

## Measurement and evaluation of ambient temperature distribution in Mubi town, Adamawa State, Nigeria

Usman, A<sup>1\*</sup>, Sunday, A<sup>2</sup>, Ibrahim, M. N.<sup>3</sup>

<sup>1,3</sup>Department of Science Laboratory Technology, Federal Polytechnic Mubi, Adamawa State, Nigeria

<sup>2</sup>Department of Applied Physics, Federal Polytechnic Mubi, Adamawa State, Nigeria

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**ABSTRACT:** *This paper is based on measurement of ambient (air) temperature distribution in Lamurde, Mubi South local government area, Nigeria. HTC-2 digital LCD thermometer and hygrometer electronic meter manufactured by Shenzhen Oway Technology Co. Limited Guangdong, China was used to collect data in the study area and compared with the National Aeronautics and Space Administrative (NASA) values. The results of the research revealed the maximum air temperature of 29.30°C against 33.70°C (NASA). Instat 3 and Microsoft Excel statistical package were used to analyze the data obtained. The results of T-test revealed p value of 0.0009 which is considered as extremely significant at 95% confidence interval and F-test showed that  $f(0.08) \leq F(0.42)$  which revealed that there is no significant difference between the two data because it has 75% correlation coefficient. The study concluded that the data obtained could be used for research purpose and recommended that other sophisticated equipment should be used to validate the data.*

**KEY WORDS:** temperature, ambient temperature, thermometer, climate, weather

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## INTRODUCTION

Temperature is one of the essential weather parameters because it is useful for various industrial, agricultural, energy, environmental needs (Rahayu *et al.*, 2022). In the community's environmental requirements, the temperature can affect cloth that is suitable for daily life (Juyoun & Choi, 2012). The increase in the surface temperature of the earth, known as global warming, causes changes in climate patterns. As a result of climate change, including drought, bad weather, in the field of the industry can cause food shortages, increase the spread of diseases, damage to infrastructure, and damage to natural resources as people's livelihoods (Rahayu *et al.*, 2022). The temperature rise or

fall can make the body uncomfortable using clothes that are not appropriate to the ambient air temperature. This allows the public to adjust clothing materials to be used at certain temperatures.

Potter *et al.* (2017) stated that the Heat Strain Decision Aid (HSDA) was derived from the Givoni-Go Idman equilibrium body in order to solve Army problems or needs. The authors used four elements as input; to predict core temperature rise over time and also estimated water turnover from sweat loss during the military training and concluded that the HSDA model predicted was a robust integration of physiological rules that usually guide a variety prediction but limited to generalized prediction of thermal strain. Rahayu *et al.* (2022) described temperature as a parameter that need to be considered as a part of the daily activities on earth. The authors further stated that temperature has influence on other parameters like humidity, wind speed and rainfall in any area. The authors obtained 20 years (2000-2019) data from Meteorology, Climatology and Geophysics (BMKG) in Bandung, West Java, Indonesia and used the data to build a model to predict daily temperature over next three days and used Recurrent Neural Network (RNN) and Long Short-Term Memory (LSTM) through the two-optimization model: SGD and Adam. Their result showed that Adam optimization predicted better than SGD.

The spatial variation of rainfall in the Northwest of Nigeria in different localities were predicted by (Abdulkadir & Sani, 2021): The data of thirty locations from 2010 to 2019 was obtained from National Aeronautics and Space Administration (NASA, 2021). The rainfall prediction model used humidity, pressure temperature and wind speed as input, the predicted rainfall models showed that southern part of the study area revealed higher prediction whereas the northern part showed lower prediction. The authors validated their model through Geographically Weighted Regression (GWR), Outperform Ordinary Kriging (OOK) and Inverse Distance Weighted (IDW) in terms of Root- Mean Square Error (RMSE) and coefficient of determination ( $R^2$ ).

Lai *et al.* (2019) worked on thermal environmental control in order to improve the urban thermal environment for attracting people in outdoor space and reduce global warming. The authors' research reviewed many papers and found out that to obtain thermal comfort and control global warming, people shall adopt four strategies. Changing the urban geometry, planting vegetation, using cool surface and incorporating bodies of water which will reduce air temperature to bare minimum and concluded that their result can be used by thermal comfort designers and planners throughout the globe.

Models for predicting skin temperature and heat loss for thermal comfort indicators in hot and humid areas specially in Sub- Saharan Africa was carried out by (Ze Ze *et al.*, 2021), the authors carried out their experiment on a representative sample of 64 people both men and women in experimental building in Douala, Cameroon in Africa and subjected these representatives to hot and humid zone thermal balance according to recommended standard. Their model was validated and compared with Fanger models which is which commonly used as a standard for the

temperature zone (ISO7730). They claimed that their model is more suitable to predict than those of Fanger models in term of thermal comfort condition in air-conditioned building in hot and humid areas of Arid Zone in Africa and concluded that the skin of people living in their study area have higher thermal inertia with less water kids by diffusion.

Adnan *et al.* (2021) stated that air temperature is a vital climatic parameter especially in water resources management and meteorological activities planning. The researcher used monthly temperature data of Astore and Gilgit climatic station in Pakistan to predict air Temperature through different machine learning models Least Square Support Vector Machine (LSSVM), Group Method and Data Handling Neural Network (GMDHNN) and Classification and Regression Trees (CART). They validated the capacity of result obtained using different statistical tools; Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and coefficient of determination ( $R^2$ ) and revealed that LSSVM model predicted air Temperature better than GMDHNN and CART models. The quality of raw material for pharmaceutical products stored and distribution temperature condition should be considered.

Paoli *et al.* (2021) conducted a research on the quality of raw materials, the right storage and distribution temperature condition of pharmaceutical products in order to simplify the storage and distribution management of raw materials. The authors subjected their data to analysis and obtained a new storage and distribution model of three temperature conditions for raw materials (15-25°C, 2-30°C and unrestricted). They concluded that their model can be applied to all non-cold chain raw material by suppliers and manufacturer in order to harmonize temperature condition and easily manage temperature excursion easier during operations

Mercier *et al.* (2017) worked on cold chain review to access the current state of commercial cold chain which is responsible for the preservation and transportation of perishable food in the proper temperature range to show biological decay processes and deliver safe and high-quality food to consumers. Their result showed that the efficiency of the cold chain is always less than ideal, as temperature abuses above or below the optimal product specific temperature range occur frequently, a situation that significantly increase food waste and endangers food safety and finally stated that response food inventory management system and cold chain management in developing countries should be improved on. Aguilera *et al.* (2019) stated that non-optimal air temperature almost have serious consequences on human health and productivity because of climate change, heat wave and cold streaks have become more frequent and intense. The authors presented a method to predict indoor air temperature to evaluate indoor thermal condition. The authors used two input data to predict their model. The air temperature obtained from online weather service and the general building attribute which is provided by smart phone app users in order to generate the model through decision tree classification algorithm. Their result showed 92% accuracy when predicting temperature under previously known condition and they concluded that it is possible to

develop a straight forward and fairly accurate method for indoor temperature estimation grounded on weather data and simple building attributes.

Ambient temperature of distal joint temperature at the forelimb of racehorses was conducted by (Soroko *et al.*, 2017). Their study investigated the influence of differing ambient temperature on the temperature difference between joints; measured in ipsilaterally and contralaterally. Authors used sixty-four (64) healthy racehorses which is monitored over 10 months in their research. At each session, three thermographic images were taken in dorsal, lateral and medical aspect of the distal forelimbs. The authors also took temperature measurements from region of interest (ROIS) covering the carpal and fetlock joint. They revealed that there is a moderate correlation between ambient temperature and the ipsilateral temperature difference between joints when measured from the medical and lateral aspect. No significant correlation was noted when measured dorsally and concluded that the temperature distribution between the forelimb of the healthy equine is generally symmetric, although some horses differ markedly.

An Artificial Neural Network (ANN) can be used to predict daily mean ambient temperature in Denizli South- Western of Turkey (Dombayci & Golcu, 2009). The authors used temperature measured value by the Turkish state metrological service three years value (2003-2005) as training data in order to generate model and used the measured data of 2006 as a testing data. They used different training algorithms; the number of neuron and hidden layer varies between 3 to 30 and transfer function in the hidden layer/ output layer were changed to obtain the optimal network architecture and obtained best results when the number of the neuron is 6 through Levenberg–Marquardt (LM) feed - forward back propagation algorithms. They concluded that their result is a reliable model for predicting ambient temperature when compared the values of fraction of variance ( $R^2$ ) and Root Mean Square Error (RMSE) values obtained. Peng et al. (2017) worked on extreme ambient temperature effect on the risk of mental disorder (MD's) in Shanghai, China by evaluating the short-term effect of daily mean temperature on hospital admission data for MDs. The authors obtained daily hospital admission data for MD's daily meteorological and ambient pollution data in Shanghai from January 2008 to December 2015 and adjusted for time trend, air pollution, relative humidity and other confounders, a quasi-poisson generalized additive model (GAM) combined with a distributed Agmon\_ linear model (DLNM) was used to analyze the lag-exposure-response relationship between daily mean temperature and hospital admission for MDs. Their result showed total daily hospital admission for MDs During the study period there were 93,971 with a reference of median temperature of 18.3°C which revealed a significant positive association between the temperature above threshold of 24.6°C and MD hospital admission visit at a lag 0-1 day the relative risks of extreme hot temperature (33.1°C, 99% percentile) over the lag 0-1 day compared to median temperature were 1.266 (95% confidence interval:1.074-1.493) and also claimed that there is no effect of cold weather in the hospital admission for MDs was observed. They concluded that extreme hot temperature poses significant risk on MD health counseling and cooling measure should be considered for the susceptible population.

Zeng *et al.* (2022) investigated an age-specific discrepancy of mortality burden attributed to temperature measured as Years of Life Lost (YLL), rates (per 100,000) relationship and quantified YKL per death caused by non-optimal temperature in China. They collected daily meteorological data, population data and daily death count from 364 locations between 2006-2017 in China. They also divided their YLL into three age groups; 0-64 years, 65-74 years and 75 years and above. A distributed lag nonlinear model was first used to determine the relationship between temperature and age-specific YLL rate in each location in China and later, used multivariate meta-analysis to determine the relationship. Their result showed greater effect of cold and hot temperature on YLL per rates for the elderly compared with the young population by region or cause of death and concluded that most life loss by death result from moderate temperature, especially moderate cold for all age group. The effect of wearing glasses on the human eyes temperature distribution in different ambient condition and convection coefficient of ambient air, blinking and body's temperature on the human eyes temperature distribution were investigated in Divandarreh, Kurdistan province, Iran the authors consider three scenarios; without glasses (scenario1), wearing medical glasses (scenario2), and wearing sunglasses (scenarios 3) under weather conditions of summer and winter as input. The sunlight intensity reaching the eye. In three scenarios for both winter and summer was measured experimentally. In scenarios 1, the corneal temperature increased by 5°C which can cause cataract in the long term. The result reveal that by wearing sunglasses in winter, the corneal temperature reduced by 4°C that may lead to blurred and diplopia visions, Aqueous Humor circulation pattern in summer is clockwise while in winter, it is counterclockwise and concluded that there is significant effect of the convection coefficient of air ambient on the corneal temperature (Zarei *et al.*, 2021). The objective of the present work is to investigate the monthly average air temperature distribution of the study area and compare with other standard measurements.

## MATERIALS AND METHOD

### Study Area

Lamurde is a settlement in Mubi South local government area in Adamawa State which is located on Latitude (10.12° & 10.30°N) and Longitude (13.27° & 13.32°E) with elevation of 575m above the sea level. It experiences annual rainfall between 900mm and 1050mm (National Aeronautics and Space Administration [NASA], 2021).

### Weather data resource.

In this study, the primary data was obtained using HTC-2 digital LCD thermo-hygrometer electronic meter manufactured by Shenzhen Oway Technology Co. Limited in Guangdong, China as shown in Figure 1. HTC-2 thermometer was used to record maximum/ minimum temperature of air temperature of study location (Lamurde) and also has temperature display precision of 0.1°C. The HTC-2 thermometer was pressed to switch between degree, display, outdoor temperature and maximum values of temperature.



Figure 1: HTC-2 digital LCD thermo-hygrometer

Data were collected on hourly basis from 6:00 am to 6:00 pm everyday throughout the year (2021) i.e., from January to December. The huge amount of data was collected was subjected to Microsoft word Excel (2016) for the analysis to obtain average monthly temperature values. The Microsoft word Excel was also used to generate monthly air temperature as in table1.



Table 1: Monthly air temperature of Lamurde, Mubi South Local Government

Area	Month	Lamurde Experiment (L Exp.)
	January	28.2
	February	27.4
	March	29.3
	April	28.4
	May	27.4
	June	25.8
	July	24.8
	August	25.7
	September	25.4
	October	26
	November	27.5
	December	28.4

**Validation of the air temperature**

Paired t- test was carried out to find accuracy of the two experiments with some assumption test:  
 - Was the pairing effective? Are there differences in sample from a Gaussian distribution? - Does the mean of the differences between LExp. values and NASA experiment (NASAExp.) values. This study also used F- Test two samples to validate the relationship between the two values.

**RESULTS AND DISCUSSIONS**

In the presented work, we describe the result of measurement of air temperature of Lamurde settlement in Mubi South, Adamawa State. Air temperature of both NASA Exp. and L Exp. values were presented In Figure 2.

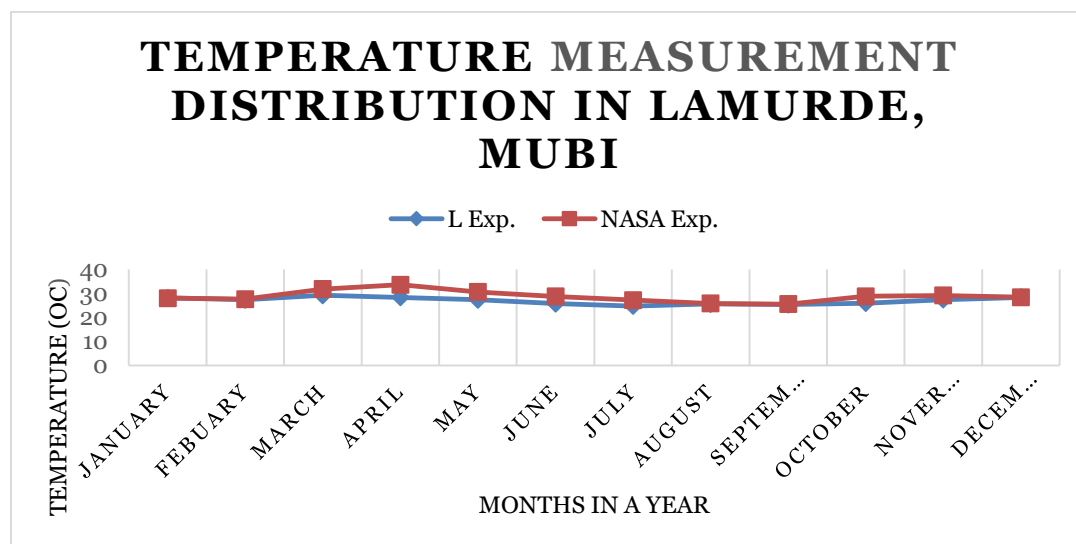


Figure 2: Comparison of air temperature distribution in Lamurde, Mubi and NASA value

The result revealed that Mubi (LExp.) has minimum value of 24.80°C when NASA Exp. has 25.6°C whereas the maximum air temperature in Lamurde was 29.3°C while NASA experiment has 33.7°C. It was also shown that air temperature of both values was bracket in January, February, August, September and December.

The air temperature distribution values obtained in Lamurde was compared with the standard measurement values obtained from NASA website. We validated the two data with two statistical test methods: pair T-test and F-test two samples for variance, i.e. Insta3 statistical package and Micro Excel Data analysis (2016) respectively as shown in table 2.

Table 2: F-Test Two-Samples for Variance

	L Exp.	NASA Exp.
Mean	26.825	28.85833
Variance	2.285681818	5.459015
Observations	12	12
Df	11	11
F	0.418698566	
P(F≤f) one-tail	0.082195239	
F Critical one-tail	0.35487036	



The F-test two sample for variances results revealed mean of Mubi exp. (26.83°C) and NASA exp. (28.86°C) with variance of 2.29°C and 5.46°C respectively when both have 11 degree of freedom.

Table 3: t test for two samples

Parameter	L Exp.	NASA Exp.
Mean:	26.825	28.858
Observation of points:	12	12
Std deviation:	1.512	2.336
Std error:	0.4364	0.6745
Minimum:	24.700	25.600
Maximum:	29.300	33.700
Median:	27.200	28.650
Lower 95% CI:	25.864	27.374
Upper 95% CI:	27.786	30.343

The paired T-test revealed the two-tailed p value of 0.0009 which considered as extremely significant when bound between 95% confidence interval of the difference: -3.03 to -1.033. The result also showed correlation coefficient (r) of 0.7454 with one tailed p value of 0.0027 which revealed that the data should be considered very significant, effective pairing results in a significant correlation between the columns and the pairing (or matching) appears to be effective. The pair T-test from Gaussian distribution used Kolmogorov and Smirnov (KS) method, revealed 0.13. The p value is greater than 0.10 means that the data passed the normality test with p greater than 0.05.

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

This study has shown that both experiments bracket in January, February, August, September and December. The paired T-test used in this study showed a P value that is extremely significant when bound between 95% and finally, showed a reasonable value of correlation of 0.75 (75%) which revealed that the data had significant correlation. F-test showed that there is no significant difference between the experimental values: Mubi experiment and NASA experiment. This method may be time consuming to obtain best data but it is a realistic data. Therefore, these data can be used for research purpose. It is advised that future investigations are necessary to validate the kind of conclusion drawn from this study by using other sophisticated equipment used to generate the same weather condition capacity in order to determine the accuracy of the Lamurde (Mubi) experimental values.

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