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Highlights

Adaptive Comfort Model

The Resolution of Cornucopian

Discovering Thoughts, Inventing Future

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Thermal Comfort and Occupant Behaviour in a Naturally Ventilated Hostel in Warm-Humid Climate of Ile-Ife, Nigeria: Field Study Report During Hot Season

By Olanipekun Emmanuel Abiodun

Obafemi Awolowo University, Nigeria

Abstract- Naturally ventilated buildings have been observed to be ineffective in warm-humid tropical especially during hot season. To ascertaining this observation, this study presents the results of a short-term thermal comfort survey performed in a naturally ventilated hostel building in Obafemi Awolowo University, Ile-Ife, Nigeria during hot season. Using the data obtained from questionnaire survey and physical measurement of (air temperature, relative humidity and air velocity) using Kestrel model 4500, thermal environmental conditions, occupant comfort and adaptation methods were investigated considering class II protocol. Ninety six respondents participated in the study. Statistical analysis of students` responses and measured thermal environmental variables was performed to determine existing indoor environmental conditions and priority of using adaptive controls. All the measured environmental variables fell below the comfort range recommended by ASHRAE standard 55 and ISO 7730 standard. On the contrary, respondents were comfortable, preferring cooler, no change environments and more air movement. First preference of the respondents adaptive control was window opening (77.4%), closely followed by wearing light clothes (77.3%) and lastly, the use of electric fans. This study concludes that in warm-humid climate of Ile-Ife, during the hot season the desire for sustainable thermal comfort may not be achieved without mechanical ventilation system.

Keywords: thermal comfort, occupant behaviour, naturally ventilated hostel, dry season, ile-ife, nigeria.

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Olanipekun Emmanuel Abiodun

Absract- Naturally ventilated buildings have been observed to be ineffective in warm-humid tropical especially during hot season. To ascertaining this observation, this study presents the results of a short-term thermal comfort survey performed in a naturally ventilated hostel building in Obafemi Awolowo University, Ile-Ife, Nigeria during hot season. Using the data obtained from questionnaire survey and physical measurement of (air temperature, relative humidity and air velocity) using Kestrel model 4500, thermal environmental conditions, occupant comfort and adaptation methods were investigated considering class II protocol. Ninety six respondents participated in the study. Statistical analysis of students` responses and measured thermal environmental variables was performed to determine existing indoor environmental conditions and priority of using adaptive controls. All the measured environmental variables fell below the comfort range recommended by ASHRAE standard 55 and ISO 7730 standard. On the contrary, respondents were comfortable, preferring cooler, no change environments and more air movement. First preference of the respondents adaptive control was window opening (77.4%), closely followed by wearing light clothes (77.3%) and lastly, the use of electric fans. This study concludes that in warm-humid climate of Ile-Ife, during the hot season the desire for sustainable thermal comfort may not be achieved without mechanical ventilation system.

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I. Introduction

The chief goal of hostels is to provide quality living and sleeping environment for the occupants. Sekhar and Goh [1] noted that a quality night sleep allows adequate daytime functioning: concentration, attention and comprehension as well as learning level. Similarly, [2-3] also believed that thermal discomfort can affect the quality of sleeping environment and subsequently the performances of daytime functions. Sleep is also an important factor that affect a person`s health and well-being. Health symptoms like fatigue, headache, stress and tiredness, undesired physiological stress on the body and aggressiveness are common scenario faced by occupants due to lack of quality sleep and bad thermal comfort conditions [4-5]. Regarding the relationship between thermal comfort and academic performance, [6-8] highlighted some reduction in the learning performance of the students. Dhaka et al. [9] and Dahlan et al. [10] from their undergraduate hostel buildings studies in Malaysia noted that the intellectual capabilities as well as academic performance of occupants of hostel buildings was closely related to the quality of indoor environment Several research projects [11-12] revealed that man`s physical strength and mental activities are their best within a given range of climatic conditions, and outside this range efficiency lessens, while stresses and the possibility of disease increases. Based on the foregoings, the importance of thermal comfort topic in Hostel Architecture can be appreciated. It is therefore important to study thermal comfort in learning environments.

In Nigeria, the issues of thermal comfort and occupant adaptive behaviour in the case of naturally ventilated family residential and office buildings have been studied by several researchers and are well documented in the scientific literature [13-16]. However, the indoor spaces in naturally ventilated hostel, especially season by season types using subjective and objective approach have not been much studied as other forms of buildings. Only the study recently carried out by Adebamowo and Olusanya [17] involved student hostel buildings in Southwest Nigeria uses both approaches. Correspondingly, thermal comfort study in student hostels has not been fully explored using occupants comfort needs. This gap in literature motivated the researcher to conduct a field survey on indoor environmental conditions, occupants` thermal comfort and adaptation in a naturally ventilated hostel building during the dry season. The results can be helpful to recommend the sustainable thermal standards for future hostel buildings in Nigeria. Besides, this study is expected to provide relevant and recent data to provide a better understanding of how student living in warm-humid have adapted to their naturally ventilated (NV) hostel.

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II. Methodology

Two major approaches used to assess thermal comfort were field experiments and laboratory climate chamber experiments. Field experiment was adopted in this study because a recent study revealed that the results from the field measurements were widely accepted to predict the comfort temperature of naturally ventilated buildings [18]. Field studies have immediate relevance to living condition

a) Climate and description of object building

The field study focused on one undergraduate female hostel at the Obafemi Awolowo University in Ile-Ife, Nigeria as a pilot study. Ile-Ife is situated in the tropical area of Southwest Nigeria. Its geographical coordinates are 4°35´ north latitude and 7°30´ east longitude. It has a warm-humid climate characterised by two seasons (rain and dry). It experiences constant high temperatures and relative humidity and low air movement throughout the year. It has a diurnal temperature range of minimum 23–27◦C and maximum 30– 34◦C, with a mean annual RH value of 84%. Abundant rainfall occurs from April to November, and the dry season occasion and with cold-dry harmattan wind blowing from November to March.

The hostel building is a two-storey building including ground floor, first and second floors under a concrete flat roof. The roof overhanged over a balcony at the front elevation. The walls are made of 225 mm aerated hollow sandcrete block with inserted columns rendered with brown and white paints while the internal wall is painted with cream colour. The size of a typical room is 6.3 m (l) x 4.0 m (w) x 3.0 m (h) with windows on north and south for cross ventilation and admission of natural light. Both its north and south facing windows are 1.5 m wide by 1.8 m high and consisted of wooden/aluminium frame and single (4mm thick) common plain glass. The windows accounted for 40% of the floor area. The Window to Wall Ration (WWR = 0.35). There are two doors in each room of size 0.9 x 2.1m made of wood. Electric lighting is provided through a 40W fluorescent lamp. The hostel building is in the midst of other hostel buildings of similar height. The hostel block was built according to the country`s climatic features, suitable orientation with appropriate shading devices. The main features of the hostel is summarised in Table 1. Purposive sampling was used for the selection of the building due to insufficient measuring equipment and was specifically chosen because it is one of the mainstream typology of the country`s student housing, for its similar size with other buildings and location. Figure 1 illustrates the general view of the selected hostel block.

Table 1 : Main features of the analysed hostel

No. of occupant	Volume (m^3)	Floor area (m^2)	Height (m)	Wall/Floor ratio	Exposure	Ventilation system	No. of floor
150	10200	3400	10	0.43	N-S	NV	3

Figure 1: General view of the case study building (a) roof overhang (b) screen wall

b) Data Collection

Objective and subjective assessments approaches were used for data collection. Using a combination of research methods is common in thermal comfort field studies and helps to balance the strengths and weaknesses inherent in individual data collection strategies.

i. *Objective measurement of indoor climate*

Kestrel 4500 multi-purpose pocket and handheld indoor climate tracker was utilized to measure the indoor climate conditions. The multi-purpose Kestrel 4500 is ideal because it measures air velocity, temperature and relative humidity with sensory accuracy of ±0.3m/s, ±0.3oC and ±1.6% respectively. The system collected concurrent physical data: air temperature, relative humidity and air velocity. The instruments were placed at 1.1 m from the floor closed to the subjects to record the thermal comfort variables simultaneously, as the subjects filled in the subjective thermal comfort questionnaire. The data logger was set to acquire data at 60-min intervals manually from 9.00 am till 7:00 pm. The readings were recorded in separate data sheets. All the completed questionnaires and data sheet entries were given serial numbers for easy identification and synchronization. The readings were transferred onto the corresponding questionnaires at the end of every survey day. Mean radiant temperature was calculated based on the equation provided by the ASHRAE standard 55. While the instruments recorded the surrounding environmental conditions, the researcher observed and kept track of the respondents` clothing levels as well as the utilization of environmental controls. Figure 2 shows the equipment employed. The outdoor environmental data was procured from the local meteorological station for all the dates of surveys. During the measurement periods, the building was in free-running conditions.

Figure 2 : Thermal Comfort equipment

ii. *Subjective assessment*

The subjective assessment consisted of a questionnaire administered to a group of respondents and was used to address occupant thermal, relative humidity and air movement sensations, preferences and acceptability. The questionnaire survey was designed as transverse data collection and consisted of four parts. Contained in the questionnaire are the respondents` demographic information, most preferred method of adaptation when they sensed thermal discomfort and votes for thermal sensation, preference and acceptability, with regards to the current conditions. Questions on relative humidity and air movement as well as overall thermal comfort were also included. Subjective assessments of the indoor thermal conditions were also conducted between the three sessions of the day: morning, afternoon and evening sessions. The questionnaire was distributed personally to the respondents. The subjects were asked to fill in the questionnaire while the instruments continuously recorded the surrounding environmental conditions. The thermal sensation vote was based on the ASHRAE 7-point sensation scale. Thermal preference vote employed McIntyre`s 3-point scale of preference namely; I wish for a warmer or cooler thermal condition or no change, Acceptability was aimed to understand if the interviewee considers the current environment condition as acceptable and was assessed using binary scale (acceptable/unacceptable). The relative humidity, air movement and overall thermal comfort were recorded on 5-point Nicol`s scale. To facilitate the observational study on the common behavioural adaptation, a set of questions were also given. The answers provided for those questions were in the form of five-scale frequency of actions (5-very important, 4-important, 3-sometime important, 2-not important and 1-not at all important). Stratify random sampling method was employed in the selection of the rooms for this study. All students in each of the selected room were given an opportunity to complete the questionnaire. Most of the subjects were surveyed for eight consecutive days in a month. They were interviewed three times a day: morning, afternoon and evening between 9am and 7pm. A fresh questionnaire was filled by the subjects in all the interviews. The field study was conducted from January to March, 2013. The months of January to March were chosen because most places in southwest of the country had higher than average temperature in these months.

iii. *Unit of analysis*

The data from the questionnaire survey and measured indoor environmental were imported to the SPSS (Statistical Package for the Social Sciences (SPSS) version 16.0) for analysis in different format. Data analyses were mainly descriptive statistics. It included the calculation of mean values, standard deviation, minimum, maximum and frequency distribution. Line graphs and bar charts related to different measured indoor environmental conditions were generated. Additionally, correlations between the measured data were carried out.

III. Results and Discussion

a) Environmental conditions in the surveyed hostel

i. *Outdoor climates*

Fig. 3 gives the physical data of outdoor climate during the survey period. The lowest temperature was recorded at 9 am in the morning, while the highest temperature was recorded at 4 pm in the afternoon (Fig. 3(a). Air temperature (ta) ranged between 22.5◦C and 32.9◦C (mean = 29.6◦C, STD = 2.50). Relative humidity (RH) fell within 20.36% and 85.82% (mean = 51.40%, STD = 19.83) (Fig. 3(b). The global solar radiation ranged from 0-788W/m2 (mean = 377.8 W/m2, STD=) (Fig. 3(c). In January, the outdoor air temperature (ta) ranged between 22.5oC and 32.6oC (mean =29.3oC, STD =3.21). Relative humidity showed low values in January and fell within 20.36% and 49.34% (mean = 28.86%, STD = 8.70. The global solar radiation ranged from 0-625 W/m2 (mean = 346 W/m2, STD =229). In February, the outdoor air temperature (ta) ranged between 25.1oC and 32.9oC (mean = 30, STD = 2.36). The relative humidity (RH) fell within 42.88% and 85.82% (mean = 59.01%, STD = 13.99). The global solar radiation ranged from 0-788 W/m2 (mean = 390 W/m2, STD =278). In March, the air temperature variations were narrower, averaging around 29.5oC with a minimum of 26oC and a maximum of 31.8oC. Relative humidity showed high values with a mean of 66.34% against 59.015% in February.

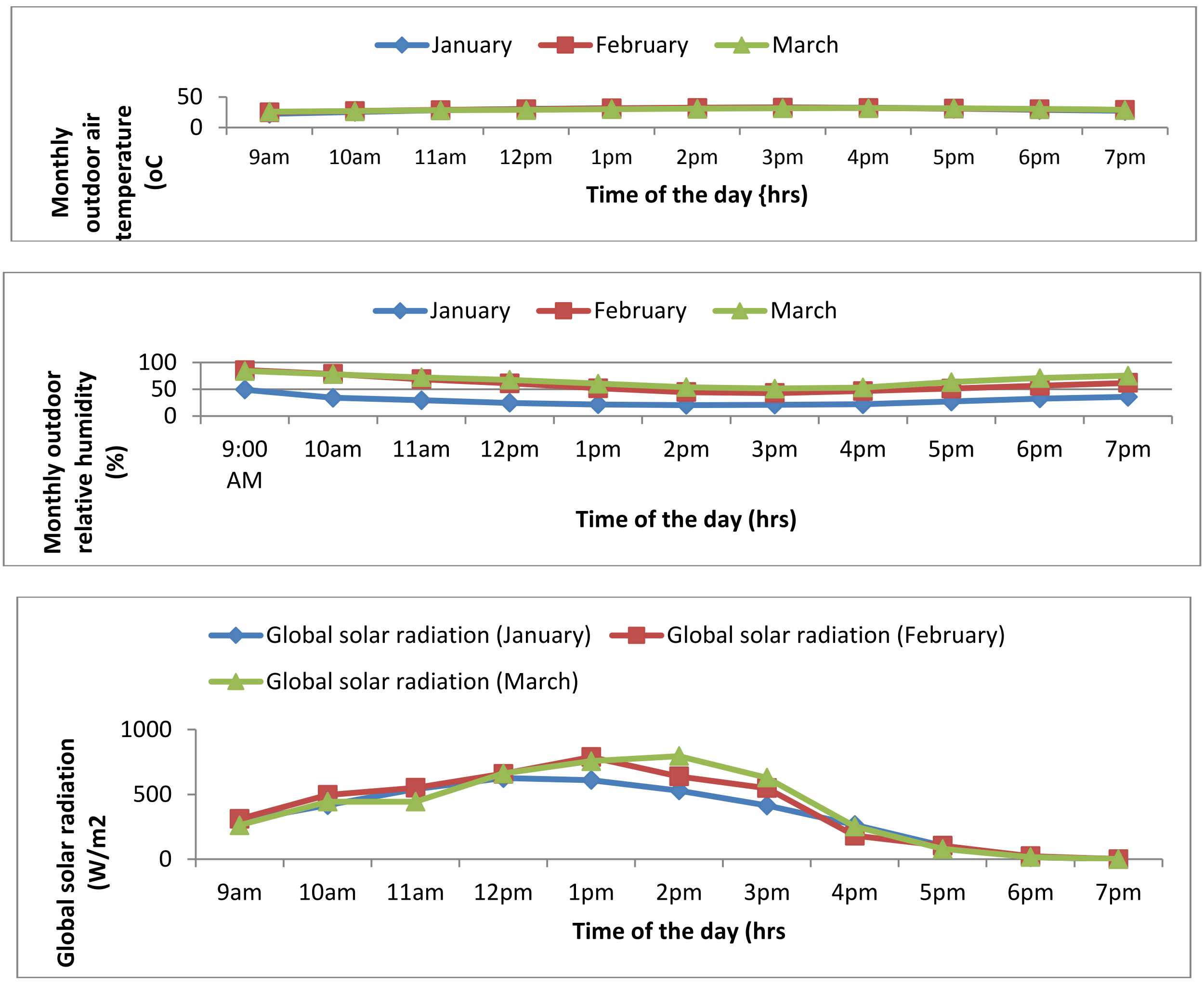


Figure 3 : The outdoor environmental variables of the respective days

ii. *Indoor climates: air temperature and relative humidity*

The measured hygro-thermal conditions reflect the occupants` space conditioning and ventilation preferences as well as the extent to which they will exercise environmental controls. Statistical summaries of measured physical parameters of indoor and outdoor climatic data are provided in Table 2 for the total data set broken down by months and by floors. For all data, the indoor air temperature ranged from 28.1oC to as high as 34oC (mean = 31.1oC, STD = 1.83). The relative humidity ranged from 30.8-75.5% (mean = 45.45%, STD = 12.64). In January, the air temperature was between 28.4oC and 33.5oC (mean=30.9oC, STD

= 1.71) with relative humidity (RH) readings between 31.8% and 71% (mean = 46.16%, STD =12.45). In February, air temperatures ranged from 28.1oC to as high as 33.7oC (mean = 31.1oC, STD = 1.86). The RH fell within 30.8% and 75.5% and 83.8% (mean = 45.72%, STD = 14.03). In March, the air temperature was between 28.5oC.and 34oC (mean =31.3, STD = 1.96). Table 3 shows the descriptive statistical summary of the measured environmental variables by floors. In general, second floor recorded higher mean air temperature value compared to the ground floor in all the months.

Table 2 : Descriptive summary of measured environmental variables on monthly basis

Month	Descriptive statistic	T_o (°C)	RH_o (%)	Global solar rad. (W/m2)	T_a (°C)	RH (%)	MRT (°C)
January	Mean	29.3	28.86	346.17	30.9	46.16	30.83
	Max	32.6	49.34	625.27	33.5	71	33.06
	Min	22.5	20.36	0	28.4	31.8	28.3
	STD	3.21	8.70	229.44	1.71	12.45	1.736
February	Mean	30	59.01	390.91	31.2	45.72	30.88
	Max	32.9	85.82	788.83	33.7	75.5	33.35
	Min	25.1	42.88	0.014	28.1	30.8	28.11
	STD	2.36	13.99	278.09	1.86	14.03	1.867
March	Mean	29.5	66.34	394.45	31.3	44.48	31.02
	Max	31.8	84.02	795.67	34	66.3	33.35
	Min	26	51.19	0	28.5	32.8	28.3
	STD	1.98	10.89	293.14	1.96	11.89	1.955
All months	Mean	29.6	51.40	377.18	31.1	45.45	30.92
	Max	32.9	85.82	718	34.0	75.5	33.06
	Min	22.5	20.36	0.005	28.1	30.8	28.3
	STD	2.50	19.83	263.36	1.81	12.64	1.795

Table 3 : Descriptive summary of measured indoor environmental variables by floors

Season Sample size	Descript. Statistics	Ground floor			Second floor			All floors		
		Jan	Feb	Mar	Jan	Feb	Mar	Jan	Feb	Mar
Ta(°C)	Mean	30.4	30.9	31.1	31.1	31.4	31.1	30.87	31.17	31.31
	Max	32	33.6	34	34	33.7	34	33.5	33.7	34
	Min	28.7	28.5	28.5	28.5	28.1	28.5	28.4	28.1	28.5
	STD	1.21	1.77	1.95	1.95	2.01	1.95	1.71	1.86	1.96
RH (%)	Mean	47.04	30.9	45.69	45.29	44.65	44.48	46.16	31.17	44.48
	Max	69.1	33.6	63.7	71	75.5	66.3	71	33.7	66.3
	Min	36.5	28.5	34.6	31.8	30.8	32.8	31.8	28.1	32.8
	STD	12.33	1.77	11.77	13.11	15.23	11.89	12.45	1.86	11.89
MRT (%)	Mean	30,11	30.62	30.75	30.99	31.1	31.23	30.55	30.85	30.99
	Max	31.67	33.25	33.65	55.16	33.4	33.45	32.26	33.3	33.55
	Min	28.4	28.21	28.21	28.11	27.8	28.3	28.25	28.3	28.25
	STD	1.208	1.749	1.933	2.056	1.99	2.008	1.586	1.855	1.961

Fig. 4 (a) shows the profiles of air temperature recorded during the field study. The lowest temperature was recorded at 9 am in the morning, while the highest temperature was recorded at 4 pm in the afternoon. In all the months, minimum and maximum air temperatures occurred at 9 am and 4 pm respectively. Observable there was minimum deviation of air temperature across the different months. In January the mean air temperature was 30.9oC, In February, it was 31.2oC and in March, it hovered around 31.3oC. The low change in temperature intervals was because for summer months the difference between mean radiant temperature and dry bulb temperature is less then 1oC and wind speed is less than 0.1 m/s. Besides, similar higher indoor air temperature conditions were experienced across the different months. According Djamila et al. [19] and Feriadi and Wong [20], the higher temperature variations observed are common with concrete structure in this climatic zone. From the temperature profile, it was observed for all the three months the temperature swings were between 4oC and 5.3o. According to Singh et al. [18] these temperature swings lie in permissible range for naturally ventilated buildings. In comparison, we recorded a slightly higher indoor temperature in February than that of January. The indoor temperature of February was marginally higher than that of January (on average 0.26). For about 91% the values of measured indoor air temperature were higher in February than that of January. Only one data deviated marginally (<1). Similar trend was observed between February and March. For more than 72% the values of measured indoor air temperature were higher in March than that of February. In about 23% it was higher in February than that of March. Fig. 4(b) shows the profiles of measured RH data. The highest humidity was recorded at 9:00 am and after 5:00 pm. For all data about 58% of RH data was within the 30% and 70%. In about 21% of the environments, the indoor RH was observed to be above 70%. Breaking down by months, it was observed that 63.6% of the measured relative humidity data was within the range of 30%-70% in January while 36.4% fell above 70%. In February, 81.8% of measured RH was in the range of 30%-70% and 18.2% fell above 70% beyond the higher comfort humidity limit. The relative humidity decreased about 10% in March compared with that of February. About 55% of the measured RH ranged between 30% and 70% and 45% of the relative humidity was more than 70%, beyond the higher comfort humidity limit.

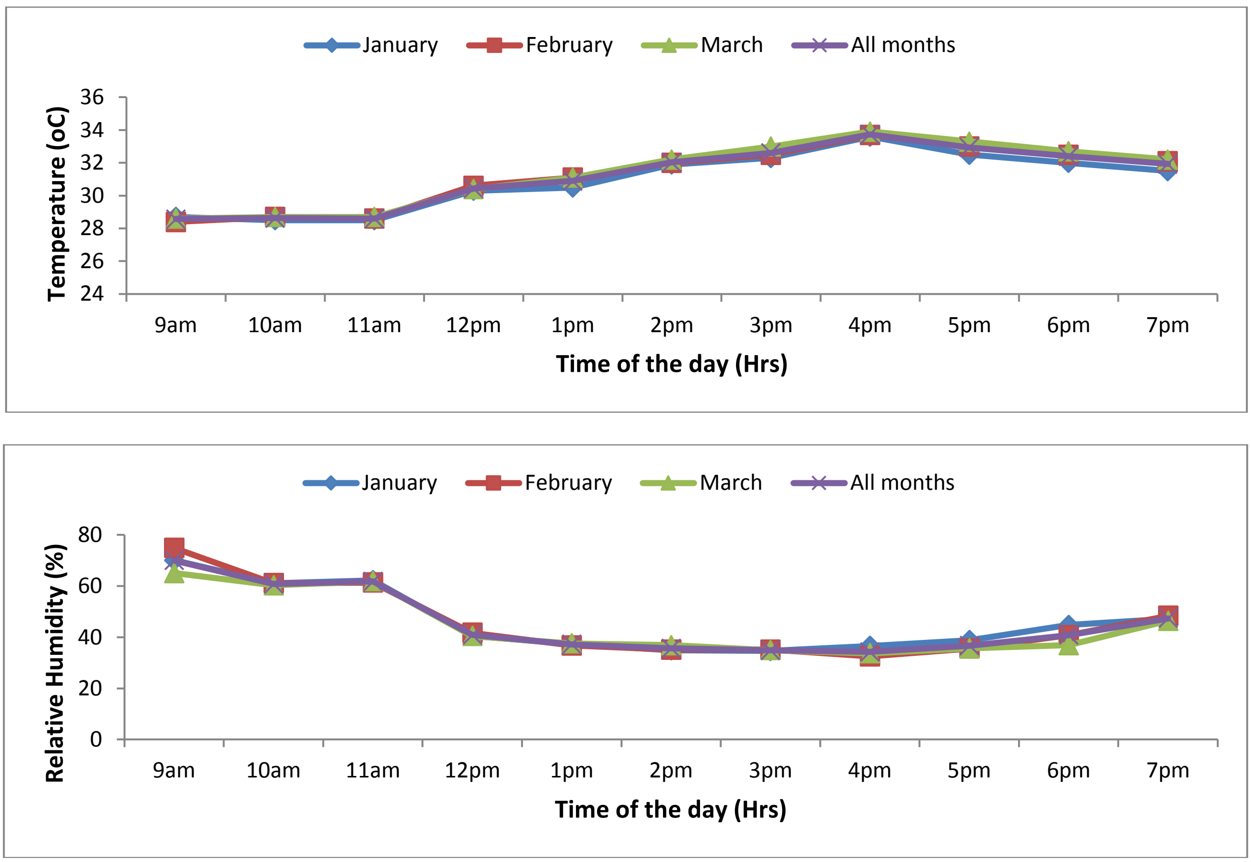


Figure 4 : Profiles of indoor environmental variables of the hostel

Fig. 5 depicted the comparison between ground and second floor across different months in terms of temperature. The ground floor was clearly performing better than the second floor. Its average temperatures were 30.4oC, 30.9oC and 31oC in January, February and March respectively, whereas the mean temperatures on second floor for these months were 31.1oC, 31.4oC and 31.1 respectively. The second floor on the average was 0.5 - 0.9oC warmer than the ground floor similar to Appah-Dankyi and Korateng [21] study in naturally ventilated classrooms in Accra, Ghana and Taylor et al. [22] in a rammed office building. The indoor air temperature on the ground floor correlated robustly with second floor (r =0.9808). For between 82-100% the measured temperature data on the second floor were higher than that of ground floor. This finding does not agree with the commonly held belief that the higher one goes the higher it becomes. The reason may be that during the monitoring period respondents were found cooking in their rooms instead of kitchenette provided for them. Inquiry shows the kitchenette is too small and far from their rooms. Therefore, in future design the issue of kitchen location must be addressed. However, both floors recorded air temperatures outside the upper and lower limits of the comfort zone. The diurnal variation in indoor temperature and relative humidity in these three months is very small (about 4-5.3oC and 20-42% respectively). In a study conducted in Japan, Indraganti et al [23] observed similar trend in all the office buildings surveyed.

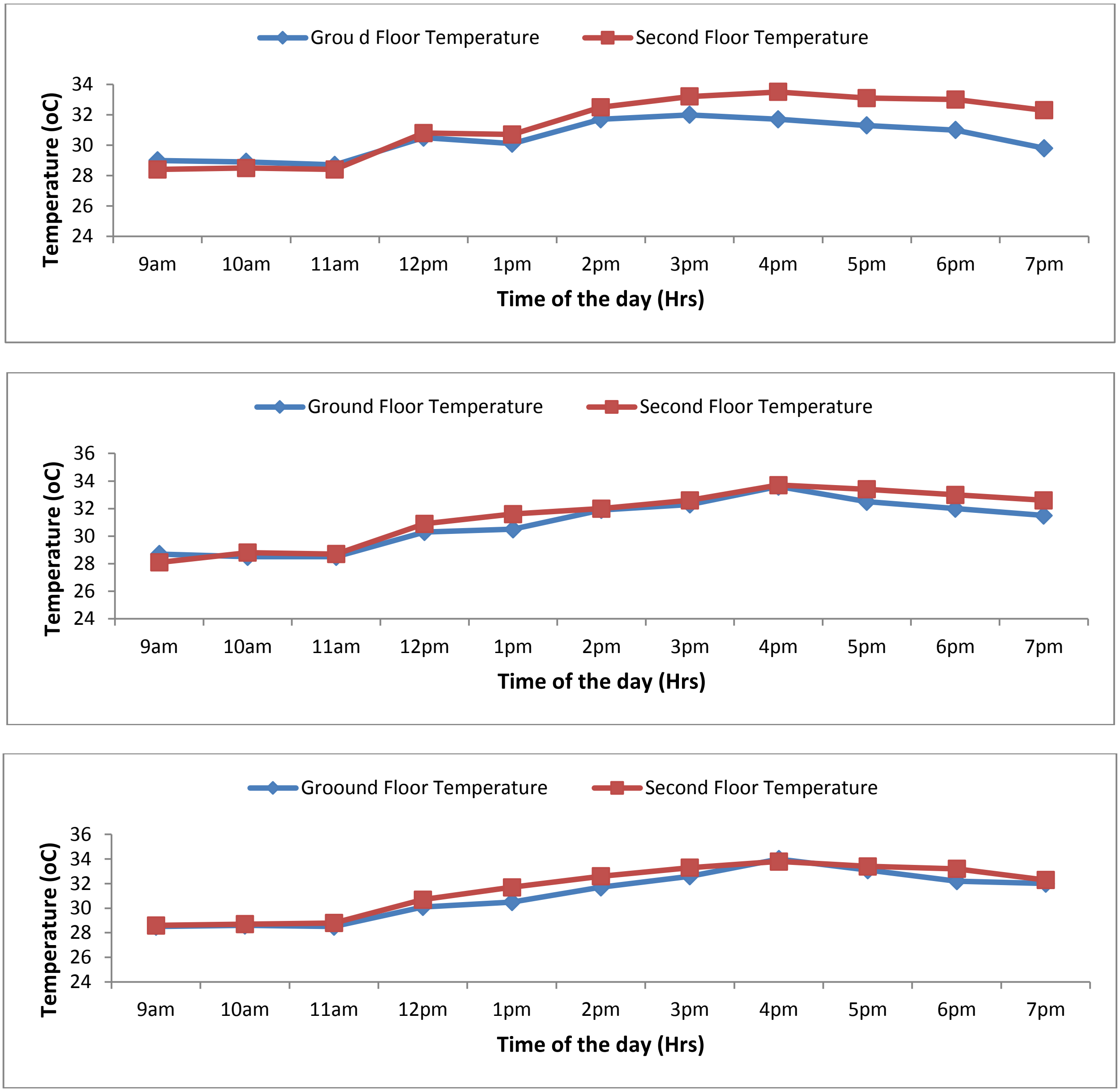


Figure 5 : Comparison of performance of indoor air temperature of ground floor and second floor

Fig.6 compared the performance of indoor relative humidity on both floors during monitoring period. The second floor performed better than ground floor throughout the survey period. Its mean relative humidities were lower than that of second floor. For example it was 45.3% as against 47.04% recorded on ground floor in January. Similarly, it was 44.65% compared with 46.16% found in February. Similar trend was observed in March and all months. For between 55-82%, the RH values on second floor were higher than that of ground floor. The second floor on the average was 1.7-2.4% less humid than the ground floor. The indoor air RH on the ground floor correlated robustly with that of second floor (r =0.9765).

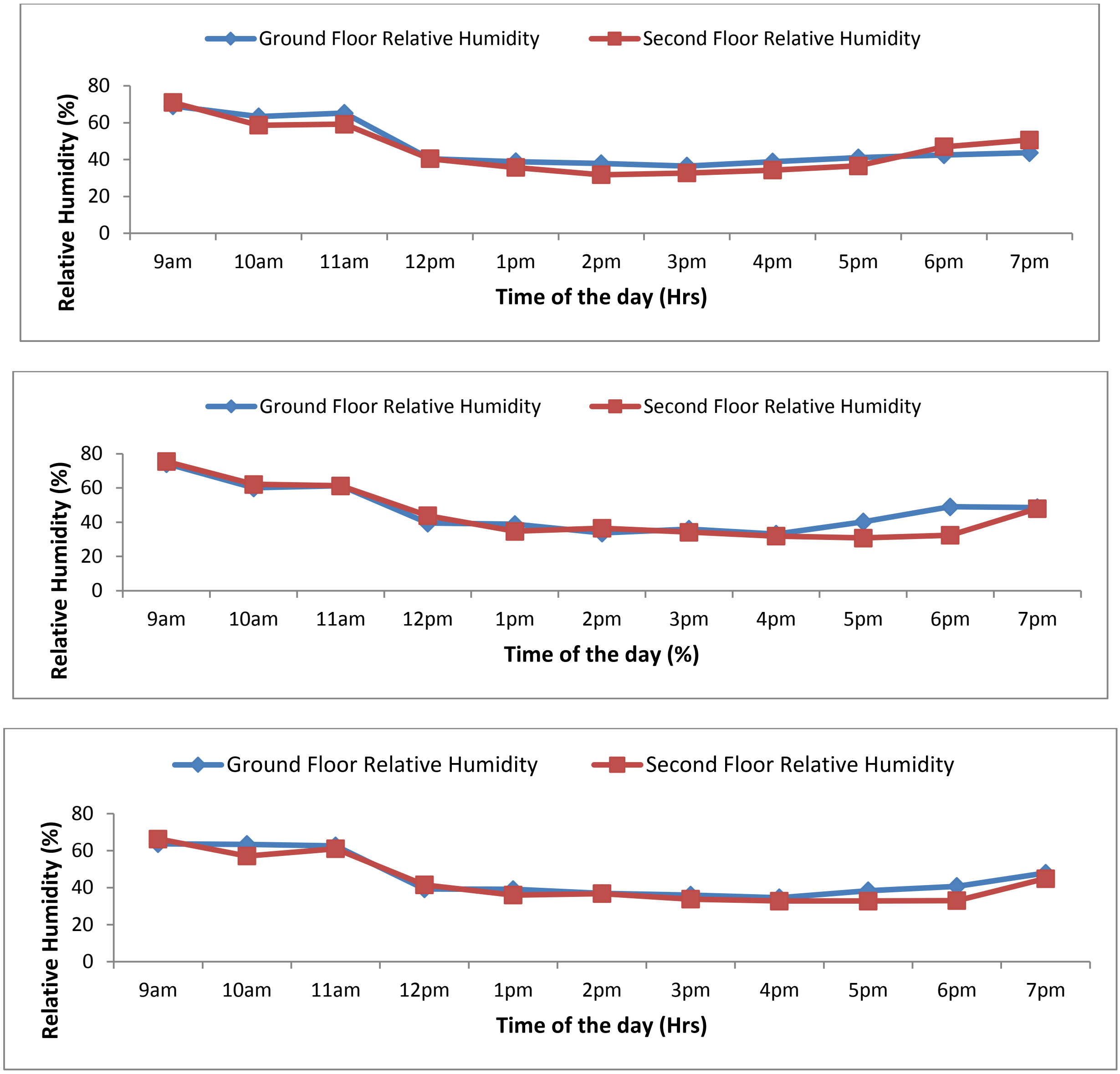


Figure 6 : Performance of ground floor RH compared with second floor RH

iii. *Indoor conditions: air velocity*

In hot season air movement will be an important factor in improving human thermal comfort. We have known from previous studies that air movement has a great influence on the respondents' comfort sensation and people require a higher level of air movement in order to feel comfortable. In this building, ventilation was primarily achieved through the use of windows and personal fans. The indoor air velocity was similar in all the months with the mean values of 0.02 m/s, evidently, the respondents in 100% of the environments were operating with less than 0.1 m/s air speed. Although they are naturally ventilated buildings, the air velocities in general are low.

The measured indoor environmental variables were compared with the ASHRAE standard 55 [24] and ISO 7730 [25] standard. These Standards used 23-26oC and 30-70% lines to delineate the air temperature and RH boundaries of comfort on the psychrometric chart. In relation to air velocity, the ASHRAE standard 55 suggested an air velocity between 0.18 m/s, and 0.25 m/s as the optimal air velocity for comfort. It also recommended increased air speeds to offset the elevated air temperatures. For a maximum indoor operative temperature increase of 3.0 K above comfort limits, it encouraged air speeds up to 0.8 m/s, with occupant control on the air speed. According to Wagner et al. [26] and Karyono [27] if NV buildings were designed correctly according to the local climate, for instance entirely protected from the direct sun`s radiation, which is common to the selected hostel, there would be a greater opportunity for naturally ventilated buildings to provide low indoor temperature. However, on the contrary, most of the measured air temperature in NV buildings especially in warm-humid climates showed that, in most cases none did fall within the acceptable standard [28-31]. Such conclusion was is in line with the findings of the present study. In comparison, in all cases, the values of indoor air temperature, relative humidity and air velocity were not within the comfort zone limits. The values of air temperature were higher than the maximum acceptable value; range of difference was between 2oC and 8oC. The values of air velocity were found to be away below the narrow range of 0.18 m/s and 0.25 specified in the ASHRAE Standard 55 and ISO 7730 standard. The reason may be that cross ventilation was found to be limited during this period because the outdoor temperature was very high. About 58% of measured relative humidity values were within the comfort zone limits. The results of this study seem to support the argument of [9, 32-33] that in warm-humid tropical climate the potential of NV buildings for sustainable thermal comfort is limited in hot season.

b) Measured subjective thermal responses

i. *Physical characteristics of the respondents*

A comprehensive profile of the respondents is shown in Table 4. The sample size varied each month; a maximum of 96 respondents voluntarily participated in the short-term survey. They were in the age group of 16-30 years with mean age of 24 years. They were Nigerian nationals from different ethnic group (Yoruba, Hausa, Igbo and Edos) living in the hostel for at least three month. Mean activity level of the group was found to be 1.06 met although respondents were observed to be either lying down/sleeping (0.7 met) or sitting passively (1 met) or sitting and working (1.2 met) and cooking (1.6 met). The mean clo value was 0.58, although individual respondent clo values varied from 0.42 and 0.73. The body surface area was estimated to be 1.65m^2.

Table 4 : Demographic characteristics of the respondents

N =96	Height (m)	Weight (kg)	Age (years)	Body surface area (m^2)	Clothing insulation (Clo)
Mean	1.68	58	19.6	1.65	0.58
STD	8.85	9.6	1.6	0.15	0.14
Maximum	1.92	92	27	2.14	0.73
Minimum	1.25	36	17	1.21	0.42

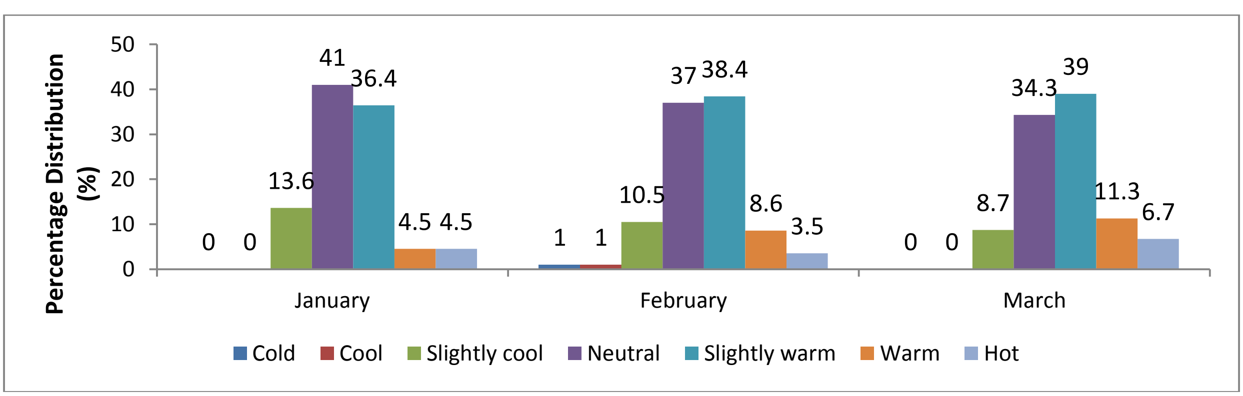
ii. *Thermal sensation, preference and acceptability*

Thermal sensation, preference and acceptability are the most important human responses to thermal environments and their relationships to a large extent determine the definitions of optimal conditions and acceptable ranges. By its literal sense, the term ''thermal sensation'' can be viewed as the interviewee's judgement of stimuli from the thermal environment to a certain extend. It is an important psychological expression relating to the feeling of warmth or coolth. On the other hand, thermal preference indicates what respondents preferred to be having in their environments. Thermal acceptability relates to a very important dimension of thermal comfort perception. It reflects several aspects pertaining to the occupant comfort: indoor and outdoor conditions, access and use of environmental control, hermal history, air quality, exposure etc.

The subjective feeling of warmth or coolth was measured using the ASHRAE thermal sensation scale. The respondents responded to the question "how do you feel the present temperature of this room" on a seven-point scale. Thermal preference was assessed from the questionnaire using the McIntyre scale of thermal preference through the question "at the moment, would you prefer warmer (+1), no change (0) or cooler (-1) environments. A direct question "do you accept the present indoor condition" to all respondents was used to ascertain their thermal acceptability. A comfortable subject usually voted within the central three categories (-1, 0, +1) of ASHRAE scale. The ASHRAE standard 55 [24] specified that the thermal acceptability should be defined as the condition where 80% of occupants vote for the central three categories (-1, 0, +1). Studies conducted by Zhang et al. [31] in NV buildings in hot-humid area of China and Zhang and Zhao [34, 35] carried out in a climate chamber under stead-state or dynamic, uniform or non-uniform conditions have shown that thermal sensation relationship varied significantly with the type of conditions. On the other hand, European SCATs project data base [36] observed that temperature changes that take place over a year in a building do not affect the overall assessment of environmental comfort in buildings. The frequency distribution of thermal sensation, preference and acceptability votes given across different months is shown in Fig. 7. It can be found through comparisons that the relationships obtained in the present study seem to support the observation of European SCATs project data base. All thermal sensation votes across the three months fell within the central three categories of the ASHRAE scale. Although, it showed some variations, the variations in TSV was very small (Fig. 7(a). In January, respondents were more comfortable (91%) when mean temperature was 30.9oC than in February (85.9%) when mean temperature was 31.2oC a difference of 0.3oC. Proportion voting within the comfort band on the sensation scale reduced to 82% in March when mean temperature was 31.3oC. The mean comfort vote of respondents (MTSV) was between neutral and slightly warm (MTSV = +0.45, +0.56, +0.73). These results showed that a perturbation of temperature produced a change in the sensation vote in the hostel. On the average, thermal sensation vote changed by 9% for every 0.4oC change in air temperature in the hostel. This indicated that respondents recorded a slightly lower sensitivity to the temperature rises. In the hot season, as the variations in the indoor air temperature are more important in this building, occupants can develop various human-environment relationships through thermal adaptation to local climate. This can be explained by the diversification of thermal experiences of occupants and the interactions between occupants and their environments as suggested by Nicol and Humphreys [37]. In comparison, Indraganti et al. [23] observed a unit sensation for every for 3.2K and 4.7 K perturbation in temperature in Chennai and Hyderabad, India. Similar trend was reported by Moujalled et al. [38] in France where on the average mean thermal sensation changed one unit for every 5oC of operative temperature in dry season.

According to Kwok and Chun [39], perhaps a more accurate measure of comfort is to ask what people prefer. Various distributions of respondents` votes are presented in Fig. 7(b). As found in many studies where respondents in naturally ventilated buildings expressed a preference to be cooler and wanted more air movement, it is clear to identify that a majority voted for the maintenance of ‘‘cooler’’ and ‘‘no change’’ environment. In January, the thermal preference votes show that 72.7% and 23.7% of respondents prefer cooler and no change environment. Incidentally, no respondent wanted warmer environment. In February, they also preferred air temperature on the cooler (73.5%) and no change (22.7%) categories despite accepting their thermal environment. However, 4.6% of the respondents still prefer the temperature to be warmer. In March, a preference for cooler (71.5%) and no change (23.2%) environments was evident, even though a significant number of subjects voted on the central three categories (-1, 0, +1). 5.3% still desired warmer environment. This in the opinion of the researcher were due to higher temperatures coupled with the insufficient air movement during the survey period, led to a psychological sense of `thermal comfort insecurity` in the occupants. As a consequence, they yearned for cooler environment irrespective of the current thermal sensation. The result confirms the tendency outlined by McIntyre`s research [40] who found that people of warm climates may prefer what they call a “slightly cool” environment and, on the contrary people of cold climates may prefer what they call a “slightly warm” environment.

Thermal acceptability is the percentage of the respondents to the questionnaire who found acceptable their thermal conditions. Various distributions of respondents` votes are presented in Fig. 7(c). Their responses are rather interesting. In January, almost 73% and 27% of the participants judged their environment to be acceptable and unacceptable. In February, 71% and 29% of the participants judged their environment to be acceptable and unacceptable. In March, just 75.2% found their environment thermally acceptable. It is generally expected that people voting comfortable (TSV = -1, 0, +1) accept the environment. Interestingly, 18%, 14.9% and 6.8% of respondents voting in the comfort band, especially, those voting “neutral” have also voted the environment unacceptable. According to Indraganti et al. [28], this complex pattern of acceptance is attributed to many reasons: lower expectations in some user groups, overall satisfaction with oneself and her immediate environment, age, health, availability/access to controls. These results indicate that most of the participants adjusted for the climatic variation and remained satisfied with the indoor thermal environment. An attempt was made to examine the subjective assessments of the indoor thermal conditions between the three sessions of the day: morning, afternoon and evening sessions. Fig. 7(d) shows that only the in morning, sessions (on the average, 82.9%) with mean thermal sensation votes of -0.4 can satisfy the above criteria. For evening session, 74.9% of respondents found that their environment condition was acceptable with a mean vote of -0.37, between neutral and slightly cold category. A lower percentage of 72.6% was found in the afternoon hours with a mean vote of +0.29.



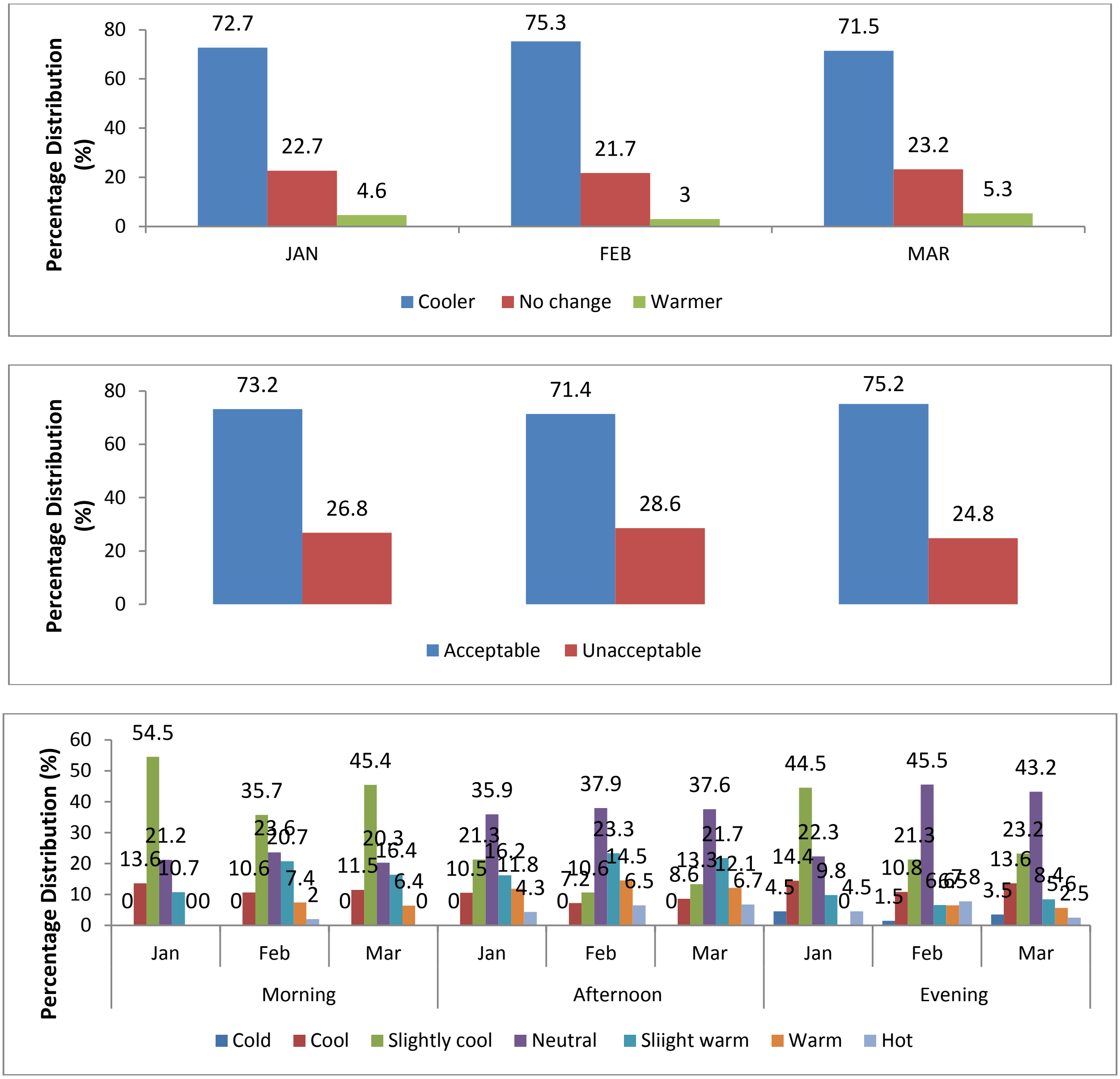


Figure 7 : Distribution of subjective response on thermal environment

iii. *Relative humidity sensation, preference and acceptability*

Fig. 8 presents the frequency distribution of RH sensation, preference and acceptability votes across the various months. Relative humidity was assessed using the 5-point Nicol relative humidity sensation scale ranging from -2 (moderately dry), -1 (slightly dry), 0 (neutral), +1 (slightly humid) and +2 (moderately humid). The frequency distribution of RH sensation is shown in Fig. 8 (a). In January, about 23% experienced moderately humid at the existing room conditions. About 41% of respondents perceived the air was slightly dry while 36.4% perceived the air neutral. In February, Similar patterns in relative humidity sensation as that of January were observed in February and March. Generally, the subjective responses to relative humidity were biased towards dry with the mean vote within the neutral and slightly dry category (MSV = -0.86, -0.88, -0.86). Fig. 8(b) shows the RH preference of respondents. It was noticed from the study that between 50% and 56% of respondents preferred to be neutral; between 13.5% and 20% respondents preferred to reside at slightly dry conditions. Up to 25% of the students preferred to reside in moderately humid conditions. The mean preference votes were biased towards the neutral and slightly dry category (MSV = -0.2, 0.-0.3). Fig. 8 (c) shows that on the average more than 85% of respondents accepted their relative humidity across the three months.

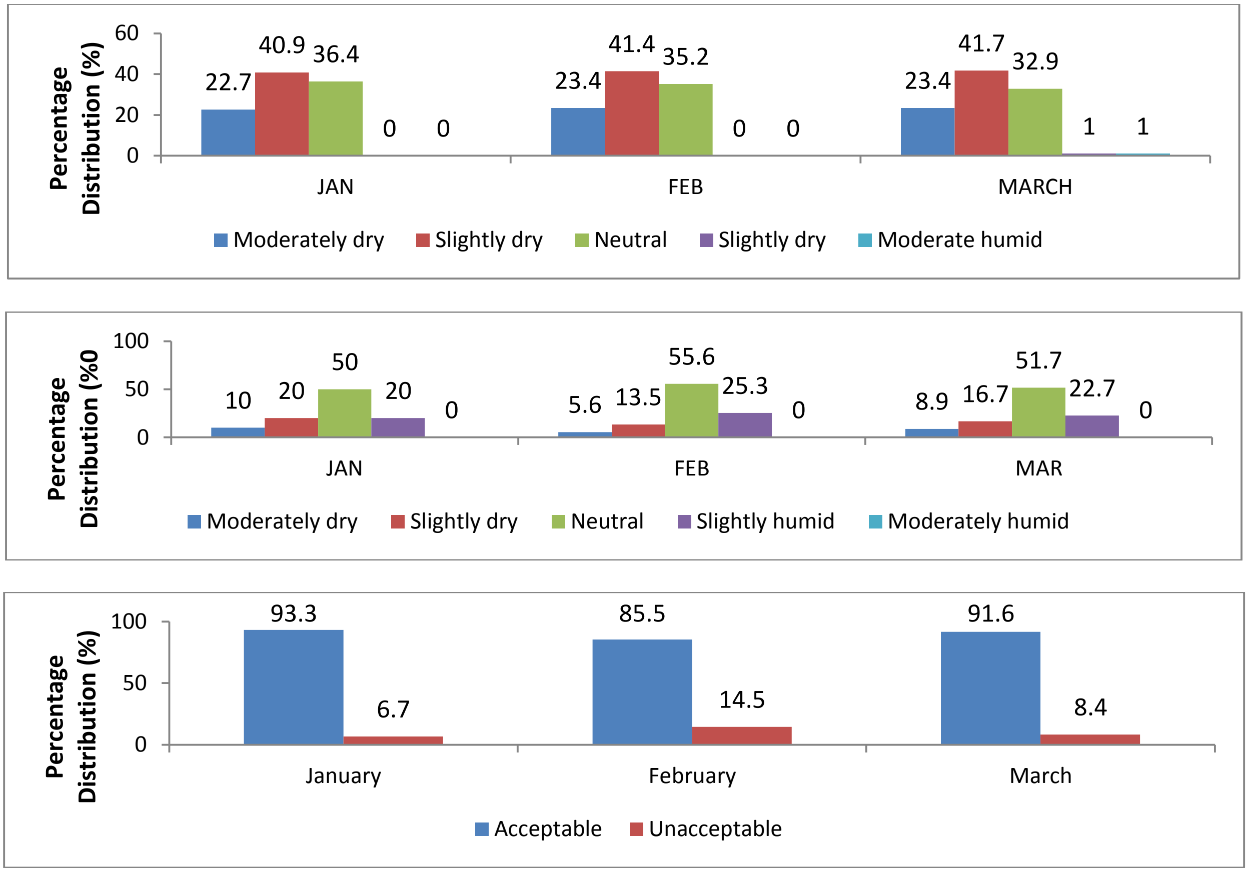


Figure 8 : Distribution of subjective response on relative humidity

iv. *Air movement sensation, preference and acceptability*

In the warm-humid climate of Ile-Ife, air movement plays a major role in achieving thermal comfort. Therefore, it is important to understand the hostel occupant`s perception, preference and acceptability for the actual indoor air movement in spite of low air movement data recorded. Fig. 11 presents the frequency distribution of air movement sensation (AMS), air movement preference (AMP) and movement acceptability (AMA) across the various months. Fig. 11(a) shows the indoor AMS votes of the respondents. AMS was assessed on Nicol five-point scale using the question "how is the air movement in this room?" with a vote of +2 indicating that the air velocity level in the hostel was high, a zero vote means that the respondents felt that the air velocity was just right. In January, 81% o of respondents claimed that the air was slightly high and just right. Only 19% reported that the air movement was low. In February, 75% of respondents sensed the air velocity as slightly high and just right. 25% of all respondents perceived that the air was slightly low. In March, 82.2% o of respondents perceived the air to be slightly high and just right. 17.8% of all respondents indicate that the air movement was slightly low. The mean air movement sensation (MAMS) votes were biased towards the neutral and just right category (MAMS = +0.2, +0.1, +0.2) giving the overall impression that the air was sensed okay.

The question "how do you prefer to have air movement in this room elicited responses on the air movement preference (AMP) on McIntyre three-point scale (Fig. 11(b). Most of the subjects (95.5%, 93.6%) indicate more air movement as their preference for air movement for the months of January, February and March respectively. A small portion (4.5%) of respondents desired no change in their thermal environment. Interestingly, no respondent wanted less air movement except in March where only 2.3% respondents preferred less air movement. The present results confirm previously findings that occupants in warm-climate would prefer more air movement and no change in their thermal environment [31, 41-42].

Air movement acceptability (AMA) was assessed on binary scale (acceptable and unacceptable). Figure 9(c) shows the indoor AMA votes of the respondents. In January, 93.3% and 6.7% of the participants judged air movement to be acceptable and unacceptable. In February, 85.5% and 14.5% of the participants perceived the air movement to be acceptable and unacceptable. In March, just 91.6% found their environment thermally acceptable. A large portion.

Figure 9 : Distribution of subjective response to air movement

c) Overall comfort conditions

During the study occupants were asked to judge the 'overall thermal comfort' based on their experience of room temperature, RH and air velocity. The recorded perception was analysed on Nicol`s five-point thermal acceptance scale as presented in Fig. 10. It was observed that above half of the respondents (56.5%) in January, 51.7% in February and 54.4% of this group in March felt slightly comfortable. More than 25% in January, 19.3% in February and 23.9% in March were comfortable at present room conditions. There were fewer votes noticed on uncomfortable and very uncomfortable categories. There was no vote on very comfortable state in all the months. The mean thermal comfort vote was within the slightly uncomfortable category.

From the above distribution of votes, it is possible to relate the votes of the various environmental parameters to that of overall thermal comfort (Figs. 7-10). Given the mean overall thermal comfort vote of slightly uncomfortable, the mean temperature, humidity and air movement votes were under the categories of neutral and slightly warm, neutral and slightly dry and neutral and just right respectively. This reinforces the idea that the occupants perceptions of thermal comfort indeed hinges on sensations of temperature, humidity and air movement, as illustrated in Fanger`s thermal comfort equation.

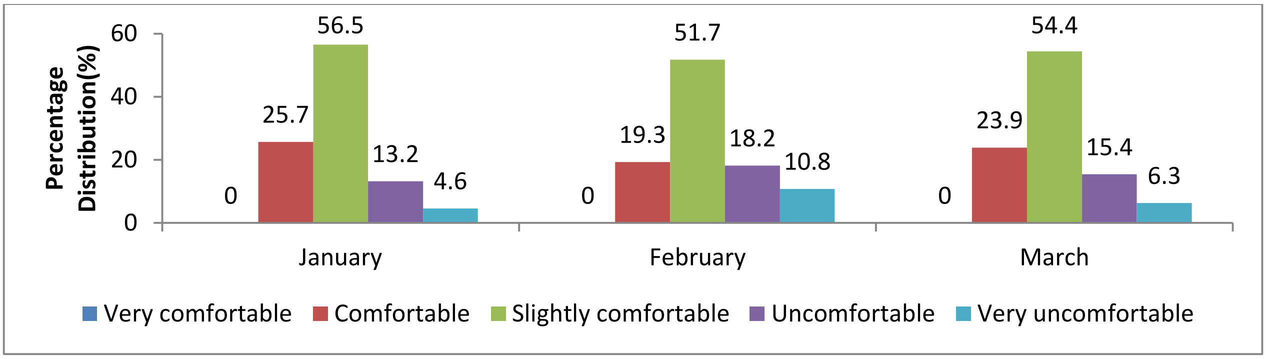


Figure 10 : Assessment of indoor environment based on overall thermal comfort

d) Relationship between measured physical thermal comfort parameters and TSV

A comparative analysis was performed to find out the relationship between actual survey vote and measured physical thermal comfort parameters. Studies have shown that no correspondence existed between the measured physical data and occupants' perceived votes in NV buildings especially in warm-humid tropical climate [20, 26, 43]. They also reported that occupants of NV buildings were thermally comfortable in a wider range of environmental conditions beyond what was recommended in ASHRAE standard 55 and ISO 7730 standard. Zhong et al. [44] and Huang et al. [45] observed that the capacity to control an indoor environment could improve the subject`s thermal comfort level and extend the acceptable range of thermal environment. That is more than 80% of the occupants will express satisfaction with the thermal condition. Such conclusion is in line with the findings of the present study. Comparison of physical measurement and TSV indicates that people can develop various human-environment relationships through thermal adaptation to local climate, resulting in different thermal neutral temperatures in various climates. We recorded higher indoor air temperatures beyond the recommended unit set by the standards for summer across the different months. On the contrary, occupants of the hostel found their thermal environment comfortable, acceptable and satisfied. This in our own opinion was due to adaptive behaviour, expectation and acclimatisation of occupants` of warm-humid climate to higher temperatures. The findings of this study seems to support the argument of previous researchers that thermal sensation vote in field study hinges primarily on the use, access and perceived access to the adaptive controls and several psychological parameters in addition [46].

e) Adaptation to achieve thermal comfort

Studies have shown that, in general, respondents in NV buildings preferred to employ environmental control (window opening) first before they resort to personal adjustment which involves some thermoregulation of their bodies [9, 17, 20, 47]. On the contrary, Indraganti [46] study in India revealed that occupants used the environmental control only when adaptation through clothing and/or metabolism was not sufficient or feasible. Again, Feriadi and Wong [20] add that in warm-humid climate the immediate cooling effect is mainly anticipated from higher wind speed through window openings. Hwang et al. [45] also observed that the habitual adaptation method of respondents is influenced by (i) the effectiveness of the adaptive control in relieving thermal discomfort (ii) availability and accessibility (iii) convenience (iv) cost. Other factors mentioned included sufficient window-wall-ratio (WWR). The results of this study seemed to compare favourably with the above findings. Fig. 11 shows the preference to use control features to restore thermal comfort state. While there were individual differences in the way people have adopted adaptive opportunities, the environmental control by opening the windows was highly preferred by respondents with the percentage of 77.4%, closely followed by wearing light clothes (77.3%). The used of fans, open door and close door as well as adjustment to window blind, showed the same percentage of 59.1%. Other favoured adaptive actions taking were cold food/drink (50%), change activity (47.6%) and partial opening of windows (46.4%). Moving out to cool place and usage of hand fan constituted 36.1%. The least favorable action was adjusting shading/sun control (27.3%). The high preference for the window opening, wearing light clothes and use of fan signifies that they were adequate and effective for the evaporation of skin moisture found at various humidity and temperature ranges observed during the survey. It also indicated that those adaptive actions are accessible and convenience for the occupants. The above finding can be used not only as information on the percentage of "likeliness" but also on the student`s preference in choosing various adaptive actions to make their living environment more comfortable. Certainly, for hostel building designers, this information is very useful so they would pay more attention to incorporating them into student housing design.

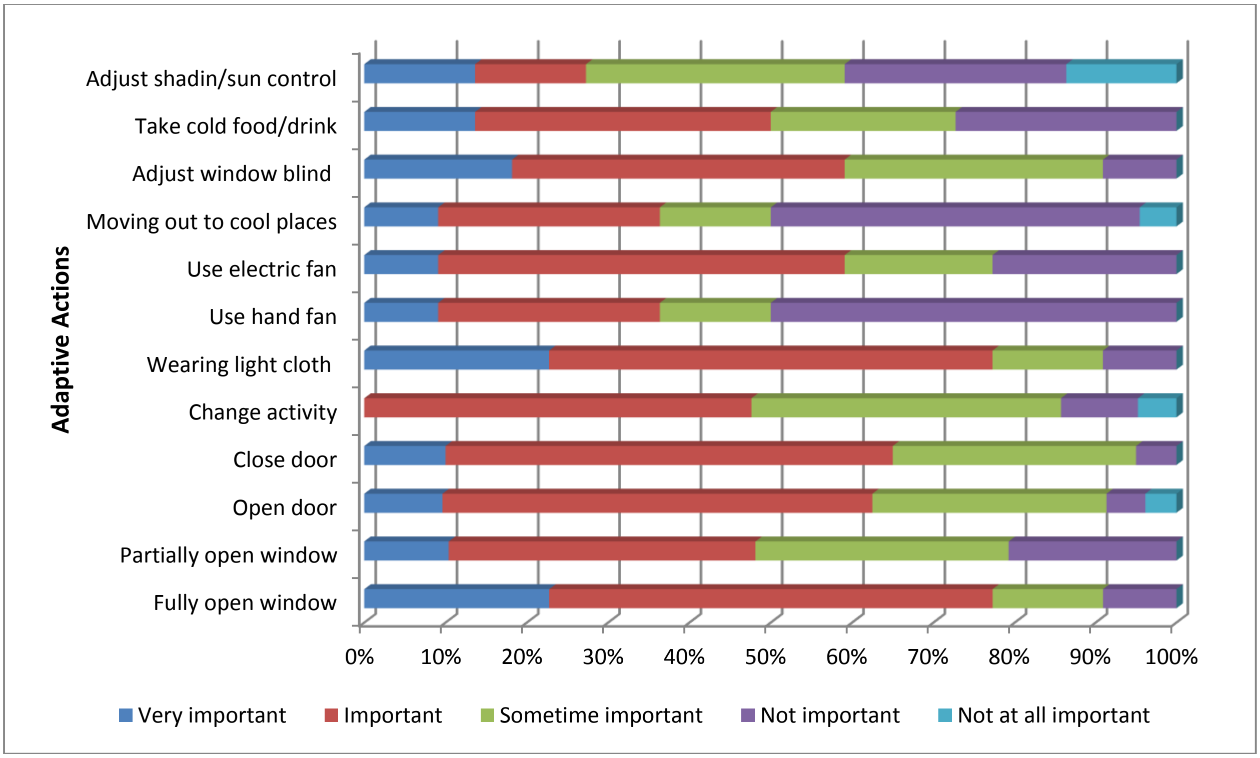


Figure 11 : Adaptive behaviour

Further analysis was carried out on the frequency of windows, window blinds and fan usage at different times of the day. The usage was divided into three time slots: morning (9–12 a.m.), afternoon (1–4 p.m.), and evening (5–7 p.m.). The results are presented in Fig. 12. Fig. 12(a) shows the preference to open their room window. The highest percentage of opened window was in the morning and afternoon with the value of 90.9% respectively. The percentage of occupants who opened the window in the evening is still very high (77.3%). If the usage of window is assumed to be indirectly related to indoor environmental condition then it implies that in the morning, afternoon and evening the indoor condition might be less comfortable.

The adjustment to window blind is much higher in the afternoon and morning with the percentage as high as 80.9% and 79.9%, respectively (Fig.12 (b). In the evening, the percentage was still relatively high with 68.2% respondents adjust their window blind. The reason may be that the outdoor/indoor was usually higher at that time. Another possible reason may be to allow natural light indoor.

The use of fans is significant to human comfort and is the most commonly used environmental control option [48]. It was observed that the usage of fan is much higher in the afternoon and evening with the percentage as high as 83.6% and 75.8%, respectively (Fig. 12 (c). This is because in the afternoon and evening, the outdoor/indoor is usually higher than that of the morning time. The frequently windless condition in these periods might be the reason for the high usage of fans that expected to improve uncomfortable indoor condition. Interestingly, Feriadi and Wong [20] found the use of fans occurring when the daily mean outdoor temperature was beyond 25oC. Fig. 11(d) shows the unique combination of the usage of various environmental controls at these times of the day.

f) Limitation to sustainable thermal comfort in the hostel

As stated in section 3.1.3 of this paper that if NV buildings were designed correctly according to the local climate, it will give such buildings a great opportunity to adapt to elevated temperatures. Also, the tendency for such buildings to provide lower indoor temperature is high. However, in this building, many issues, some of them contributed by the occupants hindered sustainable thermal comfort. Temperature excursions beyond the comfort limits were a daily feature in warm-humid climate of Ile-Ife during this season. Many of the windows and doors were found with limited accessibility as most of the windows were blocked due to arrangement of the indoor spaces. Profligate attitudinal disregard was observed towards the environment as occupants were found cooking in their rooms instead of the kitchenette provided for them. Finally, psychological preparedness of the subjects resulted in some display of thermal empathy

V. Conclusion

A dry season thermal comfort field measurement was performed in a naturally ventilated

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female hostel in Obafemi Awolowo University, Ile-Ife, Nigeria. The indoor environmental conditions, human responses and adaptation to thermal environment as well as hindrances to sustainable thermal comfort were systematically investigated in the present study. The key findings from this study are as follows:

- Objective measurement of the hostel showed that none of the measured data had thermal conditions falling within the comfort zone of ASHRAE standard 55. However, occupants found temperature range beyond the comfort zone comfortable, satisfying and acceptable.
- Respondents preferred cooler and no change environments and more air movement.
- A comparative analysis of ground floor and second floor performance showed that second floor indoor air temperature was higher than ground floor temperature.
- There was no much difference in thermal performance of the hostel across the three months as they exhibit similar trend.
- The investigation on thermal adaptation methods reveals that first preference of the respondents was window opening (77.4%), closely followed by wearing of light clothes (77.3%) and lastly the fan use
- Prominent among the barriers identified was the profligate attitudinal disregard towards the environment as occupants were found cooking in their rooms instead of the kitchenette provided for them.
- The results of the study show that occupants in warm-humid climate have a wider range of thermal acceptability than that specified by the ASHRAE Standard 55.

The study concludes that in warm-humid of Ile-Ife during hot season the desired for optimal thermal comfort in NV hostels may not be achieved. However, the availability of behavioural controls and mechanical ventilation system can help to improve thermal environmental conditions.

VI. Limitation of the Study

Our study represents a relatively small sample size (1) with 96 responses collected in the naturally ventilated hostel, which could cause misleading interpretations. However the general tendencies of thermal sensation and preference corroborate findings from studies in both offices and schools. In pursuing this research further, the researcher plan to expand the study to more hostels, conduct the study during the rain and harmattan months of the year, and make seasonal evaluations on perceptions of comfort.

References Références Referencias

1. Sekhar, S.C. and Goh, S.E. Thermal comfort and IAQ characteristics of naturally/mechanically ventilated and air-conditioned bedrooms in a hot and humid climate Building and Environment 2011; 46:1905-1916.
2. Zhang, L., Yuan, Q., Wu, Q., Kwauk, S., Liao, X. and Wang, C. Sleep quality and sleep disturbing factors of inpatients in a Chinese General Hospital. Journal of Clinical Nursing 2009; 18: 2521-2529.
3. Lin, Z. and Deng, S. (2006): A questionnaire Survey on Sleeping Thermal Environment and Bedroom Air Conditioning in High-rise Residences in Hong Kong. Energy and Buildings, 38:1302-1307.
4. Teli, D., Jentsch, M.F. and James, P.A.B. Naturally ventilated classrooms: An assessment of existing comfort models for predicting the thermal sensation and preference of primary school children. Energy and Buildings 2012; 53; 166–182.
5. Ismail, A.R., Jusoh, N., Makhtar, N.K., Daraham, M.R., Parimun, M.R. and Husin, M.A. Assessment of environmental factors and thermal comfort at Automotive Paint Shop. Journal of Applied Sciences 2010; 10; 1300-1306.
6. Chen, H.J., Moshfegh, B. and Cehlin, M. (2013): Investigation on the Flow and Thermal Behavior of Impinging Jet Ventilation Systems in an Office with Different Heat Loads: Building and Environment, 59:127-144.
7. Pourshaghaghy, A. and Omidvari. Examination of thermal comfort in a hospital using PMV-PPD model. Building and Environment 2012; 43-1089-1095.
8. Schellen L, Lichtenbelt, W.D.V., Loomans, M.G.L.C., Toftum J. and de Wit M.H. Differences between young adults and elderly in thermal comfort, productivity, and thermal physiology in response to a moderate temperature drift and a steady state condition. Indoor Air 2010; 20:273-283.
9. Dhaka, S., Mathura, J., Wagner, A., Das Agarwal, G. and Garg, V. Evaluation of Thermal Environmental Conditions and Thermal Perception at Naturally Ventilated Hostels of Undergraduate Students in Composite Climate. Building and Environment, 66:42-53
10. Dahlan ND, Jone PJ, Alexander DK. Operative temperature and thermal sensation assessments in non-air-conditioned multi-storey hostels in Malaysia. Building Environ 2011; 46:457-467.
11. Bako-Biro, Z., Clements-Croome, D.J., Kochhar, N., Awbi, H.B. and Williams, M.J. Ventilation rates in schools and pupils` performance. Building and Environment 2012; 48; 215-223.
12. Fanger, P.O. Thermal comfort, analysis and applications in environmental engineering. New York: McGraw-Hill; 1972.

13. Olanipekun, E.A. Post occupancy performance characteristics of office buildings in selected universities in Southwest, Nigeria. A Ph.D Thesis submitted to the Department of Building Obafemi Awolowo University, Ile-Ife 2012.
14. Adunola, O. A. and Ajibola, K.O. Thermal considerations and space use within residential buildings in Ibadan. Proceedings of 7th Windsor Conference: The changing context of comfort in an unpredictable world Cumberland Lodge, Windsor, UK, 12-14 April 2012. London: Network for Comfort and Energy Use in Buildings, http://nceub.org.uk
15. Adunola, O.A. Adaptive comfort and energy-saving sustainable considerations for residential buildings in Ibadan, Nigeria. In Afon, A.O. and Aina, O.O. eds, Issues in the Built Environment in Nigeria, 2011, Chapter 17; 308-326.
16. Adebamowo, M.A. and Akande, O.K. (2010): Indoor Thermal Comfort for Residential Buildings in Hot-Dry Climate of Nigeria, 2010, http://www.nceub.org.uk. (Accessed: September 10, 2012).
17. Adebamowo, M.A. and Olusanya, O. Energy savings in housing through enlightened occupants behaviour and by breaking barriers to comfort: a case study of a hostel design in Nigeria. Proceedings of 7th Windsor Conference: The changing context of comfort in an unpredictable world Cumberland Lodge, Windsor, UK, 12-14 April 2012. London: Network for Comfort and Energy Use in Buildings, http://nceub.org.uk
18. Singh, M.K., Mahapatra, S. and Atreya, S.K. (2010): Thermal Performance Study and Evaluation of Comfort Temperatures in Vernacular Buildings of North-East India. Building and Environment 2010; 45:320–329
19. Djamila, H., Chu, CM. and Kumaresan, S. Field study of thermal comfort in residential buildings in the equatorial hot-humid climate of Malaysia. Building and Environment 2013; 62; 133-142
20. Feriadi, H. and Wong, N.H. Thermal comfort for naturally ventilated houses in Indonesia. Energy and Building 2004; 36-614-626.
21. Appah-Dankyi, J. and Koranteng, C. An assessment of thermal comfort in a warm and humid school building at Accra, Ghana. Advances in Applied Science Research 2012; 3 (1):535-547
22. Taylor, P., Fuller, R.J. and Luther, M.B. Energy use and thermal comfort in a rammed earth office building. Energy and Building 2008; 40; 793-800.
23. Indraganti, M., Ooka, R. and Rijal, H.B. Field Investigation of Comfort Temperature in Indian Office Buildings: A case of Chennai and Hyderabad. Building and Environment 2013; 65: 195-214.
24. ASHRAE, ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy, American Society of Heating, Refrigerating and Air-Conditioning Engineering, Atlanta, GA, 2004.
25. ISO International Standard 7730. Moderate thermal environment: determination of the PMV and PPD indices and specifications of the conditions for thermal comfort, International Organisation for Standardisation, 2005, Geneva.
26. Wagner, E. Gossauer, C. Moosmann, K. Thermal comfort and workplace occupant satisfaction-results of field studies in German low energy office buildings. Energy and Buildings 2007:39 (7):758–769.
27. Karyono TH. Report on thermal comfort and building energy studies in Jakarta, Indonesia. Building and Environment 2000; 35:77-90.
28. Indraganti M, Ooka R, Rijal HB. Thermal comfort in offices in summer: findings from a field study under the 'Setsuden' conditions in Tokyo, Japan. Building and Environment 2013; 61: 114-32.
29. Wafi, S.R.S., Ismail, M.R. and Ahmed, E.M. A Case Study of the Climate Factor on Thermal Comfort for Hostel Occupants in Universiti Sains Malaysia (USM), Penang, Malaysia Journal of Sustainable Development 2011; 4(5); 50-61
30. Razman, R. B., Abdullah, A. B. and Abdul Wahid, A. B. Study on thermal comfort in university hostel building case study at Universiti Tun Hussein Onn Malaysia (UTHM), Batu Pahat. International Conference on Environment Science and Engineering IPCBEE 2011; 8, IACSIT Press, Singapore.
31. Zhang, Y., Wang, J., Chen, H., Zhang, J. and Meng, Q. Thermal Comfort in naturally ventilated buildings in hot-humid area of China. Building and Environment 2010; 45:2562-2570.
32. Haase, M and Amato, A. An investigation of the potential for natural ventilation and building orientation to achieve thermal comfort in warm and humid climates. Solar Energy 2009; 83; 389–399.
33. Wang, L. and Wong, N.H. The impacts of ventilation strategies and facade on indoor thermal environment for naturally ventilated residential buildings in Singapore. Building and Environment 2007; 42; 4006-4018.
34. Zhang, Y. and Zhao, R. Relationship between thermal sensation and comfort in non-uniform and dynamic environments. Building and Environment 2009; 44(7):1386-91.
35. Zhang Y, Zhao R. Overall thermal sensation, acceptability and comfort. Building and Environment 2008;43(1):44-50.
36. European project [18]
37. Nicol, J.F. and Humphreys, M.A. (2004): A stochastic approach to thermal comfort-occupant behaviour and energy use in buildings, ASHARE Transactions 2004; 110 (2):554-568.
38. Moujalled B, Cantin R, Guarracino G. Comparison of thermal comfort algorithms in naturally ventilated

office buildings. Energy and Buildings 2008; 40 (12):2215-23.

39. Kwok, A.G. and Chun, C. (2003): Thermal Comfort in Japanese Schools. Solar Energy, 74 (3):245-252.
40. McIntyre, D.A. Indoor Climate, Applied Science Published Ltd., London, 1980.
41. Brager GS, Paliaga G, de Dear R. Operable windows, personal control. ASHRAE Trans 2004; 110(2):17-35.
42. Caˆndido, C., de Dear, R.J., Lambert, R. and Bittencourt, R.L. Air movement acceptability Limits and Thermal Comfort in Brazil's Hot Humid Climate Zone. Building and Environment 2010; 45: 222–229.
43. De Giuli, V., Zecchin, R., Salmaso, L., Corain, L., and De Carli, M. (2013): Measured and perceived indoor environmental quality: Padua Hospital case study. Building and Environment 59 (2013) 211-226
44. Zhong, Ke., Fu, H., Kang, Y. and Peng, X. Indoor thermal conditions and the potential of energy conservation of naturally ventilated rooms in summer, China. Energy and Building 2012; 55-183-188.
45. [45] Hwang, RL., Ming-Jen Cheng, MJ., Lin, TP. and , Ho, MC. Thermal perceptions, general adaptation methods and occupant's idea about the trade-off between thermal comfort and energy saving in hot–humid regions. Building and Environment 2009; 44; 1128–1134
46. Indraganti M. Thermal comfort in naturally ventilated apartments in summer: findings from a field study in Hyderabad, India. Applied Energy 2010; 87 (3):866-83.
47. Wong, N.H. and Khoo, S.S. Thermal Comfort in Classrooms in the Tropics. Energy and Buildings 2003; 35:337–351.
48. Nicol, J.F. and Humphreys, M.A. A stochastic approach to thermal comfort-occupant- behaviour and energy use in buildings. ASHRAE Transaction 2004; 110 (2): 5554-572.

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The Resolution of the Cornucopian-Ecologist Issue

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Abstract- Cornucopians and ecologists have debated the hypotheses of global warming as a result of the emission of greenhouse gases for several decades, focusing upon different interpretations of risk: resilience against precaution. One can now employ recently available data on GDP, energy consumption, emissions and global average temperature to decide between these two positions. The cornucopian position is wrong, the evidence strongly indicates.

Keywords: greenhouse gases, global temperature, energy consumption, GDP per capita, cornucopians, ecologists, simon, wildavsky, lomborg, lovelock, CPRs, logic of collective action.

GJHSS-B Classification : FOR Code: 060299, 050299

THE RESOLUTION OFTHECORNUCOPIAN-ECOLOGISTISSUE

The Resolution of the Cornucopian-Ecologist Issue

Jan-Erik Lane

Abstract- Cornucopians and ecologists have debated the hypotheses of global warming as a result of the emission of greenhouse gases for several decades, focusing upon different interpretations of risk: resilience against precaution. One can now employ recently available data on GDP, energy consumption, emissions and global average temperature to decide between these two positions. The cornucopian position is wrong, the evidence strongly indicates.

Keywords: greenhouse gases, global temperature, energy consumption, GDP per capita, cornucopians, ecologists, simon, wildavsky, lomborg, lovelock, CPRs, logic of collective action.

I. Introduction

For two decades the battle over global warming – climate change has raged with the sciences, especially within the social sciences. What social scientists debate is whether our social systems generate the problematic of global warming as well as whether policies should be enacted to combat climate change. At the centre of this heated discussion is the nature of the global market economy: Does global capitalism result in the pollution of the atmosphere besides overall environmental degradation?

In this article I will employ most recently available data to show that there is a link between the economy and greenhouse gases over the consumption of massive amount of energy, which all lead to global average temperature rise. The recent much talked about climate report stated:

Climate change, once considered an issue for a distant future, has moved firmly into the present. Corn producers in Iowa, oyster growers in Washington State, and maple syrup producers in Vermont are all observing climate-related changes that are outside of recent experience. So, too, are coastal planners in Florida, water managers in the arid Southwest, city dwellers from Phoenix to New York, and Native Peoples on tribal lands from Louisiana to Alaska. This National Climate Assessment concludes that the evidence of human-induced climate change continues to strengthen and that impacts are increasing across the country. [U.S. Global Change Research Program, 5/6/14; Media Matters, 5/7/14].

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II. The Cornucopian Position

Until the recent release of this climate change report to the US federal government, politicians have not taken the hypothesis of global warming or its accompanying hypothesis of climate change too seriously. There are of course exceptions, but in general the elites in politics and business adhere to the cornucopian view, namely that climate change if really occurring is due to other factors than an irreversible global warming process as well as that the burning of fossil fuels has little to do with this process of global warming. On the contrary, cornucopians regard the recent climate change report as "climate hysteria", because the more affluent the world becomes due to economic growth, the better it will handle pollution. Planet Earth is a horn of plenty (cornucopia).

The action implications of the cornucopian position are clear: do nothing about global warming, which may actually result from temporary and irregular changes in the sun. This no-policy stance is called: resilience. Global coordination upon the governance of climate change policies is a waste of time and resources that could be employed to fight other problems of the planet, like poverty, deceases, malnutrition, etc.

The cornucopian position was first developed by economist Simon (2003) and political scientist Wildavsky (1988, 1997). It was part of a general rebuttal of environmentalism and deep ecology, based upon the argument that economic incentives when allowed free reign will sooner or later solve pollution problems though technological innovation. What are crucial are private property rights, as they induce people to clean up around themselves. The world has enormous resources which can be tapped wisely through allocation in perfect markets. Scarcity is only a temporary phenomenon.

Where as Simon in his critique of environmentalism targeted in particular the fear of a population boom with attending scarcities of resources, Wildavsky focused upon the ecological accusations against business of selling unsafe products of various kinds. Yet, both rejected emphatically the three hypotheses concerning global warming and climate change, stated above.

The cornucopian position is today connected with the books and writings of Danish Bjorn Lomborg (2001, 2007, 2009, 2010, 2013). He has argued

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perhaps somewhat inconsistently along four somewhat different lines of argument:

1) The first hypothesis about global warming is not sufficiently backed by data;
2) The second hypothesis about a link between temperature rise and greenhouse gases is not supported by data, nor is it plausible.
3) The third hypothesis cerning climate change being the outcome of global warming is not correct, as it could be explained better by other hypotheses;
4) Finally, it is not economical to engage in lots of costly actitivies to counteract global warming and the emission of greenhouse gases.

The only policy stance supported by this scepticism about global warming, emissions and climate change is: resilience, or wait and see.

III. Environmentalism

There is a variety of schools within environmentalism, from prudent anthropomorphism to radical deep ecology, but they all tend to endorse the global warming – climate change hypotheses stated above. The differences in opinions between the various environmentalist positions do not concern the existence of global warming and climate change. Instead, they cover other dimensions in ecology policy, such as:

a) How far is mankind to be allowed to draw upon natural resources for its livelihood and nourishment?
b) What species besides the human beings are considered to have so-called moral standing?
c) How is the principle of sustainability to be defined?

Radical environmentalism, or deep ecology, states that the human race has become too numerous for Mother Earth and that it directly or indirectly eliminates other species. Here, I would argue for prudent anthropomorphism.

It cannot be more underlined that the global warming hypothesis is not self-evidently true. It needs backing from a set of empirical evidence that would be increasing as research into climate change continues. One could refer to theoretical support in the form of the laws of thermodynamics, stating that energy is indestructible. Thus, burning such an incredible amount of fossil fuels to get energy must result in pollution and heating.

In any case, accumulating empirical data supports the three links established in the Figure 1 below:

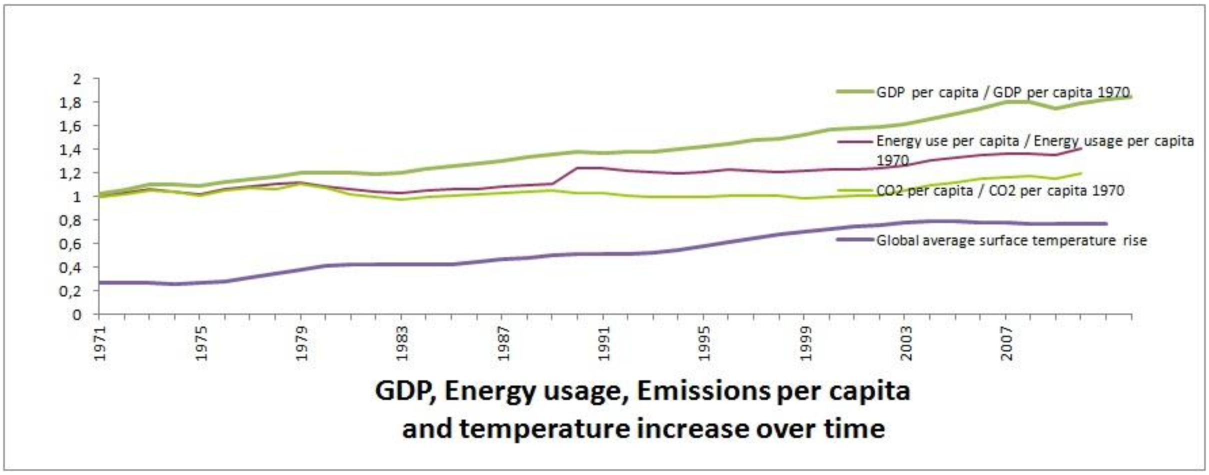
a) From global GDP to global energy usage;
b) From total energy consumption to global emissions of CO2 equivalents;
c) From CO2 emissions to temperature rise.

Nothing indicates that we may expect any changes in these trends (a) – (c) above. Why, then, is the global economy like a Juggernaut in producing them? And why is politics so ineffective in counter-acting climate change? To understand why coordination to counteract global warming is extremely difficult, either by means of voluntary means in the market economy or through state cooperation in IGOs, we need to draw upon the lessons from modern game theory, both 2-person game theory and N-person game theory, about collective action.

IV. Basics of Global Warming

CO2 equivalent emissions are generated in several ways. The focus in the debate about global warming is upon the contribution of the prevailing economic system, referred to as the "global capitalist market economy". This makes an analysis of the economic background of global warming politically relevant. However, emissions are produced by human beings breathing as well as animals digesting. Thus, emissions go up as the world population grows. Moreover, emissions are increased when the forests, especially the rain forests and the Siberian forests, are cut down and burned. And the more acid the oceans, the less CO2 they can take up.

The focus upon the impact of the economic system upon emissions includes not only illegal activities such as logging the Siberian forests and burning the rain forests or increasing desertification in Africa and Asia. It covers the entire effect of economic production upon the emissions of C02 equivalent stuff via the key link: energy consumption, or mainly the frantic burning of fossil fuel. We start by looking at the relationship between total global economic output and total energy consumption for the period 1990-2011.The global market economy delivering goods and services or income uses an enormous amount of energy. Figure 1 shows the close link between GDP and energy consumption. As global income has almost doubled since 1990, so has energy consumption – see Figure 1



Note: GDP per capita, energy consumption per capita, CO2 equivalent emission per capita – all 2011/1971; global average temperature 1971 and 2011. Sources: http://ds.data.jma.go.jp/tcc/tcc/products/gwp/gwp.html; World Bank Indicators - data.worldbank.org/indicator.

Figure 1 : GDP per capita, energy consumption, emissions and temperature rise 2011-1971

Given the almost one to one increases in GDP and energy use, one understands the attention devoted to increase energy efficiency, meaning more output for less input of the main types of energy sources today: fossil fuels (80 %), atomic energy (5%) and renewable energy (15%). One has suggested that hydrogen and electricity should be used more, but they are intermediate energy sources, to be derived ultimately from the ones employed today. To use fossil fuels to get hydrogen or electricity involves little gains in energy efficiency.

Today's energy problematic has two somewhat contradictory aspects or sides, the fear of running out of oil on the one hand (Hubbert peak), and the reduction in usage of atomic energy on the other hand. Although the risk of a Hubbert peak for oil has subsided due to the arrival of the exploitation of shale oil and gas, it is true that some countries face Hubbert peaks for their conventional oil production, like Norway and Russia for instance.

Environmentalists are much concerned about the massive retrieval of shale oil and gas, but at the same they cheer the reduction in the use of atomic energy. When a country like Germany decides to give up atomic energy, then the risk is considerable that the usage of coal will increase. Today Germany imports large amount of coal from Columbia with negative environmental impact for Indians as well as Germans.

It is a matter of searching for safety, when environmentalists reject shale oil and gas as well as atomic energy. Policy-making for the environment and energy is much based upon risk evaluations, as underlined by late American Aaron Wildavsky (1988, 1997). The fear in relation to shale oil and gas is the attending environmental destruction, whereas the danger in relation to atomic stations refers to human damage. It seems that both horn of this dilemma are potentially destructive.

When it comes to the environmental risks with resent day structure of energy consumption, it is the rapidly increasing CO2 emissions that take centre stage. Environmentalist Lovelock (2000) saw atomic energy as the promising way out of the fossil fuel – emissions dilemma, but in vain it seems at the moment. The key focus is now upon the link between energy and CO2 emissions.

The usage of energy produced in various forms results in an enormous amount of pollution, namely CO2 equivalents. It is again a matter of an almost one – to – one relation. As energy usage has expanded by some 50% since 1990, so have emissions increased by roughly 50%.

Given the slope of the graph (Figure 1), one understands the search for energy that has less emission of CO2 equivalents or perhaps even no emissions at all. That would be sun based energy, either heating or directly retrieved electricity. Sun generated energy is most promising, but it is not economically competitive with the burning of fossil fuels. Thus, the global energy-environment conundrum has a most essential basis in the global market economy.

I adhere to the hypothesis that emissions are conducive to global warming or climate change. It is true that some scholars reject this hypothesis and others claim it is too costly to do anything to counter-act global warming (Lomborg, 2013). But the accumulating evidence supports this hypothesis, which when true would by a guiding idea for all forms of change in both our social and natural systems for the 21rst century.

One may move on from looking at the link between GDP and emissions to study the link between emissions and temperature rise. Figure 1 indicates a strongly positive relation between emissions and temperature rise since 1990. Since energy consumption is predicted to keep going up sharply in the next 10 years or so, we arrive at the global warming scenario with at least 2 degrees warming, if not more. This trend could only be reversed if sun power replaced fossil fuels to a significant extent, but that is an economic question for the global market economy as well as a problem for ecology coordination in the political systems of the Earth.

V. Collective Action and Global Warming

There is no lack of proposals for combating climate change. They range from various methods to increase the price of fossil fuels – taxes, markets for pollution permits etc, over blueprint schemes to massive usage of sun power to various forms of rule make – national, international, and regional – about the overuse of environmental resources, like forests or rain forests. They founder all upon the impossibility of the global market to handle externalities due to the omnipresence of free riding.

In the global market place, players are driven by clear incentives: minimize costs and maximise benefits in the short run. All proposals to cut down emissions, either by making fossil fuels more expensive or halting the cutting down of forests, are based upon some form of altruism, which market egoism will not accept, however this scheme is formulated, enacted or enforced. The emission of CO2 equivalents like the destruction of the rain forest constitute in reality external effects that the market economy will not pick up and price correctly. Thus, reneging upon external costs is the incentive compatible strategy by market players – that is the strategy of free riding in collective action.

The atmosphere like the rainforest is an open access resource in a global market economy. From the point of view of the incentives of the market players, whoever they may be: entrepreneurs, firms, nations or illegal operators, the game involves is the so-called Prisoners' dilemma, where the rational solution of the interaction (Nash equilibrium) is defection instead of cooperation to eliminate externalities. Thus, shale oil and gas will replace conventional oil, coal fired power stations will continue to be built and loggers and peasants will compete in cutting or burning down the rain forests.

It has been argued that a so-called common pool regime (CPR) may overcome the PD-game that drives the "tragedy of the commons". CPRs would rely upon the logic of iterative and successive PD-games to generate a stable cooperative outcome – the Tit-for-Tat solution (Axelrod, 1984). The players would start cooperating and then defect as a response to defection, retaking cooperation against cooperation. The CPR scholars find such strategic behaviour behind the protection of open access resources like pastures, irrigation schemes and voluntary quotas in fish harvesting (Ostrom, 1990; Keohane and Ostrom, 1994). However, these CPRs are basically national ones, limited to a country of non-compliance by free riders can be counteracted, in the last resort by some form of state intervention.

In a globalised market economy, CPRs are extremely difficult to establish and operate. Thus, China and India will refuse to pay extra for carbon emissions via some scheme, claiming that more expensive coal would hinder their catch-up with advanced economies. After all, carbon emissions per capita are higher in several rich countries, especially in the Gulf monarchies. The Stern Review (2007) suggestion that Western countries and Japan should assume the developing country's burden of extra costs for paying for carbon externalities was unrealistic, given the present economic weakness of the US and the EU.

The conditional cooperative strategy in a PD-game is not a Nash equilibrium when this is iterated in a finite series of play. The backwards solution gives the sub-game perfect Nash equilibrium of reneging at each node. Voluntary schemes of cooperation are bound to break down sooner or later. They persist because there is some form of third party intervention.

International CPRs are extremely difficult to implement fully, meaning the enforcement of the rules in question – take e.g. the International Whaling Commission. These institutions like CPRs are also very difficult to set up by political coordination among governments – the social choice problematic.

The UN has engaged in global state coordination in relation to global warming. It has held a large number of global reunions about climate change and it operates a large program – UNEP – with numerous global activities to protect the environment. However, the global meeting of states has resulted in little expect expressing support for vague principles like e.g. sustainability. The difficulty of a group to take collective action has been modelled in N-person game theory, analysing the drawbacks of a decision rule like unanimity or highly qualified majorities.

The UN global ecology coordination uses unanimity, meaning that each state has a veto against collective action proposals. As the number of participating states is high, the probability of a final positive decision is extremely low. Tiny states have the same weight as the huge states in the G20 group. The outcome is endless meetings but no decisive collective action: the so-called Polish Diet or liberum veto.

VI. Conclusion

The much debated issue of global warming and greenhouse gases between cornucopians and ecologists can now be decided with much confidence.There is a significant increase in global temperature due to the emission of greenhouse gases. It is worrisome, as climate change will be permanent and yet unpredictable. Global warming is to a considerable extent driven by economic development, requiring enormous amounts of energy, in order to deliver higher levels of affluence per capita.

Literature

1. Axelrod, R. (1984) The Evolution of Cooperation. New York: Basic Books.
2. IEA World Energy Outlook 2013. Washington: IEA.
3. Keohane, R.O. and Ostrom, E. (eds) (1994) Local Commons and Global Interdependence. Special issue of Journal of Theoretical Politics 6: 4.
4. Lomborg, B. (2001) The Sceptical Environmentalist. Cambridge: Cambridge University Press.
5. Lomborg, B. (2007) Cool It: The Sceptical Environmentalist Guide to Global Warming. New York: Vintage Books.
6. Lomborg, B. (ed.) (2009) Global Crises, Global Solution: Costs and benefits. Cambridge: Cambridge University Press.
7. Lomborg, B. (ed.) (2010) Smart Solutions to Climate Change. Cambridge: Cambridge University Press.
8. Lomborg, B. (2013) How Much have Global Problems Cost the World?: A Scorecard from 1900 to 2050. Cambridge: Cambridge University Press.
9. Lovelock, J. (2000). Homage to Gaia: The Life of an Independent Scientist. Oxford University Press.
10. http://mediamatters.org/research/2014/05/09/study-top-cable-news-coverage-of-federal-climat/199247.
11. Ostrom, E. (1990) Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge: Cambridge University Press.
12. Ostrom, E. (1992b) Institutions and Common Pool Resources. Journal of Theoretical Politics, 4(3): 243–245.
13. Simon, J. (2003) *A Life Against the Grain: The Autobiography of an Unconventional Economist. Piscataway: Transaction.*
14. Stern, N. (2007) The Economics of Climate Change: The Stern Review. Cambridge: Cambridge University Press.
15. Tokyo Climate Center - Japan Meteorological Agency, http://ds.data.jma.go.jp/tcc/tcc/products/gwp/gwp.html
16. Wildavsky, A (1988) Searching for Safety. Piscataway: Transaction publishers.
17. Wildavsky, A. (1997) But is it really true? Cambridge: MA: Harvard University Press.
18. World BankIndicators-data.worldbank.org/ indicator.

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Spatio-Temporal Trends in Major Food Crop Yields in Rwanda

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Abstract- This study uses various statistical techniques in an attempt to quantify the magnitude and to determine the significance of trends in the yields major food crops at seasonal and annual timescales over Rwanda for the period 2000-2010. The magnitude derived from the slopes of the regression lines is presented spatially in the form of maps. A steady rise in major food crops yields was registered. There was a higher non-significant increase in beans yields in the east, northern and southwestern regions; and a higher nonsignificant decrease in the southern and northwestern regions. A significant increase in cassava yields was observed in the central region. The east southern and southwestern regions had significant decreases in cassava yields in 2000-2005. The same was witnessed in the northwestern region in 2006-2010. The central and northwestern regions had a significant increase in Irish potato yields, especially in 2000-2005 and a significant reduction was registered over the southwestern, western and eastern regions. However, the southeastern region recorded a decrease in 2000-2005, and an increase in 2006-2010. A significant decline in maize yields was observed in the western region in 2000-2005, while the rest of country had an increase especially during the period 2006-2010. A significant decrease in sweet potato yields was recorded in the southwestern and western regions in 2000-2005; and in the western, northwestern and southeastern regions in 2006-2010. A significant increase in sweet potato yields was recorded in central Rwanda.

Keywords: food crops, yields, trends, Rwanda.

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Abstract- This study uses various statistical techniques in an attempt to quantify the magnitude and to determine the significance of trends in the yields major food crops at seasonal and annual timescales over Rwanda for the period 2000-2010. The magnitude derived from the slopes of the regression lines is presented spatially in the form of maps. A steady rise in major food crops yields was registered. There was a higher non-significant increase in beans yields in the east, northern and southwestern regions; and a higher non-significant decrease in the southern and northwestern regions. A significant increase in cassava yields was observed in the central region. The east southern and southwestern regions had significant decreases in cassava yields in 2000-2005. The same was witnessed in the northwestern region in 2006-2010. The central and northwestern regions had a significant increase in Irish potato yields, especially in 2000-2005 and a significant reduction was registered over the southwestern, western and eastern regions. However, the southeastern region recorded a decrease in 2000-2005, and an increase in 2006-2010. A significant decline in maize yields was observed in the western region in 2000-2005, while the rest of country had an increase especially during the period 2006-2010. A significant decrease in sweet potato yields was recorded in the southwestern and western regions in 2000-2005; and in the western, northwestern and southeastern regions in 2006-2010. A significant increase in sweet potato yields was recorded in central Rwanda. These spatio-temporal trends in the yields major food crops may be influenced by the variability in precipitation intensity and frequency observed recently over Rwanda in combination with the agricultural reforms undertaken since 2007.

Keywords: food crops, yields, trends, Rwanda.

I. Introduction

Agriculture is undoubtedly the most important sector in the economies of African countries. The agricultural sector is the mainstay of local livelihoods and national GDP in most of these countries (Mendelsohn et al., 2000a; Devereux and Maxwell, 2001). Agriculture contributes an average of 21% (ranging from 10 to 70% and varying from one country to another) to the GDP of African countries (Mendelsohn et al., 2000b). According to an FAO finding (2005), agriculture contributes about 50% of the total export value, with 70% of the continent's population depending on this sector for their livelihood; two-thirds of the working population makes their living from rain-fed agriculture (ILO, 2007; Mary and Majule, 2009).

Although smallholder farmers in sub-Saharan Africa dedicate most of their time to growing food crops, their farm productivity is too low to meet their food needs. They spend most of their income on food rather than other goods or savings (UNDP, 2012). This can be attributed to minimal use of agricultural inputs (e.g. fertilizers, quality seeds, use of pesticides and insecticides, etc.), land degradation, significant food crop losses both pre-and post-harvest, seasonal climatic fluctuations with their adverse effects (Bart, 1993).

It is predicted that the future of agricultural production in Africa is likely to experience difficulties from factors other than the impact of climate change and variability. The situation will get much worse when the two factors mentioned above are put into the equation (Mendelsohn et al., 2000b; Tiffen, 2003; Arrow et al., 2004; Desta and Coppock, 2004 and Fegurson, 2006). The rapid population growth prevailing in many sub-Saharan African countries, rapid urbanization and off-farm increases all contribute to a reduction in farm sizes and ultimately to low food crops production (Bryceson, 2002). This precisely is the case for Rwanda (NIRS, 2010).

Increase in temperatures and rainfall fluctuations coupled with weather extreme events (droughts and floods) have had negative effects on livelihoods and crop productivity in Rwanda. The eastern, southern and central lowlands have experienced frequent droughts, while the wet western and northwestern highlands have been stressed by landslides, landslips and floods, (Bart, 1993; MINITERE, 2006; MINERENA, 2010 and David et al., 2011) which cause failure and destruction of crops and infrastructure. Since 1902, a number of famines following prolonged drought episodes have been registered in Rwanda (David et al., 2011) notably in the eastern, southeastern and central parts of the country (e.g. Umutara and Kibungo to the east,Bugesera to the southeast, Mayaga, Nyaruguru, Muhanga in the central regions) (CAMCO, 2011 and David, 2011). Previously, prolonged droughts were reported in 1910 (accompanied by a famine called “Kazuba”); 1917-1918 (accompanied by a famine called “Rumanurimbaba”); 1925-1926 (accompanied by a famine called “Gakwege”); 1928-1929 (accompanied by a famine called “Rwakamigabo”); 1942-1944, 1962-

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1963, 1981-1984, 1989-1992 (accompanied by a famine called "Ruringaniza"); 1996, 1998-2000 and 2004-2005 respectively (Bart, 1993 and MINITERE, 2006). It is worth noting that although all these droughts have been associated with famines, there is no published scientific evidence linking the impact of droughts on food crop productivity in Rwanda.

Flooding has been reported mainly in the western and north-western highlands of the country. The floods that occurred in the region in May 2002 led to the death of 108 persons and the destruction of many hectares of crops together with infrastructure (MINITERE, 2006). Later in 2007, floods caused the displacement of more than 456 families and destruction of large areas under crops in Bigogwe sector in Nyabihu District. The heavy rainfall witnessed in September 2008 accompanied with strong winds affected eight of the 12 sectors of Rubavu District. In total, 500 families were displaced; about 2,000 hectares of land under crop cultivation as well as infrastructure were destroyed. The most recent floods were experienced in September 2012 in Nyabihu, Rubavu and Kirehe Districts, which saw more than 1,000 families displaced and their crops completely submerged (NIRS, 2012) to result into decline in crops production.

Landslides and landslips occurred in the north (Gakenke, Cyeru, Rulindo, and Gicumbi Districts) and in the west (Nyamasheke, Nyamagabe, Karongi and Ngororero Districts, etc.) regions of the country in 2001, 2002, 2007, 2008, 2012 (David, 2012). Despite these repeat episodes, no scientific interrogation has been carried out in the last decade to establish the total loss in food crops production that is caused by these extreme weather events (droughts and floods). The same could also be said on research into the impacts of the agricultural reforms undertaken in Rwanda (since 2007) on food crops productivity. It is in this regard, therefore, that a study on spatio-temporal trends in major food crop yields in Rwanda has been carried out to establish the country's potential agricultural productivity during the last decade to facilitate future projections in further studies.

II. Area of Study

Rwanda is a small country with an area of 26,338km2. The countrywasmade up of 11 provinces and Kigali Citybefore the 2006 administrative reforms which saw the country subdivided into 30 districts and five provinces including Kigali City (figure 1)(REMA, 2009; MINERENA, 2010; CAMCO, 2011).

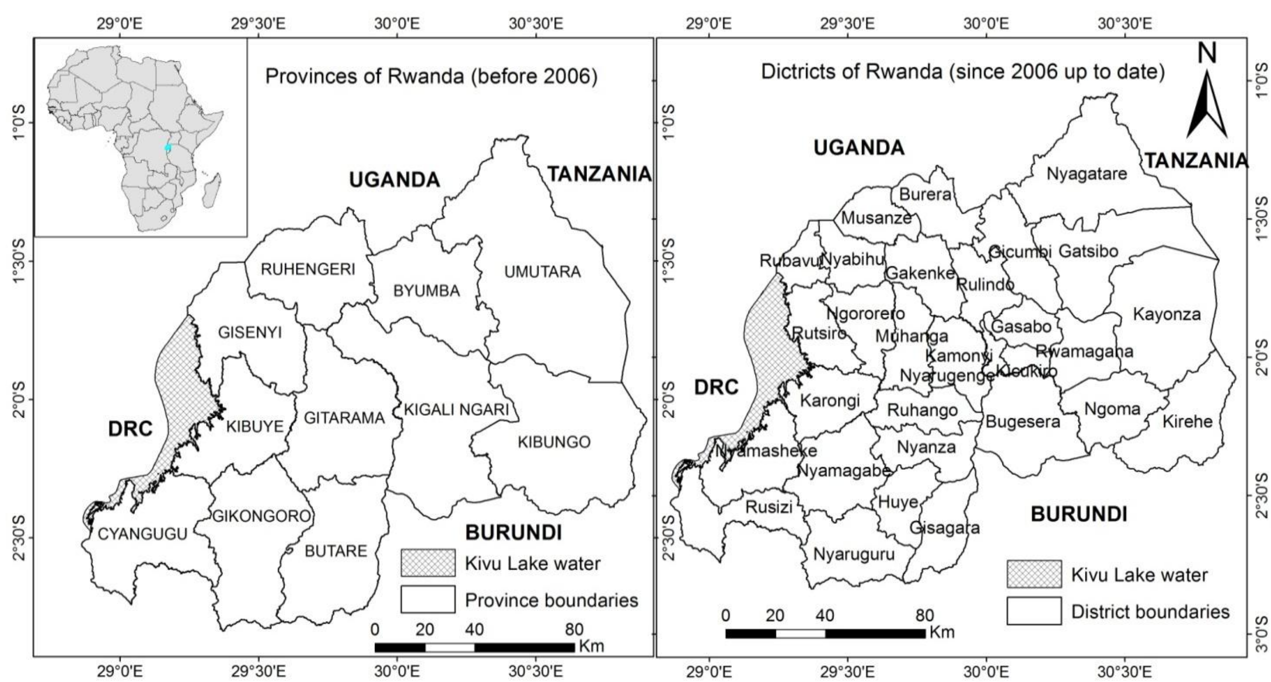

Figure 1: Location of the study area

All data was collected and published with reference to these 11 provinces and 30 districts. 12 livelihood (figure 2) were differentiated based on crops'agro-ecological requirementsof individual crops grown in Rwanda.

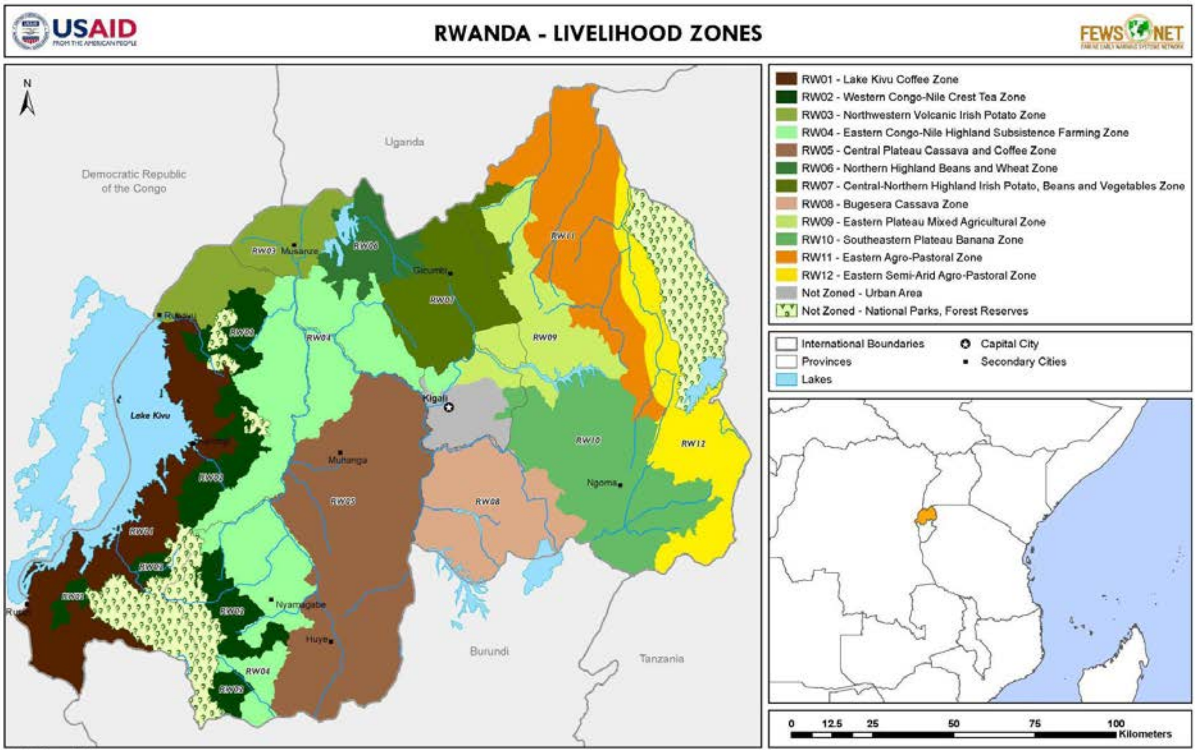

Figure 2 : Rwandan livelihood zones

Source: USAID, 2011

The total arable land of Rwanda is about 14,000km2 or 52% of the country's total surface area. The total cultivated area rose to1,747,559 hectares(figure 3)or 66.35% in 2010 (NISR, 2010 and NISR, 2011) with 93,754 hectares (57%) of the 165,000 hectares of marshlands under cultivation throughout the year (REMA, 2009; NIRS, 2011).

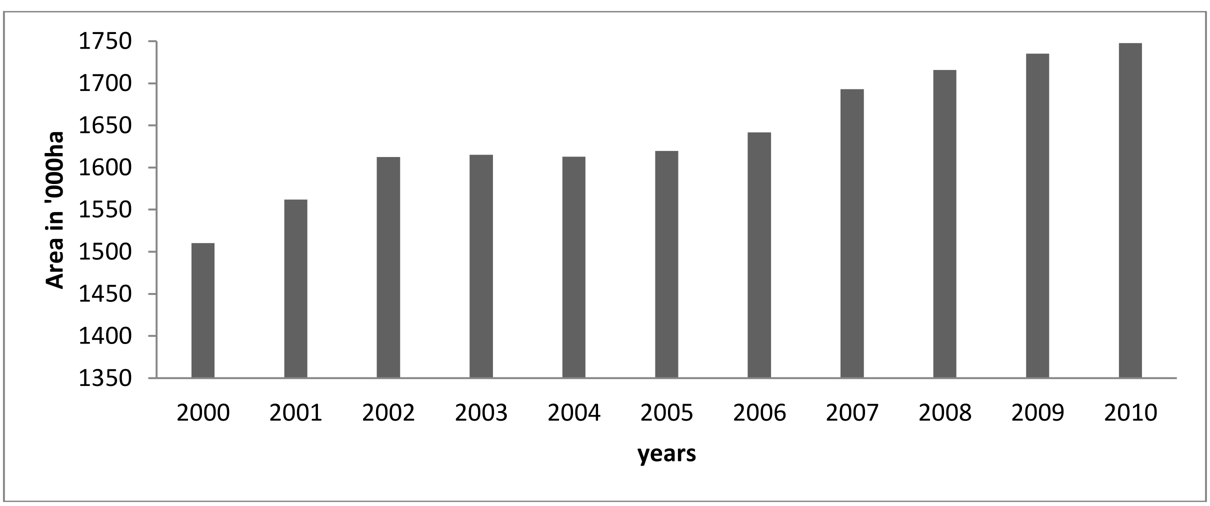

Figure 3 : Evolution of total annual area (103ha) covered by food crops in Rwanda

What this means in essence is that some lofty, rugged mountainous and protected areas have progressively beenput under agriculture. These areas are thus exposed to climate change and variability effects. These effects are devastating whenthey come calling.

More than 85% of the population of Rwanda (around 9.5 million) are engaged in rain-fed agriculture, (NIRS, 2011) which is dominantly subsistence and traditional in nature.Farm ownership per household has decreased from 1.2 ha in 1984 to 0.89 ha in 1990 and 0.6 ha in 2010, (Philip, 2002 and NISR, 2011) which is areduction of 50% over 16 yearsowing to population growth. Fallow land and pastures also decreased from 22% in 1994 to 14% in 2002 and so have woodlots from 11% in 1990 to 7% of the national area in 2002 (Mpyisi et al., 2003). The small plots are overexploitedleading to more degradation(World Food Organization, 2009; NIRS, 2011) culminating in lowcrop productivity.

Food crops contribute 84% of the agricultural sector income(30.3% of overall GDP)while cash crops, livestock keeping, fishing and forestry combined make up for the remaining 16% (NISR, 2010, NISR, 2011).Food cropscover about 67.1% of all cultivated farmlands, where multiple cropping systemsarepra-cticedthroughout the agricultural season "A" (September-January of the following year) and "B" (February-June) respectively (Ilunga et al., 2008; MINAGRI, 2010; NISR, 2010; NISR, 2011). The crops are grown in different seasons depending on the individual agro-ecological requirements of each.The evolution of the total annual area under food crops cultivation in Rwanda from 2000 to 2010 isshownin figure 4.

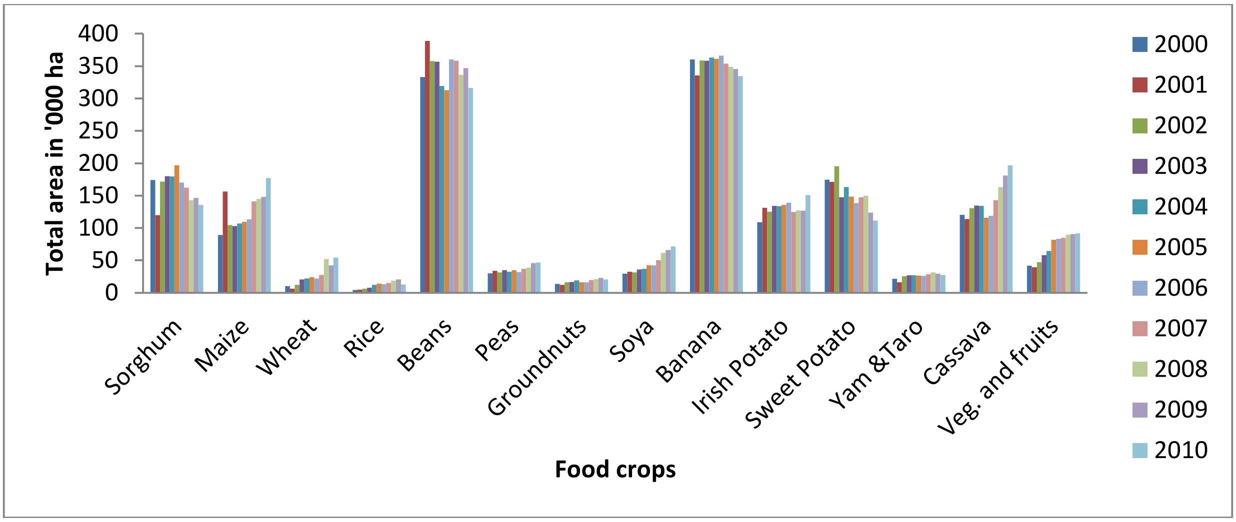

Figure 4 : Evolution of total annual area (103ha) covered by key food crops in Rwanda

The increase in food crops production observed recently in Rwanda (figures5, 6 and 7)is the result of the agricultural reformsin place since 2007. These reforms include the use of agricultural inputs like improved seeds and fertilizers; land use consolidation policy, which encourages farmers in adjacent lands to grow the same crop; marshland irrigation; one cow per family programcalled "GIRINKA program" which sets out to integrate livestock keeping in agriculture by increasing the use of manure to increase soil fertility;the erosion control programs by constructing progressive and/or radical terraces (MINAGRI, 2008). It should be noted that in spite of these reforms, the use of practices such as mulching, planting trees, digging trenches, destumping or green fencing are used on a low scale in Rwanda (Karangwa, 2007).

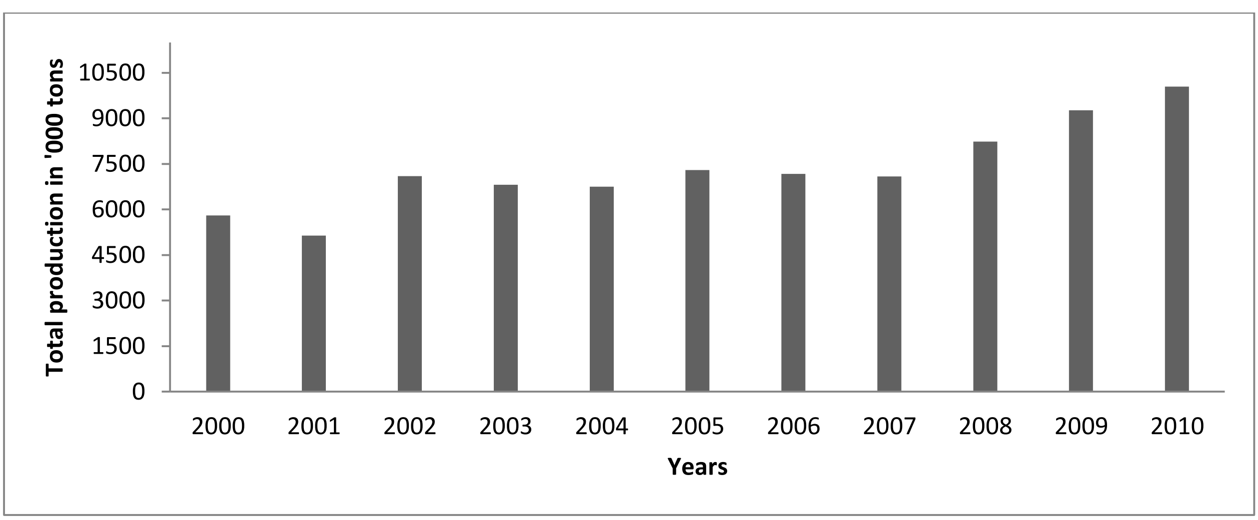

Figure 5 : Evolution of total annual food crop production (103 tons) in Rwanda

The programs have seen food production rise from 5,807,322.5 to 10,044,548 tons for the period 2000 to 2010(NIRS, 2010; NIRS, 2011).However, these agricultural reforms stand in the way of climatic variability observed recently over the East African region (Mutai et al., 1998; Mutai and Ward, 2000; Funk and Brown, 2006; Anyah and Semazzi, 2007). Although a general increase in food crops production has been observed, all crops did not register the same rate of production (figure 6).

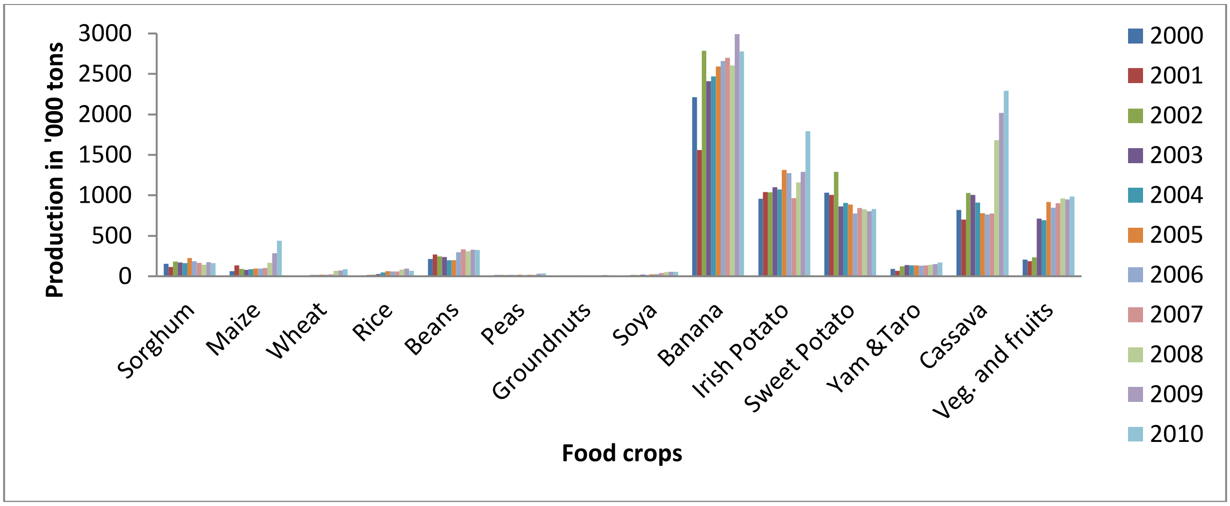

Figure 6 : Evolution of total annual production (103tons) of key food crops in Rwanda

It is clear from figure 6 above, that bananas, cassava, Irish potatoes, sweet potatoes, vegetables and fruits, beans and maizegave the highest production(in'000 tons) respectively for the period 2000-2010. The greatest increase in food crop production was registered between 2008 and 2010. For this study, cassava, Irish potatoes, sweet potatoes, beans and maize have been selected for investigation because they are grown overlarger areas in most parts of the country during the agricultural seasons "A" and "B".

The annual mean yields (kg/ha)vary from one crop to the next due to their productivity capacity (figure 7) and suitability to the agro-ecological conditions present in Rwanda.

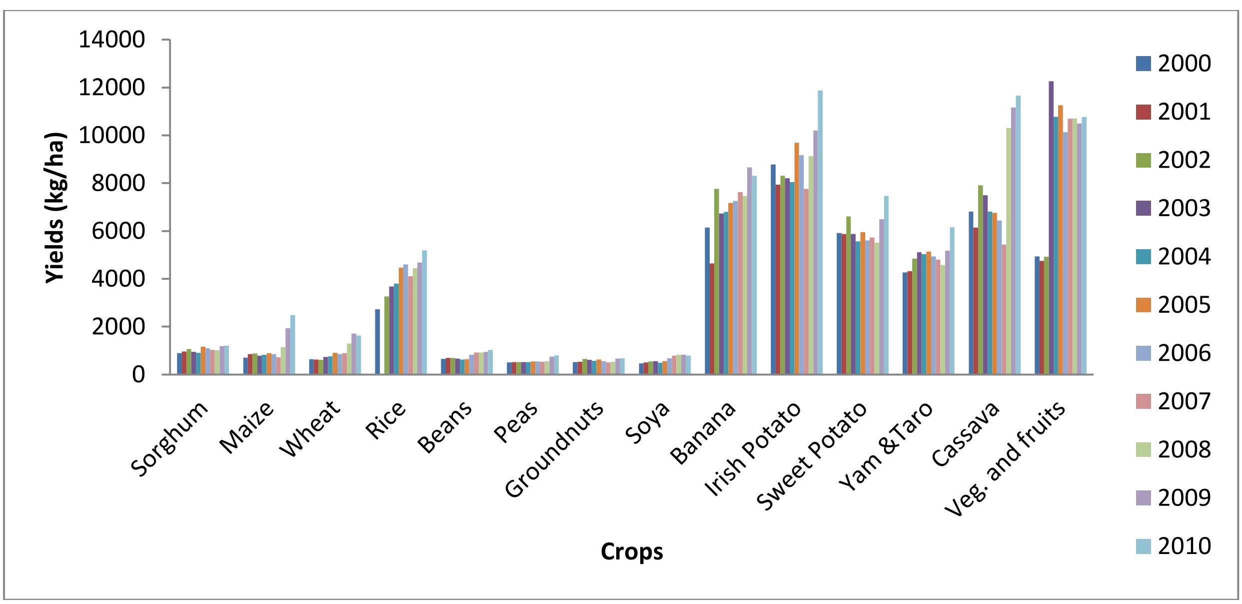

Figure 7 : The evolution of annual mean yields (kg/ha) of key food crops in Rwanda

Figure 7 shows that bananas, Irish potatoes, cassava, vegetables and fruits, sweet potatoes, yam and taro, and ricerecorded the highest food crop yields (kg/ha) respectively. The spatio-temporal variations in food crop yield trendsfor the major crops under investigationi.e.beans, cassava, Irish potatoes, maize, and sweet potatoes are presented spatially in figures 8-12.

III. Data and Materials

Agricultural recordsper districtwereobtained from the National Institute of Statistics of Rwanda (NISR) and the Ministry of Agriculture and Animal Resources (MINAGRI) based at Kigali. Five major crops, namely, beans, cassava, Irish potatoes, maize, and sweet potatoes were selected for investigation. This was as pointed out above, because they are grown over large areas in most parts of the country during the two agricultural seasons (A and B).

Completeness of records wasthe basic criteria used to select the food crop yields to be investigated so as to satisfactorily cover most of the country during the two agricultural seasons. The food crop yields trend analysiswasdone for the period 2000-2010 using the raw seasonal values (food production and cultivated areas) from 11 provinces for 2000-2005 and 30 districts for 2006-2010, from which annual food crop yield trends were derived.These two periods were purely determinedon the basis that the administrative reforms of 2006 arbitrarily subdivided the country into 30 districts without taking into consideration the existing provincial boundaries. Thus the harmonization of data for the whole study period was rather difficult and this constitutes the limitations of this study.

Statistical techniques (linear and nonparametric tests) were applied on agricultural data used in this study to determine the magnitude and significance of trends in food crops yields at seasonal and annual resolutions (Parry et al., 2004; Agustin, 2006; Rodrigo and Trigo, 2007; Kizza, 2009; Del Rio et al., 2012). The linear trend values represented by the slope of the simple least-square regression line showed the rise/fall in selected food crops yields (Sharad and Kumar, 2012).

The magnitude of the trends derived from linear regression analysis (Sen, 1968) and their statistical significance at 95% level were calculated (Horton et al., 200; Partal and Kahya, 2006; Peterson et al., 2008; Kizza et al., 2009; Olofintoye and Sule, 2010; Karpouzos et al., 2010 and Del Rio et al., 2012) using Stata 10 software (Christopher, 2011). The trends were considered significant if P was $\leq$ 0.05. A geographical information system (GIS) was used to represent the spatial variations in food crop yields trends on the maps.

IV. Results and Discussion

Analysis of major food crops yields in Rwanda for the period 2000-2010 helps to establish crop productivity across the country with a view to coming up with recommendations for the future. Crops productivitywas bound to have been impactedbythe agricultural reforms undertaken in Rwanda since 2007 (MINAGRI, 2010) together with the recent climate variability along with their adverse effects (Mutai et al., 1998; Mutai and Ward, 2000; Funk and Brown, 2006; Anyah and Semazzi, 2007). However, the impact of these reforms and variability in climate are to be realized after a long period though.

Therefore, the following spatial representation of yield magnitude trendsfor major foodcrops in Rwanda (figures 8-12) may serve as a key reference point for further investigations on the impact of climate change and variability on food crops productivity. Although the statistical significance of trends was not represented graphically, most of the crops showed either decreasing or increasing patterns in different parts of the country. It is on this ground that studies on spatial food crop productivity across Rwanda with regard to projected climatechange and variability should be founded.

a) Beans yields trends

Dry beans, (Phaseolus vulgaris L.) which are a major source of proteins for the poor in sub-Saharan Africa were grown in Rwanda in areas covering between 333.2 and 347.03 (103ha) for the period 2000-2009, and reduced to 316.4(103ha) in 2010. With a total production of between 215,346.9 and 325,165 tonsof beans for the period 2000-2010,Rwanda was the fourth highest producer in Africa after Kenya, Uganda and Tanzania (FAO, 2008; Katungiet al., 2009). The average bean production in Rwanda is 0.78 ton/ha (NIRS, 2010) compared to Kenyan, which oscillates between 0.35ton/ha and 0.54 ton/ha; 0.5 to 0.77 ton/ha for Tanzanian and 0.36 to 0.75 ton/ha for Malawi(Katungiet al., 2009). The bushy type is the predominant type of beans that is grown not only in Rwanda but also in most of Africa (Buruchara, 2007).

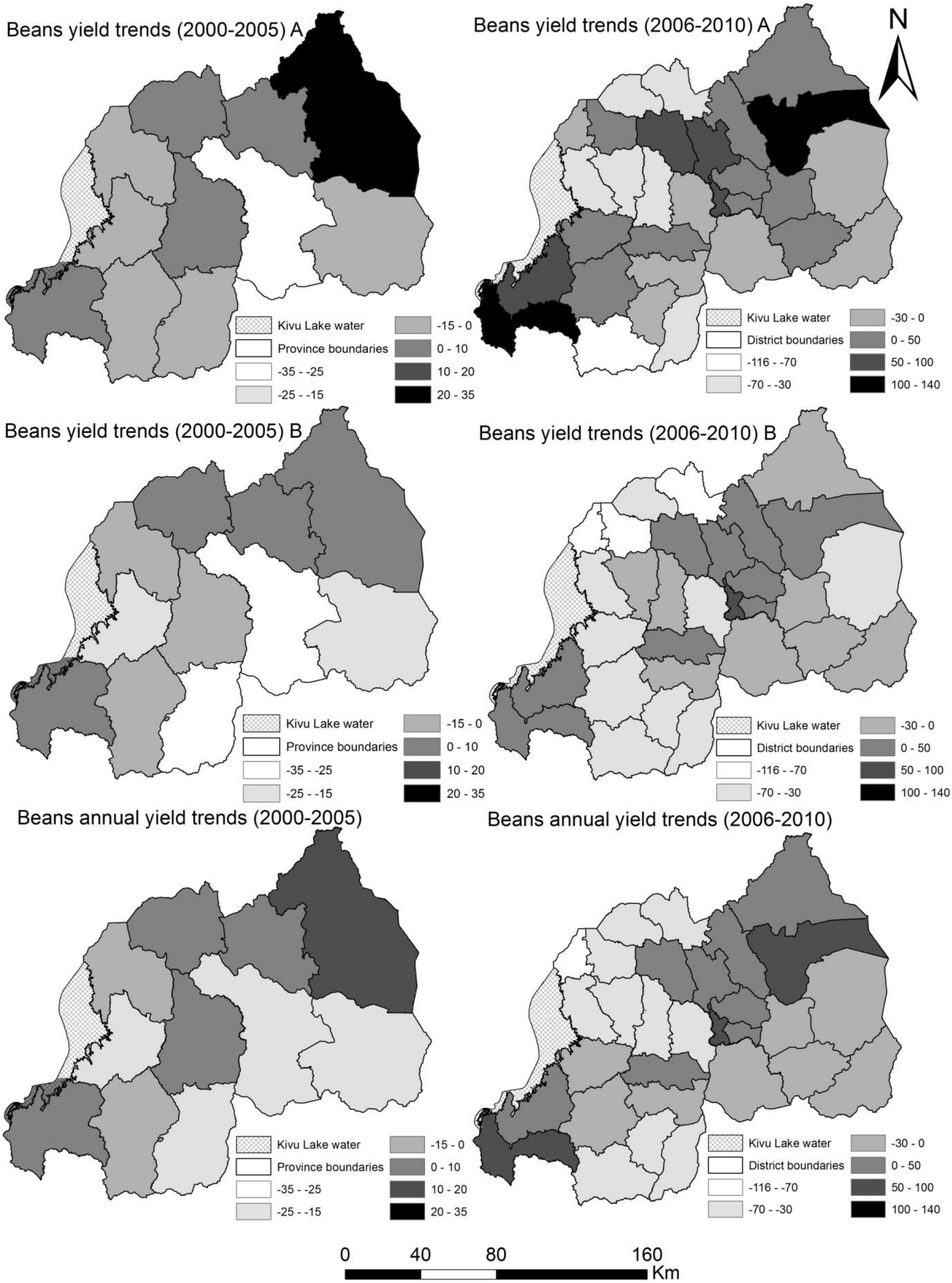

Figure 8 : Beans yields (kg/ha) trends per province (2000-2005) and per district (2006-2010)

Although the trend in beans yield was not significant in Rwanda, the spatial representation of trend magnitude in bean yields (figure 8) at seasonal timescale for the period 2000-2005 reveals that yields increased by between 0 and 10 kg/ha per year in the northern area. This trend was duplicated in the southwest for both agricultural seasons. An increase of between 20 and 35 kg/ha was observed in the northeastern region for season A. However, the yields decreased by between 0 and 35 kg/ha in the central, western and southern parts of the country except in Gitarama Province where yields showed an increase pattern in season A. The magnitude in yields at annual resolution for the period 2000-2005 showed the same trends as it was in season B, with slight differences in the northeastern region where they increased by between 0 and 10 kg/ha. The central and southern areas showed a decreasing pattern of 25-35kg/ha per season.

An increasing trend in beans yields of between 100 and 140 kg/ha per year was observed in the eastern and southwestern regions of the country, while the adjacent regions showed an increasing pattern of between 0 and 50 kg/ha in season A for the period 2006-2010. The adjacent regions registered a rise of between 0 and 50 kg/ha during season B.

A high decreasing pattern in yields of between 70 and 116kg/ha was observed in the northern areas of Rwanda during season B for the period 2006-2010. This may be attributed to the destruction of the crop that was caused by increasedflooding episodes observed in these areasrecently (MINERENA, 2010).A decrease of between 0 and 70 kg/ha was registered in the southern and northwestern regions of the country especially during season B. At annual resolution, the trend in yieldsfor the period 2006-2010 was almost similar to that observed in season A with slight differences in the southern and northwestern regions.

It is clear thata higher increasing pattern was observed in the northeastern and southwestern regions, while a higher decreasing pattern was seen in the central and southern regions for 2000-2005, and in the northwestern region for the period 2006-2010. The southern and the northwestern areas showed a decreasing pattern for the whole study period.

b) Cassava yield trends

Cassava (ManihotesculentaCrantz) is a major food crop in Rwanda in particular and for the people living in the tropics in general(Plessis et al, 2009; NIRS, 2010; NIRS, 2011). The area under cassava cultivation in Rwanda ranged between 120.5 and 196.6 (103ha) for the period 2000-2010, compared to 2,190 (103ha)in the DRC, 590 (103ha) in Tanzania and 290 (103ha) in Uganda in 1991 (FAO, 2005). Rwanda produced between 820,992 and 2,292,533 tons of the crop between 2000 and 2010, with the yield oscillating between 6.8 and 11.7 tons/ha (NIRS, 2010, NIRS, 2011) compared to 14.7 tons/ha in Nigeria, 10.5 tons/ha in Tanzania and 10.6 tons/ha in Uganda in 1991 (FAO, 2005). The spatial distribution in cassava yield trends is shown in figure 9.

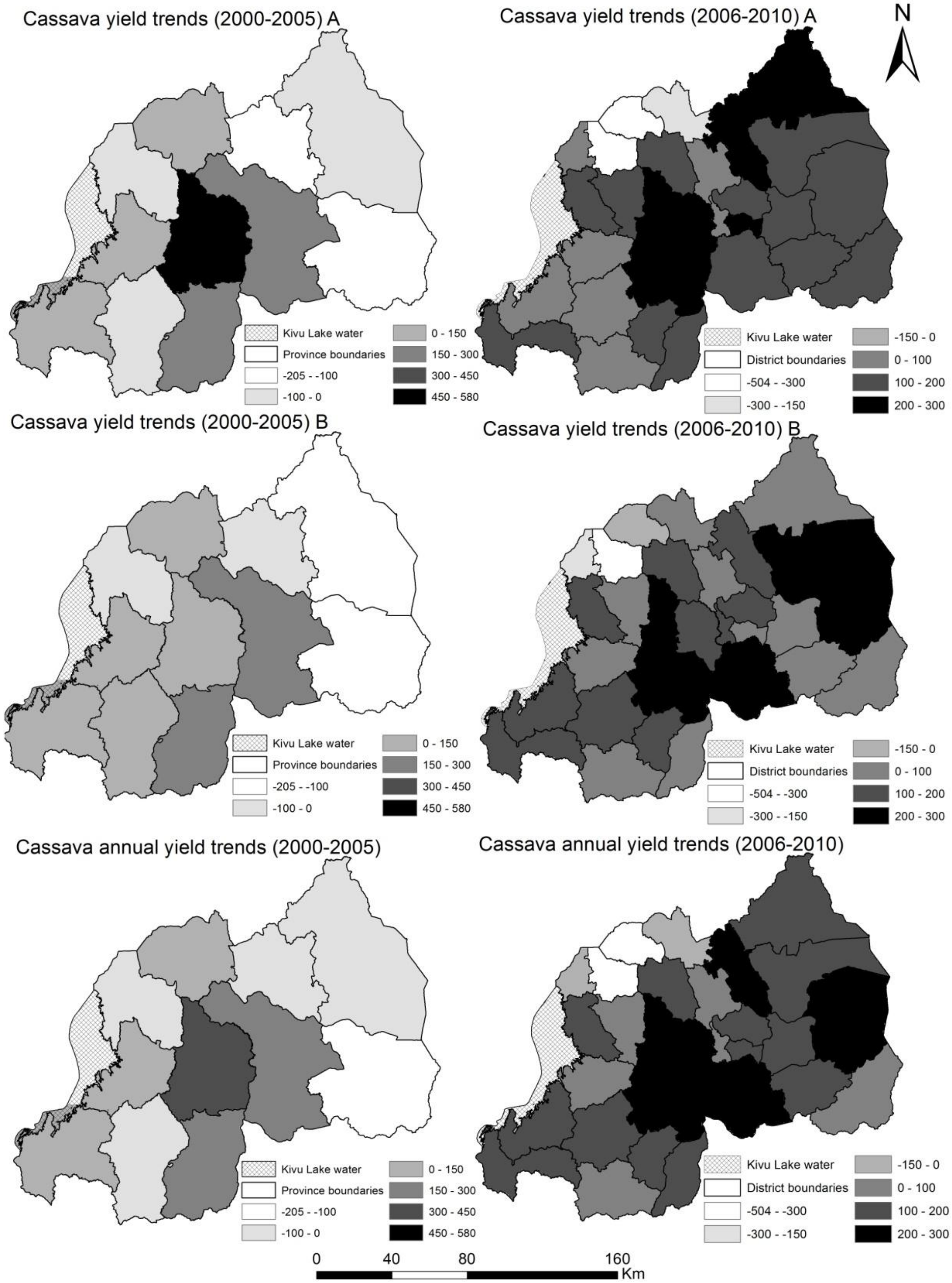

Figure 9 : Cassava yields (kg/ha) trends per province (2000-2005) and per district (2006-2010)

The spatial distribution in cassava magnitude yield trends (figure 9) at seasonal timescale for the period 2000-2005 reveals that yields increased by between 300 and 580 kg/ha per season in the central region of the country during season A. An increase of between 150 and 300kg/ha was observed in the southwestern and northern regions (Ruhengeri Province) in the same season. A rise of between 0 and 150 kg/ha was registered in the northeast. However, a significant seasonal decline of 100-205kg/ha in yield was observed in the provinces of Kibungo (in the southeast), Byumba (in the north). Adeclining trend of 0-100 kg/ha was observed in Gisenyi Province (in the northwest) and Gikongoro (in the south).

A rise in yield of 0-300 kg/ha per season was registered in the central and western regions of the country,while a decreasing trend of 100-205 kg/ha was observed in the eastern region during season B for the period 2000-2005. Byumba (in the north) and Gisenyi (in the northwest) were the only provinces with a decline in yield of 0-100kg/ha in season B. The rise and fall in yieldsat annual resolution for the period 2000-2005 were observed in same provinces in season A with the difference beingthe magnitude where it was lower at annual resolution.

A significant decreasing pattern in yields of between 300 and 504kg/ha was registered only in the northern areas of the country,with the adjacent regions having a decline of between 0 and 300kg/ha in both seasons A and B for the period 2006-2010. This may be attributed to the destruction of crops by floods as was the case with beans. The rest of the country showed an increasing trend in yields. However, a higher increasing pattern of 200-300 kg/ha was registered in the central and eastern regions of the country. As the variability in yields during seasons A and B was very low, the yield pattern at annual resolution looks was similar for the two seasons. Overall, cassava had an increasing pattern in yields since 2006 for most of the study area.

c) Irish potatoes yield trends

Irish potatoes, (Solanumtuberosum) also known as “earth apple” arethe most important non-cereal crop, and are ranked fourth after wheat, rice, and maize (Hoffler and Ochieng, 2008; FAO, 2008;Muthoni and Nyamongo, 2009; Ndegwaet al., 2009). The area under Irish potatoes in Rwanda was between 108,982 and 151,049 ha for the period 2000-2010. Production stood at between 957,197.5 and 1,794,042 tons compared to Kenya’s 790,000 tons in 2006. The yieldsper hectare in Rwanda varied between 8,783 and 11,877kg/ha for the period 2000-2010 compared to 7,500 to 9,500kg/ha in Kenya in 2006 (FAO, 2008, NIRS, 2010, 2011).

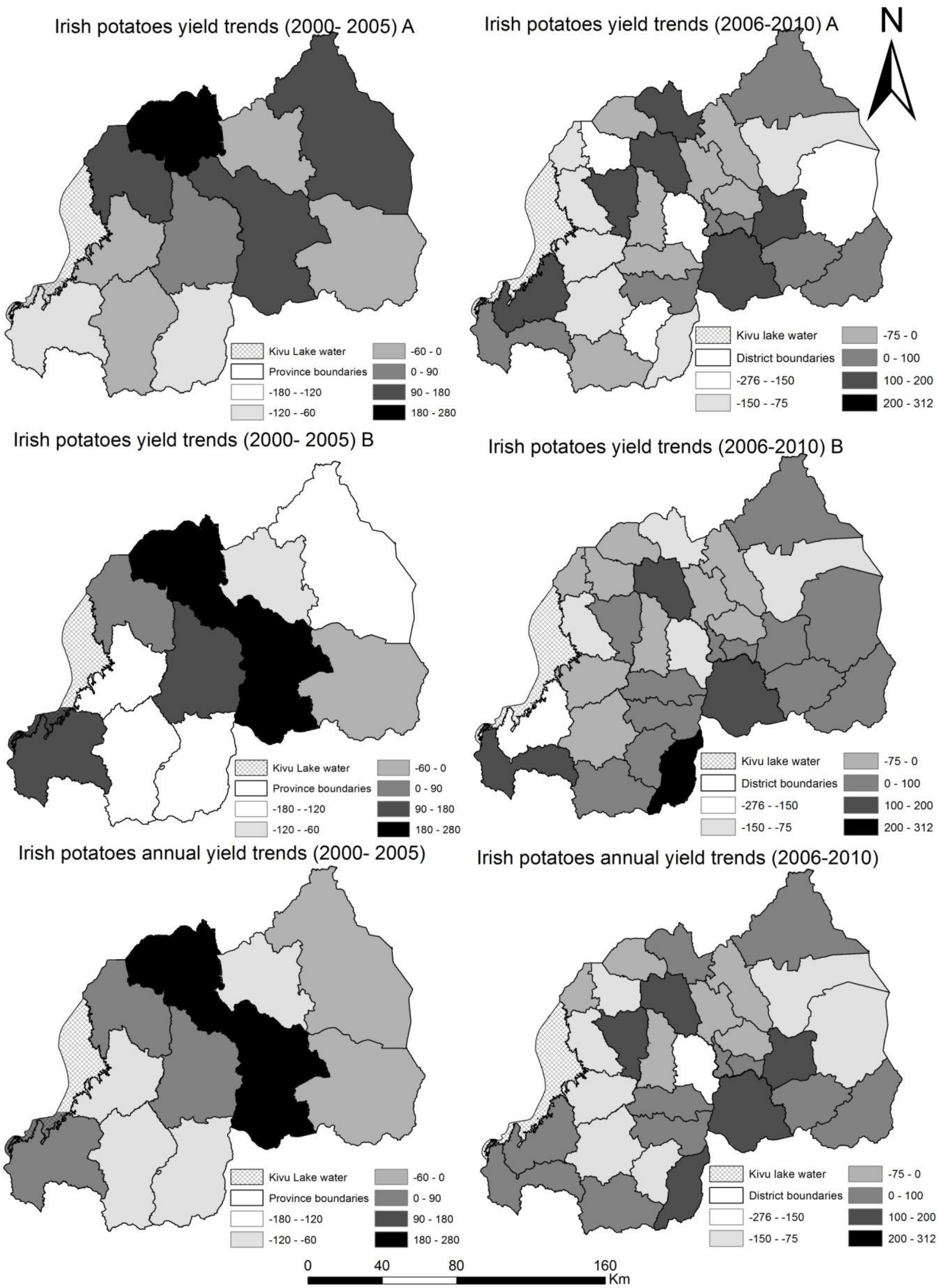

Figure 10 : Irish potatoes yield (kg/ha) trends per province (2000-2005) and per district (2006-2010)

The spatial representation of Irish potatoes magnitude yield trends (figure 10) at seasonal timescale for the period 2000-2005 reveals that yields increased by between 180 and 280 kg/ha per season in the northern region during season A. An increase of between 90 and 180 kg/ha was observed in the northeastern (Umutara Province), central (Kigali Ngari Province) and northwestern (Gisenyi) regions. The central region showed an increasing pattern of 0-90 kg/ha for season A. However, the southwestern, southeastern and northern (Byumba Province) areas showed a decreasing trend of 0-120 kg/ha in season A.

During season B for the period 2000-2005 (figure 10), a significant increasing pattern of 180 to 280 kg/ha was registered in the central region, while the adjacent (western) regions showed a rise in yields of 90-180 kg/ha. The southwestern and northern regions had an increasing pattern of 0-90 kg/ha in season B for the period 2000-2005. A declining pattern of 120-180 kg/ha was seen in the southwestern, western and northeastern parts of the country. The western and adjacent areas showed a decreasing trend of between 0 and 120 kg/ha in season B. The rise and fall in yields at annual resolution for the period 2000-2005 were observed in the same provinces in season B, with the only difference being the magnitude of trends where it was lower at annual resolution.

AlthoughIrish potatoes yield trends showed a high spatial variability for the period 2006-2010, an increasing pattern of between 0 and 200kg/ha was registered in the southeastern and southwestern regions for season A and in the southern regionfor season B. A similar trend was observed in isolated areas of the northeastern, central and northern regions (Gakenke District) for both seasons, and Burera and Ngororero Districts for season A. The remaining areas of the country showed a declining trend of 0-276 kg/ha for the two seasons for the period 2006-2010. The rise and fall in yield at annual resolution for the period 2000-2005 were observed in same district in season B with the only difference being the magnitude where it was lower at annual resolution. From this data, it is concluded that the decreasing pattern was more pronounced in the latter period (2006-2010) compared to the earlier one (2000-2005) especially in season A. This is attributed to increased flooding episodes in recent years.

d) Maize yields trends

Maize (Zea mays L.) also called “corn” is an important cereal crop in sub-Saharan Africa (IITA, 2002) and it is the staple food for over 50% of the sub-Saharan Africa population (FAO, 2008).That said, however, Africa produces only 7% of the world’s maize compared to 39% by the United States of America (USA) in 2006 (IITA, 2002; FAO, 2008, USDA, 2013). In the period 2000-2010, the area under maize cultivation in Rwanda wasannually between 89,052.5 and 177,268 ha. This gave rise to an annual produce of between 62,501 and 440,951tons of 48,908 (103tons) total production in Africa in 2006 (FAO, 2008). The average maize yield for theperiod2000-2010 was between 701.8 and 2,487.5kg/ha in Rwanda compared to the 4,255kg/ha world average; 8,600kg/ha in the USA; 1,730kg/ha in Africa and 2,000kg/ha in East Africa in 2006 (IITA, 2002, FAO, 2008, USDA, 2013). The spatial distribution of yield trends between1999and 2010 is as shown in figure 11.

The spatial distribution of maize magnitude yields trends (figure 11) at seasonal timescale for the period 2000-2005 reveals that yields increased by between 15 and 42kg/ha per season in the western, northeastern and central regions of Rwanda during season A. An increase of between 0 and 15 kg/ha per season was registered in the southern (Butare Province), the southeastern (Kibungo Province) and the northern (Byumba Province) regions for season A. A decline of 40-66 kg/ha during season A was observed in the northern area of the country (Ruhengeri Province), while a decrease of 20-40 kg/ha and 0 to 20 kg/ha were seen in the south (Gikongoro Province) and Central (Kigali Ngari Province) regions respectively.

A rise of between 30 and 42 kg/ha and 15 and 30 kg/ha were registered in the southeast (Kibungo Province) and the north (Byumba Province) respectively during season B. The rise stood at 0-15 kg/ha in the northeastern (Umutara), central (Gitarama and Butare), northwestern (Gisenyi) and southwestern (Cyangugu) regions for season B. A decline of between 40 and 66 kg/ha per season was observed in the western region (Kibuye Province) followed by Ruhengeri Province in the north, which registered a decline of 20-40 kg/ha. Kigali Ngari in the central region recorded a reduction of 0-20 kg/ha in season B. A fall of 0-40 kg/ha in yields at annual resolution for the period 2000-2005 was observed in Gikongoro, Kibuye, Kigali Ngari and Ruhengeri Provinces, while a rise of between 0-30 kg/ha per year was observed in the remaining regions of the country.

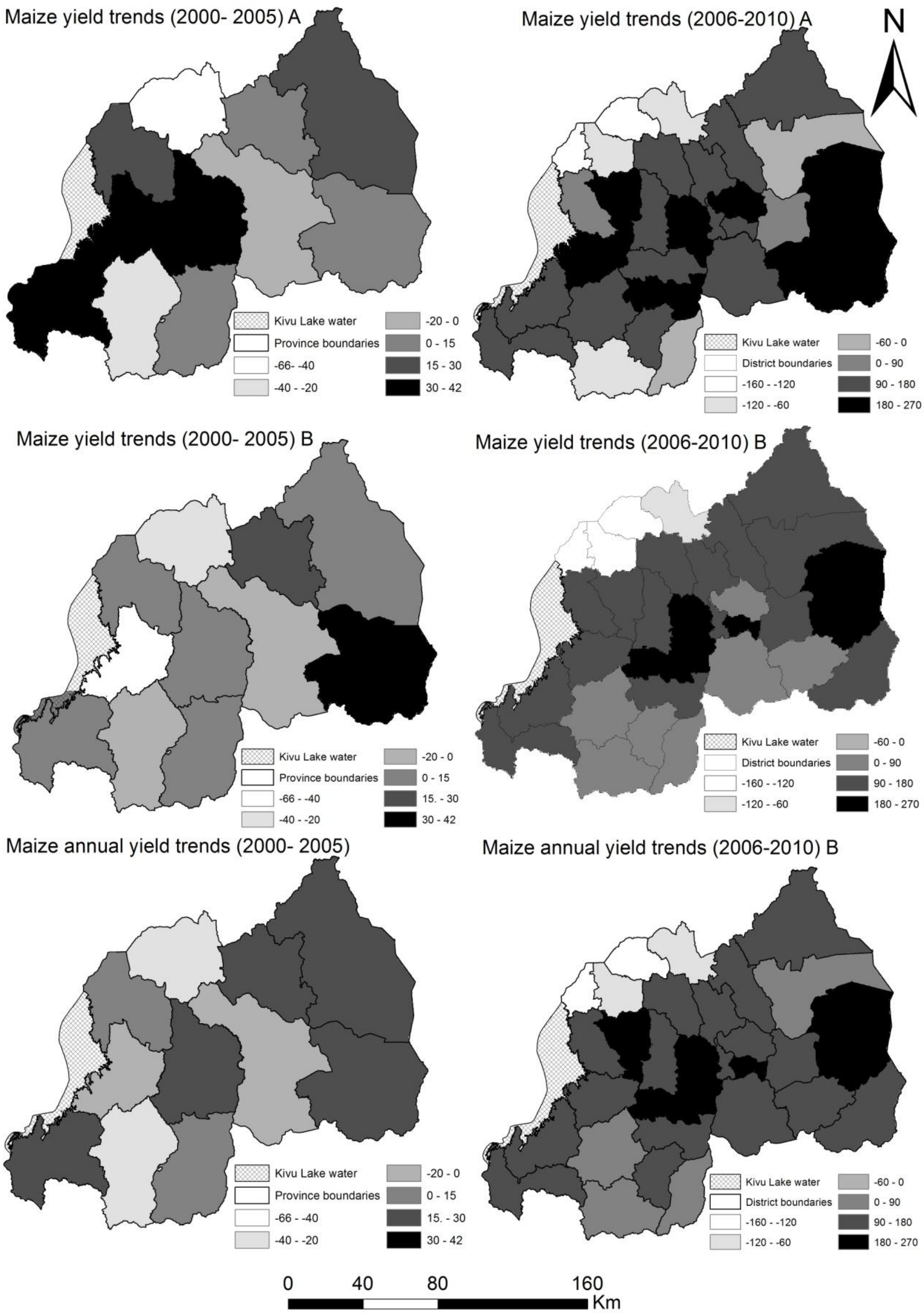

Figure 11 : Maize yields (kg/ha) trends per province (2000-2005) and per district (2006-2010)

A decreasing pattern in yields of between 60 and 160kg/ha was registered only in the northwestern area of the country during seasons A and B at an annual timescale for the period 2006-2010. This may be attributed to the destruction of crops by floods. Another declining trend of 0-60 kg/ha per season was recorded in small areas of the southern and eastern regions in season A. The rest of the country showed a seasonal increasing trend in yields, ranging between 0 and 270kg/ha in both seasons. This is evidence that maize yieldsincreasedin the period 2006-2010 in most areas of the country, perhaps due to the agricultural reforms that were undertaken since 2007.

e) Sweet potatoes yields trends

Sweet potatoes (Ipomoea batatas) are an important staple food not only for Rwanda but also for most of East Africa (Mukhtaret al., 2010). The crop is known to be resistant to drought. During the period 2000-2010, the area of Rwanda under sweet potatoes was annually between 111,432 and 174,662.5 ha, producing between 831,530 and 1,032,916 tons, and a yield of 5,913.8-7,462.2 kg/ha (NIRS, 2010; NIRS, 2011).

The spatial representation of trend magnitude in sweet potato yields (figure 12) at seasonal timescale for the period 2000-2005 reveals that yields increased by between 150 and 290 kg/ha per season in the central region for seasons A and B. An increase of between 100 and 150 kg/ha per season was registered in the northwestern region for season B, while it stood at 0-100 kg/ha in the southwest region for season A. The eastern and northern regions showed an increasing trend of 0-50 kg/ha. A decline of between 0 and 74 kg/ha was recorded in the southwestern and western regions during the two seasons between 2000 and 2005. The central region showed a significant rise of 150-250 kg/ha in annual yields while it ranged between 0 and 50 kg/ha in the eastern and northern regions. It was recorded at 50-100 kg/ha in the southwestern and western areas of the country.

A rise in yield trends of between 100 and 290 kg/ha was registered in isolated areas of the eastern, central and southwestern parts of the country for season A between 2006 and 2010. An increase of 0-100 kg/ha per season was registered in small areas of the southern, western and northern regions of the country. The rest of the country showed an increasing trend in yields, ranging between 100 and 270 kg/ha over the western and northwestern regions and 0-100 kg/ha in the eastern region. The situation was different during season B for the period 2006-2010 where most of the regions showed an increasing trend except in Karongi, Kirehe, Musanze and Rwamagana Districts, which recorded a decline of between 0 and 200 kg/ha. Overall, season B registered a high increasing pattern in sweet potato yields. Arising from this, therefore, season B may be the most ideal to grow sweet potatoes.

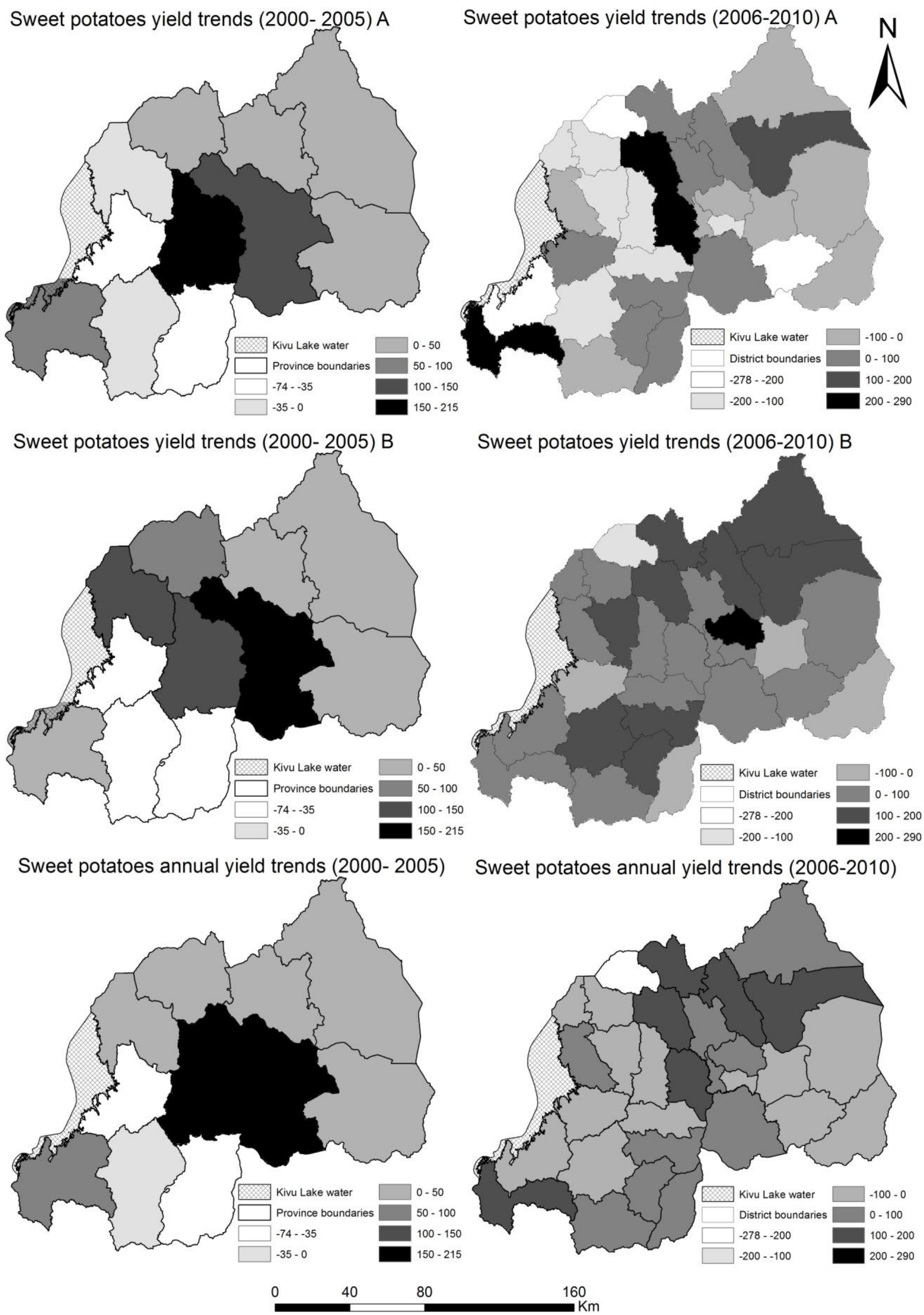

Figure 12 : Sweet potatoes yields (kg/ha) trends per province (2000-2005)and per district (2006-2010)

The yield pattern at annual resolution showed a decreasing pattern of between 0 and 200kg/ha in the southeastern and westernregions of the country to stand at 200-278kg/ha inMusanze District in the northwestern region. The south and northeast recorded an annual rise ranging between 0 and 200kg/ha for 2006-2010. Sweet potatoes gave the highest yields in season B for the period 2006-2008 in most parts of the country.

V. Conclusion

It was observed that on average, there was an increase in major food crops yields across the country. This may be attributed to the agricultural reforms undertaken by the government since 2007.

Althoughthe use of chemical fertilizers by small-scale farmers in Rwanda has emerged as a way of improving crop productivity, it has been reported to cause soil degradation. Further, soil degradation induced by erosion, chemical depletion, water saturation and solute accumulation, is touted as a major challenge (Oldemanet al., 1991) to agriculture because it contributes to the decline of the land's productivity. Irrigation projects that are designed to compensate the impact of recent climate variability in Rwanda (MINAGRI, 2008) may be seen to slow down productivity due to the degradation caused by water logging and salinization (Alexandratos, 1995). There could also be soil emanating from the pressure of a rapid population growth in Rwanda, which is among the highest in Africa (NISR, 2012).

In addition, it is anticipated that climate change and variability will have a big impact on food crops productivity in future if the recurrent flooding episodes especially in the northwestern regions of Rwanda are anything to go by. The southern and southeastern areas registered a decline in food crop yields perhaps due to an increase in aridity.Consequently, a study on the crop productivity in response to climate change and variability is recommended.

VI. Acknowledgements

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References Références Referencias

1. Alexandratos, N., (1995). World agriculture: towards 2010. An FAO study. Chichester, UK, John Wiley and Rome.
2. Agustin, G., (2006). Climate change and variability in the Mixed Crop/Livestock Production Systems of the Argentinean, Blazilian and Uruguayan Pampas. The International START Secretariat, Florida Avenue, N.W. Washington, DC 2009, USA.
3. Anyah, R. O. and Semazzi, F. H. M., (2007). Variability of East African rainfall based on multiyear RegCM3 simulations. International Journal of Climatology, 27:357-371.
4. Arrow, K. J., Dasgupta, P., Goulder, L. H., Mumford, K.J. and Oleson K., (2004).Sustainability and the measurement of wealth. Environment and Development Economics, 17:317–353.
5. Bart, F., (1993). Montagnes d'Afrique: Terres paysannes, le cas du Rwanda. CEGET, PUB, espaces tropicaux n°7.
6. Bryceson, D. F., 2002. The scramble in Africa: reorienting rural livelihoods. World Dev., 30:725-739.
7. Buruchara, R. (2007). Background information on Common Beans (Phaseolusvulgaris L.) in Biotechnology, Breeding & Seed Systems for AfricanCrops.http://www.africancrops.net/rockefeller/crops/beans/index.htm. Accessed on 5 September 2013
8. CAMCO, (2011).Rwanda Country Situational Analysis. Nairobi, Kenya.
9. Christopher, F.B., (2011). Introduction to Stata. Boston College, USA.
10. David, K., Megan, C., Christian, C., Jillian, D., Ryan, H., Robert, M., Mathew, W., Sally, T., Andrew, A.B., Michael, H., (2011).Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development. Republic of Rwanda, Kigali.
11. Del Río S., A. Cano-Ortiz, A. and Herrero, L.A., (2012). Recent trends in mean maximum and minimum air temperatures over Spain (1961–2006). Theoretical and Applied Climatology, 109:605-625.
12. Desta, S., and D.L. Coppock, 2004. Pastoralism under pressure: Tracking system change in southern Ethiopia. Human Ecology, 32 (4): 465-486.
13. Devereux, S. and Maxwell, S. E., (2001). Food Security in Sub Saharan Africa. ITDG Publishing, Pietermaritzburg.
14. FAO, (2005).31st Session of the Committee on World Food Security.23-26 May 2005, Special Event on Impact of Climate Change, Pests and Diseases on Food Security and Poverty Reduction, Background Document, FAO, Rome.
15. FAO, (2008). Climate Change and Food Security: A Framework Document, Rome, FAO.
16. Ferguson, J., (2006). Global Shadows: Africa in the Neoliberal World Order. Duke University Press, Durham and London, 257pp.
17. Funk, C.C. and Brown, M.E., (2006). Intra-seasonal NDVI change projections in semi-arid Africa. Remote Sensing of Environment, 101:249 – 256.
18. Hoffler H., Ochieng B.O. (2008). High Commodity Prices – Who gets the Money? Preliminary findings for World Food Day 2008.Heirich Boll Foundation.
19. Horton, E.B., Folland, K., Parker, E., (2001).The changing incidence of extremes in worldwide and central England temperatures to the end of the twentieth century. Climate Change, 50:267–295.

20. International Institute of Tropical Africa (IITA), 2002. Maize. Available at http://www.iita.org/crop/maize.htm 20/05/2004.
21. ILO, 2007. The Decent Work Agenda in Africa: 2007-2015. A report of Eleventh African Meeting Addis Ababa availabe on www.ilo.org/public/english/standards/relm/rgmeet/africa.htm Accessed on 5 September 2013.
22. Ilunga, L., Mugiraneza, A., Mukingambeho, D., Maguru, M. and Uwimana, J., Muhire, I., (2008).Probable sowing period in Rwanda. GEO-Eco-Trop., 32 (32):29-36.
23. Karangwa, M., (2007).The effect of land fragmentation on the productivity and technical efficiency of smallholder maize farms in Southern Rwanda. Unpublished Mastersthesis, Makerere, Uganda.
24. Karpouzos, D. K., Kavalieratous. S., Babajimopoulos, C., (2010).Trend analysis of precipitation data in Pieria Region (Greece).Europ Water, 30:31–40.
25. Katungi, E., Farrow, A., Chianu, J., Sperling, L., Beebe, S., 2009. International Centre for Tropical Agriculture: Targeting breeding and delivery efforts to improve the livelihoods of the poor in drought prone areas, Directorate of Agricultural Information Services, Department of Agriculture, Pretoria, South Africa.
26. Kizza, M., Rodhe, A., and Xu, C.Y., Ntale H. K., Halldin, S., (2009). Temporal rainfall variability in the Lake Victoria Basin in East Africa during the twentieth century. Theoretical and Applied Climatology, 98: 119-135.
27. Mary, A. L. and Majule, A. E., (2009). Impacts of climate change, variability and adaptation strategies on agriculture in semi arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. African Journal of Environmental Science and Technology, 3 (8):206-218.
28. Mendelsohn, R., Morrison, W., Schlesinger, M.E. and Andronova, N.G., (2000a). Country- specific market impacts from climate change. Climatic Change, 45:553-569.
29. Mendelsohn, R., Dinar A. and Dalfelt, A., (2000b). Climatechange Impactson African Agriculture. Preliminaryanalysisprepared for the World Bank, Washington, District of Columbia.
30. MINAGRI (Ministry of Agriculture and Animal Resources), (2008).Strategic Plan for the Transformation of Agriculture in Rwanda – phase II (PASTA II). Ministry of Agriculture and Animal Resources (MINAGRI), Kigali. Rwanda.
31. MINAGRI (Ministry of Agriculture and Animal Resources), (2010).Rwanda Irrigation Master Plan. Kigali, RwandaMINAGRI, 2011.
32. MINERENA, (2010). Second National Communication under United Nations Framework Conventions on Climate Change (UNFCCC). Kigali.
33. MINITERE (2006).National Adaptation Programmes of Action (NAPA) to Climate Change. Ministry of Lands, Environment, Forestry, Water and Mines (MINITERE), Kigali.
34. Mpyisi, E., Weber, M., Shingiro, E. and Loveridge, S., (2003). Changes in Allocation of Land Holdings, Production and Farm Size in the Rwandan Smallholder Sector over the Period 1984/1990 to 2002.AgriculturalPolicy Synthesis. Number 6E.Rwanda Food Security Research Project/MINAGRI, Rwanda.
35. Mukhtar, A. A., B. Tanimu, B., Arunah, U. L. and Babaji, B.A. Evaluation of the Agronomic Characters of Sweet Potato Varieties Grownat Varying Levels of Organic and Inorganic Fertilizer. World Journal of Agricultural Sciences 6 (4): 370-373, 2010.
36. Mutai, C.C., Ward, M.N. and Colman, A.W., (1998).Towards the prediction of the East African short rains based on sea-surface temperature and atmosphere coupling. International Journal of Climatology, 18:975-997.
37. Mutai, C.C and Ward, M.N., (2000). East African rainfall and the tropical circulation/convection on intraseasonal to inter annual timescales. Journal of Climate, 13: 3915-3939.
38. Muthoni, J. and Nyamongo, D.O. (2009).A review of constraints to ware Irish potatoes.Journal of Horticulture and Forestry Vol. 1(7) pp. 098-102 September, 2009. Available online http://www.academicjournals.org/jhf
39. Ndegwa, N., Maingi, G., Krain, E., Koome, N. (2009). Irish Potatoes Enterprise Budget:
40. The Case of Molo and Meru-Central Districts, main report, Nairobi.
41. NISR (National Institute of statistics of Rwanda), (2010).Statistical Year Book 2010 Edition, Kigali, Rwanda.
42. NISR (National Institute of Statistics of Rwanda), 2011.Statistical Year Book, 2011 Edition, Kigali, Rwanda.
43. NISR (National Institute of Statistics of Rwanda), 2012.Statistical Year Book, 2011 Edition, Kigali, Rwanda.
44. Oldeman L. R., Hakkeling R. T. A., and Sombroek W.G., 1991. Word Map of the status of human-induced soil degradation, and explanatory notes, Global Assessment of Soil Degradation (GLASOD), ISRIC, Wageningen, The Netherlands.
45. Olofintoye, O. O., Sule, B.F. (2010).Impact of global warming on the rainfall and temperature in the Niger delta of Nigeria.J Res Inform Civil Engineer, 7(2):33–48.
46. Parry, M.L., Rosenzweig, Iglesias, C., A., Livermore, M. and Fischer, G., (2004). Effects of climate change on global food production under SRES emissions and socio-economic scenarios. Global Environmental Change, 14 (1):53-67.

47. Partal, T., Kahya E. (2006).Trend analysis in Turkish precipitation data. Hydrol Process, 20(9):2011–2026
48. Peterson, T.C., Zhag X., Brunet-India M., Vázquez-Aguirre J.L. (2008). Changes in North American extremes derived from daily weather data. J Geophys Res., 113:D07113
49. Plessis, M J., Fourie, D., Liebenberg, A J, Liebenberg, M M., van Zyl, C.J. (2009). Common bean in Eastern and Southern Africa: a situation and outlook analysis, Agriculture, Forestry and Fisheries Department, Pretoria, South Africa.
50. REMA (Rwanda Environment Management Authority), (2009).Rwanda State of Environment and Outlook Report, Kigali, Rwanda.
51. Rodrigo, F.S., Trigo, R.M., (2007).Trends in daily rainfall in the Iberian Peninsula from 1951 to 2002.International Journal of Climatology, 27(4):513–529.
52. Sharad, K. J., and Kumar V., (2012).Trends analysis of rainfall and temperature data for India. Current Science, Vol., 102, No.1.
53. Sen, P. and Farquharson, F. A. K., (1998). Sampling errors for water resources design: the need for improved hydrometry in developing countries. Water Resources Management, 12:121-138.
54. Tiffen, M., 2003.Transitioninsub-SaharanAfrica: agriculture, urbanization and income growth. World Dev., 31:1343-1366.
55. UNDP, (2012). Africa Human Development Report 2012: Towards a Food Secure Future. 1 UN Plaza, New York, NY 10017, USA. Available on Web: https://unp.un.org,www.undp.org/africa and www. afhdr. org and accessed on 1/10/2012.
56. USAID, (2011). Livelihoods zoning “plus” activity in Rwanda: A special report by the Famine Early Warning Systems Network (FEWS NET).
57. USDA. National Agricultural Statistics Service. Crop Production. March 8, 2013.

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Investigating the Applicability of Adaptive Comfort Model in a Naturally Ventilated Student Housing in Nigeria

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Keywords: adaptive comfort model, applicability, naturally ventilated hostel.

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Strictly as per the compliance and regulations of:

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Olanipekun Emmanuel Abiodun

Abstract- Thermal comfort, influenced by thermal sensation is an important building performance indicator. In the context of this work, the applicability of adaptive comfort model (ACM) to simulate the thermal comfort level in a naturally ventilated hostel building at Obafemi Awolowo University, Ile-Ife, Nigeria was investigated. The applicability of ACM was investigated by determined the neutral and comfort temperature in addition to comfort range temperature of the occupants using the environmental data derived from field measurements and information from questionnaire survey. A total of 288 responses participated in the three months short-term thermal comfort field study. The results obtained were compared with the recommendations of ASHRAE Standard 55, ISO 7730 Standard and results of previous field studies located in the warm-humid tropics. The predicted neutral temperature was found to be 26.8°C. The acceptable ranges of comfort temperature around thermal neutrality were 24.3-29.3°C and 23.3-30.3°C for 90% and 80% acceptability. These values closely matched the recommended range of ASHRAE Standard 55 and ISO 7730 standard. The results of this study indicated that the use of ACM seems to be promising regarding the prediction of indoor climatic conditions under steady-state non-uniform environments. The study concluded that the adaptive algorithms are more reliable to evaluate the thermal comfort in naturally ventilated buildings.

Keywords: adaptive comfort model, applicability, naturally ventilated hostel.

I. Introduction

Thermal comfort, influenced by thermal sensation is an important building performance indicator [1, 2]. Thermal comfort has been defined in different ways. In ASHRAE Standard 55 [3] thermal comfort is defined as 'that expression of mind which expresses satisfaction with the thermal environment'. Thermal comfort and satisfaction with the thermal environment is a complex phenomenon, and therefore complicated to predict in the design phase [1]. Therefore, accurate models for predicting thermal comfort during the design phase of a building can be beneficial in avoiding mal-performance in the use phase. In the past many researchers carried out laboratory and field studies to investigate the parameters which affect thermal comfort.

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Several models have been developed during the past years in order to predict human thermal comfort in various climatic conditions [4, 5]. Fanger`s PMV-PPD model is among the most well-known and probably most referred thermal comfort index commonly used in practice to predict thermal comfort in the design process of a building especially in airconditioned spaces [1,4, 6, 7, 8, 9]. However, the direct applications of PMV-PPD model for indoor environmental design in NV buildings led to overestimation of occupants` comfort and dissatisfaction levels [10, 11, 12, 13, 14, 15, 16]. There are a number of other theoretical and practical reasons why the steady-state heat balance approach gives the wrong predictions of thermal sensation in the variable conditions that are found in NV buildings in the tropics [13, 16,17,18,19, 20, 21, 22, 23, 24, 25]. The inapplicability was apparently due to the limitations of the model regarding differences in different subpopulation, ignorance of adaptive behaviour that occurred in real buildings and symmetrical distribution of the model as well as characteristics of the input data. Many field researchers [26, 27] further attributed the inapplicability of the model to what they collectively called `context-effects`. Steady-state comfort theory was first challenged by Nicol and Humphreys [28] in 1972. They also put forth the concept of adaptation of occupants. The adaptive models have been integrated in ASHRAE standard 55 [8]. The adaptive standard defines the ''optimum'' temperature as a function of the mean monthly outdoor temperature of a location. It includes also an acceptable range of temperatures based on criteria that either 80% or 90% of the occupants will be comfortable within those respective ranges. According to studies [1, 15], the adaptive algorithms seem to be more efficient for naturally ventilated buildings. Detailed researches [29; 30] have also pointed that the application of adaptive comfort standard in real building offers a huge potential in energy saving. In the context of climate change and global warming, the inclusion of adaptive thermal comfort concept in the thermal comfort standards which allows adopting new energy efficiency strategies and consistently meeting the requirement of sustainable development makes it more relevant to present context.

However, the need of worldwide investigation of the applicability of ACM in different types of NV buildings and climates has been reported in many publications [6, 15, 29, 31, 32]. The research here involves the assessment of the applicability of ACM model in evaluating indoor climate in a naturally ventilated hostel building in a warm-humid tropical environment of Ile-Ife. Specifically, the study determined the neutral temperature (T_n), comfort temperature (T_c) and acceptable comfort range temperature of the occupants in the selected hostel using the environmental data derived from field measurements. In addition, the occupants` perception of their thermal environment was also was also investigated.

II. Methodology

The study is based on a case study carried out on an undergraduate female hostel at Obafemi Awolowo University, Ile-Ife, during the dry season of the year 2013. The aim was to investigate the applicability of ACM in predicting indoor thermal conditions in this hostel building. The approach to the thermal comfort survey was underpinned by the adaptive thermal comfort paradigm as adopted by Djongyang and Tchinda [31], based on the adaptive theory that physiological and adaptive factors play equally-central roles in the perception and interpretation of thermal comfort. The whole of measurements were carried out on the basis of a special protocol for the assessment of the Indoor Environmental Quality (IEQ) [33] in schools taking into accounts both thermal comfort measurements and subjective evaluation.

a) Climatic background and description of the building

Ile-Ife is in southwest Nigeria located on latitude 4°25` N and longitude 7°30`E. It has a warm-humid tropical climate characterised by two sessions (rain and dry). Abundant rainfall occurs from April to October, and the dry season occasioned with cold-dry harmattan with wind blowing from November to better part March. Ile-Ife experiences a constant high temperatures ad relative humidity with low air velocity throughout the year.

The hostel selected for the case study, is of medium size and rectangular in shape. It is a reinforced concrete building and the envelopes were made of aerated sandcrete block. The hostel with a 3400 m2 built-up area consists of three floors (Fig. 1). The hostel was selected in order to give representative sample of typical Nigerian university student housing. The main features of the hostel is summarised in Table 1.

Figure 1 : General view of the case study building (a) roof overhang (b) screen wall

Table 1 : Main feature of the analysed hostel

NC	V (m^3)	F (m^2)	H (m)	W/F	EXP	VS
150	10200	3400	12	0.43	E-W	NV

NC: number of occupant, V = volume, F = floor area, W/F = window to floor area, EXP = exposure, VS = ventilation system

b) Measurement of the physical and personal parameters

The measurement of the physical thermal comfort parameters was carried out by mean of a special comfort data logger, Kestrel 4500 (handheld and pocket weather tracker) with sensors for air temperature, relative humidity and air velocity. Kestrel 4500 is ideal because it measures air velocity, temperature and relative humidity (RH) with sensory accuracy of ±0.3 m/s, ±0.3oC and 1.6% respectively. The measurements were conducted from morning until evening (9 an-7 pm) with an interval of 1 hour. This was necessary to capture the different conditions and rapid environmental changes at different times of the day. To maximize the reliability and minimize the effect of the measurement accuracy on the assessment of the thermal environment, the measurement of thermo-hygrometric parameters characterizing the environment and the instruments used for the assessment of physical variables were done according to the procedures reported in the ISO 7726 Standard [34]. The meteorological data were obtained from the weather station operated by the Department of Physics, Obafemi Awolowo University, Ile-Ife located very close to the hostel building studied. Data collected included air temperature, relative humidity, wind speed and direction and global solar radiations.

c) Subjective investigation

To take into account subjective matters in the assessment of thermal comfort conditions of the hostel, the physical measurements were accompanied by subjective investigation. The subjective investigation was conducted by mean of a questionnaire survey designed in compliance with ASHRAE standard 55 [3] containing four sections: personal information (age, height, weight) and second section provided information on clothing and activity level of respondents. Section three discussed thermal comfort assessment; in this case students were asked a judgement on the perception, preference and acceptability of air temperature, relative humidity and air velocity. The last section was devoted to the behavioural adaptation, which was not discussed in this paper. The questions of this section were formulated in compliance with the recommendation of ISO 10551 Standard [35] and deal with acceptability of the environment (would you accept/this thermal environment rather than reject it). On the basis of the answers to the questionnaire some indicators of the subjective thermal comfort were formulated, in particularly:

- TSV: Thermal Sensation Vote obtained by questionnaire expressed on the typical 7-point scale [3] and calculated as a mean value of the votes attributed to the environment.
- TPV: Thermal Preference Vote obtained by questionnaire expressed on the typical 3-point scale [27] and calculated as a mean value of the votes attributed to the environment.
- Percentage of people accepting /not accepting based on the acceptability criterion and calculated on the basis of occupants who felt the thermal environment not acceptable.

Finally, statistical analyses were carried out by mean of SPSS version 16.0. The assessment of the quality of the thermal environment was carried out by comparing the measured indoor environmental parameters, neutral, comfort and comfort range temperatures obtained with the limits suggested by ASHRAE standard 55 [3] and ISO 7730 [7].

III. CALCULATED ADAPTIVE COMFORT ALGORITHMS

a) Neutral Temperature (T_n)

The neutral temperature is defined as the temperature at which people will on average be neither warm nor cool. A simple method used in thermal comfort studies for the calculation of neutral temperature is to access the relationship between thermal sensation and indoor climate through regression analysis. However, Humphreys [36] have showed that regression analysis is liable to error of feedback. For purpose of practical predictions, Auliciems and de Dear [37] adaptive model was employed to estimate Tn. It has been indicated from the previous thermal comfort field studies [12; 16, 38; 39, 40] that a neutrality temperature calculated using this model provided the centre point for comfort zone. In addition, the relationship is a good indicator for calculating the neutral temperature (T_n) under warm conditions. Auliciems and de Dear reported a strong positive correlation between the observed neutral temperature and the mean outdoor temperature.

$$T_n = 17.6 + 0.31\, To \qquad (1)$$

b) Comfort Temperature (T_c)

Comfort temperature always associated with adaptations and was calculated based on Humphreys [41] and Auliciems [42] models. Humphreys and Auliciems both reported strong positive correlations between the observed comfort temperature and the mean temperature prevailing in indoors and outdoors.

Using Humphrey's model, the comfort temperature (T_c) for was estimated from mean hourly outdoor temperature (T_m) in °C, using the equation:

$$T_c = 0.53To + 11{:}9 \ (r = 0{:}97) \qquad (2)$$

Employing Auliciems model, the absence of thermal discomfort is predicted by simple equation in terms of mean indoor (T_i) and outdoor temperature (T_o) in °C:

$$T_c = 0{:}48Ti + 0{:}14Tm + 9{:}22 \ (r = 0{:}95) \qquad (3)$$

The input outdoor data was obtained from the nearest weather station (Department of Physics Meteorological Services).

c) Data analysis

The responses from thermal comfort field measurement and questionnaire were entered into SPSS ver. 16.0 for a primary analysis. The data were transferred to Microsoft Excel for re-evaluation for careful quality assurance. Detailed descriptive statistics were performed on the environmental measurement, personal records and questionnaire survey. In addition, outcomes from this investigation were compared with other studies carried out in the warm to hot humid tropics. This offered further insight about similarities and differences of the parameters under investigation which enabled researchers to understand some of the reason that led to different outcomes in the determination of neutral and comfort temperatures.

IV. Results and Discussion

a) Results of physical measurement of thermal comfort parameters

i. *Outdoor climatic data*

Table 2 shows the statistical summary of outdoor climatic data during the monitoring period. In January, the outdoor air temperature ranged between 22.5°C and 32.6°C (mean = 29.3°C, STD = 3.21). Relative humidity showed low values in this month and fell within 20.36% and 49.34% (mean = 28.86%, STD = 8.70%). In February, the air temperature ranged from 25.1oC-32.9°C (mean = 30°C, STD = 2.36°C). The relative humidity fell within 42.88% and 88.82% (mean =59.01%, STD = 13.99). In March, the air temperature variations were narrower, averaging around 29.5°C with a minimum of 26°C and a maximum of 31.8°C. Relative humidity showed higher mean value (66.34%). For all months, the minimum and maximum outdoor temperature were 22.51°C and 32.9°C respectively making an average of 29.6°C (STD =2.50°C). The relative humidity reading was between 20.36% and 85.82% (mean=51.40%, STD = 19.83).

Table 2 : The average outdoor climatic data for the study area

Month	Global solar radiation ((W/m²)	Mean daily air temperature (°C)		Mean relative humidity (%)	
		Maximum	Minimum	Maximum	Minimum
January	346.17	32.6	22.5	49.34	28.86
February	390.91	32.9	25.1	85.82	42.88
March	394.45	31.8	26	84.02	51.19
All months	377.18	32.9	22.5	85.82	20.36

ii. *Indoor climatic conditions*

Statistical summaries of measured physical thermal comfort parameters are provided in Table 3 for the total data set broken down by months. In this section of report air temperature was used to characterise the indoor thermal condition of the hostel building. Air temperature is one of the most recognized parameter in thermal comfort studies. In January, the typical daily temperatures range varied from 28.4°C (9 am) to 33.5°C (4 pm) inside the hostel building (mean =30.9°C, STD = 1.71°C). RH reading ranged from 31.8%-71% (mean = 46.16%, STD = 12.45%). In February, the daily air temperature fell within 28.1°C (9 am) to 33.7°C (mean = 31.2°C, STD = 1.86°C) with RH readings between 30.8% and 75.5% (mean = 45.72%, STD = 14.03%). In March, on a typical day, the air temperature ranged from 28.5-34°C (mean = 31.3°C, STD =1.96°C). Relative humidity decreased in this month and fell within 32.8% and 66% (mean = 44.48%, STD = 11.89). For all data, the mean, minimum, maximum and standard deviation of the indoor air temperature recorded in the field thermal comfort study were respectively 31.1°C, 28.1°C, 34°C, 1.83°C. The measured indoor air temperature ranged from 28.1°C to 34°C. The indoor mean air temperature of this study was 31.1°C and the standard deviation was 1.83°C. The minimum and maximum indoor temperatures were 28.1°C and 34oC respectively making an average of 31.1°C (STD = 1.83°C). Air temperatures ranged from 28.1°C to as high as 34°C during the three months short-term survey, making an average of 31.1°C (STD = 1.83°C). The RH fell within 30.8% and 75.5% (mean = 45.45%, STD = 12.64). The highest temperatures occurred in the afternoon at 4 pm. Table 4 depicts the same indoor climatic conditions by floor levels. Approximately, 63% of all air temperatures lied between 30°C and 33°C. The higher indoor air temperatures obtained were not surprising. According to Djamila et al. [6] and Feriadi and Wong [16] such conditions would be mostly typical of buildings built with concrete or brick walls and subjected to various warm-humid tropical outdoor climatic conditions. Comparing the obtained values with others field studies in the warm-humid tropics [6, 16, 43, 44] conducted in buildings built with concrete or brick walls and subjected to various warm-humid tropical outdoor climatic conditions, the values of indoor air temperature obtained in this study are in close agreement and consistent with their results.

Table 3 : The average indoor climatic data for the selected hostel by months

Month	Temperature (°C)				Relative humidity (%)			
	Min	Max	Mean	STD	Min	Max	Mean	STD
January	28.4	33.5	30.9	1.71	31.8	71	46.16	12.45
February	28.1	33.7	31.2	2.36	30.8	75.5	45.72	13.99
March	28.5	34	31.3	1.86	32.8	66.3	44.48	14.03
All months	28.1	34	31.1	1.83	30.8	75.5	45.45	12.64

Table 4 : Statistical summary of measured indoor climatic conditions by floor level

Month	Floor level	Temperature (°C)		Relative humidity (%)	
		Min	Max	Min	Max
January	Ground floor.	28.7	32	36.5	69.1
	Second floor.	28.5	34	31.8	71
February	Ground floor.	28.5	33.6	33.1	74.2
	Second floor.	28.1	33.7	30.8	75.5
March	Ground floor.	28.5	34	34.6	63.7
	Second floor.	28.5	34	32.8	66.3

b) *Calculated adaptive thermal comfort algorithms*

i. *Neutral Temperature (T_n) and range of comfort range*

A statistical summary of Neutral Temperature (T_n) and range of comfort temperature based on months and floor levels is presented in Table 5. For the month of January, the neutral temperature obtained on the average was 28.0°C, for February it was 26.9°C and for March it was 26.8°C. For all data it was 26.8°C. In general, the neutral temperature in January on the average was 1.1°C higher than that of February and March. This is because in this month, prolonged harmattan season made respondents to feel more uncomfortable as they have limited option available for adaptation (i.e. higher clothing level and closing the windows to minimize the air movement). In relation to the floor performance, it was observed that the neutrality temperatures for the two floors were the same. However, the Tn value based on floor levels was higher in January than other two months. A mean comfort zone band around the thermal neutrality as suggested by ISO 7730, ASHRAE standard 55 and previous studies [38; 39] was also determined. According to these standards and studies it is between these mean comfort zone bands that occupants' adaptive techniques work well. Besides, the mean comfort zone band is a pre-requisite for comfortable indoor environment. In line with the recommendation of ISO 7730 Standard [7], a mean comfort zone band of ±2.5 and ±3.5 for 80% has been considered for 90 and 80% acceptability, respectively. The range of comfort temperature around Tn corresponding to 80% and 90% acceptability is also defined in Table 5. As an example, in January, for 80% acceptability, the comfort zone was between 24.5°C and 31.5°C and for 90% acceptability the comfort range was within 25.5°C and 30.5°C or a range of 7°C and 5°C respectively. In terms of floor levels, for 80% acceptability, the comfort zone is between 24.9°C and 31.9°C for both the ground and second floors and for 90% acceptability, a range of 25.9°C and 30.9°C was obtained for the two floors. From the indoor temperature profile analysis of the hostel for these months, the temperature swing was in the range of 4.5°C–5.3°C. According to Singh et al. [38], for thermally comfortable indoor environment in naturally ventilated buildings in warm-humid climate, the indoor temperature variation must not cross 6.5°C across all the seasons. It means that if a naturally ventilated building is designed where internal temperature swing is between 6.5-6.7°C, the people of this climatic zone will feel thermally comfortable. The indoor air temperature swing was quite satisfactory for the naturally ventilated hostel studied.

Table 5 : Outside climatic parameters and Neutral Temperature (T_n) (Mean Values)

Month	Floor level	Outside climatic parameters		Neutral Temperature (°C)				
		T_a (°C)	RH (%)	T_n (°C)	90% Accept.		80% Accept.	
					Tn -2.5	Tn+2.5	Tn-3.5	Tn+3.5
Jan	Grd.flr.	29.3	28.86	28.4	26.2	31.2	25.2	32.2

	Sec.flr.	29.3	28.86	28.4	26.2	31.2	25.2	32.2
	All flrs.	29.3	28.86	28.0	24.3	29.3	23.3	30.3
Feb	Grd.flr.	30.0	59.01	26.9	24.4	29.4	23.4	30.4
	Sec.flr.	30.0	59.01	26.9	24.4	29.4	23.4	30.4
	All flrs.	30.0	59.01	26.9	24.4	29.4	23.4	30.4
Mar	Grd.flr.	29.5	66.34	26.8	24.3	29.3	23.3	30.3
	Sec.flr.	29.5	66.34	26.8	24.3	29.3	23.3	30.3
	All flrs.	29.5	66.34	26.8	24.3	29.3	23.3	30.3

ii. *Comfort Temperature (T_c)*

The comparison between predicted comfort temperatures by Humphreys [41] and Auliciems [42] models and the obtained neutral temperature is presented in Table 6. Both adaptive models have predicted the comfort temperature higher than the observed neutral temperatures. In general, the predicted comfort temperatures by Humphreys and Auliciems' adaptive comfort models for the three months of survey are higher in comparison to the neutral temperature obtained from de Dear and Auliciems [43]. In general, Auliciems model seems to give prediction about +0.7°C higher compared to Humphreys\` model. This could be due to the inclusion of indoor temperature which their mean values were always higher than the mean monthly temperature. The neutral temperatures are found constantly lower than the comfort temperature predicted by Humphreys and Auliciems model. On the average, Humphreys model predicted accurately (Δ = +0.9°C) than the neutral temperature in this study, while Auliciems model estimated accurately (Δ = +1.6°C) greater than the neutral temperature. Comparing with the actual air temperature recorded during the survey, Auliciems model shows realistic prediction of comfort temperature since the temperatures indicated by Humphreys\` model (27.5-27.7°C) were hardly ever measured (mean outdoor Ta = 29.6°C). Humphreys model shows realistic prediction of comfort temperature since the comfort temperatures indicated by Humphreys\` model is closer to the neutral temperature than Auliciems model in this study.

Table 6 : Comparison between predicted and observed neutral temperature by floors

Month	Floor level	Mean (average)		Predicted comfort temperature		Neutral Temp.(°C)
		Outdoor Temp. (°C)	Indoor Temp. (°C)	Humphreys (°C)	Auliciems (°C)	
Jan	Grd.flr	29.3	30.4	27.5	27.9	28.4
	Sec.flr.	29.3	31.1	27.5	28.3	28.4
	All flrs	29.3	30.9	27.5	27.2	28.0
Feb	Grd.flr	30.0	30.9	27.9	28.3	26.9
	Sec.flr.	30.0	31.4	27.9	28.5	26.9
	All flrs	30.0	31.2	27.9	28.4	26.9
Mar	Grd.flr	29.5	31.1	27.7	28.3	26.7
	Sec.flr.	29.5	31.1	27.7	28.5	26.5
	All flrs	29.5	31.3	27.7	28.4	26.7

c) *Thermal comfort on the questionnaire survey*

i. *Demographic information of respondents*

Table 7 shows the demographic characteristics of respondents. The subjects that participated in the survey were composed of female students. The total number of subjects in each month was 96 making a total of 288 observations. The average age of all was 24 years old, ranging from 16-34 years. The average length of residence for the entire sample was 6 months.

Table 7 : Summary of the demographic characteristics of respondents

N =96	Height (m)	Weight (kg)	Age (years)	Body surface area (m^2)	Clothing insulation (Clo)
Mean	1.68	58	19.6	1.65	0.58
STD	8.85	9.6	1.6	0.15	0.14
Maximum	1.92	92	27	2.14	0.73
Minimum	1.25	36	17	1.21	0.42

ii. *Thermal sensation votes of respondents*

The distributions of votes on perception are shown in Table 8 for typical days in these three months survey. The thermal sensations distribution is not the same across the different months. In the month of January, Table 8 shows that almost all the votes (91%) are within the central three category (-1, 0, +1) on the perception scale and 14.1% on the warm side (+2, +3). The mean thermal sensation votes (MTSV) was +0.45 indicating warmer than neutral conditions but within the comfort range. In February, with only 0.3ºC difference in indoor air temperature 85.9% of the thermal sensation votes were within the central category (-1 to +1), and 14.1% on the warm side (+2, +3). The MTSV was +0.56 also on the warmer than neutral but within the comfort range. In March, proportion voting within the comfort band on the sensation scale reduced to 82% when the mean temperature increased to 31.3ºC. The MTSV was slightly higher, but was still within the comfort band (MTSV =+0.73).

Table 8 : Results of thermal sensation votes

Month	Thermal comfort scale			No of subjects	MTSV
	-3, -2	-1, 0, +1	+2, +3		
January	0%	91%	9%	N =96	+0.45
February	2%	85.9%	12.1%	N=96	+0.56
March	0%	82%	18%	N=96	+0.73

V. Discussion

a) Comparisons with previous field studies for naturally ventilated buildings

The present investigation provides the possibility for comparison between results among studies conducted in naturally ventilated buildings specifically in warm-humid tropics. Table 9 shows the various values of Tn obtained based on Auliciems and de Dear [37] conducted in NV buildings in warm seasons around the world. A close match of indoor thermal neutral temperature was observed with those of previous studies. However, compared to studies where regression analysis was adopted in predicting the indoor neutral temperature in naturally ventilated buildings, the neutral temperature obtained in the present study was lower. The difference in the mean neutral temperature between these studies fell within 1.5ºC and 3.4ºC. These differences may be attributed to the feedback error in the linear regression as reported by Humphrey [36]. The differences may also be due to the wider indoor range found in the previous studies which may affects the predicted indoor comfort temperature. In addition, the discrepancy might as well be attributed to the slight low mean air movement recorded in this study compared to previous studies. Besides, the discrepancy between results might also be ascribed to differences in the outdoor air temperatures during the period under investigation and to the differences in habits and climatic parameters. The difference in the mean indoor neutral temperature between these studies could be also attributed to time factor. Furthermore, the microclimates of the surrounding areas under investigation also could affect the indoor thermal environment as the outdoor temperature may not necessary be the same as that reported by meteorological stations. Most importantly, the method of analysis might greatly responsible for the difference.

Table 9 : Thermal neutralities in Auliciems and deDear model in various studies on NV buildings

Researchers	Country	Building type	T_n (ºC)	method of analysis
Zhong et al. [2012]	China	Residential building	27.7	Auliciems and de Dear [1986]
Mohazabieh et al. [2010]	Malaysia	Residential building	26.5	Auliciems and de Dear [1986]
Singh et al. [2010]	India	Residential building	27.1	Auliciems and de Dear [1986]
Wijewardane and Jayasinghe [2008]	Sri-Lanka	Factory buildings	26.7	Auliciems and de Dear [1986]
Djamila et al. [2013]	Malaysia	Residential building	30.2	Regression
Dhaka et al. [2013	Malaysia	Hostel buildings	30.15	Regression
Adebamowo and Olusanya [2012]	Nigeria	Hostel building	29.09	Regression
Wafi et al. [2011]	Malaysia	Hostel building	28.3	Regression
Dahlan et al. [2011]	Malaysia	Hostel building	28.3	Regression
Feriadi and Wong [2004]	Indonesia	Public housing	29.2	Regression
This study	Nigeria	Hostel building	26.8	Auliciems and de Dear [1986]

b) A comparison with comfort models

An optimal method is provided in the ASHRAE standard 55 [8] for determining acceptable thermal conditions in NV spaces, in which both indoor neutral and acceptable temperature range are determined by mean monthly outdoor air temperature. It is therefore useful to compare the results obtained in this study to investigate the applicability of adaptive comfort standard in the selected hostel building. According to the adaptive model in the ASHRAE 55, when the mean monthly outdoor air temperature is 27.0°C, for naturally ventilated spaces, 80% acceptability limits are between 22.5°C and 29.5 °C. Employing Auliciems and de Dear [37] model the indoor neutral temperature on the average was 26.8ºC and the 90% (80%) acceptable range was 24.3-29.3ºC (mean daily outdoor air temperature was 29.6ºC). Based on these results and according to the recommendations of adaptive model in the ASHRAE 55, 80% of the occupants can accept the air temperature range of 24.3-29.3ºC, which was within the acceptability limits of adaptive model. The results of this comfort survey clearly indicated the applicability of the recommendation of ASHRAE Standard 55 [8] in the selected hostel. The outcomes of study also indicated the applicability of the recommendation of ISO 7730 Standard [7] and de Dear and Brager [45] of 7°C for the range about the neutrality temperature for free running spaces. In addition, the maximum temperature on the average of 30.3°C without significant air velocity matches well with the findings of the comfort surveys. `

VI. General Conclusions

A field study has been conducted in a naturally ventilated hostel building in Ile-Ife southwest of Nigeria during hot season. The neutral and comfort temperatures were determined using adaptive comfort model proposed by Auliciems and de Dear [37]. This study has allowed for the assessment of the applicability of adaptive comfort algorithms in Nigerian environment. The main outcomes of the field study can be summarised as follows:

- The thermal indoor climate was in general warmer than the ASHRAE Standard 55 during this season, however, more than 80% of the participants were satisfied with the indoor thermal conditions but wanted to have cooler environment.
- The predicted neutral temperature using adaptive comfort model was found to be 26.8oC for the population under investigation and 80% of the occupants can accept the air temperature range of 24.3-29.3oC, which is within the acceptability limits of adaptive model in ASHRAE Standard 55 [8].
- The results of the study also reveal that the respondents involved could feel reasonably comfortable even up to a temperature of 31oC. This validated the use of a broader margin of about 3.5oC from the neutrality temperature for free running buildings accommodating people acclimatised to that particular climate.
- The occupants were less sensitive to the rise of temperature during the warm season.
- The adaptive comfort algorithms of ASHRAE standard 55 was in close agreement with the measured comfort votes. It predicts well the thermal comfort of subjects in this case study.

Based on the results presented here, it appears that the adaptive algorithms are more reliable to evaluate the thermal comfort in naturally ventilated buildings. Further analysis about the applicability in other building types is highly recommended as it may not be similar.

References Références Referencias

1. Schellen, L. Loomans, MGLC., Kingma, BRM., de Wi, MH., Frijns, AJH. And Lichtenbelt WD. The use of a thermophysiological model in the built environment to predict thermal sensation coupling with the indoor environment and thermal sensation. Building and Environment 2013; 59; 10-22
2. Steskens P, Loomans MGLC. Performance indicators for health, comfort and safety of the indoor environment. Clima 2010-10th REHVA World Congress. Antalya, Turkey; 2010.
3. ASHRAE 55 (2010), Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-conditioning Engineering, Atlanta, 2010.
4. Wei, S., Li, M., Lin, W. and Sun, Y. Parametric studies and evaluations of indoor thermal environment in wet season using a field survey and PMV–PPD method. Energy and Buildings 2010; 42; 799–806
5. Kilic, M., Kaynakli, O, Yamankaradeniz, R. Determination of required core temperature for thermal comfort with steady-state energy balance method. Internal Community Heat Mass Transfer 2006; 33:199-210.
6. Djamila, H., Chu, CH. And Kumaresan, S. Field study of thermal comfort in residential buildings in the equatorial hot-humid climate of Malaysia. Building and Environment 2013;62;133-142
7. ISO, International Standard 7730, Ergonomics of the Thermal Environment-Analytical Determination and Interpretation of Thermal Comfort Using Calculation of the PMV and PPD Indices and Local Thermal Comfort Criteria, International Standard Organization, Geneva, 2005.
8. ASHRAE, ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy, American Society of Heating, Refrigerating and Air-Conditioning Engineering, Atlanta, GA, 2004.
9. Hensen, JLM. Literature review on thermal comfort in transient conditions. Building and Environment 1990; 25:309-316.
10. d'Ambrosio Alfano FR, Ianniello E, Palella BI, PMV – PPD and Acceptability in Naturally Ventilated Schools, Building and Environment (2013), doi: 10.1016/j.buildenv.2013.05.013.
11. Azizpour, F., Moghimi, S., Salleh, E., Mat, S., Lim, CH. and Sopian, K. Thermal Comfort Assessment of Large-Scale Hospitals in Tropical Climates A Case Study of University Kebangsaan Malaysia Medical Centre (UKMMC). Energy and Buildings (2013), http://dx.doi.org/10.1016/j.enbuild.2013.05.033
12. Zhong, Ke., Fu, H., Kang, Y. and Peng, X. Indoor thermal conditions and the potential of energy conservation of naturally ventilated rooms in summer, China. Energy and Buildings 2012; 55; 183–188
13. van Hoof J, Mazej M, Hensen J. Thermal comfort: research and practice. Front Bioscience 2010; 15:765-788.

14. van Hoof J. Forty years of Fanger's model of thermal comfort: comfort for all? Indoor Air 2008; 18:182-201.
15. Moujalled, B., Cantin, R. and Guarracino G. Comparison of thermal comfort algorithms in naturally ventilated office buildings. Energy and Buildings 2008; 40 (12):2215-2223.
16. Feriadi, H. and Wong, N.H. Thermal comfort for naturally ventilated houses in Indonesia. Energy and Building 2004; 36:614-626.
17. Kingma BR, Frijns AJ, Saris WH, van Steenhoven AA, van Marken Lichtenbelt WD. Increased systolic blood pressure after mild cold and rewarming: relation to cold-induced thermogenesis and age. Acta Physiol (Oxf) 2011; 203:419-427.
18. Schellen L, Lichtenbelt WDV, Loomans MGLC, Toftum J, de Wit MH. Differences between young adults and elderly in thermal comfort, productivity, and thermal physiology in response to a moderate temperature drift and a steady state condition. Indoor Air 2010;20: 273-283.
19. Zhang H, Arens E, Huizenga C, Han T. Thermal sensation and comfort models for non-uniform and transient environments: part I: local sensation of individual body parts. Building and Environment 2010;45:380-388.
20. Humphreys MA, Hancock H. Do people like to feel 'neutral'? Exploring the variation of the desired thermal sensation on the ASHRAE scale. Energy and Buildings 2007; 39:867-874.
21. Bouden, C. and Ghrab, H. An adaptive thermal comfort model for the Tunisian context: a field study results. Energy and Building 2005; 37: 952-963.
22. Nicol, J.F. Adaptive thermal comfort standards in the hot-humid tropics. Energy and Building 2004; 36: 628-637.
23. de Dear, RJ. Thermal comfort in practice, Indoor Air 14 (S7) (2004) 32–39.
24. Humphreys, M.A and J.F. Nicol, Outdoor temperature and indoor thermal comfort: rising the precision on the relationship for the 1998 ASHRAE database of fields studies, ASHRAE Transactions 2000;38 (2);485–492.
25. Brager, G.S. and de Dear RJ. Climate, comfort and natural ventilation: a new adaptive comfort standard for ASHRAE Standard 55. In: Proceedings of conference: 2001 moving thermal comfort standards into the 21st century, Windsor, UK. UK: Oxford Brookes University; April 2001.
26. Corgnati, SP., Filippi, M. and Viazzo, S. Perception of the thermal environment in high school and university classrooms: Subjective preferences and thermal comfort, Building and environment, 42 (2) (2007) 951-959.
27. McIntyre, D.A. Indoor climate. London: Applied Science Publishers Ltd; 1980.
28. Nicol., J.F and Humphreys, M.A. Thermal comfort as part of a self regulating system in. Proceedings of the CIB Symposium on Thermal Comfort, Building Research Establishment. Watford; 1972.
29. Nguyen, A.T., Singh, M.K. and Reiter, S. An adaptive comfort model for hot humid South-East Asia. Building and Environment 2012; 56; 291-300.
30. McCartney, K.J. and Nicol, J.F. Developing an adaptive comfort control algorithms for Europe. Energy and Building 2002;34;623-635.
31. Djongyang, N., Tchinda, R. and Njomo, D. Thermal comfort. Renew Sustain Energy Rev 2010; 14:2626-26240.
32. Peeters, L., de Dear, RJ., Hensen, J. and D'haeseleer W. Thermal comfort in residential buildings: comfort values and scales for building energy simulation. Applied Energy 2009; 86:772-8680.
33. d'Ambrosio Alfano, FR, Ianniello E, Ziviello C. A protocol for objective and subjective assessment of global comfort in school environments. 10th International Conference on Air Distribution in Rooms, Roomvent. Helsinki 2007; 1:142-146, June 13th-15th.
34. ISO, International Standard 7726, Thermal Environments-Specifications Relating to Appliances and Methods for Measuring Physical Characteristics of the Environment, International Standard Organization, Geneva, 2003.
35. ISO 10551. Ergonomics of the thermal environment -- Assessment of the influence of the thermal environment using subjective judgement scales. Geneva: International Standardization Organization, 1995.
36. Humphreys, M.A. Field studies of thermal comfort compared and applied, Building Services Engineer 1976; 7 (4); 230.
37. Auliciems, A. and de Dear, RJ. Air conditioning in Australia: human thermal factors, Architectural Science Review 29 (1986) 67–75.
38. Singh, MK and Mahapatra, S and S.K. Atreya, SK. Thermal performance study and evaluation of comfort temperatures in vernacular buildings of North-East India. Building and Environment 45 (2010) 320–329.
39. Wijewardane, S. and Jayasinghe, MTR. Thermal comfort temperature range for factory workers in warm humid tropical climates. Renewable Energy 2008; 2057-2063.
40. Mallick, PH. Thermal comfort and building design in the tropical climates. Energy and Building 1996; 23; 161-167.
41. Humphreys, M.A. The dependence of comfortable temperatures upon indoor and outdoor climates, in: Bioengineering, Thermal Physiology and Comfort, Cena and Clark, Elsevier, Amsterdam, 1981, Chapter 15, pp. 229–250.

42. Auliciems, A. Human response to the environment, in: Building Design and Human Performance by Nancy C Ruck, Van Nostrand Reinhold, New York, 1989, Chapter 1.
43. Indraganti M., Ryozo Ooka, R. and Rijal, HB. Field investigation of comfort temperature in Indian office buildings: A case of Chennai and Hyderabad. Building and Environment 2013; 65; 195-214
44. Appah-Dankyi, J. and Koranteng, C. An assessment of thermal comfort in a warm and humid school building at Accra, Ghana. Advances in Applied Science Research, 2012; 3 (1):535-547.
45. de Dear, R.J. and Brager, G.S. Thermal comfort in naturally ventilated buildings: revisions to ASHRAE Standard 55, Energy and Buildings 34 (4) (2002) 549–561.
46. Adebamowo, M.A. and Olusanya, O. Energy savings in housing through enlightened occupants behaviour and by breaking barriers to comfort: a case study of a hostel design in Nigeria. Proceedings of 7th Windsor Conference: The changing context of comfort in an unpredictable world Cumberland Lodge, Windsor, UK, 12-14 April 2012. London: Network for Comfort and Energy Use in Buildings, http://nceub.org.uk
47. Wafi, S.R.S., Ismail, M.R. and Ahmed, E.M. A Case Study of the Climate Factor on Thermal Comfort for Hostel Occupants in Universiti Sains Malaysia (USM), Penang, Malaysia Journal of Sustainable Development 2011; 4(5); 50-61
48. Dahlan ND, Jone PJ, Alexander DK. Operative temperature and thermal sensation assessments in non-air-conditioned multi-storey hostels in Malaysia. Building Environ 2011; 46:457-467.

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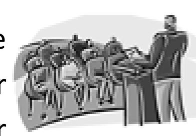

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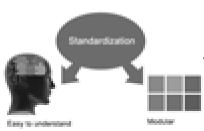

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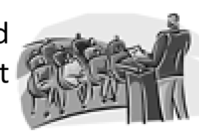

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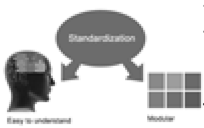

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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
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- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
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Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
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Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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