands. This implies that urban development raised the temperature by replacing natural environment (forest, water and pasture) with non - evaporating, non-transpiration surfaces. This adversely affects human comfort index in urban area.

Obasi (2003) also observes that the widely used climate models predict increases in climate extremes such as more frequent large rainfall events or more severe droughts. He also remarked that it is important that temperature and rainfall disparity be looked at in a new way; not only from year to year or decade to decade, but from storm to storm. This will help in adequate environmental planning and the result can help in maintaining human comfort index and boast crops yield. Gnomes (1996) argued that rainfall disparity at a time scale from year to year is a characteristic of climate as well as total amount recorded. Low values, however are not necessarily associated with low rainfall. However, temperature and rainfall disparity can affect human comfort index.

CONCLUSION AND RECOMMENDATIONS

This study established that temperature and rainfall trends keep on changing adversely thereby affecting human comfort index. Continuous temperature and rainfall disparity also constitute grave environmental problems, such as drought or flood. These influence atmospheric condition, vegetation, soil-water-balance and human comfort index in the area. Greenhouse gases, especially carbon dioxide (CO_2) are increasing in our atmosphere at an unprecedented rate because of constant emission of smokes, burning and global deforestation. These gases are warming our climate and impacting on life and human comfort index. Stringent application of the recommended measures will stem this grave hazard. Impact of temperature and rainfall disparity on human comfort index in Enugu environment is a worthwhile research area for attainment of sound environmental management.

There is need to promote Urban Planning-Meteorological Advisory Services: This will be useful in city planning and implementation. Closer collaboration among the meteorologist and urban planner is needed to increase the awareness on the existing data base, Urban-Weather Models among others, with a view to reaping the full benefits of research on specific problems and sustainable environmental management.

Substantial planting of trees: Government should make it compulsory for every building in Enugu urban to plant at list two tress. The ministry of environment should set up tree planting monitoring taskforce in the city. These trees will help maintain human comfort index and urban climate.

Adaptation measures: Adaptation measures will be very significant due to disparity in temperature, rainfall, water discharge regimes, surface and soil temperature as observed in the study. Broadly, these adaptations will includes refinement of early warning system to enable timely remedial measure, effective water-use-strategies, adequate basin management and intensive research into evaporation, rain formation mechanism of the study area. A central element of adaptation approach therefore should be ecosystem management restoration activities such as afforestation, watershed rehabilitation and management, effective water harvesting and conservation.

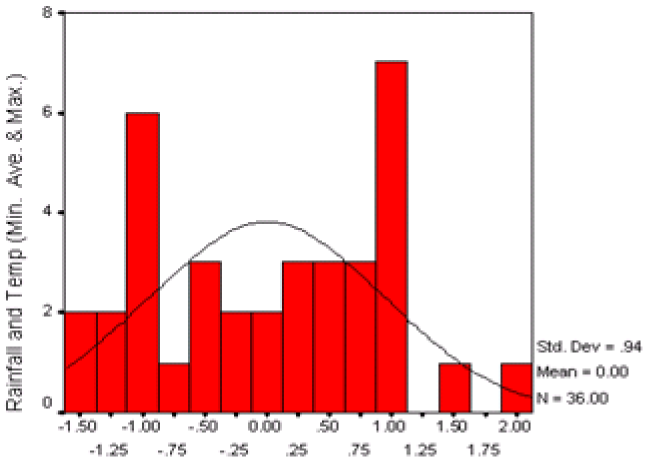
Specialized Research Programmes (S.R.P): This will involve a multi-agency coalition of researchers, fire managers, air-quality managers, and natural resource managers at the Federal, State, and local levels.

Table 1: Correlation variables results of Human Comfort Index (HCI) and meteorological parameters (1970-2005) in Enugu urban environment

	High score	Moderate score	Low score
HCI & rainfall			0.178
HCI & temp max			0.150
HCI & temp min			-0.003
Rainfall & temp max		0.291	
Rainfall & temp min			0.091
Rainfall & temp ave		0.271	
Temp max & temp max	0.946		
Temp min & temp ave	0.495		

Source: Fieldwork 2010. *Correlation variables with score of 0.4 and above indicate high positive correlation, while correlation variables with 0.2 and less than 0.4 indicate moderate correlation and correlation variables with score of less than 0.2 indicate low correlation among the parameters of study.*

Fig. 2: Histogram of change in Climatic Parameter over Human Comfort Index in Enugu Urban Environment



Human Comfort Index

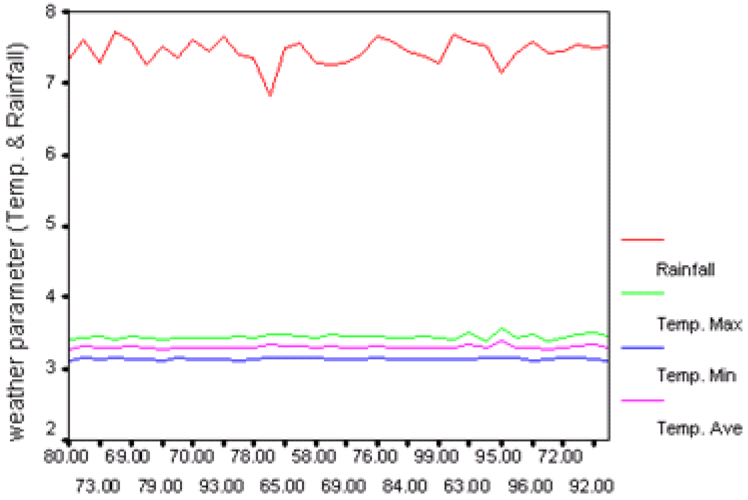
Table 2: ANOVA Result of Human Comfort Index and Meteorological Parameters (1970-2005) in Enugu urban environment

Model	SoS	df	Mean Sq.	F	Sig
1 Regression	*489.115	4	122.279	.742	.571
Residual	*5109.635	31	164.827		
Total	*5598.750	35			

a) Predictors: (Constant), temp average, rainfall, temp minimum, temp. maximum

b) Dependent variable: Human Comfort ***Source:*** Fieldwork, 2010.

Fig. 3: Sequence of change in Climatic Parameter over Human Comfort Index in Enugu Urban Environment



Human Comfort Index   Transforms: natural log

Table 3: Human comfort Index and Metrological Parameters (1970-2005) in Enugu Environment

years	% Human comfort Index	Annual rainfall	Tem. max	Tem min	tem average
1970	80	1507.1	30.6	22.4	26.5
1971	90	1986.2	31.7	23.6	27.7
1972	73	1450.4	31.8	23.3	27.6
1973	91	2243.3	30.4	23.7	27.1
1974	69	1979.7	32.4	23	27.7
1975	67	1417.7	31.3	23.1	27.2
1976	79	1827.6	30.9	22.4	26.7
1977	63	1545.8	31.7	23.5	27.6
1978	70	1988.1	31.1	23	27.1
1979	75	1696	31.3	23.1	27.2
1980	93	2090	31.4	23.2	27.3
1981	59	1639	31.8	22.7	27.3
1982	78	1566.6	31.4	23	27.2
1983	68	913.1	33.1	23.7	28.4
1984	65	1779.4	32.8	23.5	28.2
1985	81	1930.6	32.3	23.8	28.1
1986	58	1450.6	31.3	23.9	27.6
1987	88	1415.6	32.8	23.4	28.1
1988	69	1461	32	23	27.5
1989	58	1643	31.8	23.3	27.6
1990	76	2082.1	32.2	23.7	28
1991	82	1960.8	31.2	23.3	27.3
1992	84	1704.7	31.2	23.4	27.3
1993	91	1576.9	31.9	23	27.5
1994	99	1454.9	31.7	23.3	27.5
1995	85	2167.9	30.9	23	27
1996	63	1963.1	33.8	23.1	28.5
1997	85	1824	30.3	23.6	27
1998	95	1247	36.1	23.7	29.9
1999	63	1647.4	31.4	23.5	27.5
2000	96	1947.3	32.8	22.4	27.6
2001	56	1676.3	30.3	23.1	26.7
2002	72	1722.2	31.5	23.5	27.5
2003	68	1890	32.6	23.8	28.2
2004	92	1770.1	33.7	23.1	28.4
2005	58	1819.6	31.8	22.6	27.2

Source: NIMET, 2009

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Fig. 8: Gully erosion resulting from temperature and rainfall disparity. ***Source:*** Fieldwork, 2010

Table 4: Regression Analysis Results of Human comfort Index and Metrological Parameters (1970-2005) in Enugu Environment

Descriptive Statistics

	Mean	Std. Deviation	N
HC..	76.0833	12.6477	36
Rainfall	1721.8083	278.4929	36
temp. min	31.8694	1.1232	36
temp. min	23.2417	.4059	36
temp Ave	27.5778	.6293	36

Correlations

		Rainfall	temp. max	temp. min	temp Ave
Pearson Correlation	H.C.	.178	.150	-.003	.132
	Rainfall		-.291	-.091	-.271
	temp. max			.189	***.946**
	temp. min				**.495**
Sig. (1-tailed)	H.C.	.149	.191	.492	.222
	Rainfall		.043	.298	.055
	temp. max			.135	.000
	temp. min				.001

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	***489.115**	4	122.279	**.742**	**.571**
	Residual	***5109.635**	31	164.827		
	Total	***5598.750**	35			

a Predictors: (Constant), temp ave, rainfall, temp min, temp. max
b Dependent Variable: Human Comfort

Coefficient Correlations

Model			Rainfall	temp. min	temp. max
1	Correlations	temp. ave	-.420	-.994	-.999
		Rainfall		.421	.430
		temp. min			.992
	Covariances	temp. ave	-.367	-4818.617	-4716.124
		Rainfall		.188	.187
		temp. min			2398.223

a Dependent Variable: H.C. ie Human Comfort

Source: Author's SPSS Analysis, 2010