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# Identification of drought level using Normalized Difference Latent Heat Index in the South Coast of South Sulawesi Province

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**Munajat Nursaputra[1], Septian Perdana Putra Pahar[2] and Chairil A[1]**

[1]Laboratory of Forestry Planning and Information System, Forestry Science Study Program, Faculty of Forestry, Hasanuddin University, Makassar, Indonesia
[2]Forestry Vocational High School, Makassar, Indonesia


E-mail: munajatnursaputra@unhas.ac.id

**Abstract**. One of the impacts of climate change is drought. Drought is a hydrological problem that affects survival on earth significantly. This study aims to identify drought through the approach of one of the indices related to water, namely Normalized Difference Latent Heat (NDLI). NDLI values were obtained through a multispectral Landsat 8 OLI calculation process, namely band 3 (green), band 4 (red), and band 6 (SWIR). Each band interprets variables related to heat and water content. The coverage area of research is in the south coast of South Sulawesi Province which includes Makassar City, Gowa Regency, Takalar Regency, Jeneponto Regency, Bantaeng Regency, and Bulukumba Regency. The regency on the south coast of South Sulawesi Province is the region with the highest level of human activity starting from agricultural activities, ponds, industry and many other activities. NDLI values range from +1 to -1, where positive values indicate areas with good water content with latent heat and poor water content. In the south coast of South Sulawesi Province, NDLI values ranged from 0.05 to -0.71. Based Drought classification level, the level of drought on the south coast of South Sulawesi Province is near normal, moderately dry, and severely dry.

## 1. Introduction

The World Bank in 2010 stated that about 80% of natural disasters caused by climate change occurred in Asia due to regional characteristics [1]. Indonesia as part of Asia which has unique characteristics, it has three rainy areas, which are monsoon, equatorial, and local. Climate change causes unusual natural phenomena in Indonesia, such as the uncertainty of the rainy and dry seasons [2,3]. This natural phenomenon occurs in almost all regions of Indonesia, such as in the Province of South Sulawesi, which has quite complex ecosystem characteristics, especially in the city of Makassar, which is the centre of community activity in South Sulawesi Province. Based on the results of the CSIRO study in 2012, the climate in the province of South Sulawesi indicated that it would experience a temperature increase of 0.29-0.39 °C per decade [4]. This change illustrates that there will be an increase in rainfall intensity and the length of the rainy season is estimated to be shorter by 12 days. These natural phenomena have the potential to cause disasters caused by hydrometeorology such as landslides, floods and drought.

A similar projection is also explained by Fattahi et al (2015) that there will be a water crisis due to changes in the earth's surface temperature and climate change during the 2011-2030 period [5]. The issue of water availability crisis or drought has also been discussed at the Conference of Parties (COP)

21 in 2015 in Paris and in the 2019-2024 RPJMN, the issue of water carrying capacity has become a national strategic issue. Damage to forest cover is expected to lead to scarcity of raw water, especially on islands with very low forest cover such as Java, Bali and Nusa Tenggara. Raw water scarcity has also begun to occur in several other areas due to the impact of global climate change that has hit most parts of Indonesia. Currently, water availability is classified as scarce to critical in most areas of the islands of Java and Bali and it is estimated that the area of critical water will increase from 6 percent in 2000 to 9.6 percent in 2045, covering the southern part of Sumatra, West Nusa Tenggara, and southern Sulawesi [6].

Previous studies show that, southern Sulawesi, which in this case is South Sulawesi Province, has a high vulnerability to drought and water shortages in the future. The southern coastal area of South Sulawesi Province which includes Makassar City, Gowa Regency, Takalar Regency, Jeneponto Regency, Bantaeng Regency, and Bulukumba Regency is an area with a high population growth rate with high community activities which also includes urban, agricultural, pond and industrial activities. very much depends on the conditions of water availability. Due to these various reasons, it is necessary to prepare a form of adaptation to drought, but currently research on prevention, mitigation and adaptation to drought disasters is still lack.

The lack of detailed information regarding the distribution of areas prone to drought causes frequent errors in regional planning, for example the results of a study by the National Disaster Management Agency (http://inarisk.bnpb.go.id/) released in 2016 spatially only depicts the southern region of South Sulawesi Province as being in the moderate danger category for drought [7] and until now there is no more recent data update information. This information certainly does not describe in detail where the areas with high or low vulnerability are up to date, so that sector planning such as urban areas, agriculture, ponds and industry which is directed to the southern coast of South Sulawesi Province is difficult to observe in more detail. From this description, this study tries to analyse the level of drought by utilizing remote sensing technology by analysing surface-to-atmosphere reflectance so that it can predict energy and thermal waves on the earth's surface to show the level of drought and wetness that can predict water availability in an area.

## 2. Materials and methods

### 2.1. Study area
This research was conducted on the southern coast of South Sulawesi Province which includes Makassar City, Gowa Regency, Takalar Regency, Jeneponto Regency, Bantaeng Regency, and Bulukumba Regency. In the 2018-2023 RPJMD of South Sulawesi Province, these areas are the center of national activities and areas devoted to the development of the trade and service sector (urban), industry, agriculture, fisheries and tourism so that it is highly dependent on the level of water availability of a region [8].
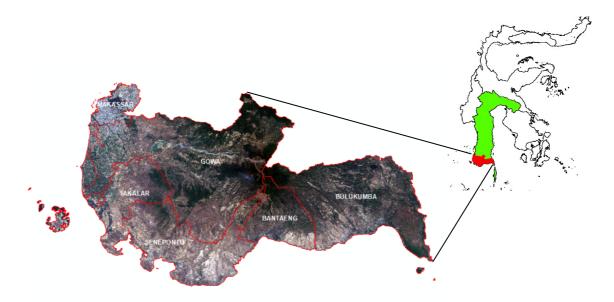
**Figure 1**. Administrative areas in southern coast, South Sulawesi Province.

### 2.2. Formulation of the Normalized Different Latent Heat Index

The approach used in this research is remote sensing based spatial analysis. The remote sensing approach is used to simplify and streamline the time in spatial-based data collection [9,10], using Landsat 8 OLI satellite imagery (L8). The acquisition of L8 image data used is the recording data between months 10 of 2019, where the selection of recording time is only based on a clean cloud image in the study area and makes an effort to assess the dry season conditions to see the maximum prone conditions. Before further processing, the L8 image is processed through several stages, namely radiometric correction and band combination for the calculation of Normalize Difference Latent Heat Index (NDLI) using QGIS software.

NDLI is a method to determine the availability of water on the earth's surface by describing the level of dryness and wetness of an area. NDLI uses three spectral bands called band 3 (green), band 4 (red), and band 6 (SWIR). Band 3, represents the chlorophyll content in both vegetation and water. For band 4 to represent the spectral characteristics of the vegetation, this is due to the strong pigmentation absorption in healthy vegetation. Reflection band 4 will increase in vegetation that has decreased water content. While band 6 is sensitive to moisture content in leaves and soil. The reaction of band 6 will decrease in conditions of high-water content, besides that band 6 is also able to distinguish levels in open land with watertight built land [11]. The corrected DN value of each spectral will produce a reflectance value. The result of the reflectance of each band is inputted into the following NDLI equation:

$$NDLI = \frac{\rho\,Band\,3 \,-\, \rho\,Band\,4}{\rho\,Band\,3 \,+\, \rho\,Band\,4 \,+\, \rho\,Band\,6}$$

The index results will later describe the values 1 to -1, the closer to the number 1, it indicates high water availability (wet), and the closer to -1 (dry) it indicates low water availability. After the NDLI value is obtained, the drought value is adjusted to the drought level classification. Drought level classification uses the SPEI table [12] with modifications. SPEI was developed by combining the sensitivity of the Palmer Dried Severity Index (PDSI) to change the evaporation value and the multi-temporal trait values of the Standardized Precipitation Index (SPI). The SPEI drought index has seven categories, as shown in table 1.

**Table 1**. SPEI drought index

| Index | | Class |
|---|---|---|
| >0.9 | 1 | Extremely Wet |
| >0.5 | 0.9 | Very Wet |
| >0.1 | 0.5 | Moderately Wet |
| -0.1 | 0.1 | Near Normal |
| -0.5 | <-0.1 | Moderately Dry |
| -0.9 | <-0.5 | Severely Dry |
| -1 | <-0.9 | Extremely Dry |

## 3. Results and discussion

The results of data processing and analysis obtained the NDLI value from the multiband calculation of Landsat 8 OLI, where the research locus has been adjusted to the administrative boundaries of regency/ cities on the southern coast of South Sulawesi Province. NDLI is used as an indicator to determine areas of water supply crisis or drought. NDLI values ranged from +1 to -1, however, in the study area, NDLI values only ranged from 0.05 to -0.71. Figure 2 shows the NDLI calculation in the study area.
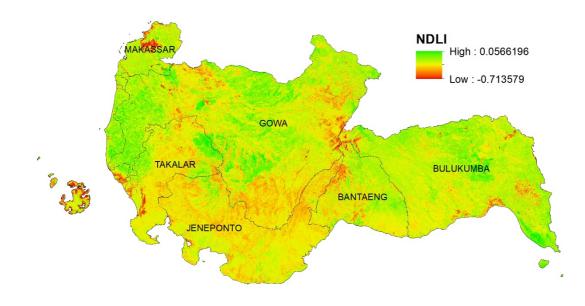


**Figure 2.** NDLI image generated from L8.

Based on the dryness class SPEI, the southern coast of South Sulawesi Province has normal to dry drought levels. There are three classes of drought at the study site, those are near normal, moderately dry and severely dry. The moderately dry classification is the largest area, which is around 319,928.75 ha or 65.12% out of the total study area. The administrative area with the widest percentage of drought is Jeneponto Regency as shown in figure 3 below.
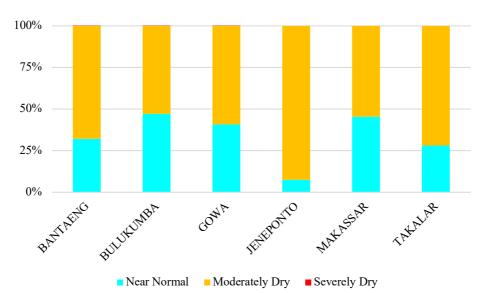
**Figure 3.** The percentage of drought level per regency/city.

From the above description, it can be seen that Jeneponto Regency has the widest level of drought from its administrative area which is 92.52%, then Takalar Regency at 71.89%, Bantaeng Regency at 67.98%, Gowa Regency at 59.29%, Makassar City at 54.86% and Bulukumba Regency at 52.86%. The high area which is categorized as dry in the southern coastal area of South Sulawesi Province, which is almost ½ of its administrative area, needs to be considered in future planning. Especially considering the locations of development projects such as housing, industry, agricultural and fisheries development. It is necessary to direct the development to locations that can still support such as locations that fall into the near normal category. The area of drought classification and spatial distribution in detail are presented in table 2 and figure 4 below.

**Table 2.** Drought level classification distribution in the southern coast of South Sulawesi Province.

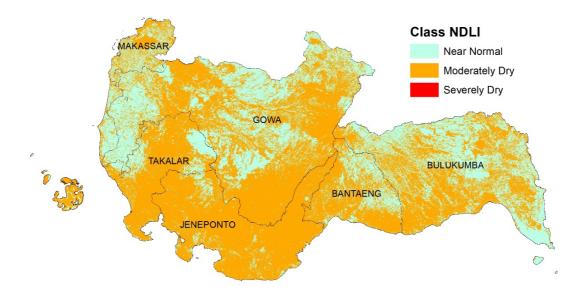| Regency/City | Total Area (Ha) | | |
|---|---|---|---|
| | **Near Normal** | **Moderately Dry** | **Severely Dry** |
| Bantaeng | 12,735.39 | 26,936.20 | 0.06 |
| Bulukumba | 55,699.54 | 62,453.31 | 0.51 |
| Gowa | 73,384.58 | 106,858.13 | 1.52 |
| Jeneponto | 5,987.15 | 74,049.75 | |
| Makassar | 7,845.11 | 9,465.28 | |
| Takalar | 15,703.48 | 40,166.08 | |

**Figure 4.** Spatial distribution of drought levels in the southern coast of South Sulawesi Province.

## 4. Conclusion

The use of remote sensing technology through the NDLI index analysis can describe drought conditions in an area up to date based on the availability of good image data. This drought analysis can describe in detail the vulnerable and non-vulnerable areas. In the future, this approach can be used to make planning decisions in spatial planning and to update the existing drought risk assessment.

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