

# Simulation of thermal comfort on public space and buildings around river in Banjarmasin- Indonesia

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## Simulation of thermal comfort on public space and buildings around river in Banjarmasin-Indonesia

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**Abstract.** The climate and environmental aspects are one of the things that affect architectural products. The city as a gathering place that interacts for a particular purpose has influenced the shape and visual of the city. The density of buildings in a city has affected the urban microclimate. Urban get hotter than rural areas. Urban planners need to pay attention to several aspects related to the solution to the design of the humid tropics. The concept of greening the city evenly and thoroughly, so that the thermal is not too high that can affect comfort. In this research used Rhinoceros 5, Grasshopper, Ladybug, and ladybug for simulation and validation data of wet bulb temperature on a psychometric chart and CBE Thermal Comfort Tool from ASHRAE-55 standard. The purpose of this study used simulation is to facilitate and predict the thermal conditions of buildings and the environment. This application is also used by researchers and architect designers. Based on the simulation, the indoor maximum effective temperature and standard effective temperature are always uncomfortable zones. The building condition with wooden construction is higher of thermal comfort compared with concrete construction buildings and the wood construction is faster reaches maximum value compared to concrete construction.

### 1. Introduction

The climate and environmental aspects are one of the things that affect architectural products [1]. The climate, or average weather, is primarily a function of the sun. Climate word is used by scientists to divide the earth region based on the different seasons experienced. The city as a gathering place that interacts for a particular purpose has influenced the shape and visual of the city. The increasing population living in a city, causing the complexity of the problem, is no exception to the architecture and urban design. The density of buildings in a city has affected the urban microclimate. Urban get hotter than rural areas [2][3]. Urban planners need to pay attention to several aspects related to the solution to the design of the humid tropics. The relationship between design and rules is the first half of what architects and planners need to know, that is, how design meets the requirements of the rules [4][5]. For example, urban design should pay attention to the comfort of pedestrians. Pedestrians do not need to use an umbrella, shelter when it rains and the sun



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shines. The pedestrian ways should be provided with corridors that are protected at the top. Buildings must be connected, so the activity does not stop when it rains or the sun shines [6][7][8][9].

The hard materials used as surface coatings will absorb much heat, but then the heat will reflect into the air, resulting in the warming of the surrounding air [10]. Thus, the concept of greening the city evenly and thoroughly, so that the thermal is not too high that can affect comfort. The building mass arrangement by optimizing the airflow around the building needs to be a concern. One way to improve thermal comfort in humid tropical climates is to optimize the airflow around (outdoor) and indoor buildings [11][12]. Wind movement will be better in public space if the airflow is not blocked. In the concept of arrangement of building mass, public space between buildings is important so that the airflow around the building. This research used Rhinoceros 5, Grasshopper, Ladybug, and ladybug for simulation and validation data of wet bulb temperature on the psychometric chart and CBE Thermal Comfort Tool from ASHRAE standard 55 [13][14]. The purpose of this study used simulation is to facilitate and predict the thermal conditions of buildings and the environment. The thermal input of the location is based on the recorded Energy + data, and the shape of the building and site is drawn according to real conditions. Also besides, to support calculations at CBE Thermal Comfort Tool, in this study also used NOAA's Solar Calculator to calculate solar altitude or elevation for simulation thermal comfort.

## 2. Research Methods

This research is quantitative research based on simulation data collected from Energy Plus to view thermal comfort in the field (Figure 1). This research used the standard thermal comfort is effective temperature and standard effective temperature by ASHRAE-55. This research was conducted in two sub-districts or three urban villages in Banjarmasin city. The sub-district is a Central Banjarmasin sub-district and the East Banjarmasin sub-district. The village located in the Central Banjarmasin sub-district, namely: Gadang village and Sasirangan village and the village in the East Banjarmasin sub-district is Bilu River village. The simulation was conducted from August 20 to September 20, 2020. The software used for simulation is shortwave solar calculator, solar position calculator, Rhinoceros 5 software, grasshopper software, ladybug software, and honeybee software. The ladybug and honeybee software are simulation-based on ASHRAE international standards. This application is also used by researchers and architect designers [15]. In addition, this application can use the energy plus data bank so that it can observe the thermal comfort conditions of a place in more detail. Step by step of the simulation method is as follows:

- Survey results in the form of maps: area and location, then processed in grasshopper software based on observations in the field.
- The sketch of buildings form based on survey results and photographs in the field, then processed in grasshopper software.
- After the drawings are complete. The maps and building images are collaborated to provide information about conditions in the location and study place.
- Import Energy+ data in grasshopper software.
- Run the honeybee application in grasshopper software, and input coordinate points based on the research place.
- Setting building and environment conditions in honeybee application, like material, orientation, and position.
- Render, and result simulation show in grasshopper software based on model design.

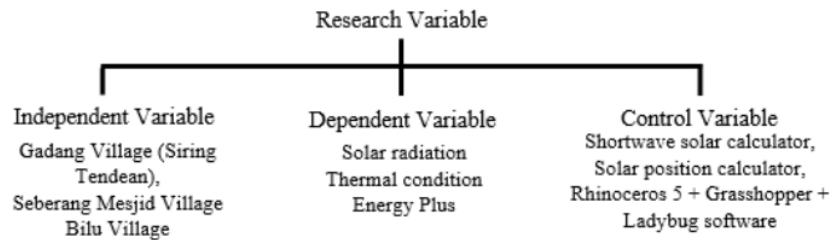


Figure 1. The research variable scheme

### 3. Result and Discussion

#### 3.1. Sunlight Hours Based on Simulation

The duration of solar radiation during the day affects thermal comfort in the study area. Simulation with Rhinoceros 5 + Grasshopper application can help to determine the duration of solar radiation so that it can be known the causes of differences in thermal and thermal comfort conditions. Building elements such as roof and wall affect indoor thermal comfort, due to longer solar radiation times. Based on the simulation results (Figure 2), the duration of solar radiation on the roof is between 10 and 11.5 hours while the wall is only 4 hours. If observed, the area covered by a roof in Seberang Mesjid village and Bilu village is around 50% while in Siring Tendea only 7.5% while the rest is green open space, open space or river. The roof surface with a long duration of solar radiation causes high thermal and thermal comfort in the building. The dominant roof that affects indoor thermal comfort, outdoor conditions affect such conditions around buildings, green open spaces, or without vegetation and rivers affects. If seen from the simulation results, the duration of solar radiation in open spaces without protection (vegetation) and river area between 11.5 to 12 hours or a full day. The duration of this solar radiation affects indoor and outdoor around the river. Meanwhile, the open space around the building has a lower sun exposure duration of between 8 and 9 hours due to the influence of building shadows. Likewise, the green open space gets much lower solar radiation in the outdoor, especially under the tree.

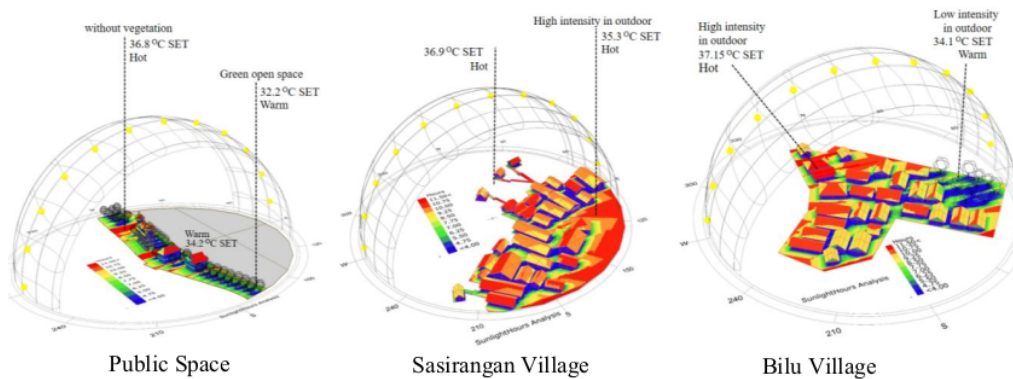


Figure 2. Simulation of sunlight hours

Based on the simulation results it can be seen (Table 1), thermal comfort in Public Space is better in green open spaces because the duration of solar radiation is lower than open space without protection or vegetation. Thermal comfort in Sasirangan village is more influenced by the duration of sun irradiation on the roof and river surfaces that affect environmental thermal and of course thermal comfort, especially in floating homes. Similar to Sasirangan village, thermal comfort in Bilu village is also affected by sun exposure on the roof surface and open space in the river area. However, the green open space around the settlements has a lower duration of solar radiation and affects the surrounding buildings.

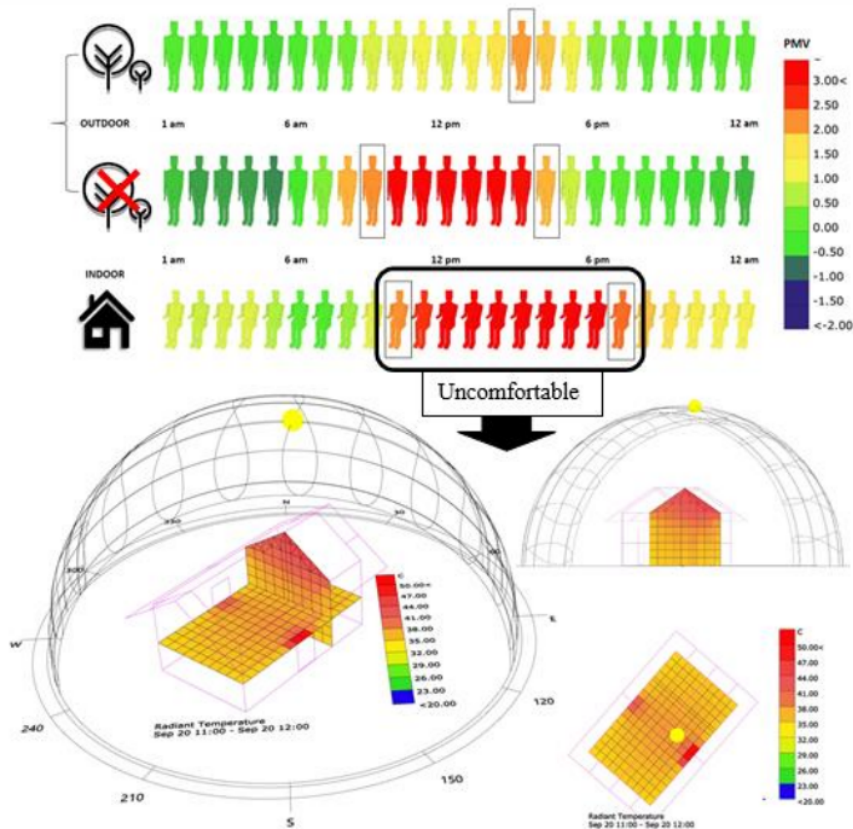
**Table 1.** Sunlight hours and the percentage covered

Place	Roof	Wall	Around building	Around the tree	Under the tree	Without protection or vegetation	Without protection (river)
Public place	10-11.5 (7.5%)	4	8-9 (7.5%)	7 (25%)	4 (25%)	11.5-12 (10%)	11.5-12 (25%)
Seberang Mesjidvillage	10-11.5 (50%)	4	8-9 (10%)	-	-	11.5-12 (15%)	11.5-12 (25%)
Bilu village	10-11.5 (50%)	4	8-9 (5%)	7 (3%)	4 (7%)	11.5-12 (10%)	11.5-12 (25%)

### 3.2. Characters of Thermal Comfort around River

The indoor effective temperature and standard effective temperature was higher during the day in floating houses at Sasirangan village and houses aside pedestrian ways at Bilu village. The Outdoor minimum effective temperature just past the threshold of thermal comfort SNI 03-6572 and almost all places have a minimum effective temperature outdoor around 20°C ET or cool comfort condition in the morning, the same time based on ASHRAE-55, the standard effective temperature around 22°C SET or slightly cool, but based this standard is not comforted as shown Figure 3. These conditions indicate that the outdoor or environmental conditions in the morning are cool. The green open space is the best condition based effective temperature and standard effective temperature because always in the comfort zone and neutral comfort until warm comfort in ASHRAE-55. This proves the open space with vegetation or green open space, the better for micro-climatic conditions. The effective temperature and standard effective temperature around the river are lower than the mainland region, this condition can be seen from the different thermal comfort between floating houses, houses aside pedestrian ways, and settlement in Sasirangan village and Bilu village. The indoor and outdoor thermal comfort are highest on minimum conditions. Meanwhile, the maximum thermal comfort is quite varied.

Sun radiation effect to thermal comfort, mean of maximum sun radiation is from 1065 W/m<sup>2</sup>-1207 W/m<sup>2</sup> occurs at 1:00 PM. If it is correlated between the mean of maximum and minimum standard effective temperature, it is known that the indoor effective temperature and standard effective temperature not so much different but the outdoor conditions are so much different because the solar radiation includes calculation in standard effective temperature. Besides, the maximum value on the time of indoor mean effective temperature and standard effective temperature occurs from 12:30 AM to 1:30 AM, except for indoor buildings in green open spaces located: slower to reach a maximum point and mean of maximum conditions are lower than houses in Sasirangan village and Bilu village. Meanwhile, the mean of outdoor maximum effective temperature and effective temperature occurs from 12:30 PM to 2:30 PM.



**Figure 3.** Comparison of thermal comfort between public space and building around the river

#### 4. Conclusion

Based on the previous explanation, thermal comfort conditions are more convenient in buildings in public space. The high solar radiation affects the dry bulb temperature and relative humidity. The thermal comfort conditions are more comfortable in public space with vegetation than buildings in Siring Tendean. Meanwhile, the public space without vegetation during the day tends to hot and early morning is cool based on ASHRAE-55. The presence of trees in public space can be control in thermal comfort because the green open space is not low at night or minimum conditions, these conditions can be concluded the vegetation affects the thermal environment and thermal comfort conditions in public space. The open space conditions that have lots of vegetation is better thermal conditions than open space without vegetation. Open space with trees has been able to reduce the thermal environment. As a public space, these places should provide comfort for visitors. Thermal comfort during the day needs to be considered and the direct sunlight barrier is required in open spaces, buildings, or houses. Based on the simulation,

the indoor maximum effective temperature and standard effective temperature are always an uncomfortable zone. The building condition with wooden construction is higher of thermal comfort compared with concrete construction buildings and the wood construction is faster reaches maximum value compared to concrete construction. The green open space in public space has been the best thermal comfort compared to the others. Meanwhile, open space without vegetation at minimum conditions an uncomfortable zone, and effective temperature and standard effective temperature are faster reach to maximum condition, compared to the open space with vegetation.

### References

- [1] Rapoport A 1969 *House Form And Culture* Prentice-Hall Englewood Cliffs New Jersey.
- [2] Roth M 2013 *Handbook of Environmental Fluid Dynamics: Urban Heat Islands*. CRS Press/Taylor and Francis Group Vol 2 143-160
- [3] Aaron R Y Sarah E D Ryan A. M 2020 *Evidence for the evolution of thermal tolerance, but not desiccation tolerance, in response to hotter, drier city conditions in a cosmopolitan, terrestrial isopod* Evolutionary Applications
- [4] Al-Bishawi M Ghadban S 2011 *International Journal of Architectural Research: A Methodological Approach for Reading Urban Open Space* ArchnetJAR Vol 5 No 1 73-85.
- [5] Silvia G David S Greg M Karine D Christhina C Simon T 2020 *Public health and well-being in public open spaces through climate responsive urban planning and design* The Journal of Public Space Vol 5 No 2 1-6
- [6] Karyono T H, 2001 *Dimensi Teknik Arsitektur: Wujud Kota Tropis di Indonesia: suatu pendekatan iklim, lingkungan dan energi* Vol 29 No 2 141 – 146
- [7] Akbar R Shoichi K 2017 *Proc. Int. Conf. on Chemical, Biological and Environment Engineering: Analysis of thermal comfort SNI-6390 in the Lanting (floating house)* 100 54-58
- [8] Satoshi S Ivan F Darko R 2020 *Public-private interaction in low-rise, high-density Tokyo* The Journal of Public Space Vol 5 No 2 63-88
- [9] Kaoru M Rui I Shihona A Akiko T Yusuke H Riki N 2020 *Research on the relationship between human behaviour and climatic characteristics in a public open space* The Journal of Public Space Vol 5 No 2 111-128
- [10] Akbar Rahman 2010 *Proc. Int. Conf. on Sustainable Environmental Architecture (SENVAR): The Different Air Temperature in The Shadowed and Unshadowed Condition* ITS Surabaya
- [11] NazhatulzalkisJ Nurul I M Mohd F K Suriani N A 2015 *Thermal Comfort of Residential Building in Malaysia at Different Micro-climates* Procedia - Social and Behavioral Sciences Vol 170 613-623
- [12] Latif S Hamzah B Ihsan. 2016 *Pengaliran Udara untuk Kenyamanan Termal Ruang Kelas dengan Metode Simulasi Computational Fluid Dynamics* Sinektika Vol 14 No 2 209-216
- [13] ASHRAE Standard 55 P 2003 *Thermal Environmental Conditions for Human Occupancy*
- [14] Fabbri K 2015 *Indoor Thermal Comfort Perception* Switzerland Springer International Publishing
- [15] Zacepins A Egils S 2012 *Proc. Int. Conf. on International Carpathian Control Conference: Architecture of automatized control system for honey bee indoor wintering process monitoring and control* Slovakia 13



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