SKRIPSI

STUDI PEMETAAN KEKERINGAN METEOROLOGI PADA PULAU JAWA MENGGUNAKAN *STANDARDIZED PRECIPITATION INDEX (SPI)*

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UNIVERSITAS KATOLIK PARAHYANGAN
FAKULTAS TEKNIK
PROGRAM STUDI SARJANA TEKNIK SIPIL
(Terakreditasi Berdasarkan SK BAN-PT Nomor: 11370/SK/BAN-PT/AK-ISK/S/X/2021)
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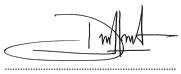
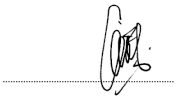
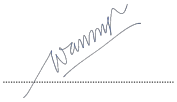
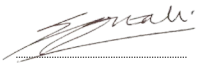
ADVISOR:	**Ir. Doddi Yudianto, Ph.D.**	
CO-ADVISOR:	**S. Sanjaya, M.Sc.**	
EXAMINER 1:	**Dr. Wanny K. Adidarma**	
EXAMINER 2:	**Salahudin Gozali, Ph.D.**	

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LEMBAR PERNYATAAN

Yang bertandatangan di bawah ini, saya dengan data diri sebagai berikut:

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Menyatakan bahwa skripsi dengan judul:

ASSESSMENT OF METEOROLOGICAL DROUGHT MAPPING IN JAVA ISLAND USING STANDARDIZED PRECIPITATION INDEX (SPI)

adalah benar-benar karya saya sendiri di bawah bimbingan dosen pembimbing. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika keilmuan yang berlaku dalam masyarakat keilmuan. Apabila di kemudian hari ditemukan adanya pelanggaran terhadap etika keilmuan dalam karya saya, atau jika ada tuntutan formal atau non formal dari pihak lain berkaitan dengan keaslian karya saya ini, saya siap menanggung segala resiko, akibat, dan/atau sanksi yang dijatuhkan kepada saya, termasuk pembatalan gelar akademik yang saya peroleh dari Universitas Katolik Parahyangan.

Bandung, 24 Januari 2023

Nicholas Audwin Agathon

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ABSTRACT

Drought ranked first among all natural hazards in terms of the number of people affected and its frequency and duration has increased by nearly a third since 2000. Drought occurrence has been exacerbated by climate change that's contributing to more droughts and water shortages on continents around the world, not to mention Indonesia. Java Island as the most populous island in Indonesia is the third largest rice producer in the world. If drought occurs in Java Island, it could disrupt the food production in Indonesia. Therefore, it is important to increase the awareness of drought to reduce the negative impacts of drought such as drought mapping. The drought in Java Island is calculated using SPI with satellite derived precipitation of GPM for the past 20 years The SPI in Java Island is calculated at 4 timescales (3 months, 6 months, 9 months, and 12 months) and the SPI chosen for further analysis is SPI-3, since it is generally used for meteorological drought analysis. After performing SPI quantification over Java Island, calculations of drought intensity and frequency over Java Island were also carried out based on the SPI results. The result shows that East Java Province is classified as a very high severity, with the highest drought intensity is 1.07 and the highest drought frequency is 23 times for the past 20 years. A further investigation of SPI-3 in four cities in East Java Province is also carried out to validate the results, by comparing it with the historical drought record.

Keywords: Drought, Java Island, SPI, Drought Intensity, Drought Frequency

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ABSTRAK

Kekeringan merupakan bencana alam yang menduduki peringkat pertama dalam hal jumlah orang yang terkena dampak dan frekuensi serta durasinya telah meningkat hampir sepertiga sejak tahun 2000. Terjadinya kekeringan diperburuk oleh adanya perubahan iklim yang menyebabkan sering terjadinya kekeringan dan kekurangan air di berbagai benua dunia, termasuk Indonesia. Pulau Jawa merupakan pulau terpadat di Indonesia dan penghasil beras terbesar ketiga di dunia. Kekeringan yang terjadi di Pulau Jawa dapat mengganggu produksi pangan di Indonesia. Oleh karena itu, penting untuk meningkatkan kewaspadaan terhadap kekeringan untuk mengurangi dampak negatif dari kekeringan, seperti contohnya yaitu pembuatan peta kekeringan. Analisis kekeringan di Pulau Jawa dihitung menggunakan metode SPI dengan input curah hujan satelit dari GPM. Kekeringan dianalisis di Pulau Jawa selama 20 tahun terakhir menggunakan data curah hujan GPM. SPI di Pulau Jawa dihitung dalam 4 rentang waktu (3 bulan, 6 bulan, 9 bulan, dan 12 bulan). SPI yang dipilih untuk analisis lebih lanjut adalah SPI-3, karena umumnya digunakan untuk analisis kekeringan meteorologis. Setelah melakukan kuantifikasi SPI di Pulau Jawa, dilakukan juga perhitungan intensitas dan frekuensi kekeringan di Pulau Jawa berdasarkan hasil SPI tersebut. Hasil analisis menunjukkan bahwa Provinsi Jawa Timur tergolong dalam tingkat keparahan kekeringan yang sangat tinggi dan merupakan provinsi dengan intensitas dan frekuensi kekeringan tertinggi, dengan intensitas kekeringan tertinggi 1.07 dan frekuensi kekeringan tertinggi 23 kali selama 20 tahun terakhir. Investigasi lebih lanjut terhadap SPI-3 di empat kota pada Provinsi Jawa Timur juga dilakukan untuk memvalidasi hasil analisis kekeringan, dengan membandingkannya dengan catatan sejarah kekeringan.

Kata Kunci: Kekeringan, Pulau Jawa, Metode SPI, Intensitas Kekeringan, Frekuensi Kekeringan

PREFACE

This undergraduate thesis was created in order to fulfill the requirements for the Civil Engineering bachelor's degree at Parahyangan Catholic University. Writing this undergraduate thesis has been a great adventure for the writer because he has gone through many different emotional phases. There are many persons in the writer's personal circle who provided both technical help and emotional support in the creation of this undergraduate thesis.

This page is therefore specifically created to express gratitude to individuals who supported the writer at all times while working on this undergraduate thesis. First and foremost, the author wishes to express his gratitude to God for allowing him to complete this undergraduate thesis through His grace, blessings, and guidance. The author is grateful for the following:

1. My advisor, Doddi Yudianto, Ph.D, who has given the writer many valuable things such as advice, recommendation, and support through the entire process of completing this undergraduate thesis.
2. My co-advisor, Stephen Sanjaya, S.T., M.Sc., who has guided the writer in writing this undergraduate thesis, working on the MATLAB program, and mapping using the QGIS program; since day one.
3. Dr. Ir. Wanny K. Adidarma, Dipl. H., M.Sc., who has helped the writer in improving this undergraduate thesis and given the writer many valuable input and support throughout the completion of this undergraduate thesis.
4. My family; father, mother, sister, Bounty, and Baby, for always giving their love and moral support, and always give prayers to the writer during the writer’s time studying at Civil Engineering of Parahyangan Catholic University.
5. Jessua Stivo and Andrea Polisar, who always give the writer moral support and encouragement, and always by the writer’s side throughout the completion of this undergraduate thesis.

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10. All family of Volleyball Student Unit Activity, who always give their support and always entertain the writer during the hard times in completing this undergraduate thesis.
11. All the writer friends and colleagues who cannot be mentioned one by one who has given their support.

The writer realized that this undergraduate thesis has many potential flaws and is far from perfection. Therefore, the writer would value any critiques and recommendations for improving this undergraduate thesis. The writer hopes that the studies in this undergraduate thesis can be continued for further contrivance and can be helpful to all readers.

Bandung, 24th of January 2023

Nicholas Audwin Agathon

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ANNOTATIONS

SPI	:	Standardized Precipitation Index
GPM	:	Global Precipitation Measurement
S	:	Drought Intensity
K	:	Drought Threshold
T	:	Duration of Drought
F	:	Drought Frequency
n	:	Number of Drought Occurrences
N	:	Time Period of Drought

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CHAPTER 1
INTRODUCTION

1.1 Background

Drought can be easily defined as a deficit of water compared with normal conditions or below-normal water availability (Van Loon, 2015). Since the year of 2000, drought frequency and duration worldwide has increased by nearly a third (The United Nations, 2022). Moreover, drought is also ranked first among all natural hazards in terms of the number of people affected (Mishra & Singh, 2010). According to the World Meteorological Organization (WMO) in 2021, the top 10 disasters that led to the highest death toll globally is drought. This condition has been exacerbated by climate change, which is contributing to more droughts and water shortages on continents around the world, especially the human-induced climate change (IPCC, 2021). This drought condition has happened worldwide, not to mention Indonesia. Based on The Geoportal of Indonesian Disaster Data, for the last 14 years, drought has occurred in 686 districts of Indonesia and 44% of the drought occurred in Java Island. One of the examples of droughts that happened in Indonesia is the severe drought in 2015 that caused forest fires and losses up to 200 trillion rupiahs (Indonesia Climate Risk Country Profile, 2021). If this persists to happen, it will have a big impact to agricultural sector in Indonesia.

As the most populous island in Indonesia, the land use in Java Island takes up to almost one million hectares for irrigation (Databoks Indonesia, 2015). Indonesia is the third largest rice producer in the world, with Java Island as the largest food-producing region (IDN Financials, 2021). Java Island contributes to 67% of total food production in Indonesia (Central Bureau of Statistics, 2022). If drought occurs in Java Island, it could disrupt food production in Indonesia. Therefore, an early mitigation strategy is important to increase the alertness and preparedness of drought.

Early mitigation strategies mean taking actions before, or at the beginning of, drought to help reducing the negative impacts of drought (National Drought Mitigation Center, 2022). An example of early mitigation strategies is a drought

mapping, to scrutiny the drought hotspots. Since drought is very difficult to define quantitatively, it creating a variety of drought indices (Van Loon, 2015). There are several drought indices such as Standardized Precipitation Index (SPI), Standardized Precipitation and Evapotranspiration Index (SPEI), Standardized Snow Melt and Rain Index (SMRI), and Palmer Drought Severity Index (PDSI).

The drought index used in this study is Standardized Precipitation Index (SPI), due to its conservative approach in estimating drought events (Suroso et al., 2021). SPI was designed to quantify the precipitation deficit for multiple timescales and could be calculated for any locations that is based on the long-term precipitation record (more than 30 years) for a desired period (World Meteorological Organization, 2012). Since the ground station rainfall in Java Island is not adequate, hence satellite derived precipitation is used as an alternative. The satellite rainfall products utilized in this study is Global Precipitation Measurement (GPM) which produced jointly by NASA and JAXA and has advantages in data availability, where the data are available from 2000 onwards.

Several studies have shown many drought events in Indonesia, such as meteorological drought that tends to occur more frequently during the month during the wet period than during the dry period and has a positive relationship with rainfed paddy productivity (Putra & Nurjani, 2021). Studies from Siswanto et al. 2022, also showed how meteorological drought analysis used as a reference to support food security in Java Island. Ma'Rufah et al. 2017, also analyzed the relationship between meteorological drought with agricultural sector and map the distribution of drought over Indonesia. Also, Setiawan et al. 2017, also found out that Monthly or seasonal meteorological drought outlook can be improved by using SPI. Unfortunately, study of early mitigation identification has never been made. Therefore, this study is conducted to find out which areas on Java Island have the highest potential of meteorological drought.

1.2 Study Urgency

Java Island is the most populous island in Indonesia with the agricultural sector as the vital sector. If drought occurs in Java Island, it could have a big impact on food productivity in Indonesia, since Indonesia is one of the largest food producers

globally. The climate change also continues to aggravate the meteorological drought conditions. It is very important to determine which part of Java Island that experienced the most severe drought. However, there has never been a drought mapping for drought monitoring purposes in Java Island. The climate change also continues that could aggravate the meteorological drought conditions. Therefore, this study was conducted to monitor the drought in Java Island, to indicate an early indication of drought, in order to increase the preparedness when drought occurs in Java Island.

1.3 Study Objectives

To achieve the aim of this study, some objectives were formulated, as follows:

1. To perform SPI quantification in Java Island using historical data
2. To analyze the severity, duration, and frequency of drought
3. To perform drought monitoring in Java Island
4. To obtain a meteorological drought map in Java Island

1.4 Scope Study

In this study, the scope limitations of the discussions are as follows:

1. The drought analyzed is meteorological drought
2. Rainfall data using satellite precipitation products of GPM
3. Meteorological drought analysis using SPI drought index
4. Drought mapping of Java Island using the QGIS software

1.5 Research Methodology

The research methodology used in this study are illustrated in Figure 1.1, as well as described as follows:

1. Literature Study

   A literature study is conducted to understand the drought concepts, especially about meteorological drought, and its characteristics for drought mapping in Java Island to obtain the drought hotspot.

2. Data Collection

   Data collection is conducted to obtain satellite derived precipitation of GPM in Java Island from The NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC).

3. SPI Calculation

   SPI calculation is conducted from satellite precipitation data to obtain drought index distribution in Java Island.

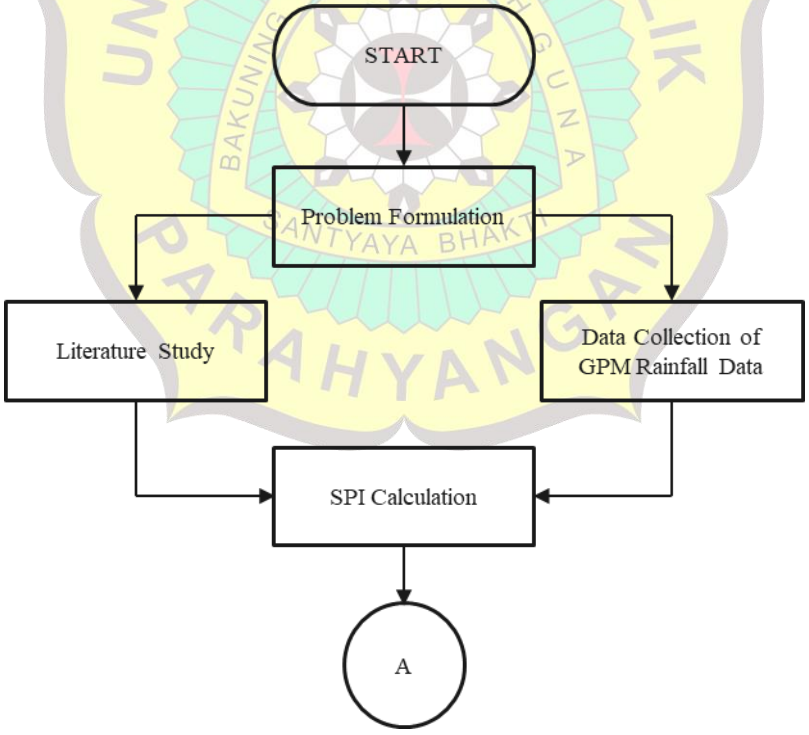
4. Data Analysis

   Data analysis is conducted to analyze the severity, duration, and frequency of drought that occurred in Java Island.

5. Drought Mapping

   Drought mapping is conducted using QGIS to perform drought monitoring in Java Island.

   The research methodologies that conducted are shown in the flowchart below.



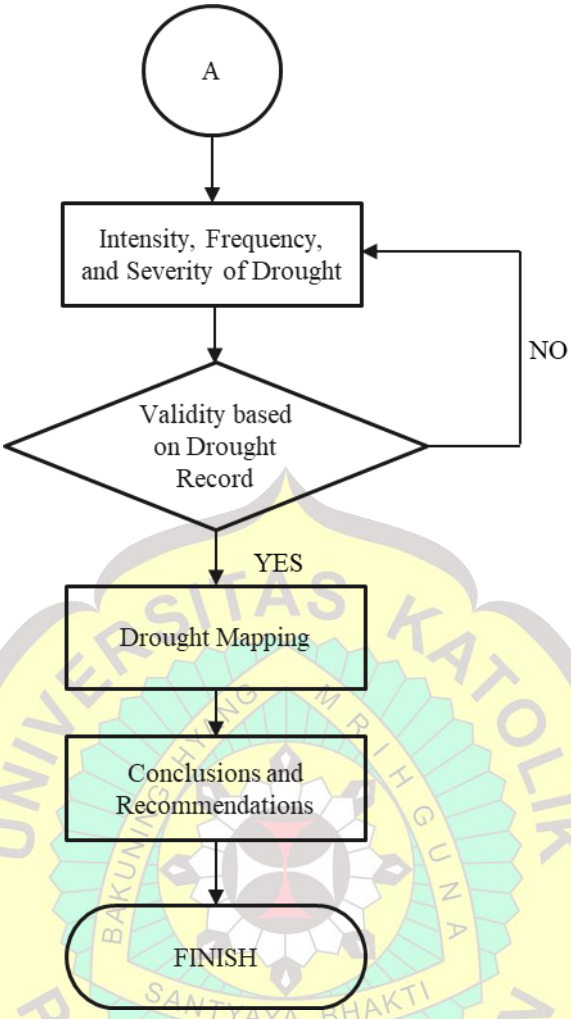


Figure 1.1 Flowchart of Research Methodology