Analysis of daily maximum temperature of Kigali city to be used in climate responsive building design

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Abstract

The fact that the earth is getting warm and will continue to be so if no proper measures are taken, has been now a well settled scientific proven truth. In our daily activities majority of them are done inside buildings, however sadly and surprisingly these buildings are the most responsible source of the greenhouse gases which are causing this global warming. At this point due to this issue of climate change, building engineers must find out a new approach of incorporating future climate reality prediction in the early stage of design in order to make these buildings capable of withstanding this trend of climate change over their design lifespan. In this paper the monthly average temperature of Kigali city from 2012 to 2016 was analysed to detect any unusual variation in temperature with respect to the year of reference of 2007. Results show that there has been not any significant change in the variation of temperature, which can be a useful tool to building designers for improving the thermal comfort of occupants.

Keywords: Climate Responsive Buildings, Climate Change, Kigali

1.Introduction

Rwanda one of the countries of the African Great Lakes Region is a landlocked nation located just below the equator (-1°56'south and 29°52'est). Due to the high elevation of the country (1463 m above sea level); Rwanda experiences a moderate climate throughout the year. Generally there are four remarkable seasons in Rwanda, the first season is characterized by some rain and runs from february to june, the second season is a dry season from june to september, the third season from september to december is again a rainy season and the last one from december to february being a short dry season. For a long time the designing of building has stood firm where the climate metrics of the building's location is never a question of concern. With this global warming challenge if no effort is made in the way building are designed so that the greenhouse gases and other numerous form of pollution released from these buildings can be mitigated; this fight against global warming will just be a waste of time and resources since buildings have been proven to be the leader in polluting the atmosphere which lead to this global warming. By reconsidering again the traditional way of designing building which always goes by starting with the architecture; there is no way we can ever achieve a genuinely sustainable perspective building design approach which can lead us to create buildings that climatically respond to their unique location because this designing method ignores the importance of the climatic factors.

The change in climate the world is facing nowadays should be a key factor to guide us in changing the conventional way of designing building to a new approach of first understanding the climate data of the region to be constructed instead of rushing to the architectural drawings. By switching to this new approach; the integration of climate data in the designing phase will be the only driving factor in the design of new buildings. Taking into account and understanding the physical location's environmental data of the region available such as: temperature, wind speed, rainfall, sun radiation intensity and sun direction path, will give a deep understanding of how the building must respond to these all factors so that it can meet the expectations and give enough comfort to the occupants and save natural resources at the same time.

2. Literature Review

At this point it is more obvious and had already been scientifically proven that over the entire lifespan of buildings; construction activities have huge impact on environment which results in the climate change and which eventually leads to global warming. For the building industry to overcome this environmental issue caused by the construction activities; the implementation of green building technologies is the one and only way feasible solution to this challenge of climate change. However green building technology has been for a long time limited only to the focus of features such as : energy efficiency, water efficiency, indoor environmental quality, sustainable sites and materials as the main components of green building technology features. There has not been so much attention given on the physical environmental climate data aspect to be integrated together with other green building features. Therefore the incorporation of these physical environmental climate data along with other features of green building technology will result in a sustainable approach of designing building which can be resilient enough to this change in climate over their whole lifetime.

Jan Koci et al [1] in their study for vindicating the need of design weather datasets in the analysis of energy in residential buildings, have observed that the significance increase in temperature and relative humidity from 2013 to 2017 in central Europe specifically during the months of winter can lead to some catastrophe factors which could have not been given attention in the past.

Mirata Hosseini et al [2] have come to a conclusion that the fact that climate is changing will also have an effect on energy consumption of building in the coming years and this must be taken into consideration while active ventilation is required in the design. They also discovered that while most engineers tend to make use of the typical meteorological year weather data for simulation, it leads to either an underestimation or an overestimation of energy savings and it does not also cover forthcoming weather modeling as this typical meteorological year weather data does not include the extreme weather conditions and this lead to inadequate future reflection of realities.

The preeminent objective of this research study is to analyse the daily maximum temperature of Kigali collected from the Rwanda Meteorology Agency to check to what extent this worldwide current scenario of global warming has affected the daily maximum temperature of Kigali.

The specific objectives of this research study include:

- Evaluation of change in the daily maximum temperature of Kigali from 2012 to 2016
- Identifying the possible reasons or factors influencing the variation in temperature
- To unveil the need of integration of future climate predictions together with other green building features

3. Methodology

Based on the daily maximum temperature data of Kigali city provided by the Rwanda Meteorology Agency , this research study analytically examines the effect of global warming on the daily maximum temperature of Kigali city for a period running from 2012 to 2016 with respect to the reference year of 2007.

4. Data analysis

By setting the year of 2007 as the reference year, the mean average temperature of each month is computed and a monthly comparison is made to detect any variation in temperature. The highlighted percentage in red color indicates an increase in temperature with respect to its corresponding month of the reference year (2007) and where there is a decrease in temperature negative percentage is used in the table.

Table 1 : Variation in the month average of maximum temperature with reference to year 2007

Months	Monthly average of refer	2012		2013		2014		2015		2016	
		Temperature(°C)	Variation in %	Temperature(°C)	Variation in %	Temperature(°C)	Variation in %	Temperature(°C)	Variation in %	Temperature(°C)	Variation in %

	ence year 2007 (°C)										
January	27.8	29.4	5.7	28.6	2.9	28.7	3.2	28.8	3.6	28.3	1.8
February	27.9	28.1	0.7	28.2	1.1	27.8	-0.4	28.8	3.2	28	0.4
March	28.3	28.1	-0.7	27.2	-3.9	27.7	-2.1	28.7	1.4	27.1	-4.2
April	27.7	25.7	-7.2	26.7	-3.6	26.6	-4	26.4	-4.7	25.5	-8
May	26.5	25.5	-3.7	26. 5	0	27.2	2.6	26.6	0.4	25.9	-2.3
June	25.8	25.8	0	27.2	5.4	26.9	4. 3	26.8	3.8	26.5	2.7
July	26.8	27.5	2.6	28.1	4.8	28.2	5.2	28.7	7.1	27.5	2.6
August	27.1	28.1	3.7	27.9	3.0	27.6	1.8	29.7	9.6	28.3	4.4
September	27.8	28	0.7	27.9	0.4	26.9	-3.2	29.5	6.1	28.5	2.5
October	27.9	27.9	0	28.1	0.7	27.7	-0.7	28.2	1.1	27.6	-1.1
November	26.4	26.2	-0.7	26.1	-1.1	26.7	1.1	26.1	-1.1	25.8	-2.3
December	26.8	26.7	-0.4	26.8	0	27.9	4.1	27.7	3.3	26.6	0.7

5.Conclusion

It has been well noticed that during the period of 2012 to 2016 when compared to the reference year of 2007 , there is a significant change in the daily maximum temperature of Kigali. The reason would be the economic growth and the overall physical development of Kigali much more pronounced in the years succeeding 2007. Therefore there is a need for building engineers

to adapt the passive ventilation approach in Kigali city as the temperature variation has been significant and minimize the incorporation of HVAC(heating, ventilation and air conditioning) systems which will ultimately have a positive effect on energy saving and as well as on other resources.

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