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THE IMPACT OF GREEN OPEN SPACES CHANGES ON TEMPERATURE AND HUMIDITY AND THE LIVABLE CITY INDEX OF BANDA ACEH

*Abdul Wahab Abdi and M. Hafizul Furqan

*Department of Geography Education, Faculty Teacher Training and Education, Syiah Kuala University
Email: wahababdi@unsyiah.ac.id
*Corresponding Author, Received: 10 Sep. 2019, Revised: 05 Nov. 2019, Accepted: 01 Dec. 2019

ABSTRACT: Construction of physical infrastructure resulted in reducing vegetation cover land. This problem has an impact on weather conditions, namely temperature and humidity, and the index of comfort for the citizens of the city. This study aims to find out (1) Changes in Open Space City of Banda Aceh for five years, from 2012 - 2017; (2) the connection between temperature and RTH relative humidity; (3) Comfort index based on the Temperature Humadity Index (THI) in the city of Banda Aceh; and (4) Comfort index based on the adequacy of green open space. The research method uses a quantitative approach. Sources of research data are Landsat Remote Sensing imagery and field measurements for temperature and humidity data. Data is processed by using GIS, product moment correlation analysis, determine the comfort index using the Temperature Humadity Index (THI) formula. Additionally, based on the results of data processing, it was concluded that (1) there was a reduction in green open space of 299 ha for five years in Banda Aceh, only Syiah Kuala District had a proportional open space area; (2) The correlation coefficient between temperature and relative humidity is -0.78 or in the strong category; (3) Comfort index based on THI Banda Aceh in the uncomfortable category; and (4) the lowest RTH with THI is 28.1 in Hutan Kota Trembesi, Jaya Baru District, while the highest THI RTH is 30.8 in Blang Padang Field, Baiturrahman District.

Keywords: Green space, Temperature, Humidity, Comfort index, Banda Aceh

1. INTRODUCTION

The phenomenon of urban development triggered by population growth, which is followed by the physical construction and infrastructure of the city. In addition, further impact that occurs is the change in land use change. Thus, pressure that often occurs is on agricultural land, plantations and urban forests, thus reducing vegetation cover land. Urban expansion caused by rapid population growth in the area, is the main cause of changes in vegetation [1].

Increased physical infrastructure and reduced vegetation cover will have a direct impact on weather conditions, humidity and will ultimately have an effect on the index comfort of the city residents. Further, case studies in Jakarta show that the distribution of UHI (increase in temperature due to human activities) from 1989 to 2002 in areas with physical buildings, parking lots, roads that do not have vegetation have higher temperatures (above 30 ^{o}C) compared to areas that have vegetation[2].

Plants or vegetation act as providers of oxygen, O^2 and other elements such as CO^2, N^2O, and NH^4 including in greenhouse gases (GHG) which can naturally absorb heat radiation in the atmosphere [3]The changes in concentration of these elements will have an impact on the instability of climate conditions both at extreme temperatures and rainfall. Vegetation in Green Open Space (RTH) as the lungs of the city which is a producer of oxygen (O^2), absorbing carbon dioxide (CO^2) and other pollutant gases, as well as water absorption areas, whose functions have not been replaced. The important of RTH purpose in the city lungs is the aspect of the ongoing function of recycling between carbon dioxide (CO^2) and oxygen (O^2) from photosynthesis, especially on leaves[4].

Sunlight illuminates the surface of the earth occur a process of reflection, transmission and absorption. Hot areas are generally found in parts of the city that are not vegetated, because in urban areas not vegetated the three processes are synergistic in increasing air temperatures[5].

As for efforts to green the city such as; management of city parks, environmental parks, green lines and so on. According to law Number 26 of 2007 concerning Spatial Planning in Article 29 it is stated that green open spaces consist of public green open spaces and private green open spaces, where the proportion of urban green open space is at least 30% of the city area, while the proportion of open spaces public green at least 20% of the total area of the city.

Banda Aceh is the capital city of Aceh Province which has a tropical climate. Banda Aceh has 61.36 km^2 with 254.905 population and population growth is 1,84% per year [6]. The increase in temperature is partly due to the

development of cities that are growing, such as housing, office buildings and other facilities.

Banda Aceh is the capital city of Aceh province which has a tropical climate. The condition of the weather which is getting hotter and hotter is an environmental problem in the city of Banda Aceh. The increase in temperature is partly due to the development of cities that are growing, such as housing, office buildings and other facilities.

The occurrence of this temperature rise is essentially a reflection of changes in microclimate and reduced vegetation will worsen the aesthetic appearance of the city face to be arid and hot. This certainly reduces the level of comfort of the population in the city of Banda Aceh. According to [7] temperatures in the city center show the highest and will gradually decrease towards the edge of the city to the village. This is a reflection of micro-climate change in the Banda Aceh City area. At present the symptoms of an increase in air temperature especially during the day are felt in Indonesia, especially in big cities, one of which is the Banda Aceh region of Aceh province. This shows that environmental problems related to the increase in air temperature in urban areas require special attention. The existence of green space is an effort to improve environmental conditions in urban areas. Green space has a role as a micro climate controller, which is as a protector from solar radiation, lowering the temperature of the city. Areas that have vegetation and water bodies have lower temperatures, can increase air humidity, reduce wind speed, and can fulfill aesthetic functions, and can be utilized to carry out various socio-cultural activities [2].

Based on the problems outlined above, this study aims to find out: 1) Changes in the City of Banda Aceh green space from 2012-2017; b) Comfort index based on Temperature Humadity Index (THI) in the city of Banda Aceh; c) Comfort index based on the adequacy of green space

2. METHODS

2.1 Determine Change in RTH

In determining the area of green space in Banda Aceh city that has undergone changes, it was done by using multi-temporal Landsat 7 satellite image data (2015-2017) results from Remote Sensing. GIS analysis is then performed using ArcGis 10 with overlay analysis techniques to determine information on changes in green space.

2.2 Temperature and Humidity of Comfort Index

The study was conducted at nine points in each district in the Banda Aceh city. The reason for determining this point is based on the consideration that each location represents green space in each district in Banda Aceh, so that it is able to represent the conditions of the microclimate in the entire city of Banda Aceh.

Data were analyzed statistically by techniques: 1) Measure and analyze the correlation coefficient (r) using the product moment formula; and b) Measuring and analyzing the Temperature Humidity Index (THI) based on data on air temperature and humidity using the formula:

$$THI = 0{,}8\ T + \frac{RH \times T}{500}$$

Information :
THI : *Temperature Humadity Index*
T : Temperature (^oC)
RH : Relative Humidity (%)

Comfort index in a location is considered comfortable if the THI is located between 21-27, and categorized as uncomfortable if the THI is greater or above 27[8].

3. RESULTS

3.1 Changes of Green Open Space in Banda Aceh 2015-2017

Green open space can be defined as an area in the form of longitudinal, pathways and areas that are more open to use, where plants grow, both naturally and intentionally grown. Public green open space is open space owned and managed by the regional government of the city that is used for the benefit of the general public. The area of public green space is at least 20% of the total area of the city, so that a balance will be reached both the balance of the hydrological system and the microlimat system, as well as other ecological systems, on its buildings (Law No. 26, 2007 concerning Spatial Planning) [9].

Banda Aceh has 61.36 or 613,600 ha. Figure 1 shows the results of the overlay of green space maps in the cities of Banda Aceh in 2015 and 2016. Based on the map, information was obtained that the area of green open space in 2015 was around 1,192.4 ha, while the green space in 2016 was around 1,185.8 ha. From this information it is known that there has been a reduction in the area of greenspace in Banda Aceh city in the range of 2015 to 2016 by 6.6 Ha.

Figure 1 and 2 shows the map of the overlay of the green space map in the cities of Banda Aceh in 2016 and 2017. Based on the map, it was identified

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that the area of green space in 2016 was around 1,185.8 ha, and the green space in 2017 was around 1,175.6 ha. The reduction in green space that occurred in the city of Banda Aceh between 2016-2017 was 10.2 ha.

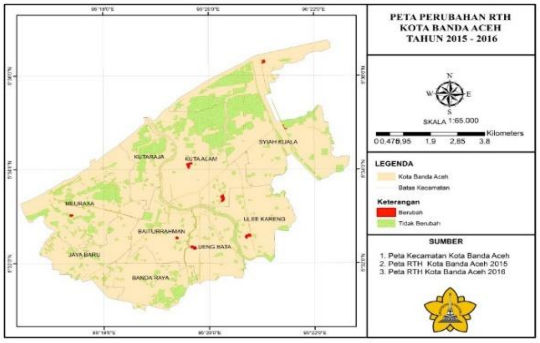

Fig 1. Changes in the Green City of Banda Aceh in 2015-2016

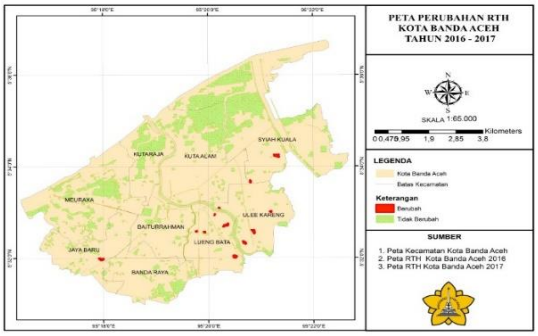

Fig 2. Changes in Banda Aceh Green Open Space 2016-2017

3.2 Climate and Humidity of Banda Aceh City

Microclimate is a climatic condition in a very limited space[10]. However, this climate component is important for the life of plants, animals and humans because air conditions on a micro scale will directly contact or directly affect these living things, especially humans. Living things are always responsive to the dynamics or changes of the surrounding climate elements.

Modification of the microclimate is done with the aim of creating a more comfortable environment for humans or to create a more optimal environment for plant growth and development. Efforts to create a more comfortable environment are carried out by presenting more plants in a residential or human work environment, including closed rooms are often modified with a vegetative environment. This can be understood because the environment that is grown by dense vegetation can produce fresh air as a result of photosynthesis.

Based on the results of research on air humidity measurements that began at 12.00-13.00 WIB at each sample point is as shown in Figure 3. Based on Figure 3 shows that the air temperature in each district is different this is strongly influenced by the number of trees, plant canopy density and conditions the environment around RTH.

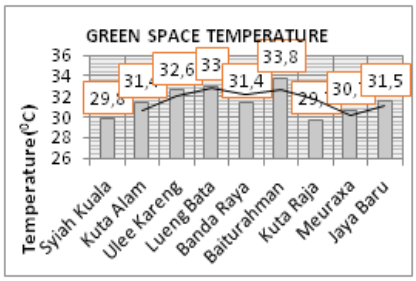

Fig 3. Green Open Temperature in each district

Based on the graph data in Figure 3, it appears that the lowest temperature was found in Kuta Raja District, which is the location of study is Hutan Kota Trembesi with a temperature of 29.8 0C. The maximum temperature is in the Baiturahman District which is the location of the study is Blang Padang Field with a temperature value of 33.8ºC

3.3 Correlation of Temperature and Humidity RTH

Based on the calculation of the correlation coefficient by using the product moment formula, the correlation coefficient (r) of -0.78 was obtained. The value was negative and in the strong category. This means that the more the temperature increases in the green open space, the less the relative humidity in the green open space, and vice versa.

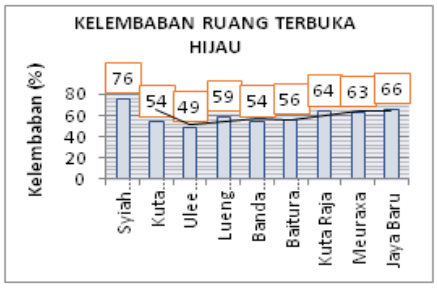

Fig 4. Humidity in each open green space

4. DISCUSSION

4.1 RTH Comfort Index in Banda Aceh City

Comfortable environment can be felt by users to meet the physical needs of users. To express this comfort quantitatively, THI (Temperature Humidity Index) measurement is needed. strong solar radiation gives a feeling of being hot, a strong wind gives a feeling of being cool, high humidity gives a feeling of being unpleasantly warm and moist (muggy weather), and a heated ground surface that cannot be touched makes us feel very hot[11]. Table 1 has shown the results of

measurements of the comfort of vegetation structured in nine different regions at 12.00-13.00 WIB.

Based on Table 1, it can be seen that the THI value of the green space structure in nine different regions. THI value was also seen in all green open structure in the Banda Aceh City area classified as uncomfortable. This is due to the air temperature in all regions is almost around 30ºC – 34ºC, while for air humidity in all regions ranges between 50-76%. A place is considered comfortable when having THI 21-27. If THI is greater than 27, it is considered uncomfortable. However, based on Table 1, it turns out that the area that has the lowest THI is Hutan Kota Trembesi area with a THI value of 28.1. While the area that has the highest THI is Blang Padang Field, which is 30.8.

In 2013 Banda Aceh had 1,474 ha of green open space[12] in 2015 the green space was 1,192.4 ha. While the 2016 green space is 1,185.8 ha, in 2017 only 1,175 ha are left. Based on these results it can be concluded that within a period of 5 years Banda Aceh has lost 299 Ha of green open space both public and private. Based on Law No. 26 /2007, it is stated that the area of green open space is at least 20% of the area for public open green space and 10% for private green open space. The wider the area in one district, the wider the need for green space in that region.

Overall, both public and private green open space in Banda Aceh in 2012 was only 24% of the total area. based on the distribution of green open space based on sub-districts in the city of Banda Aceh only Syiah kuala sub-district has public green open space that meets the specified proportions. In 2017 the Banda Aceh green space covering an area of 1,175 ha or 19.14% of the Banda Aceh area, should the Banda Aceh City with an area of 61.34 km2 must have a green space of 1,840.77 ha consisting of 1,227.2 ha of public green space and 613.6 ha of green open space private. Banda Aceh still lacks 665.77 ha of green open space. The lack of green space in the city of Banda Aceh has an impact on the comfort index of the citizens of the City. Of the subdistricts, only one subdistrict has a green space proportional to 30% of the area.

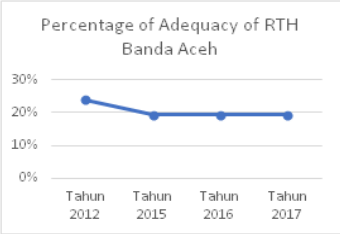

Fig 5. Percentage of adequacy of green space based on Law No. 26 of 2007 (30% of the total area)

Judging from the comfort index, there are no sub-districts in Banda Aceh that categorized into the comfort category. Factors causing the Banda Aceh region to be categorized as uncomfortable because all sub-districts in Banda Aceh experienced a reduction in green space.

The negative impact of sub-optimization of green open space in the form of an increase in the city comfort index, decreased capacity and carrying capacity of the region characterized by increased pollution, decreased groundwater quality, increased city temperatures, and decreased oxygen quality or clean air in urban areas. Changes in this function as a result of the city green space does not meet the requirements of the number and quality, namely green space is not available, insufficient, and not functional[12].

The lowest temperature is in the Hutan Kota Tibang, Syiah Kuala District. Hutan Kota Tibang is more vegetation in the form of trees compared to grass. The dense tree canopy also causes the lowest temperature in the Hutan Kota Tibang and has the highest humidity.

The highest temperature is in Blang Padang Field. This is because in Blang Padang Field, most of the land cover is grass and there is not much vegetation in the form of trees, so it does not absorb sunlight much. The poor condition of green space at this location causes an increase in temperature.

The lowest humidity is on Panglima Nyak Makam Street which is the green line of the road, the condition of green space at this location is only in the form of medium-sized trees and dominated by grass, where grass is the smallest reducing temperature so it affects the humidity. Another factor is that because this region is a green belt, the intensity of motor vehicle smoke pollution and urban activity also causes low humidity in the region.

Based on the results obtained, the city of Banda Aceh can be said to have a category of Green Open Space that is uncomfortable. Replanting trees in the city of Banda Aceh needs to be done to improve conditions of comfort. Based on observations showing that trees have a positive influence on human comfort. The shade provided by the tree will give a smaller THI value (more comfortable) compared to the open land area. Therefore the presence of trees in urban areas is very important to control the microclimate in urban areas so that it supports more comfortable conditions in a city, especially Banda Aceh City.

The existence of vegetation in urban areas is very important to control the micro climate. Vegetation has a direct impact on the microclimate because it is able to control the temperature and comfort variables of the city such as thermal sensations are heat conduction, humidity,

shortwave solar radiation, air velocity, heat conduction, and humidity. Air temperature, humidity, wind direction, air velocity, shortwave solar radiation heat quantity, longwave radiation heat quantity, and ground surface temperature were measured.

5. CONCLUSION

The results of research and discussion, it can be concluded that within a period of five years there was a reduction in green space by 299 hectares in the city of Banda Aceh. There is a relationship between temperature and humidity of the Green Open Space in Banda Aceh City. The better the condition of green space, the lower the air temperature and increasing humidity and vice versa the less good green space conditions, the higher the air temperature and the lower the humidity. Based on the THI value used by Nieuwolt, the green open space in Banda Aceh City is classified as uncomfortable. Banda Aceh lacks green space for 665.77 ha. Suggestion to the community, must have a big initiative to plant trees so that air pollution can be absorbed by green plants. To the Goverment, in order to increase the availability of green open space in order to achieve good management of Green City in Banda Aceh at least 30% of the total area of the city.

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REFERENCES

[1] F. Bongers, L. Poorter, and W. D. Hawthorne, “The forests of Upper Guinea: gradients in large species composition.,” Biodivers. West African For. an Ecol. atlas woody plant species, no. January, pp. 41–52, 2009.
[2] A. Wibowo and A. Rustanto, “Spatial - Temporal Analysis of Urban Heat Island in Tangerang City,” Indones. J. Geogr., 2013.
[3] Abdillah, Taman dan Hutan Kota. Jakarta: Azka Mulia Media, 2006.
[4] F. J. Grey, G.W., dan Deneke, Urban forestry. Second Edition. New York: NY: John Wiley and Sons., 1886.
[5] A. N. Gadeng and M. H. Furqan, “The Development of Settlement in the Tsunami Red Zone Area of Banda Aceh City,” vol. 2019, no. December 2004, pp. 1–13, 2019.
[6] H. Antara et al., “Hubungan antara vegetasi dengan suhu dan kelembaban relatif udara di hutan kota denggung dan kebun botani biologi, kabupaten sleman, yogyakarta niken ajeng permati,” 2015.
[7] Y. Y. J. Sanger, R. . . Rogi, and J. A. Rombang, “Pengaruh Tipe Tutupan Lahan Terhadap Iklim Mikro Di Kota Bitung,” Agri-Sosioekonomi, vol. 12, no. 3A, p. 105, 2016.
[8] Permendagri, Tentang Penataan Ruang Terbuka Hijau Kawasan Perkotaan. Indonesia, 2007, p. No 26.
[9] B. Lakitan, Dasar-Dasar Klimatologi. Jakarta: PT Raja Grafindo Persada, 2002.
[10] A. Aruninta, Y. Kurazumi, K. Fukagawa, and J. Ishii, “The integration of human thermal comfort in an outdoor campus landscape in a tropical climate,” Int. J. GEOMATE, vol. 14, no. 44, pp. 26–32, 2018.
[11] Hermon, D. Climate Change Mitigation. Rajawali Pers (Radjagrafindo). 2017.
[12] S. Bahri, S. A. Ali, K. Ruang, T. Hijau, and K. Banda, “Kebutuhan Ruang Terbuka Hijau Kota Banda Aceh,” J. Manaj. Sumberd. Lahan, vol. 1, no. 1, pp. 10–22, 2012.