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Simulation and Analysis of Thermal Environment and Building Comparing Wetland Conditions in Banjarmasin-Indonesia and Saga-Japan

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Abstract. Climate change has actually happened, according to NASA data the surface temperature of the earth has increased significantly. The impact of rising earth surface temperatures causes erratic weather conditions, high rainfall and drought in the summer season. In August 2019, devastating forest fires in Indonesia caused smoke on the islands of Sumatera and Kalimantan. Meanwhile in Japan, flooding occurred in Saga prefecture due to high rainfall for several days. Environmental conditions between Indonesia and Japan are different but experience disasters at the same time. This study examines the real conditions of the thermal environment in Banjarmasin and Saga. The analysis results of the thermal environment and building thermal simulations in the two cities, there are similarities in thermal anomalies that tend to be high or extreme. In addition, thermal measurements are carried out in the summer of August and September. That month is summer conditions with a maximum temperature of 37^{O}C, but in Saga it floods when the Banjarmasin experiences a drought. Building technology and accurate weather predictions from the government has been able to reduce the impact of disasters from climate change.

1. Introduction

Global warming is the unusually rapid increase in Earth's mean surface temperature over the past century, primarily due to the greenhouse gases released as people burn fossil fuels. Climate change has actually happened and caused disasters in various countries. Christina Figures, former UN climate director, said that climate change is out of control [1]. The climate change causes erratic weather conditions, high rainfall-and drought in the summer season.-August 2019 in Indonesia, when the summer forest fires cause smoke on the islands of Sumatra and Kalimantan. At the same time and season in Japan, a different phenomenon occurred on the Kyushu island, Saga prefecture, which was flooded.

Indonesia and Japan have different climates, Indonesia has a humid tropical climate while Japan has a sub-tropical climate and also causes different seasons. In Indonesia there is summer and rain, while in Japan there is summer, autumn, winter and spring. Based on these climate differences, but both have the same season, namely summer. Summer in Indonesia occurs in April-October while in Japan in June-September.

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Based on these similarities, this study aims to discuss the micro-condition of the region between Indonesia and Japan by taking case studies in Banjarmasin City and Saga City. The reason is that the two cities have similar characteristics and landscape, which are located in the lowlands with wetlands conditions with high humidity conditions every year (Table 1). Many studies are conducted in one place with variable research variables, but it is still rare to do research comparing the thermal conditions of the environment with different climates. Research in humid tropical climates such as in Indonesia, Singapore and Malaysia relating to thermal continues to attract researchers' interest to be developed. Like the research that has been done [2,3,4], This study examines the thermal environment and buildings with measurements in the field and conducts evaluations to validate the results of thermal measurements. In addition, this research also takes into account the government's mitigation or efforts towards disaster in both cities.

Table 1. Comparison of physical conditions between Banjarmasin City and Saga City

Comparison	Banjarmasin	Saga
Coordinate points	S 3°15', E114°32'	N 49° 25', E 55° 11'
Total area	98,46 km²	431,84 km²
Climate	Humid Tropical	Humid subtropical
Total Season	2	4
Summer season	April - October	June - September
MASL	1	4
Land	wetland	wetland
Soil	Peat	Peat

2. Literature Review

Thermal effect to comfortable and comfort is the result of the interaction of physical exchanges, physiological, psychological, social and cultural rights, it depends on the architecture, the clothing, the eating habits and the climate [5]. Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation [6]. To create thermal comfort must understand the environmental conditions that can make heat to be lost [7]. There are four conditions that must be considered and affect thermal, are: solar radiation, temperature, relative humidity and wind.

2.1. Solar radiation

Solar radiation is the only renewable energy source available today. Meanwhile, city regulations and geographical conditions often hamper the use of renewable energy sources. Thus, the necessary connections with the environment are provided with apertures through which radiation is admitted [8]. The effect of solar radiation on a site is determined by: duration, intensity, and the sun angle [9].

2.2. Temperature

Temperature is important in creating a comfort in the building and environment. The solution to heat stroke is paying attention to comfort factors, such as humidity and wind [4]. The temperature will determine the rate at which heat is lost to the air by convection. The temperature also affects human comfort and the value of comfort will vary depending on natural conditions [7].

2.3. Relative Humidity

Relative humidity can experience high fluctuations, depending on changes in temperature. The temperature impacts the ability of air to absorb water. Relative humidity shows the ratio of water vapor pressure to the maximum vapor pressure, expressed in percent. The rainy season or wet season is a season characterized by increased rainfall in a region within a certain period regularly. The rainy season is only known in areas with a tropical climate [10].

2.4. Wind velocity

Air movement affects the heat-loss rate by both convection and evaporation. Consequently, air velocity has a very pronounced effect on heat loss. In the summer, it is a great asset and in the winter a liability. Low-speed winds can improve the microclimate, while stronger winds should be avoided. Although air movement from a breeze is usually desirable in the summer, it is not in very hot and dry climates. The higher the temperature, the less the total cooling [7].

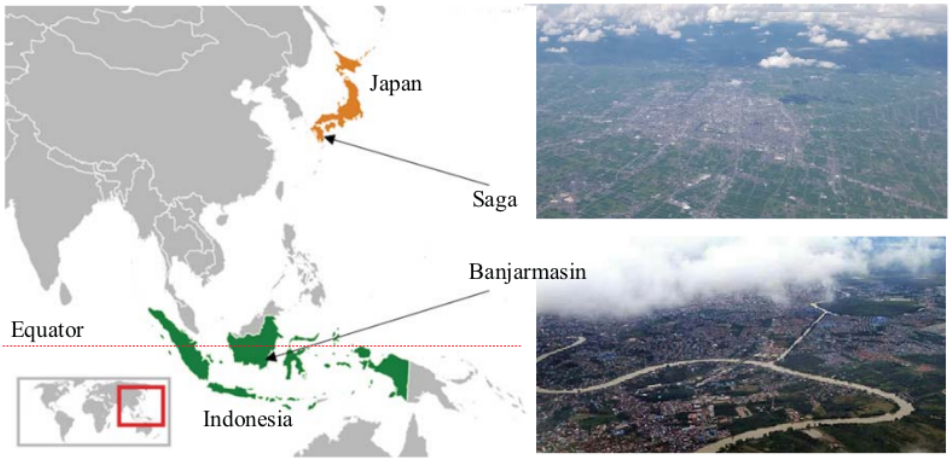


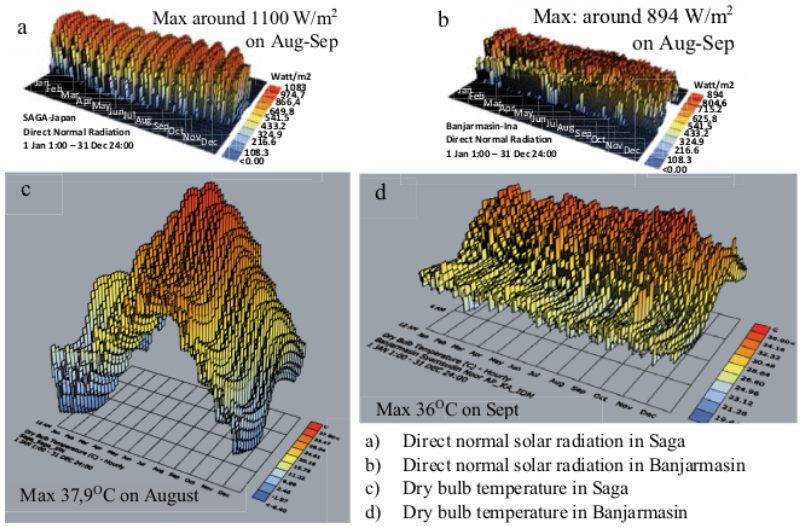
Figure 1. Research locations

3. Research Methods

This research is a qualitative research based on quantitative data collected from the results of monitoring in the field. The study was conducted from August 20 to September 20, 2019. The research site was at the residence, HKSN Permain, North Alalak Village in Banjarmasin and at Honjo Machi, Saga Shi, Saga, also at the residence (Figure 1). The data collected is dry ball temperature which is an indicator of heat, other supporting data are relative humidity and wind speed. Solar radiation is also monitored, because sunlight affects the thermal environment and buildings. The data collected was then analyzed using control variables from the Energy Plus (Energy +) data simulation process, the purpose of which is to provide a clearer picture of the environmental and building thermal conditions at the study site.

Measuring instruments use: lux meter, data logger, and extech AN100 while other gauges: Self-retracting tape measure, drone, camera and tripod. While the software used for simulation is: shortwave solar calculator, solar position calculator, hinorceros 5 software, grasshopper software, ladybug software and honeybee software. The reason for using the honeybee application in a simulation is because this application is based on ASHRAE international standards. This application is also used by researchers and architect designers [11]. In addition, this application can use the energy plus data bank so that it can observe the thermal conditions of a place in more detail. The simulation method is as follows: a) Survey results in the form of maps: area and location, then processed in grasshopper software based on observations and measurements in the field. b) The results of the survey in the form of building sketchs and photographs, then processed in grasshopper software based on the measurement results in the field. c) After the drawings are complete. The maps and building images are collaborated to provide information about conditions in the location and study place. d) Import Energy+ data in grasshopper software. e) Run the honeybee

application in grasshopper software, and input coordinate points based on research place. f) Setting building and environment condition in honeybee application, likes material, orientation and position. g) Render, and result simulation show in grasshopper software based on model design (Figure 2 and 3).



a) Direct normal solar radiation in Saga
b) Direct normal solar radiation in Banjarmasin
c) Dry bulb temperature in Saga
d) Dry bulb temperature in Banjarmasin

Figure 2. Simulation results of thermal environment in research study

4. Result and Discussion

4.1. Simulation results of thermal environmental and building

Based on the results of environmental thermal simulations in Banjarmasin and Saga (Figure 2), thermal environments differ between Banjarmasin and Saga especially in January to May and November to December. At that time, the thermal environments in Saga was lower than Banjarmasin. While in June to October the conditions are the same, even the thermal environments in Saga City is higher. This difference is due to the season, when the spring, autumn and winter are lower temperature in Saga City, while in Banjarmasin the environmental conditions are relatively the same throughout the year. In summer, temperatures in Saga are higher around 37.9^{O}C while Banjarmasin has a maximum of 36^{O}C. High temperatures in Saga are caused by high direct solar radiation around 1100 W / m2, while in Banjarmasin around 950 W / m2. In addition, the high temperature in Saga is also due to the length of irradiation in summer which is around 14 hours / day, whereas in Banjarmasin it is only 12 hours / day throughout the year.

Aerial photography shows, the majority of residential buildings in Banjarmasin City are residential houses with zinc roofing, as seen in Figure 1. In contrast to Saga, many buildings use earthen roof tiles. The average age of buildings in Banjarmasin and Saga is 10 years and above. In addition, this roofing material is also known as metal tile which is made from zinc and aluminum. New technology in building materials is still using basic materials from zinc. Based on the results of measurements in the field, the thermal conditions of buildings in Banjarmasin are higher than Saga, this is due to the better use of materials and technology in Saga. Measurement results in Banjarmasin, zinc surface temperature is high during the day until late at night, ie between 10 AM - 7 PM. At that time, the zinc surface temperature is above 43°C, to

the maximum point of 57°C at 1 PM - 2 PM (Figure 3). It shows a high value and affects the temperature of the building and the surrounding environment from convection and reflection. Inversely related to daytime conditions from midnight until early morning, the zinc surface temperature is lower than room temperature, which is below 25°C or between 20°C - 23°C.

The high surface temperature of zinc has been proven to have influenced the temperature of the indoor and outdoor space or the environment around the building (outdoor). The Effective Standard Temperature (SET*) value is high when the zinc roof temperature is also high at 10 AM - 7 PM. Current SET* values are above 30°C between 31°C to 37°C. The SET* value is high, because the SET* is a combination of various thermal factors, namely the temperature, relative humidity and wind that influence each other. The effect of the high surface temperature of zinc has been shown to have affected the temperature of the room and the temperature of the environment around the building.

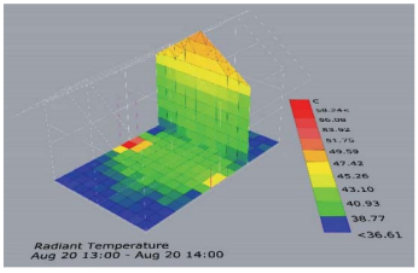


Figure 3. Simulation result of building thermal condition in Banjarmasin

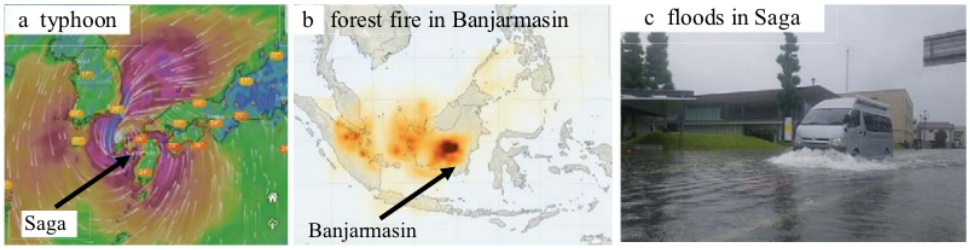


Figure 4. Environmental conditions in research study, a) typhoons in Saga have an effect on heavy rains, b) forest fires in Kalimantan, Banjarmasin, and c) floods in Saga

4.2. Climate change disasters

Summer conditions with a maximum temperature of 37^{O}C, but in Saga it floods when the Banjarmasin experiences a drought. Although the temperature and solar radiation in Banjarmasin are lower than Saga, in August and September there was a drought. The drought caused land fires and smoke resulting in air pollution. This phenomenon always occurs in the summer, the cause is the clearing of land by communities and plantation companies by burning. Meanwhile in Saga, although temperatures and solar radiation are higher, there is no drought. Conversely, on August 28, flooding occurred after raining 3 days non-stop. This flood is the largest flood in Saga that has caused 3 people to die. The cause of this flood is the typhoon of the Pacific Ocean which often occurs in the summer. The snaking pattern is caused by large movements and

high pressures that usually surround Japan in the summer to the Pacific, causing storms to move southeast of Japan. In addition, the typhoon surrounding the Japanese mainland caused heavy rain to several places.

Flooding on August 28, 2019 (Figure 4), only happened for 1 day with the water level on the road around 80 cm. Floods recede quickly after rain, a good and clean drainage system causes water to quickly flow into the lower plains or the sea. The management and anticipation of disasters in Saga are carried out by the government through television, smart phones and officers distributed at the disaster site. This disaster management helps local residents and can reduce the impact of losses from disasters, such as floods. The use of technology in dealing with disasters has been able to reduce the impact of disasters. Up-to-date weather information helps the public know and plan for disaster relief measures.

5. Conclusion

Based on the explanation above it can be concluded that in summer, the thermal environment is not much different between Banjarmasin and Saga, even the temperature in Saga is higher than in Banjarmasin. Increasing the surface temperature of the earth has given disasters in several countries. Drought does not only occur in the summer, floods can occur in the summer as in Saga. Although temperature is higher in Saga, indoor temperature is lower than in Banjarmasin, due to the use of building materials and the use of building technology. Disaster management and anticipation is carried out through the use of effective technology to overcome the impact of disasters. Disaster management methods in Saga are better than in Banjarmasin. The Indonesian government can imitate the use of technology in Japan in dealing with disasters.

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