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EXPLORATION OF THERMAL PERFORMANCE OF THE KULTEKA (KULINER TEPI KAYAN) USING THE EFFECTIVE TEMPERATURE METHOD

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Abstract.

Bulungan Regency has one of the rivers, which serves as the core river, providing a source of economic, social, and cultural activities, namely the Kayan River. In the Kayan River, there is a trestle building 500 meters long and 15 meters wide. In 2006, the local government constructed a fish auction facility, known as TPI. During its development, the Fish Auction Place facility underwent a change in function to become the Culinary area, named Kulteka (Kuliner Tepi Kayan). This new function, which was not previously planned, drew the interest of many visitors, including both local residents and tourists from outside the region. Thermal comfort in the riverside culinary area is a major concern in creating a comfortable and attractive public space for visitors. There is a contradiction between the microclimate and thermal comfort in the Kulteka. So that the thermal comfort in this area is interesting to study. This study aims to analyze thermal comfort in the Kayan Riverside Culinary Area using a qualitative approach, with a focus on relative temperature. Microclimate data was collected through Onebuilding.org secondary data, then analyzed using relative temperature to identify the level of thermal comfort felt by local people and tourists from outside the region. This method allows a deeper understanding of the relationship between microclimate parameters and thermal comfort in open spaces. The study is expected to provide insight into the planning of riverside culinary areas that consider thermal factors to enhance resident comfort and support the development of an environment more conducive to the local microclimate.

Keywords: thermal comfort, microclimate, riverside culinary area, relative temperature

1. Introduction

According to Gunawan and Ananda (2017), Human productivity performance is also influenced by good air quality and thermal comfort levels. Thermal comfort is one of the main factors that influence the experience and satisfaction of visitors in open spaces. The design of public spaces plays a crucial role in supporting the comfort and quality of life within the community. One of the areas that is a hub of social activity is the riverside culinary scene. This area is not only attractive to local people but also to tourists, so it requires special attention in terms of thermal comfort (Susanti, 2020). Thermal comfort in open spaces, particularly in areas surrounding water bodies such as rivers, is influenced by various environmental factors, including microclimate, which encompasses thermal air temperature, relative humidity, solar radiation, and wind speed (Bruse & Fleer, 1998). These four factors directly affect the level of thermal comfort felt by visitors, so they need to be measured and analyzed in depth to create a comfortable culinary area (Sangkertadi et al., 2008).

E-ISSN:
2721-13988

Thermal comfort is a state where a person feels satisfied with the thermal conditions around them. According to ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers), thermal comfort is defined as “a state of mind that expresses satisfaction with the thermal environment” (ASHRAE, 2004). This concept is important because poor thermal comfort can reduce a person's stay time in a location and negatively impact visitor satisfaction and experience (Givoni, 1998). In the riverside culinary area, visitors often spend extended periods of time, making the thermal comfort factor a crucial aspect in maintaining the location's quality and attractiveness (Nikolopoulou & Steemers, 2003).

Managing thermal comfort in riverside culinary areas faces several challenges. Unpredictable weather factors, such as high sunlight intensity and humidity, as well as limited space for installing thermal control systems, such as air conditioners, in open areas, make microclimate planning more complex (Ali-Toudert & Mayer, 2007). The use of shade plants, strategic spatial arrangements, and the selection of building materials that reduce heat reflection are some solutions to address these challenges. This study focuses on the use of PMV as an effective tool to understand the complexity of microclimate and thermal comfort in open spaces, particularly in riverside culinary areas, thereby supporting more informed and contextual design decisions (Oke, 1987).

On the other hand, the microclimate in the riverbank area tends to have different characteristics from those in other areas. Microclimate factors, such as temperature and humidity, can vary significantly during the day and night due to the reflection and distribution of heat from the river water surface (Brown & Gillespie, 1995). Rivers often have a natural cooling effect that can affect the thermal conditions around them. On the other hand, high solar radiation during the day or a lack of vegetation around the river can cause hotter thermal air temperatures, thus disrupting the thermal comfort of visitors (Lin, 2009). Therefore, it is important to consider microclimate conditions in the design and management process of riverbank culinary areas.

Effective temperature is a concept used in architecture and environmental science to measure the perceived thermal comfort of air temperature in a space or environment. It takes into account not only the actual air temperature but also other factors that affect how a person perceives that temperature, such as humidity and wind movement.

Some of the main factors that affect effective temperature include:

1. Air Temperature: The actual temperature of the environment.
2. Relative Humidity: High humidity will make the air feel hotter because it reduces the evaporation of sweat from the body, so the temperature is felt more.
3. Wind Speed or Air Circulation: Good wind or air circulation helps evaporate sweat and can provide a cooling effect.
4. Heat Radiation: The presence of heat radiation from sunlight or other heat sources also affects the perception of temperature..

By understanding effective temperature, designers and architects can design more comfortable spaces according to climate conditions and human activity needs.

This study aims to analyze thermal comfort in the riverside culinary area using the relative temperature method as the main indicator. By utilizing microclimate data collected through on-site direct measurements, this study aims to determine the extent to which microclimate variables influence the thermal comfort of visitors in the area. Through relative temperature

E-ISSN:
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analysis, it is hoped that the results of this study will provide recommendations for enhancing thermal comfort in the riverside culinary area and developing design strategies that prioritize improving the quality of the visitor experience in a thermally comfortable environment.

Figure 1. Kulteka
Source: Author

2. Method

This study uses a qualitative method to analyze the thermal comfort of the Kayan Riverside Culinary Area. A qualitative approach is employed to understand visitors' perceptions and experiences of thermal conditions at the research location, while the effective temperature method is used to obtain objective data on thermal comfort based on microclimate parameters, including air temperature, relative humidity, wind speed, and thermal radiation.

The qualitative approach was conducted through in-depth interviews and participant observation. Interviews were conducted with visitors to the riverside culinary area to explore their perceptions of thermal comfort and the factors they believe influence comfort while in the area. The purpose of collecting this perception data was to understand visitors' thermal preferences and tolerances, which often vary according to individual backgrounds, activities, and habits. Participatory observation was also conducted to record the actual thermal conditions experienced by visitors at various points in the research location, both during the day and at night, thereby enriching the understanding of the environmental situation and visitor behavior under specific thermal conditions.

- The effective temperature method is used as a tool to measure thermal comfort objectively. Relative temperature is an index that predicts average thermal comfort based on physical environmental variables. For the purposes of this study, the variables measured include:

E-ISSN:
2721-13988

- Air temperature(°C)
- Relative humidity (%)
- Wind velocity (m/s)

Microclimate data were collected through direct measurements using portable weather monitoring devices placed at several points in the riverside culinary area. The measurement points were selected based on the level of crowd, distance from the river, and exposure to sunlight. The results of these measurements were then analyzed using effective temperature calculations to determine the level of thermal comfort at each measurement point and time.

2.1 Research Procedures

2.1.1 Preliminary Study

The study began with a literature review to understand the characteristics of the microclimate in the riverside culinary area and the factors that have the potential to affect thermal comfort. This study involved direct observation to determine the appropriate location and time for microclimate measurements.

2.1.2 microclimate measurement

Data collection using secondary data from the climate database from onebuilding.org. namely in the morning, afternoon, and evening. This data is then used to calculate the effective temperature value at each measurement point, according to the method developed by Fanger (1970).

2.1.3 Data analysis

The data is processed in the order of air temperature (Tud), air speed (Vud), and relative humidity (Rh), then the data is grouped based on the time of the visit, namely at 2 pm, 5 pm, and 9 pm.

2.1.4 drawing up conclusions

Based on the analysis carried out, the conclusion of the design of the riverside culinary area was drawn up to assess thermal comfort, by taking samples at 2 pm, 5 pm, and 9 pm at several points at the research object.

3. Result and Discussion

Thermal performance follows the function of 9 other variable functions, namely: Dry bulb air temperature (Tud); Air velocity or wind speed (Vud); Relative air humidity (Rh); mean radiant temperature (MRT); metabolism (met); clothing (clo); health; race; and gender. However, the last 5 factors are not factors that directly affect the design, so they can be eliminated. Although the building in the Kayan Riverside Culinary Area (Kulteka) is a structure without walls, it features a zinc roof that shades the entire room, preventing direct sunlight from entering. In a situation like this, where there is no MRT, the MRT factor is not considered in the analysis. After this elimination, there are only three factors left: dry bulb air temperature (Tud), air velocity or wind speed (Vud), and relative air humidity (Rh), which affect the thermal

E-ISSN:
2721-13988

performance of the Kulteka area. Tanjung Selor City has the following location coordinates: Latitude (north latitude) = 2.850 and Longitude (east longitude) = 117.333.

3.1. result

3.1.1. Dry bulb air temperature (Tud)

Dry bulb temperature (Tud) is the air temperature read on a regular thermometer. This temperature varies rhythmically according to the time of year, month, and even day. However, a condition will not be exactly the same. What can be seen is the pattern. The dry bulb temperature profile of Tanjung Selor City, North Kalimantan, obtained from https://climate.onebuilding.org/ shows the average from 2009-2023 as in the following graph.

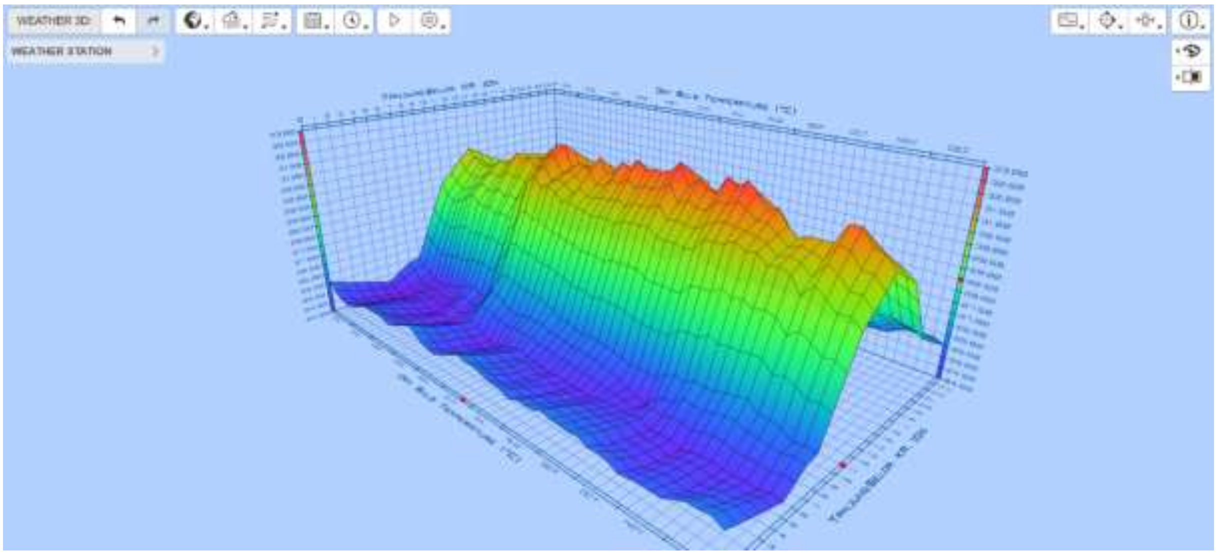

Figure 2. Temperature Profile every year

From the graph, we can infer that the lowest daily temperature occurs at 05:00 am, and the lowest annual temperature occurs at 05:00 am on January 17th. The hottest daily temperature occurs at 14:00 (noon) on August 12th, marking the highest temperature of the year. The hottest average temperature is 33 ºC and the coldest average is 24 ºC.

Although the Kulteka Area has been open (operating) from morning until midnight, from initial observations, it can be seen that the number of visitors peaks at 12:00-13:00 during lunch, 17:00-18:00, and at 20:00-21:00 during dinner. These peak times are defined as visits 1, 2, and 3.

Therefore, the air temperature figures during the visits are important. From the graph, it can be seen that the average temperature during visits 1, 2, and 3, as seen in the following graph, is

Tud Visit 1 = 32 oC (figure 2), Tud Visit 2 = 29.5 oC (figure 3), and Tud Visit 3 = 26.5 ºC (figure 4).

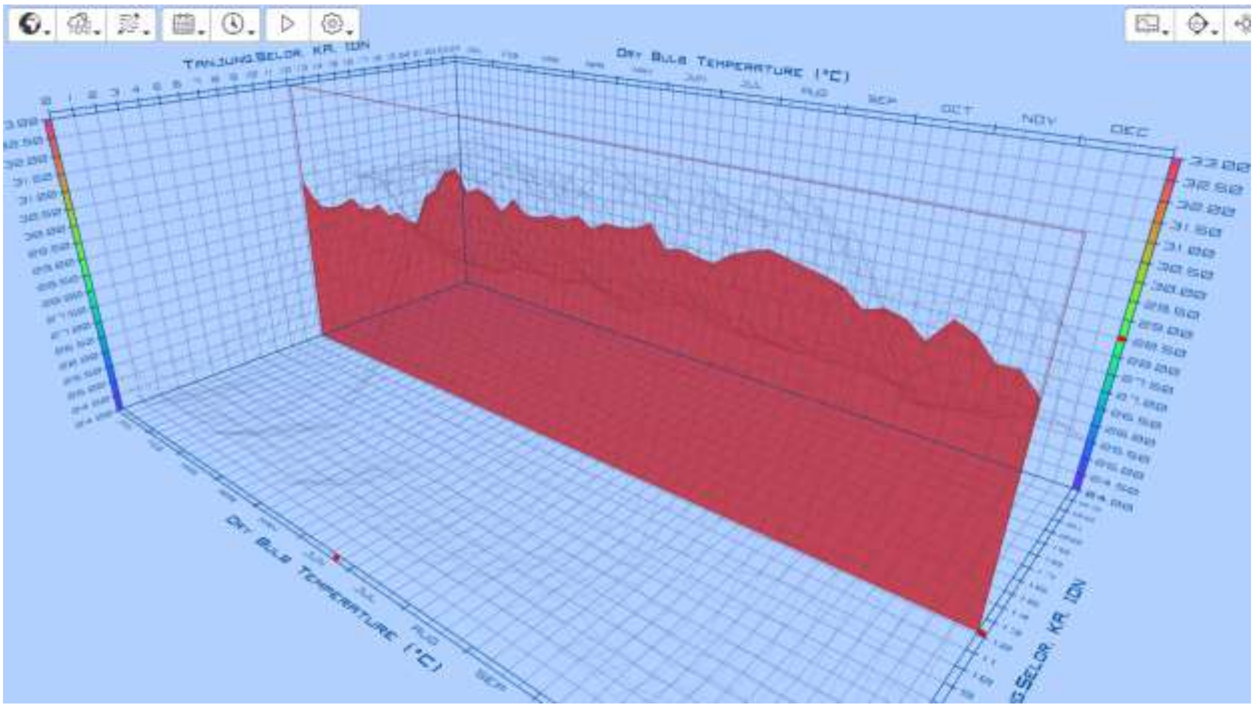

Figure 3. Profil temperatur tahunan pada jam kunjungan 1, rata-rata 32oC

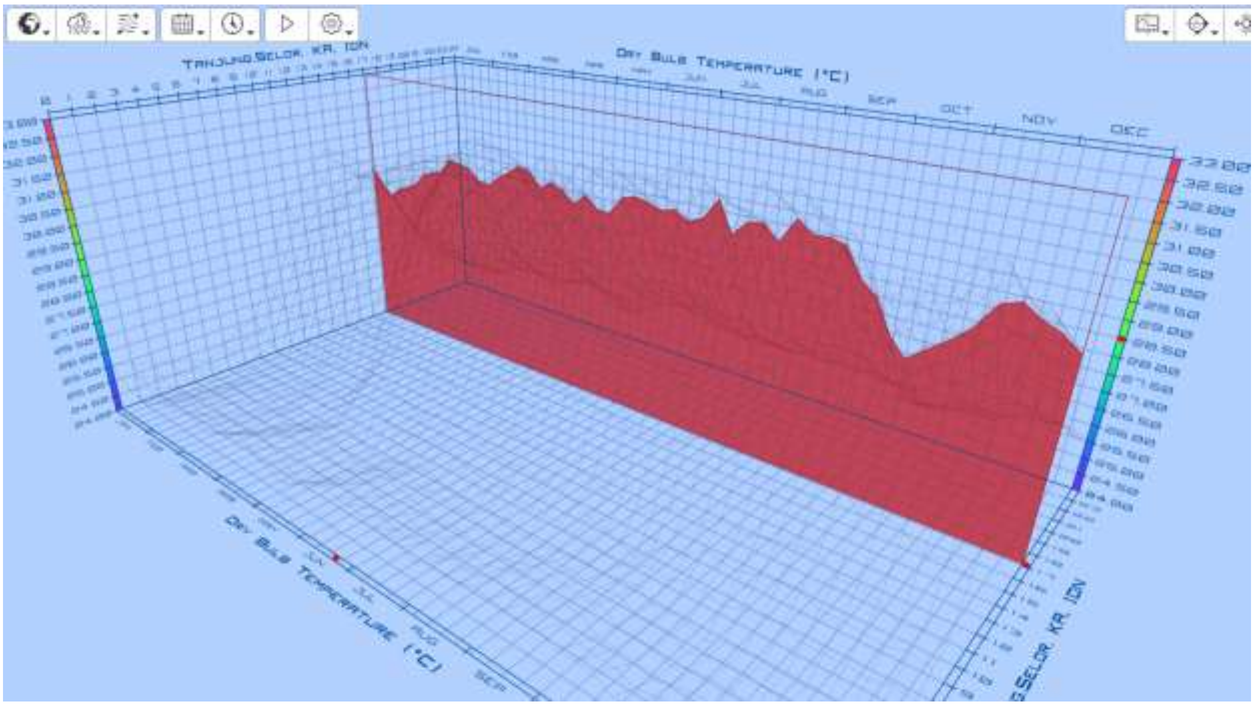

Figure 4. Profil temperatur tahunan pada jam kunjungan 2, rata-rata 29,5oC

E-ISSN:
2721-13988

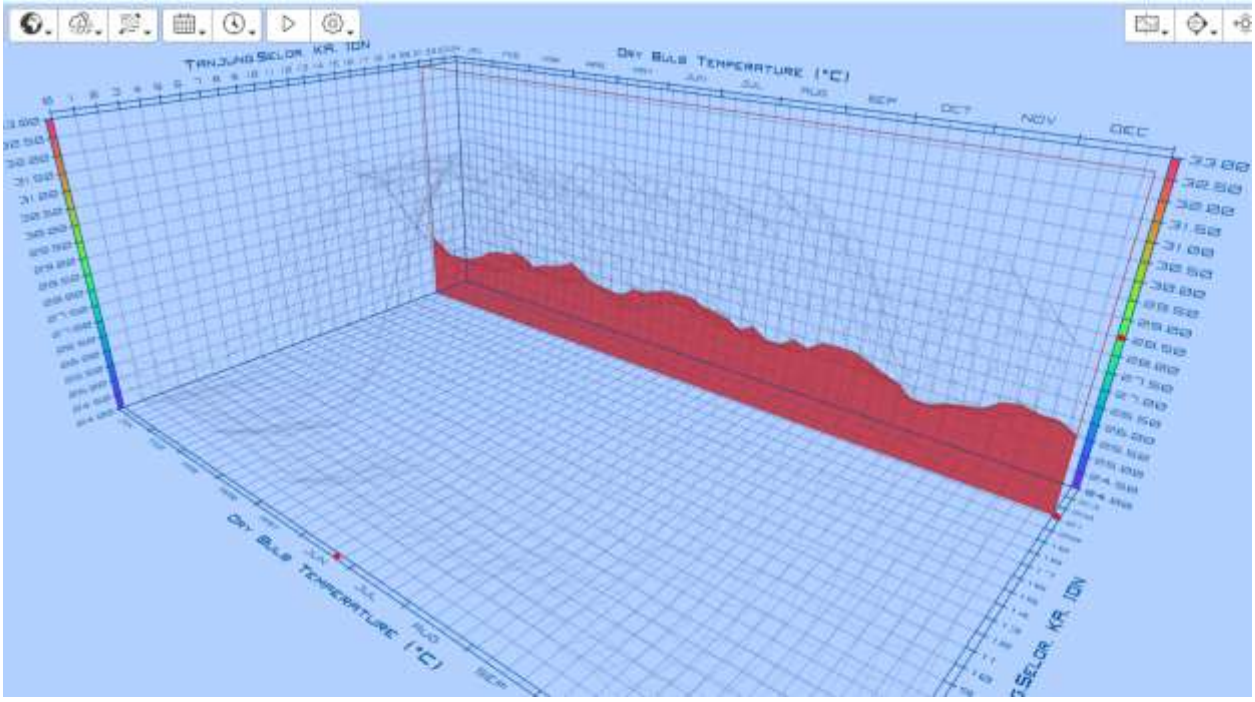

Figure 5. Profil temperatur tahunan pada jam kunjungan 3, rata-rata 26,5°C

3.1.2. Air speed and wind speed (Vud);

Tanjung Selor City has a wind character that never experiences a dead wind, as seen in the following figure 5.

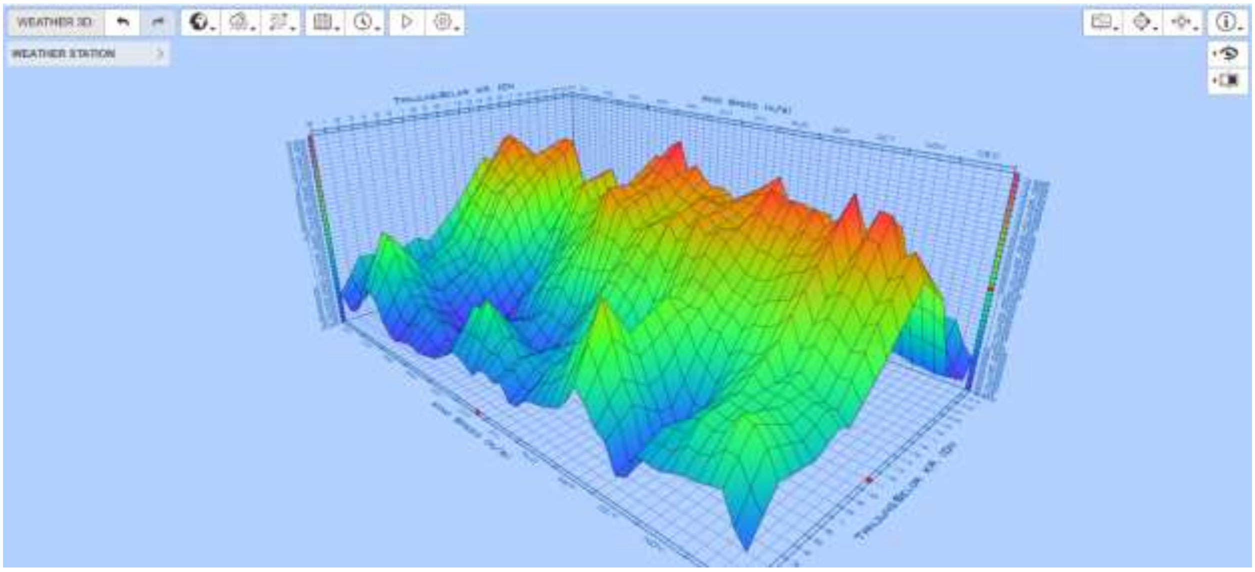

Figure 6. Profil kecepatan angin tahunan

E-ISSN:
2721-13988

Since the wind speed figures are important, it can be seen from the graph that the average wind speed at visits 1; 2 and 3 as seen in graphs 6; 7; 8; below is Tud Visit 1 = 3.1 m/sec (figure 6); Tud Visit 2 = 2.7 m/sec (figure 7) and Tud Visit 3 = 0.3 m/sec (figure 8).

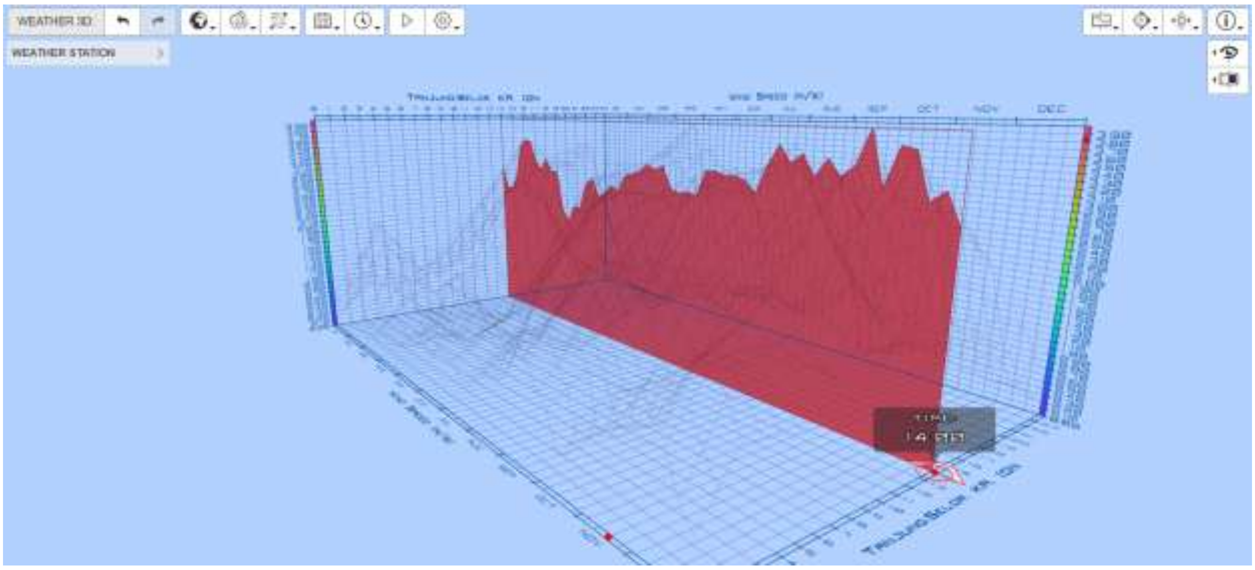

Figure 7. Kecepatan angin rata-rata pada jam kunjungan 1 yaitu 3,1 m/det

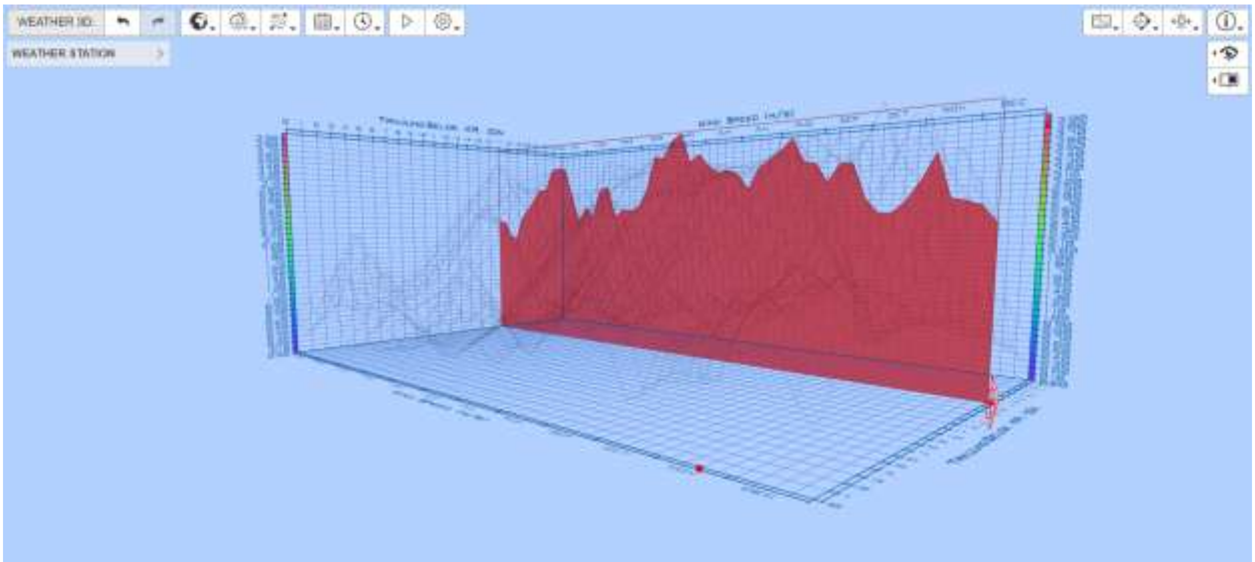

Figure 8. Profil kecepatan angin, pada kunjungan 2 kecepatan angin rata-rata 2,7 m/det

E-ISSN:
2721-13988

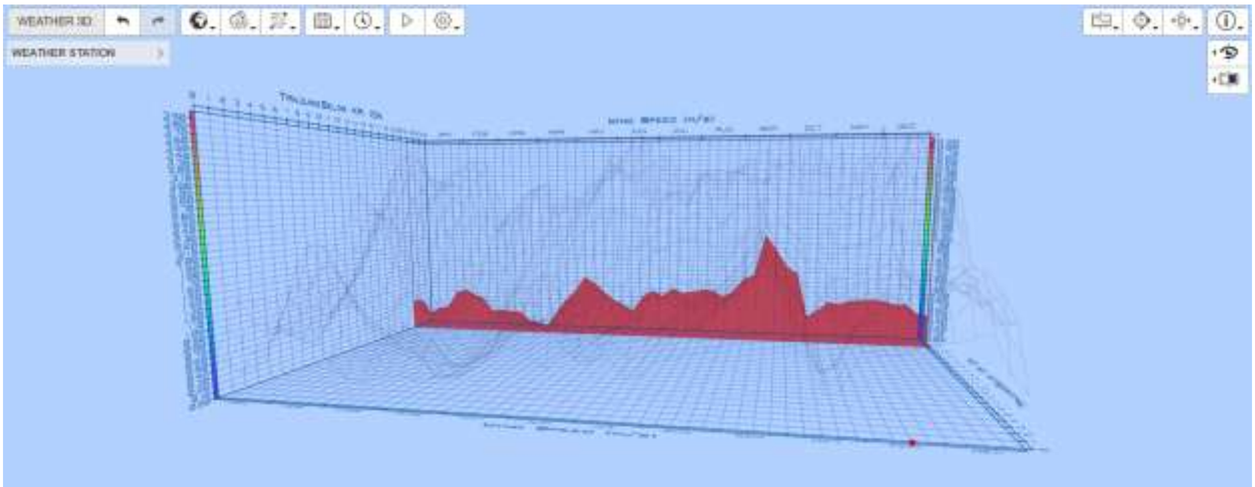

Figure 9. Profil kecepatan angin tahunan pada jam kunjungan 3, rata-rata 0,3 m/det

3.1.3. Relative humidity (Rh)

Tanjung Selor City is a city on the banks of the Kayan River. The Kayan River is a very wide river and its water flows throughout the year. Relative humidity is influenced by rain and evaporation of river water. According to theory, thermal performance will decrease as air humidity increases. The air humidity profile in Tanjung Selor City is shown in Figure 9 below.

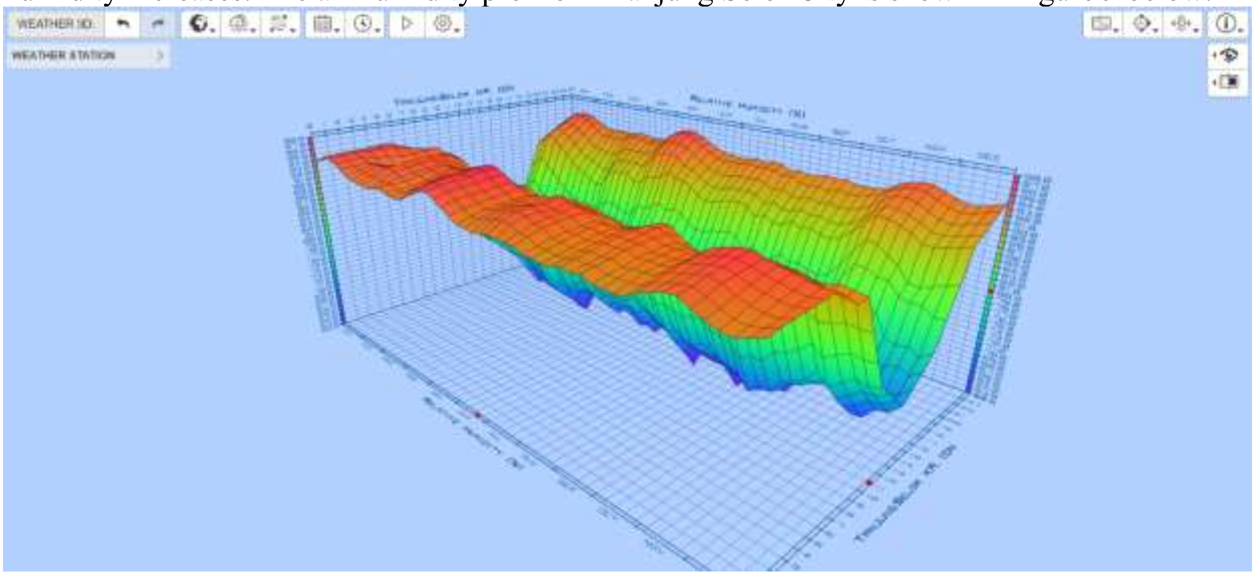

Figure 10. Profil kelembaban udara tahunan

From the graph, it can be seen that the humidity is very high, above 90% for 10 hours starting from 20:00 to 06:00 the next day. After 6:00 a.m., the humidity gradually decreases as the intensity of the sunlight increases. The lowest humidity was recorded at 62%, as shown in the following graph.

E-ISSN:
2721-13988

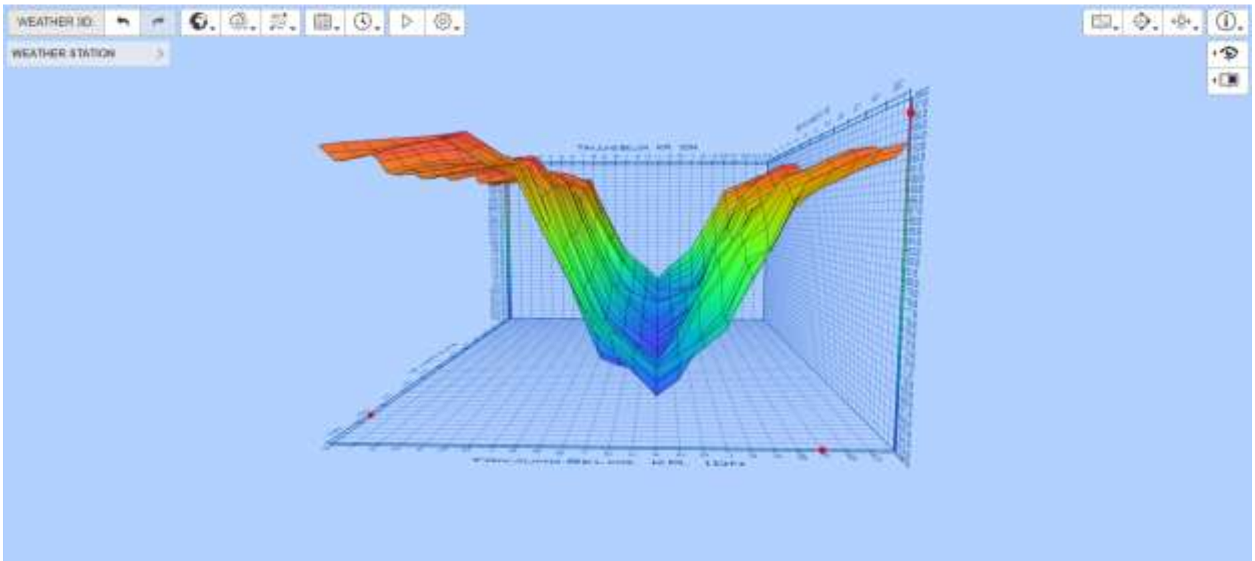

Figure 11. Profil kelembaban udara relatif. Kelembaban terendah terjadi pada pukul 14:00

At visiting hour 1, namely at 14:00, humidity reached its lowest, averaging 67%, as seen in graph 11.

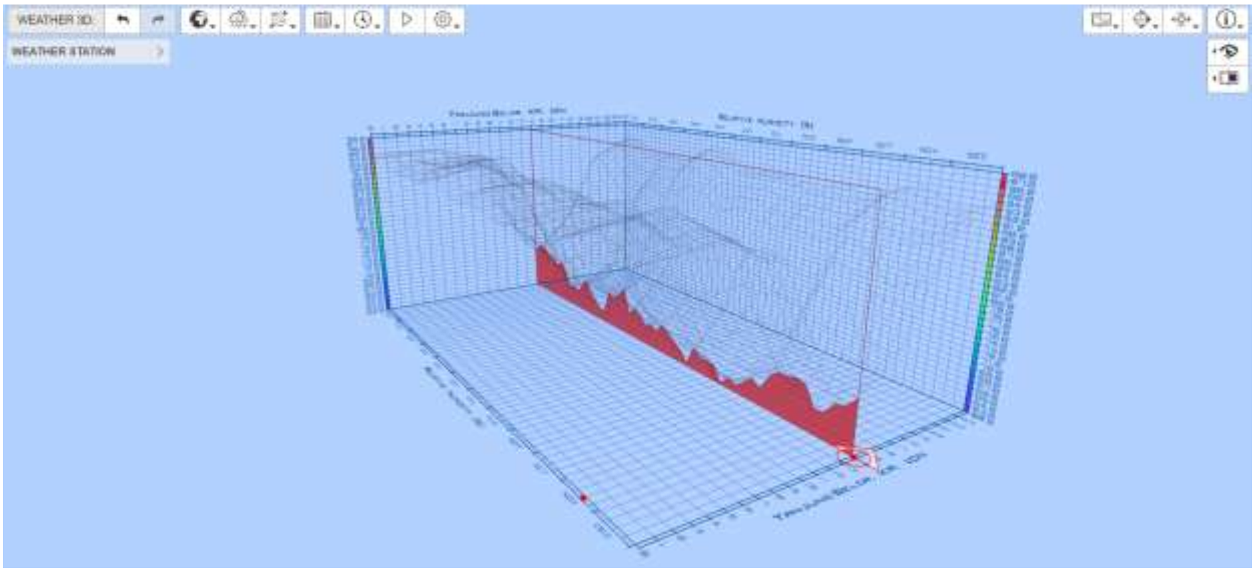

Figure 12. Profil kelembaban udara relatif pada jam 14:00

E-ISSN:
2721-13988

At visiting hour 2, namely at 17:00, the average relative air humidity was around 74% as seen in Figure 12. This value is higher than the ideal relative air humidity, which is around 50%.

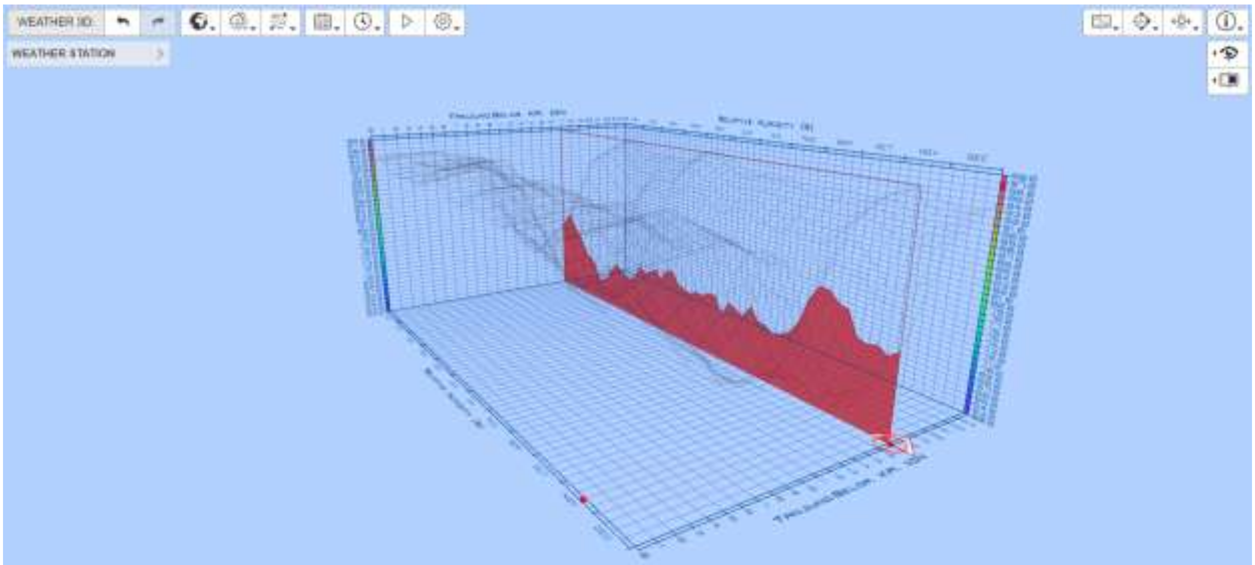

Figure 13. Profil kelembaban udara relatif pada jam 17:00, rata-rata 74%

At the 3rd visit hour, which is at 21:00, the average relative humidity is around 91% as seen in Figure 13. This value is much higher than the ideal relative humidity of around 50%. It should be noted that when the relative humidity reaches 100%, this means that the air is saturated with water vapor, and sweat can no longer evaporate. In other words, its thermal performance will be very small, very uncomfortable.

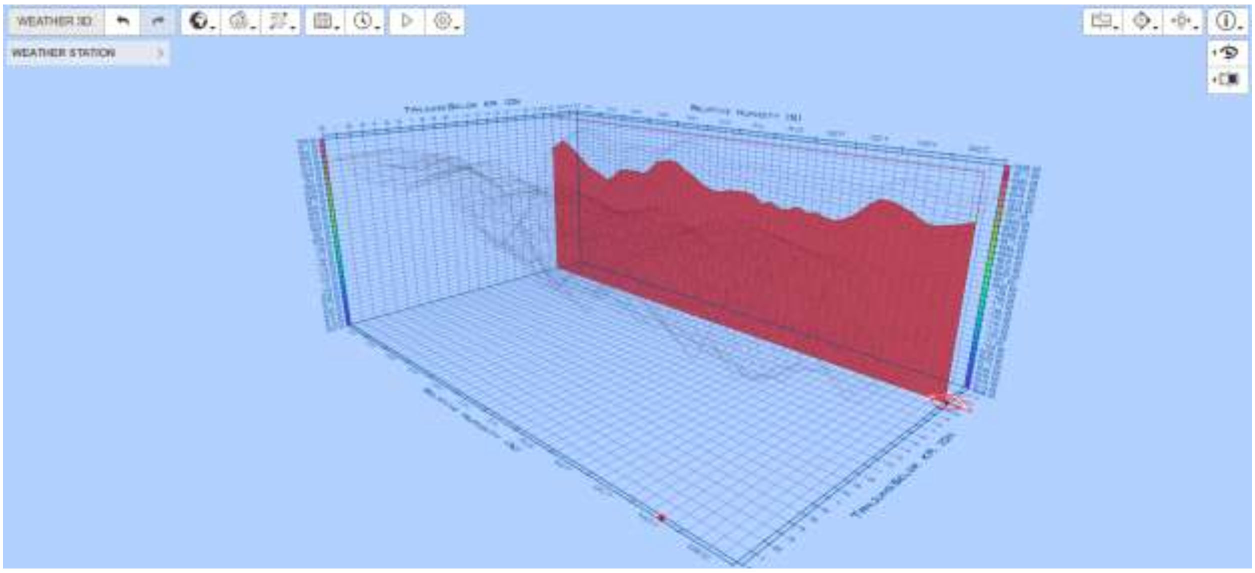

Figure 14. Profil kelembaban udara relatif pada jam 21:00, rata-rata sebesar 91%

E-ISSN:
2721-13988

3.2. Discussion

If the 9 conditions above are combined and made bold, then table 1 will be arranged as follows:

Table 1. Tabel kombinasi Temperatur, Kecepatan udara dan kelembaban udara relatif

visiting hours	dry bulb temperature (T_{ud}) in °C	air speed (V_{ud}) in m/det	Relative humidity (R_h); in %
1 (14:00pm)	32,0	3,1	67
2 (17:00pm)	29,5	2,7	74
3 (21:00pm)	26,5	0,3	91

Effective temperature is not temperature, but rather is one way to assess the level of thermal performance. Referring to the Thermal Comfort Standard of comfortable temperature for Indonesians, effective temperature is detailed as follows:

- Comfortable cool, which is between 20.5 - 22.8 °C ET*
- Optimal comfort, which is between 22.8 - 25.8 °C ET*
- Comfortable warm, which is between 25.8 - 27.1 °C ET*

Where *ET is the Effective Temperature according to the Standard Procedures for Technical Planning of Energy Conservation in Building Structures - LPMB Foundation - PU

By referring to these details, the thermal performance assessment for visiting hours to the Kulteka Area is shown in the following table:

Visiting Hours	**Research result**
1 (14:00pm)	Very uncomfortable
2 (17:00pm)	Uncomfortable
3 (21:00pm)	Warm comfortable

4. Conclusion

1. Conclusion:

Kulteka area in Tanjung Selor city, although many visitors are crowded at 14:00, 17:00, and 21:00, but in fact, its thermal performance is not good. During the visit period, there was no optimal comfort, but only comfortable warmth at 21:00. At other visiting hours, the thermal performance was not comfortable.

2. Recommendation:

Further research is needed, preferably in the form of qualitative research, with the Tanjung Selor community population, using respondents (samples) of community members who have visited the Kulteka Area.

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