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ABSTRACT

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DISTRIBUTION OF DROUGHT IN THE WATERSHED JENEBERANG UPSTREAM, SOUTH SULAWESI

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Abstract

In the dry season, there is a significant decrease in the intensity of rainfall which will have an impact on a prolonged drought. This can result in a significant decrease in water discharge which affects the quantity of water available. The impact of the long drought was felt, such as dry rice fields, cracked soil, 33.188 ha of agricultural land experienced crop failure in 2019, water needs were only met 35% and many others. This study aims to see the distribution of drought levels in the Jeneberang upstream watershed by using Remote Sensing data and geographic information systems. The focus of this research location covers all the upstream areas of the Jeneberang watershed, starting from the Bili-Bili dam towards the upstream watershed. Remote Sensing and Geographic Information System (GIS) data can be used to detect areas of potential drought. Remote Sensing data can be used to identify the characteristics of the water content and the percentage of potential latent heat on the surface of the earth using the NDLI (Normalized Difference Latent Heat Index) transformation. The results of the NDLI transformation on the image produce very diverse values, so the values are grouped using the Natural Breaks method. The results of the latent heat index transformation produce spectral values between -0.0817 to 0.0829. The results are then divided into 5 classes with very low, low, moderate, high, and very high categories. In the Jeneberang upstream watershed, the widest potential for drought is in the low category with a percentage of 55.92% spread over 9 sub-districts in the Gowa Regency.

Keywords: Remote Sensing, NDLI, Drought and Natural Breaks.

1. Introduction

The condition of the hydrology of an area in water conditions is not balanced being the cause of the drought. Drought occurs as a result of the uneven distribution of rain which is the only input for an area. This inequality of rain will result in some areas that fulfill the small burden will experience an imbalance between the input and output of water (Shofiyati, 2007).

The drought itself is one type of natural disaster that occurs slowly (slow on-set), with the duration to the rainy season arrives, and has a very broad and cross-sectoral impact (economy, social, health,

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and education). Drought is a complex disaster and is marked by a lack of prolonged water. The consequences of this disaster are lack of water, damage to ecological resources, reduced agricultural production, and the occurrence of hunger, and casualties (BNPB, 2016).

In 2019 several areas in South Sulawesi experienced drought due to a prolonged dry season from June to September. It was seen that some dry rice fields and land were cracked, this signifies a lack of water in the region. Similarly, which hit Maros and Gowa Regency where the source of water was used by the Regional General Company of Makassar City Drinking Water to meet the needs of Makassar residents who were reduced by existing ones. Of course, this is very difficult to provide maximum service to meet basic water needs. The Ministry of Agriculture also said that in the 2009-2019 period, it was recorded at 33.188 ha of agricultural land experiencing crop failure which caused very large and threatened losses to return to large amounts of food. The drought that hit South Sulawesi during the long dry season was very much and most suffered by the public, which reached 934.705 people (Walhi, 2019). In 2020 BMKG estimates that Indonesia will enter the beginning of the dry season in April, while the peak of the dry season in most of the predicted seasons will occur in August. Pusat Data Sumber Daya Air (2019) states that, in the dry season, the flow of the Jeneberang river water is very small so that water needs for the city of Makassar are only 35% of the needs.

Judging from the consequences of the drought, efforts need to reduce the impact. The depiction of regional information hit by drought is considered very important. Along with the advancement of Remote Sensing technology and Geographic Information Systems (GIS), spatial information of an area can be done easily. Data Remote Sensing and GIS can be used to detect potentially drought areas. Data Remote Sensing can be used to identify the characteristics of the water content and the percentage of latent heat potential on the surface of the earth using the transference of Normalized Difference Latent Heat Index (NDLI) (Anggoro, 2019). NDLI is the most sensitive index to determine the characteristics of water content in various types of land cover. Understanding latent heat and seeing the amount of water available is very important for monitoring plants, groundwater content, the dangers of forest furniture, drought, and analyzing the vegetation response to the availability of water which aims to optimize and improve the efficiency of irrigation management and plant productivity.

2. Material and Method

2.1. Research Sites

This research was conducted from September 2019 until January 2020. This study through two stages of activity, namely field activities and data analysis. Field activities were carried out on the Jeneberang watershed in Gowa Regency. The focus of the location of this study covers all upstream areas of the Jeneberang watershed, ranging from the Bili-Bili Dam towards the upstream watershed. Data analysis was carried out the Laboratory of Watershed Management Faculty of Forestry, Hasanuddin University.

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2.2. Data and Tools Used

The tools used in this research are Global Positioning System (R-GPS) Receiver, Camera, Stationery, Laptop equipped with Geographic Information System (GIS) software. The data used in this research include Landsat Imagery for August 8, 2020, Path 114 Row 64, Watershed Boundary Map from the Ministry of Forestry 2009, the National Digital Elevation Model (DEMNAS) Resolution 8 M, and the Gowa Regency Administration Map.

2.3. Research Procedure

2.3.1. Making Watershed Boundary Maps

The watershed boundary map was made using DEMNAS data. The DEM data to be cut is then superimposed with the Jeneberang Watershed Boundary Map, so that DEM data management can be more efficient at the research location. In addition, the Gowa Regency administration map is used to see the boundaries of sub-districts and villages that are within the scope of the study.

2.3.2. Normalized Difference Latent Heat Index (NDLI)

The Normalized Difference Latent Heat Index (NDLI) carries a multiband satellite index by assessing the availability surface water of earth for Remote Sensing of latent heat flow using three bands of Landsat 8 OLI imagery, with the equation (Liou, et al., 2018):

$$NDLI = \frac{\rho GREEN - \rho RED}{\rho GREEN + \rho RED + \rho SWIR}$$

$\rho GREEN$ = Band 3 (Green)
ρRED = Band 4 (Red)
$\rho SWIR$ = Band 6 (Short Infrared)

Govender, et al., (2007) said that these three bands were chosen because of their special spectral-reflection characteristics in response to air features. Air usually appears greenish because the blue is stronger at these two wavelengths.

The transformation of NDLI in this study was used to determine the potential for drought. The higher the NDLI value, the lower the latent heat of an object in the image, conversely the lower the NDLI value in the image, the higher the latent heat of the object. The results of the NDLI transformation on the image produce very diverse values, so the values are simplified into several classes. The following is the classification of NDLI values based on natural breaks with ratings adjusted for drought potential in the watershed Jeneberang upstream.

NDLI Value	Latent Heat Class
0.0571 – 0.0829	Very Low
0.0371 – 0.0571	Low
0.0209 – 0.0371	Moderate
0.0015 – 0.0209	High
-0.08175 – 0.0015	Very High

Table 1. Classification of Latent Heat.

2.3.3. Natural Breaks

The Jenks optimization method, also known as the Natural Breaks classification method, is a data clustering method designed to determine the best value arrangement into different classes. Natural breaks are the best way to split a ranges. Best ranges imply the ranges where similar areas are grouped. This method minimizes the variation within each range, so that the areas within each range are as close as possible in value to each other. This is done by minimizing the average deviation of each class from the class meanwhile maximizing the deviation of each class from the average value of other groups. In other words, this method seeks to reduce variations within classes and maximize variations between classes (Ahmad, 2019).

Natural Breaks are also used to determine the class of potential drought. The drought potential class can be defined and presented as follows in Table 2.

Table 2. Classification of Drought Potential Class

NDLI Value	Latent Heat Class	Potential Drought
0.0571 – 0.0829	Very Low	Very Low Drought
0.0371 – 0.0571	Low	Low Drought
0.0209 – 0.0371	Moderate	Moderate Drought
0.0015 – 0.0209	High	High Drought
-0.08175 – 0.0015	Very High	Very High Drought

2.3.4. Drought Validation Test and Determination of Observation Location Points

The validation process is carried out to test the results of geographic information system (GIS) analysis in mapping drought by looking at the suitability of the results obtained through GIS analysis with field conditions. Field validation was carried out through interviews with local communities and ground checks. The validation point is also the point of observation. Each point that has been determined is then repeated three times to be more valid.

3. Result And Discussion

Normalized Difference Latent Heat Index (NDLI) or latent heat index is obtained from the analysis of Landsat 8 imagery. The results of the transformation of latent heat index produce spectral values

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between -0.0817 to 0.0829. The results are then divided into 5 classes with very low, low, moderate, high, and very high categories. The data on the area of the latent heat class in the watershed Jeneberang upstream are presented in Table 3.

Table 3. Latent Heat Class in the Watershed Jeneberang Upstream.

NDLI Value	Latent Heat Class	Potential Drought	Area (ha)	Percentage (%)
0.0571 – 0.0829	Very Low	Very Low Drought	1.121,33	1.83
0.0371 – 0.0571	Low	Low Drought	34.331,42	55.92
0.0209 – 0.0371	Moderate	Moderate Drought	13.162,67	21.44
0.0015 – 0.0209	High	High Drought	8.473,76	13.80
-0.08175 – 0.0015	Very High	Very High Drought	4.308,18	7.02
Total			**61.397.37**	**100**

Investigation of heat transfer can provide insight into the interactions between land cover types and the hydrological cycle of certain land cover patterns. This is very important for numerical modeling of atmospheric processes, hydrology, and improving the accuracy of weather forecasts. If there is a significant decrease in soil moisture due to lack of rain or water drainage by irrigation, the thin layer above the surface of the earth will dry up and the rate of latent heat flow from the surface will be controlled by water availability (Liou et al., 2018).

Based on the table above, the widest latent heat class is in the low latent heat class, which is 34.331,42 ha with an NDLI value of 0.03711-0.05714. The latent heat class which has the smallest area is in the very low latent heat class, namely 1.121,33 ha with an NDLI value of 0.05714 - 0.08298. The potential for drought is very high, only having an area of 4.308,18 ha or 7.02%. The distribution of latent heat classes can be seen in Figure 1 and conditions in the field can be seen in Figure 2.

Figure 1. Latent Heat Class Distribution

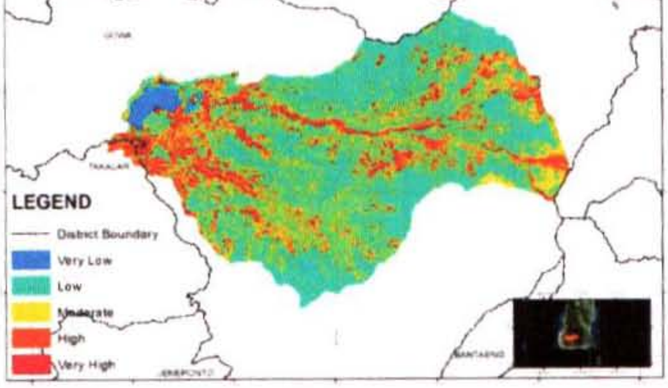

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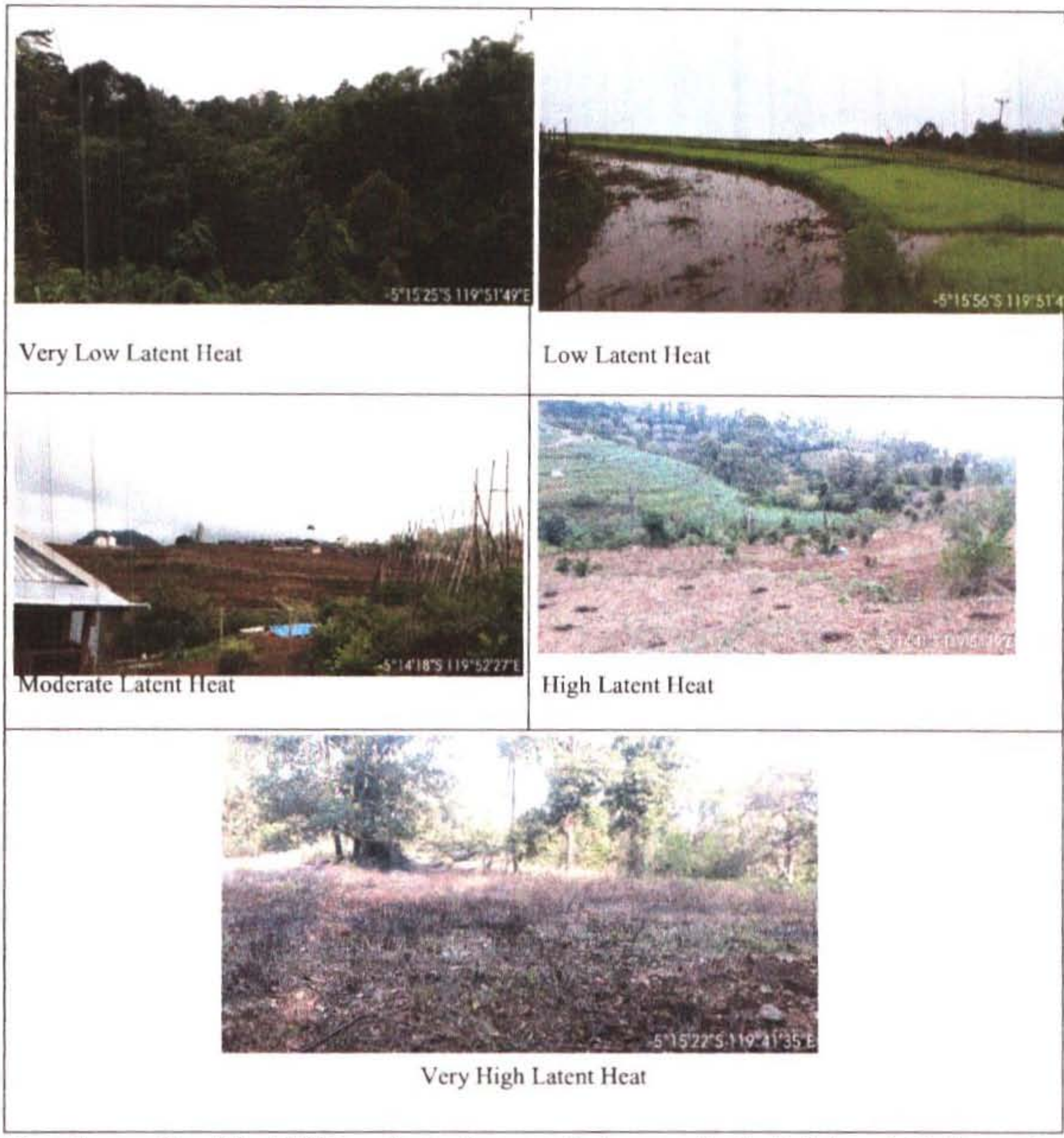
Figure 2. Field Conditions for Latent Heat Distribution



Very Low Latent Heat

Low Latent Heat

Moderate Latent Heat

High Latent Heat

Very High Latent Heat

Based on the results of the NDLI analysis, there are 5 classes of potential drought in the watershed Jeneberang upstream. The drought potential class is divided into categories: Very low drought potential, low drought potential, moderate drought potential, high drought potential, and very high drought potential.

a. Very Low Drought

The Jeneberang upstream watershed has a very low drought class of 1.121,33 ha or 1.83% spread over 7 sub-districts, especially Parangloe and Manuju sub-districts. This drought class is mostly found in paddy field cover, plantation forest, secondary dryland forest, and primary dryland forest.

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b. Low Drought

The Low Drought Potential Class is the broadest potential class of all other drought potential classes. The low drought potential class has an area of 34.331,42 ha or 55.92% spread over 9 sub-districts, especially Manuju and Tinggimoncong sub-districts. This potential for drought is mostly found in forested land cover and the water source used comes from Mount Bawakaraeng springs.

c. Moderate Drought

The moderate drought class occupies the second-largest position in the watershed Jeneberang upstream. The area of the moderate drought class reached 13.162,67 ha or 21.44% spread over 9 sub-districts, especially Tinggimoncong and Bungaya sub-districts.

d. High Drought

The Jeneberang upstream watershed has a high drought potential of 8.473,76 ha or 13.80%. The high drought potential is spread to 9 sub-districts, especially in Parigi, Manuju, and Tinggimoncong sub-districts. The dominant land cover is dryland agriculture, scrub, and mining.

e. Very High Drought

The watershed Jeneberang upstream has a very high drought potential covering an area of 4.308,18 ha or 7.02% with an NDLI value of -0.08175 - 0.00158. Very high drought is found in agricultural land cover, dry land, shrubs, and open land. The potential for drought is very high spread to 9 sub-districts, especially Manuju and Bungaya sub-districts.

Several observation points are located around the foot of Mount Bawakaraeng. People use pipes and hoses to collect water from springs for their daily needs. People who find it difficult to get water from springs choose to use bore wells. Agricultural land and crop plantations on water irrigation. The observation points in the drought class are generally rocky and sloping land. The distribution of drought in the watershed Jeneberang upstream is very diverse. This is influenced by several factors such as the condition of an area within an administrative boundary such as a sub-district having a lot of land cover and varying altitude conditions. So that within one administrative boundary the sub-district has a variety of drought classes.

After mapping the drought class in the upstream Jeneberang watershed, the next step is to determine mitigation efforts to reduce the impact of drought. Measures such as agroforestry, water use indices, and evapotranspiration are some of the many things that can be done for drought mitigation efforts. Water Use Index (IPA) and evapotranspiration are parameters that determine drought susceptibility that can be modified, while other parameters such as rainfall or water sources are natural factors that cannot be modified. In the IPA parameters, what can be modified are the number of residents and the more efficient use of water. Efficient use of water can be done through outreach to the community. The utilization of rainwater can also solve problems that can reduce the use of water for daily needs (Susilawati, 2006). Making a reservoir or water storage reservoir is one example of the use of rainwater (Maarif, 2011).

Conclusion

Based on the results of research on the distribution of drought levels in the Watershed Jeneberang Upstream, there are 5 classes of potential drought, namely very low drought, low drought, moderate drought, high drought, and very high drought. Low drought is the broadest potential class, namely 55.92% or 34.331,42 ha of the total area of the study site with an NDLI value of 0.03711 - 0.05714. While the very low drought potential class became the lowest class, namely 1.83% or 1.121,33 ha with an NDLI value of 0.05714 - 0.08298. The higher the NDLI value, the lower the latent heat of an object, conversely the lower the NDLI value, the higher the latent heat of the object. In general, NDLI can provide information on latent heat-related to water content in an area. This information is the first step to determine appropriate mitigation efforts to reduce the impact of drought.

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