

Temperature Assessment of Urban Rooftop Farming for Cooling Effect to Buildings Significant Determinant of Micro-Climate Change and Urban Heat Island Effects.

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Abstract

Recently the increasing of urbanization larger number of flats, buildings apartment and hotels are establish rapidly. For that the heat is increase due to the roof of the buildings and tremendous use air condition, hot air relies to atmosphere. The temperature of the urban area gradually increase rapidly very year. As a matter of fact in temperature assessment study in urban areas cooling effect the building and their surrounding due to Urban Roof top Farming being reduces the temperature. Cooling effect in Building determines the micro-climate change and urban heat island effect. Solution of these aspects occurs by the dense of the plants grown on rooftop farming. Cultivations of worm- climatic plants on the rooftop farming provide coooling benefits for urban inhabitance of the urban agriculture and impact of climate change in many building level. The monitoring the temperature larger the Rooftop farming reduce the temperature in the room of building and adjacent area for reducing cooling expenses of urban peoples. The measurement of temperature varies in different location of the buildings depending upon the different storied and direction of the buildings. Rooftop farming ruled out the reduction of temperature and involved in micro-climate change of the building. According to this concept the surrounding of the urban and peri-urban area directly influence by urban agriculture can be cooling effect and climate change if the urbanize. The building Converted in to land for cultivation rooftop garden, balcony garden, terrace garden. These gardens are covering the building and provide Shade which maintain cool to Building. Rooftop farming lower the temperature of room of the building .The study carried out in Bhubaneswar city of India. Measurement of temperature in different buildings with and without rooftop garden and compare the temperature which is increase or decrease.

Keywords: Cooling effect, Micro-Climate, Urban farming, Heat, Island

1. Introduction

Rising Mercury Scale of temperature by growth of factories, buildings, concrete road and other construction works in urban area, apart from that use of electronics and air condition. In hot environment difficult to survive for human beings and habitat loss of other animals. Heat absorbed by Wall of the building. Alternatives to reduce temperature are impossible to accommodate in urban area. In present study only rooftop farming reduce temperature in small scale and maintain the building cool. Rooftop

farming directly interaction with reduce temperature in Various aspects such as maintain relative humidity, availability of water on rooftop garden, use of a layer of light weight soil cover to the roof, evaporation from soil, transpiration of plants maintain relative humidity and provide cover green shade by plants and it parts to roof of the building, rising of temperature in term of distribution of buildings, Rooms and storied depending. The rooftop farming (intensive and extensive) meet to micro climate change and urban heat island effect, For recent study concluded that urban and peri-urban agriculture makes to reduction of heat in urban which impact of economic, social and environmental dimension. The Urban Rooftop farming Provide significant contribution to reduction of temperature of building. The room temperature of concrete house is less due to the rooftop farming as compare to house of without rooftop farming. This phenomenon the study seeks to emphasized the cooling effect potential Of urban rooftop farming in connection with micro-climate change. This comparison study analyzed the assessing the cooling effect by rooftop farming, rooftop garden, balcony garden, Terrace garden and grass plantation on roof and wall of the building. Present study carried out in Bhubaneswar a city of India. Where sampling reading taken of building having rooftop farms and without rooftop farming. Reading of temperature and documented the data every month for two year 2024 and 2025. The sample data recorded top reading of the temperature of each month. Reading compared of temperature in Celsius scale in different location of the building and months for two year. The result find out the higher and lesser the temperature and future recommended.

2. Materials and Methods

Materials: The materials are used for the measurement of temperature instrument name Operating Temperature Thermo Detector GIS 500, Model BOSCH-5-50.

Method: The resent study carried by survey and semi- experimental design by measurement of temperature for two consecutive years 2022 and 2023 continuously temperature has been measured whole month in four variable location with and without rooftop garden and in rooms under the roof with gardens on the top. The result has been presented in (Table 1 and Fig. 5) overall in results that temperature is lower in rooms having rooftop gardens than outside and in rooms without rooftop farming. The temperature on May 2022 and 2023 afternoon 3 p. m.. The temperature has been recorded under the different conditions in rooms with and without gardens for the years 2022 and 2023 The study Implemented to the measurement of temperature and record the tabulated data for two year result has been depicted in (Table 1).

3. Result

3.1.Measurement of Annual Temperature

Table 1. Average Year (2024 &2025) Annual Temperature.

Annual Temperature	TIRWRTF	TIRWTRTF	TO	TRTF
Jan-22	18.0	22.4	21.4	19.0
Feb-22	21.8	26.5	24.4	23.0
Mar-22	26.0	32.1	30.5	28.1
Apr-22	31.3	33.4	32.9	31.4
May-22	40.8	46.9	45.3	43.5
Jun-22	37.5	43.9	40.5	37.8

Jul-22	28.0	32.5	31.4	29.5
Aug-22	22.9	27.4	26.5	24.8
Sep-22	22.4	26.3	24.0	23.6
Oct-22	21.9	25.5	24.4	22.8
Nov-22	21.1	24.6	23.5	22.0
Dec-22	18.9	22.0	20.9	19.4
Jan-23	18.0	22.5	21.4	19.0
Feb-23	21.9	26.5	24.4	22.8
Mar-23	26.0	32.1	30.4	27.8
Apr-23	30.9	33.7	32.9	31.2
May-23	40.8	47.1	45.6	43.3
Jun-23	37.5	44.0	40.2	38.0
Jul-23	27.9	32.4	31.5	29.5
Aug-23	23.0	27.4	26.4	24.9
Sep-23	22.6	26.5	23.9	23.4
Oct-23	22.0	25.3	24.3	23.0
Nov-23	21.0	24.4	23.3	21.9
Dec-23	19.0	22.1	21.1	19.5

Temperature Inside the Room With Rooftop Farm= TIRWRTF

Temperature Inside the Room Without Rooftop Farm= TIRWTRTF

Temperature Outside= TO

Temperature on the Rooftop Farm (Within Canopy)= TRTF

The provided Table 1 presents monthly temperature data across different categories for the years 2022 and 2023. The columns include the Annual Temperature, TIRWRTF, TIRWTRTF, TO, and TRTF, with values measured in degrees Celsius. For January 2022, the annual temperature is 18.0°C, and temperatures for TIRWRTF, TIRWTRTF, TO, and TRTF are 22.4°C, 21.4°C, 19.0°C respectively. The data shows seasonal variations with peaks around May each year, where May 2022 has the highest recorded temperatures: 40.8°C (Annual Temperature), 46.9°C (TIRWRTF), 45.3°C (TIRWTRTF), and 43.5°C (TRTF). In contrast, the coldest month is January, where temperatures drop down to 18.0°C for annual temperature in both years. The table provides a comprehensive view of temperature trends across different measurements over two consecutive years, highlighting both seasonal changes and annual comparisons

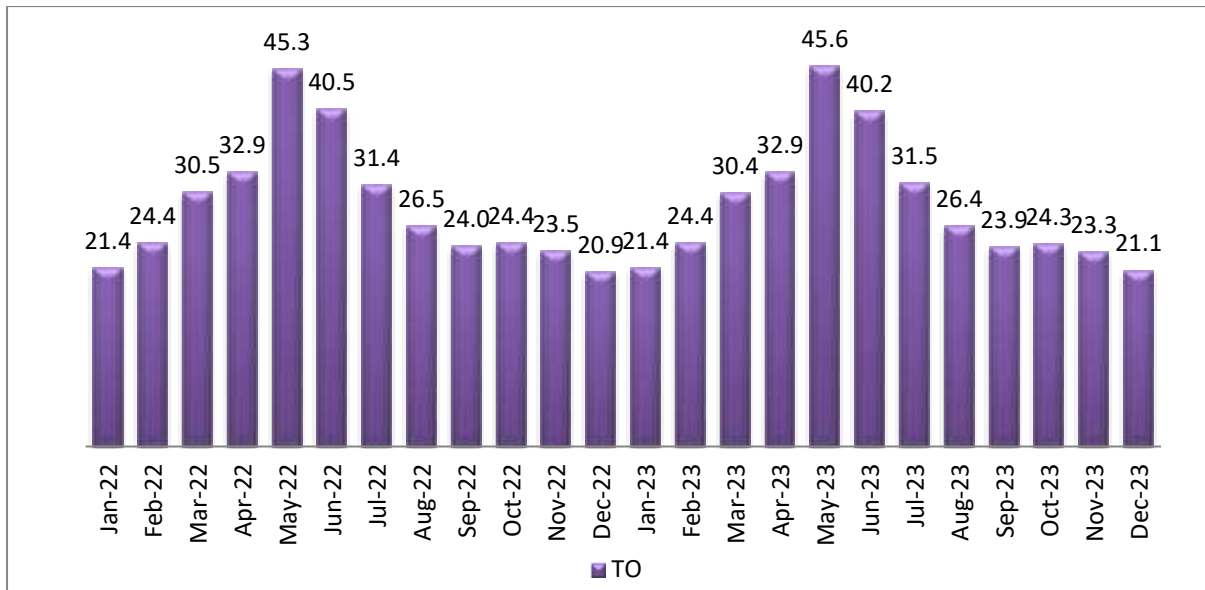


Figure 1. Average Annual Temperature of Temperature Outside (TO)

The average annual temperatures recorded monthly from January 2022 to December 2023 Figure 1. The temperature data shows seasonal variation with generally warmer temperatures from May to September and cooler temperatures from October to April. Notably, May has the highest temperatures, peaking at around 45.3°C in 2022 and 45.6°C in 2023. The cooler months, such as December and January, show lower temperatures, with January ranging from 21.4°C in 2022 to 21.4°C in 2023, and December from 20.9°C in 2022 to 21.1°C in 2023. Overall, the data reveals a consistent annual temperature pattern with peaks during the middle of the year and cooler conditions towards the end and beginning of the year.

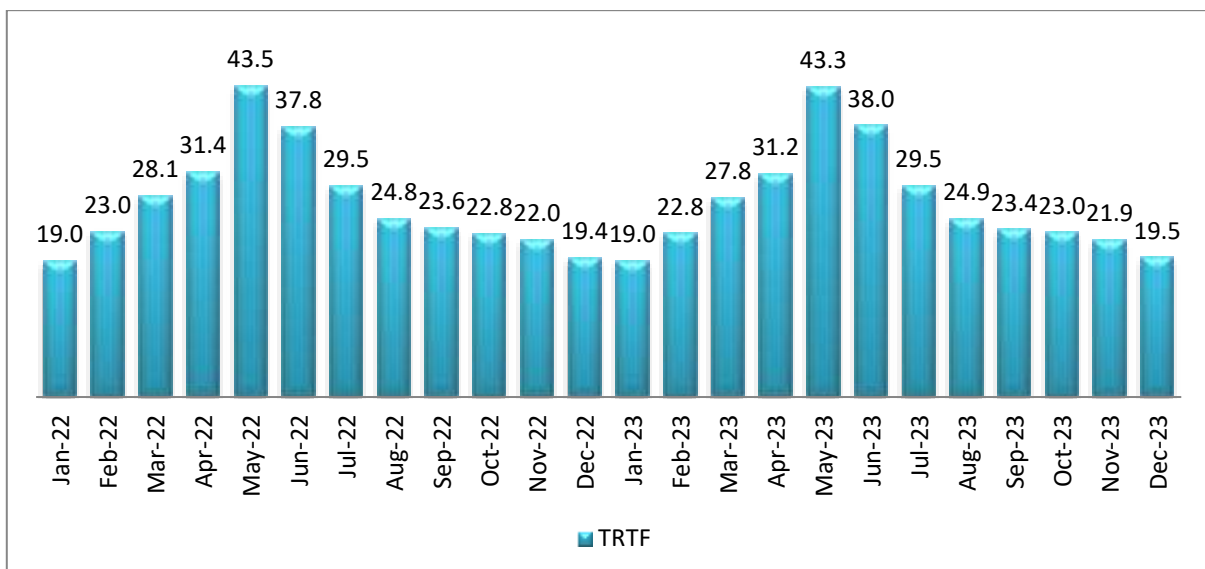


Figure 2. Average Annual Temperature of Temperature in Rooftop Farming (TRTF).

This presents study documented in Figure 2 the average annual temperatures for each month from January 2022 to December 2023. It reveals a clear seasonal pattern with temperatures generally increasing from January to May, peaking in May at around 43.5°C, followed by a slight decrease during the subsequent months. The temperatures remain relatively high through June, with a gradual decline

from July onward, reaching the lowest values in December. The temperature trend appears consistent year-over-year, with slight variations between the two years, such as a marginal increase in temperatures during May and June of 2023 compared to 2022. The data highlights the typical fluctuation of temperatures across different months and years, reflecting seasonal changes.

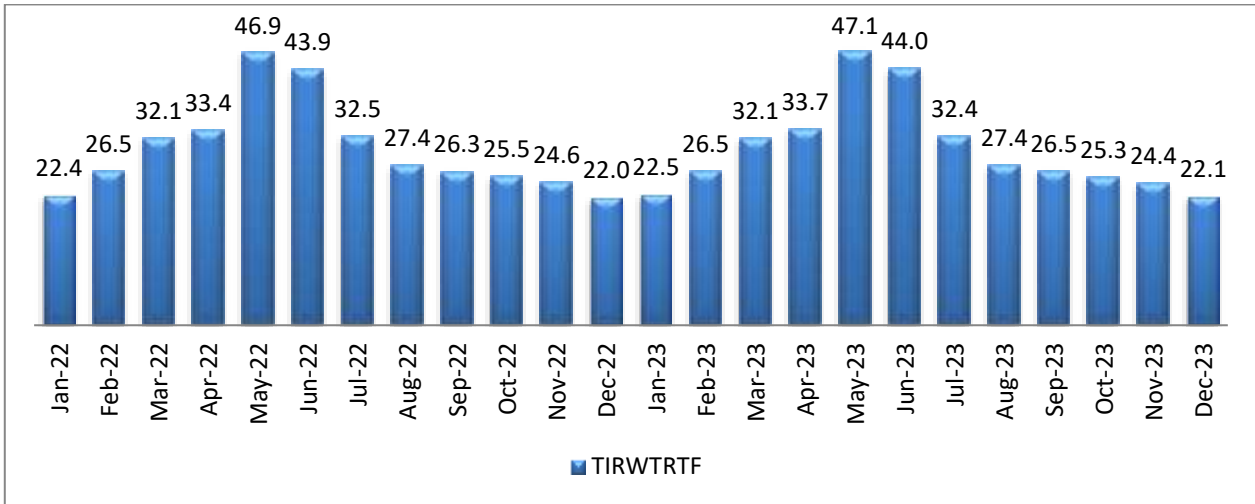


Figure 3. Average Year Annual Temperature of Temperature Inside Room Without Rooftop Farming (TIRWTRTF)

This Figure 3 displays the average annual temperatures recorded for each month from January 2022 to December 2023. The data shows temperature variations over these two years, with notable trends and patterns. Generally, temperatures increased from January to May, reaching a peak in May 2022 at 46.9°C and in May 2023 at 47.1°C. The temperatures then declined from June onwards, with June 2022 and June 2023 showing high temperatures of 43.9°C and 44°C, respectively. The cooler months of October to December reveal lower temperatures, with the lowest values recorded in December at 22°C in 2022 and 22.1°C in 2023. The overall pattern indicates a trend of increasing temperatures during the middle of the year and cooling towards the end, with some consistency observed between the two years.

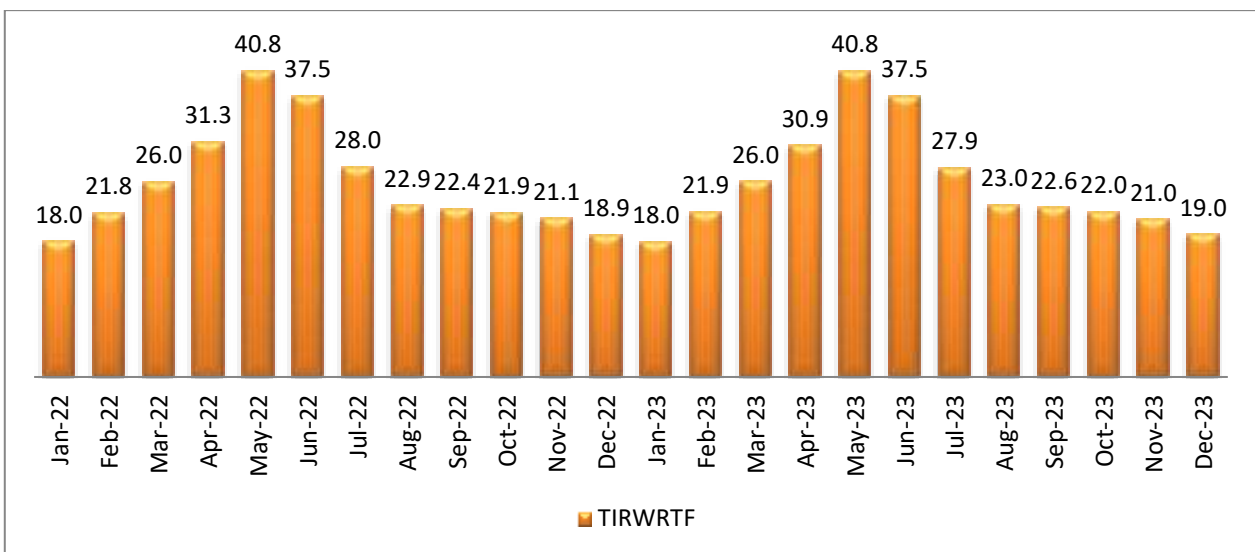


Figure 4. Average Annual Temperature of Temperature Inside Room With Rooftop Farming (TIRWRTF).

This figure 4 presents the average annual temperatures recorded from January 2022 to December 2023, alongside a corresponding variable labeled "TIRWRTF." For both years, the temperature shows a clear seasonal pattern, with the highest average temperature in May (40.8°C) and the lowest in January and December, typically around 18°C. The temperatures peak in May and June each year, reflecting the hottest months, while they generally cool down from July onwards, reaching their lowest point by December. Throughout both years, temperatures in the months of July to December are relatively cooler compared to the earlier months, indicating a typical seasonal fluctuation with warmer months transitioning to cooler periods.

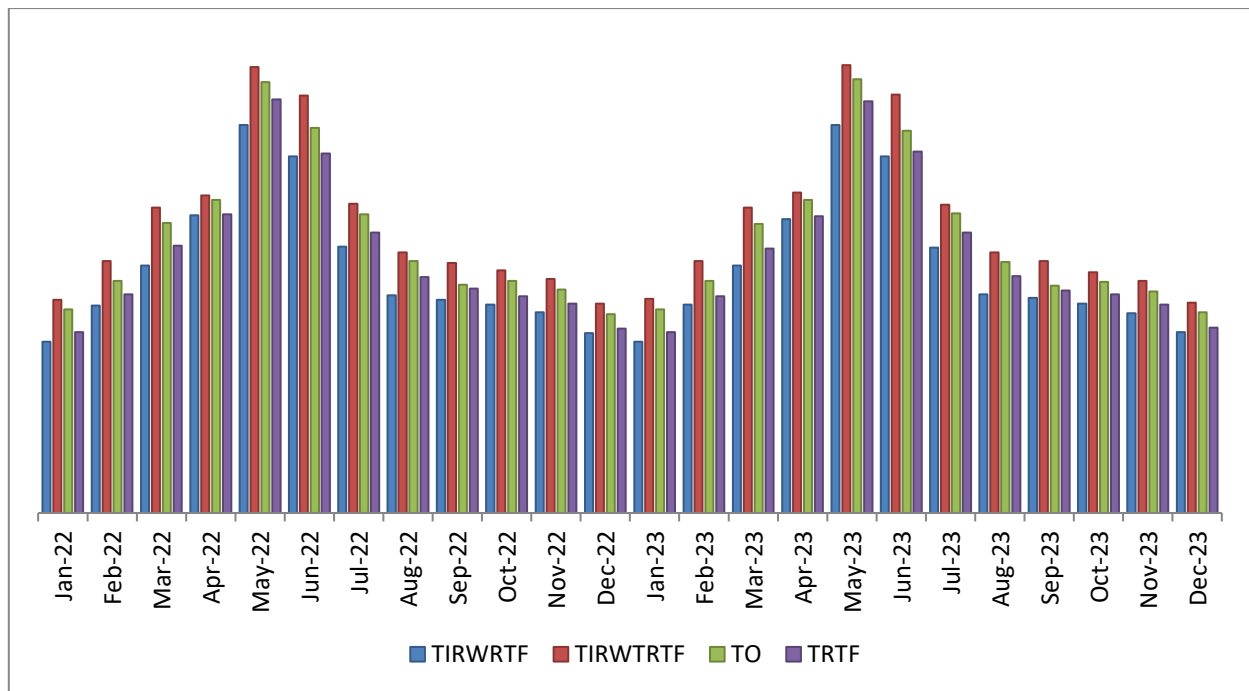


Figure 5. Comparison of Average Annual Temperature of TIRWRTF, TIRWTRTF, TO, TRTF.

This figure 5 presents monthly micro-climatic changed data for two consecutive years, January 2022 to December 2023, showing the average annual temperature alongside four other variables: TIRWRTF, TIRWTRTF, TO and TRTF. The average annual temperature fluctuates throughout the year, with the highest values recorded in May (40.8°C in both years) and the lowest in January (18°C in both years). TIRWRTF and TIRWTRTF reflect similar trends to the average temperature, with TIRWRTF values slightly higher than TIRWTRTF values in most months. For example, in May 2022, TIRWRTF reaches 46.9°C while TIRWTRTF is 45.3°C. TRTF also shows a similar seasonal pattern but is generally lower than the other two variables. The variations in these metrics suggest changes in temperature and potentially other factors influencing these measurements throughout the year.

Table 2. Average Year for 2022 & 2023 of Annual Temperature of Four Variable Locations.

Temperature	TIRWRTF	TIRWTRTF	TO	TRTF
2022	40.80	46.88	45.32	43.48
2023	40.76	47.07	45.64	43.34

The table 2 presents average annual temperatures over two years across four different locations: TIRWRTF, TIRWTRTF, TO and TRTF. In 2022, the temperatures were 40.80°C for TIRWRTF, 46.88°C for TIRWTRTF, 45.32°C for TO, and 43.48°C for TRTF. Comparing to 2023, slight variations are observed with temperatures of 40.76°C for TIRWRTF, 47.07°C for TIRWTRTF, 45.64°C for TO, and 43.34°C for TRTF. This data indicates some fluctuation in temperatures across the locations and from year to year, reflecting annual micro-climatic variations in these areas.

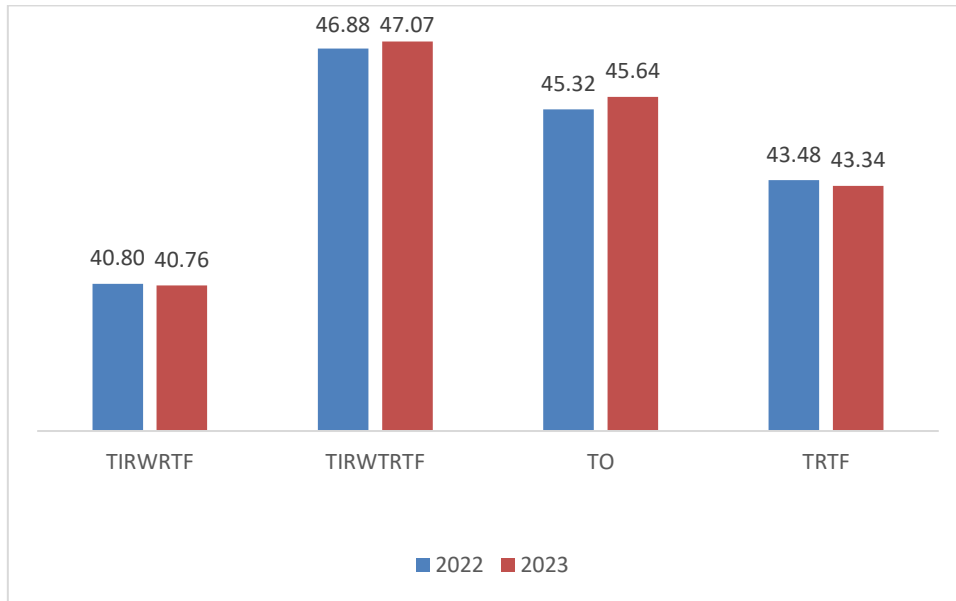


Figure 6. Average Year Annual Temperature of Variable.

The Present study explored monthly climate data for two consecutive years, January 2022 to December 2023 measure Whole month were showed the average annual temperature alongside three other variables: TIRWRTF, TIRWTRTF, and TRTF. The study reported presents annual temperatures across four different locations: TIRWRTF, TIRWTRTF, TO, and TRTF. In 2022, the temperatures were 40.80°C for TIRWRTF, 46.88°C for TIRWTRTF, 45.32°C for TO, and 43.48°C for TRTF. Comparing to 2023, slight variations are observed with temperatures of 40.76°C for TIRWRTF, 47.07°C for TIRWTRTF, 45.64°C for TO, and 43.34°C for TRTF. Further This data indicates some fluctuation in temperatures across the locations over year , reflecting rooftop farming in these areas.

4. Conclusion

The temperature data shows seasonal variation with generally warmer temperatures from May to September and cooler temperatures from October to April. Notably, May has the highest temperatures, peaking at around 45.3°C in 2022 and 45.6°C in 2023. The cooler months, overall, the data reveals a consistent annual temperature pattern with peaks during the middle of the year and cooler conditions towards the end and beginning of the year. the average annual temperatures for each month from January 2022 to December 2023. It reveals a clear seasonal pattern with temperatures generally increasing from January to May with slight variations between the two years, such as a marginal increase in temperatures during May and June of 2023 compared to 2022. The data highlights the typical fluctuation of temperatures across different months and years, reflecting seasonal changes. This displays the average annual temperatures recorded for each month from January. The data shows temperature

variations over these two years, with notable trends and patterns. Generally, temperatures increased from January to May, reaching a peak in May 2022 at 46.9°C and in May 2023 at 47.1°C. The temperatures then declined. The overall pattern indicates a trend of increasing temperatures during the middle of the year and cooling towards the end, with some consistency observed between the two years. This figure 6 presents the average annual temperatures recorded from January 2022 to December 2023, alongside a corresponding variable labelled "TIRWRTF." For both years, the temperature shows a clear seasonal pattern, with the highest average temperature in May (40.8°C) and the lowest in January and December, typically around 18°C. The temperatures peak in May and June each year, reflecting the hottest months, while they generally cool down from July onwards, reaching their lowest point by December. Temperatures in the months of July to December are relatively cooler compared to the earlier months, indicating a typical seasonal fluctuation with warmer months transitioning to cooler periods. Cooling effect of room of the building reduce temperature by Rooftop farming and micro-climate change and recommend to temperature assessment of urban rooftop farming for cooling effect to buildings that significant determinant of micro-climate change and urban heat island effects.

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