The dynamic effect of air temperature and air humidity toward soil temperature in various lands cover at KHDTK Gunung Bromo, Karanganyar - Indonesia

D P Ariyanto1,2, Z A Qudsi1, Sumani1, W S Dewi1, Rahayu1 and Komariah1

1 Soil Science Department, Faculty of Agriculture, Universitas Sebelas Maret Surakarta, Jl. Ir. Sutami 36a Kentingan Surakarta, 57126, Indonesia
2 Bachelor Program in Soil Science Department, Faculty of Agriculture, Universitas Sebelas Maret Surakarta, Jl. Ir. Sutami 36a Kentingan Surakarta, 57126, Indonesia
Corresponding author: dp.ariyanto@staff.uns.ac.id

Abstract. Human activities cause a rise in temperature that causes global warming. Land covers that were originally stand plants into open land will affect the climate of the land. This study aims to determine the dynamics of air temperature & air humidity on soil temperature in various land cover at KHDTK (Kawasan Hutan dengan Tujuan Khusus or Special Forest Area) Gunung Bromo Karanganyar. There are 6 types of land cover used in this study, namely: pine, pine-mahogany, mahogany, mixed, open land, and annual crops. Air & soil temperature were measured using Ellitech RC-5 USB Temperature Data Logger & Digital Thermometer. The results showed that the dynamics of air temperature and humidity were highest in annual crop cover, while the lowest was in mahogany cover. The highest dynamics of soil temperature are found in annual crops and open land, whereas the other cover has similar dynamics. The dynamics of air temperature and humidity are slightly different from soil temperatures. The interaction between air temperature and soil temperature can result in changes in weather and climate, especially in open land.

1. Introduction
The impact of land cover change on human health as indicated by an increase in heat exposure is starting to be a serious topic of discussion [1]. Climate change is a symptom of excessive human resource appropriation, exceeding planetary boundaries [2]. The forest canopy covers the surface of the land considerably, which is 30%. Agricultural land that has a minimum of 10% tree cover of 40% of global land [3]. Changes in land cover can result in fluctuations in surface temperature and ambient air temperature. This is caused by differences in each land cover in receiving, absorbing, and re-emitting rays obtained from the sun. solar radiation received is determined by the topographical conditions of tree shade and changes in the sun, both daily and seasonal [4].

Air temperature in forest areas has an important role in reducing local climate warming, maintaining local environmental health, and ecosystem stability [5]. Temperature is positively correlated with solar radiation. The state of the air temperature at a place on the earth's surface will be determined by the length of the sun's rays, the tilt of the sun, cloud conditions, and the condition of the earth's surface. Air humidity is the amount of water vapor contained in the air or atmosphere. The amount depends on the entry of water vapor into the atmosphere due to evaporation from water in lakes, lakes, and rivers, as well as from groundwater. Yang et al. (2020) [6] the peak of air humidity is in the morning due to the onset of evaporation, the second peak before or after sunset due to increased atmospheric stability around...
sunset but evaporation continues. Maintaining a tree cover can minimize climate change and lower high air temperatures in tropical/subtropical [7].

Soil temperature plays an important role in germination & growth of higher plants, the activity of soil organisms, weathering, decomposition & humification of organic matter, structure, groundwater, and soil air. Different soil depths can give a different role to the soil temperature. Surface temperature to a depth of 10 cm can affect the earth's water cycle, evaporation, and energy balance between the surface and the atmosphere [8]. Changes in soil temperature have a major impact on the carbon balance of forest ecosystems. Increasing soil surface temperature results in increased organic carbon and nitrogen release, which may have a significant effect on global warming [9]. The interaction between air temperature and soil temperature can result in changes in weather and climate [10].

Surface soil temperature is the temperature of the soil from the surface to a depth of 10 cm. Surface land temperatures play a significant role in the transfer of energy ecosystems to changes in the carbon cycle and monitoring drought agriculture [11]. The release of organic carbon from the earth and the reduction of soil organic carbon emissions can be expected through soil temperature [12]. The land temperature of the root zone can affect crop yields and the monitoring of droughts of agriculture. Soil temperatures at different depths can also be used to monitor forest fires [13]. This study aims to determine the dynamics of air temperature & air humidity on soil temperature in various land cover at KHDTK (Kawasan Hutan dengan Tujuan Khusus or Special Forest Area) Gunung Bromo Karanganyar.

2. Method

This research was conducted at KHDTK Gunung Bromo which is located on Jl. Raya Karanganyar-Mojogedang KM. 7, Karanganyar, Central Java, Indonesia. KHDTK Gunung Bromo is geographically located between 7°34'21.93'' – 7°35’38.90’’ S and 110°59’40.39’’ – 111°0’49.36’’ E. The sample selection used a random purposive sampling technique. Random purposive sampling, namely the selection of samples randomly with certain considerations. Water & soil temperatures were measured using the Ellitech RC-5 USB Temperature Data Logger & Digital Thermometer. Data were collected at 3 times, namely morning, afternoon, and evening. The research method used is descriptive exploratory. The descriptive exploratory method aims to describe the state of a phenomenon in the field. The data analysis used was the T-test and then continued with the F test.

3. Result and discussion

Land use on earth has affected surface vegetation changes [14]. As a result, natural vegetation cover such as height and vegetation density gradually decreased [15]. There are 6 types of land cover used in this study, namely: pine, pine-mahogany, mahogany, mixed, open land, and annual crops. High vegetation can reduce air temperature and increase humidity so that the environment is more comfortable. Changes in land cover can affect the microclimate such as air temperature and soil temperature. The increased heat flux between the air and soil is affected by the decline of high vegetation and the density of vegetation. Variations in the difference between air and soil temperature can change the microenvironment and affect the structure and dynamics of plant communities [16].

According to research, coefficients of correlation between air temperature and soil temperature can be seen through the Pearson Correlation. It suggests a linear relationship between two variables. In general, statistical use, correlation, or mutual relationship refers to the departure of two variables from independence [17]. Based on the results of the research in the Table 1, it can be seen that all variables are related to each other, which is indicated by the Sig value of 0.000 (<0.05). Air temperature, soil temperature, and light intensity have a positive correlation, while humidity is negatively correlated.

The variable X is declared to affect variable Y if it has Sig. <0.050. Based on the results of the T-test, air temperature and light intensity affect soil temperature, while humidity does not affect it. Air temperature has the highest effect on soil temperature compared to other variables. Based on the results of the F test, it can be concluded that air temperature, air humidity, and light intensity have an effect on soil temperature simultaneously because they have a Sig. <0.050.
On different types of soil and texture, the soil temperature are the main factors in regulating soil respiration. The texture of the soil plays an important role in stabilizing aggregates by forming complex mineral organs [18]. Additionally, the texture of the soil also plays a role in affecting the dynamic C and regulating the water content. Soil microbial and fauna activity are affected by soil temperature and water content [19]. Soil temperature affects the growth of plants and roots and the rate of biochemical reactions [20]. Soil temperature plays a key role in seed growth and correlates with the land maximum temperature.

| Pearson Correlation | Soil Temperature | Air Temperature | Air Humidity | Light intensity |
|---------------------|------------------|----------------|-------------|----------------|
|                     | 1.000            | .657           | -.496       | .830           |
| Correlation         | Air Temperature  | .657           | 1.000       | -.835          | .684           |
|                     | Air Humidity     | -.496          | -.835       | 1.000          | -.538          |
|                     | Light Intensity  | .830           | .684        | -.538          | 1.000          |
| Sig. (1-tailed)     | Soil Temperature | .000           | .000        | .000           |
|                     | Air Temperature  | .000           | .000        | .000           |
|                     | Air Humidity     | .000           | .000        | .000           |
|                     | Light Intensity  | .000           | .000        | .000           |
| N                   | Soil Temperature | 84             | 84          | 84             | 84             |
|                     | Air Temperature  | 84             | 84          | 84             | 84             |
|                     | Air Humidity     | 84             | 84          | 84             | 84             |
|                     | Light Intensity  | 84             | 84          | 84             | 84             |

3.1. Dynamics of air temperature

Air temperature is a movement of molecules in the air indicating degrees of heat. Air temperature helps the process of forming rainfall [21]. The increase in air temperature is a result of global warming and reduced vegetation. Air temperature can vary relative to ground surface temperature through environmental factors and soil surface conditions [22]. The higher the land cover, the lower the surrounding air temperature will be. The highest air temperature is the land on annual crops (36°C), while the lowest air temperature is in mahogany land cover (28°C). The dynamics of the highest air temperature is on the plant land cover on the 6th day of 3.2°C (Figure 1).

![Figure 1. Dynamics of air temperature.](image-url)
3.2. Dynamics of air humidity
Air temperature affects the level of water content in the air. The relationship between air temperature and humidity represents a very close inverse relationship pattern [6]. Land cover that has a high air temperature will lower the humidity. The highest humidity is in the mahogany land cover, namely 89%, while the lowest humidity is in annual plants, namely 63%. The highest air humidity dynamics is found in open land with a value of 13% on the 2nd day (Figure 2).

![Figure 2. Dynamics of air humidity.](image)

3.3. Dynamics of soil temperature
Air temperature, soil temperature, soil humidity, and solar radiation tend to increase as the canopy changes in the forest crevices [23]. The amount of solar radiation it passes depends on the size of a forest opening. Increased light radiation is responsible for photosynthesis and much of soil-based processes such as organic material mineralization, root germination, and germination [4]. Ariyanto et al. 2020 [24] the drought of land can be determined by the large moisture of the soil. The higher the level of soil moisture can minimize the possibility of drought in a land.

![Figure 3. Dynamics of soil temperature.](image)
Soil temperature and humidity have a very close relationship. If the soil temperature is high, the soil moisture will be low. Lutfiyana et al. 2017 [25] the rise of evapotranspiration are determined by the high surface temperature. Also, evapotranspiration is influenced by the climate of various land closures [26]. Evapotranspiration can cause moisture in the soil by a decrease in soil levels. The land cover in the KHDTK Gumung Bromo Karanganyar has a very low water content, which is <10%. Based on the graph of the highest soil temperature in open land and annual crops, namely 33°C and 32.5°C. The greatest soil temperature dynamics, namely 2.5°C in the 6th day observation season plants (Table 3).

The soil flap and the balance of thermal energy on the grounds surface determine the level of soil temperature [27]. Changes in soil temperature are due to changes in vegetation and reduced vegetation. It is caused by human activity through the influence of the flow of energy [28]. Soil temperature has a negative correlation with vegetation cover [29]. Annual cropland cover and open land are cultivated by cultivating annual crops such as maize, cassava, and beans. Pineland cover is managed by cutting the lower plants to facilitate tapping. Forest management is also carried out through felling old pine trees and replanting.

4. Conclusion
The soil flap and the balance of thermal energy on the surface of the ground determine the level of soil temperature. The dynamics of air temperature and humidity were highest in annual crop cover, while the lowest was in mahogany cover. The highest dynamics of soil temperature are found in annual crops and open land, whereas the other cover has similar dynamics. The dynamics of air temperature and humidity are slightly different from soil temperatures. Especially on observation days 5 to 9, all the land cover except open land and annual crops tend to be stable.

Air temperature, soil temperature, and light intensity have a positive correlation, while humidity is negatively correlated. Air temperature has the highest effect on soil temperature compared to other variables. Air temperature, air humidity, and light intensity have an effect on soil temperature simultaneously. The interaction between air temperature and soil temperature can result in changes in weather and climate, especially in open land.

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