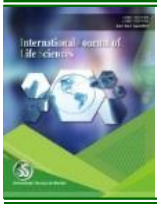

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Accuracy Verification of Extreme Weather Early Warning in Denpasar Area 2018

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extreme weather;
rainfall;
weather conditions;

Abstract

Research has been conducted to verify the accuracy of extreme weather early warnings in the West Denpasar area in 2018. This research is based on the climate and weather conditions in Indonesia which are classified as extreme due to the effects of the movement of the west wind and east winds of the Indian-Pacific Ocean which causes Indonesia to have a variety of climate and weather, especially rainfall. Rainfall conditions in various places in Indonesia, especially Bali, have moderate to heavy rain intensity. In 2018, there were 673 extreme weather early warnings in the West Denpasar area with an accuracy rate of 92% from January to December.

Contents

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1 Introduction

The country of Indonesia is located in a tropical area, between the continents of Asia and Australia, between the Pacific Ocean and the Indian Ocean, and is traversed by the equator, consisting of islands and archipelagos that stretch from west to east, surrounded by vast oceans, causing the Indonesian region to have a variety of weather and conditions. climate. Indonesia's climate diversity is influenced by global phenomena such as the El Nino Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD). Climate differences are also influenced by regional phenomena, such as the Asian-Australian monsoon wind circulation, the inter-tropical wind confluence area, or the Inter-Tropical Convergence Zone (ITCZ), and sea surface temperature conditions around Indonesia (Ahrens, 1988; Asnani, 1993).

The impact of the monsoon is the occurrence of high-pressure air that moves north of the equator and produces rain in Indonesia. Rain conditions in Indonesia have moderate to heavy rain intensity. Rainy conditions, especially in Bali Province, have an average intensity of heavy rain because it is dominated by low-pressure air patterns in the Australian region which causes the formation of wind confluence areas around southern Indonesia (Meteorologi, 2013). Based on the KBMKG regulation No. 009/2010 concerning standard operating procedures for the implementation of early warning, reporting, and dissemination of extreme weather information, it is necessary to take action in the form of early warning of extreme weather to prevent casualties when a disaster occurs in an area. For this reason, it is necessary to verify the accuracy of extreme weather early warnings to improve preparedness in dealing with disasters (Beer, 1974; Hutagalung et al., 2015).

Theoretical foundation
Extreme weather

Extreme weather events are one of the weather phenomena that we must be aware of because their impact will affect our daily lives. Before going into the discussion about extreme weather, we must know what weather is first. What is the weather like? Weather is the atmospheric conditions that occur at a certain time and place. The atmosphere is a layer of air that has to protect the Earth (Tjasyono & Syukur, 2014). The atmosphere has four main layers consisting of the troposphere, stratosphere, mesosphere, and thermosphere (Goovaerts, 2000; Sivapalan & Blöschl, 1998). All-weather events occur in the lowest atmospheric layer and closest to the earth's surface, namely the troposphere, because most of the air mass that forms the air circulation that forms the basis for weather formation is in the troposphere.

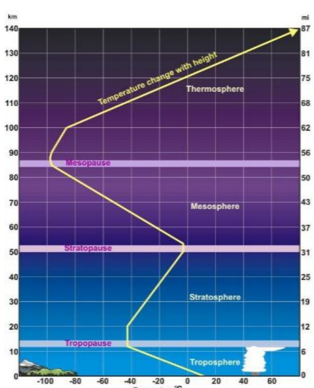

Figure 1. The structure of the layers of the earth's atmosphere (Hestiyanto, 2005)

Rain

In the field of meteorology, rain is often associated with precipitation which is the fall of water from the atmosphere to the earth's surface. In the tropics, including Indonesia, rain contributes the most (Triadmojo, 2008). The unit of rainfall is mm (millimeter) meaning that in an area of one square meter on a flat place 1 mm high water is accommodated or accommodated as much as 1 liter of water or 1000 ml. Extreme rain is seen with heavy rain (above 20 mm per hour or 50 mm per day). Heavy rain can occur in the presence of cumulonimbus (Cb) clouds. Cb clouds are clouds that rise vertically upwards to a height of 60,000 feet (±18 km from ground level) (Smart et al., 2006; Roy, 2005).

Weather radar

Based on Perka BMKG No. 009 of 2010 article 14, weather monitoring is carried out based on the original image data from the radar. Weather radar can detect the intensity of rainfall as well as bad weather. The results of radar scanning are in the form of radar images (Panteli & Mancarella, 2015; King et al., 2014). The weather radar image depicts the potential intensity of rainfall detected by the weather radar. Measurement of rainfall intensity by weather radar is based on how much radar energy is reflected by water droplets in the cloud and is described by reflectivity product which has units of dBZ (decibel). The greater the reflected energy received by the radar, the greater the dBZ value, the greater the dBZ reflectivity value indicating the greater the intensity of the rain (Meteorologi, 2013). The farthest range of reflectivity products from the BMKG radar is ±240 km from the radar location. This is because the radar used is an EEC C-BAND type radar. The dBZ scale in the legend ranges from 5 – 75 which is indicated by the degradation of the sky blue color to light purple. If the color degradation is getting towards purple, the higher the intensity of the rain. Rain intensity range based on the dBZ color scale and units of mm/hour.

Table 1
Rain intensity categories (Meteorologi, 2013)

Rain intensity category	dBZ Value	mm/hour
Light rain	30 to 38	1 to 5
Moderate rain	38 to 48	5 to 10
Heavy rain	48 to 58	10 to 20
It's raining very hard	>58	>20

Early warning system

Early warnings for extreme weather must be made carefully and in a short time to the public through the mass media, relevant agencies, and the BMKG staff. The things that need to be considered in making an early warning system for extreme weather are:

1) Local-scale includes:
   a) Air lability.
   b) Initial coverage of satellite or radar observations.
   c) Conditions of temperature, humidity, and other elements that support the location of the cu-ex.
2) The synaptic (regional) scale includes:
   a) Monsoon activation.
   b) Madden Julian Oscillation (MJO) Phenomenon.
   c) Sea surface temperature (addition of seawater vapour).
   d) Location of low-pressure centre.
   e) Active cloud freezing area (convergence).
3) The planetary (global) scale includes:
   a) The El Nino/La Nina Phenomenon.
   b) The phenomenon of dipole mode.

The time limit for sending early warning data is approximately 2 hours before the prediction of a disaster event will occur (Moon et al., 2019; Guzzetti et al., 2020).

2 Materials and Methods

In this study used data collection methods. The data used is rainfall data on the radar in the West Denpasar area in 2018, in the form of data on the time of the incident and the duration of the event (weather). Some of the software used is Telegram which is to get weather early warning data which is disseminated by the MKG Regional III Denpasar Center, then the Microsoft Excel application is used to manage radar and GSMaP data to be matched to get accuracy results from the data according to which the unit is clearly stated. Used in each quantity, either SI or CGS units. The following is a research flow chart including the following:

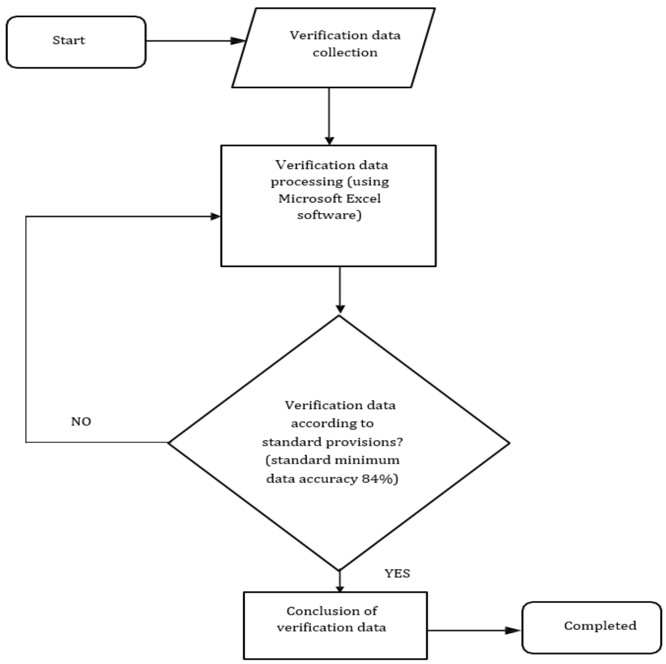

Figure 2. Research flowchart

3 Results and Discussions

In the verification process for extreme weather early warnings using GSMaP satellite data in the West Denpasar area, which is then matched with warning data from MEWS at the MKG Center Region 3 Denpasar. This satellite data is in the form of rainfall data every 1 hour, where the amount of rainfall intensity is measured and updated every 1 hour, therefore the rainfall data table is made on an hourly basis starting from 00.00 – 23.00 WITA. MEWS data is taken from extreme weather early warning messages distributed via the Telegram application where the early warning messages are updated every 30 minutes by MEWS MKG Center Region 3 Denpasar. The early warning issued by MEWS is based on daily weather forecast data from the MKG Center for Region 3 Denpasar (Bélanger et al., 2009; Moazami et al., 2019).

The data taken on the telegram is only limited to early warning data in 2018. In the matching process here using a contingency test, we get results in the form of the number of weather early warnings that have been generated, how many early warnings are appropriate according to the data in the field, in this case, satellite data, as well as how many early warnings do not match the data in the field than from the contingency table we can determine the accuracy of extreme weather early warnings. The national BMKG standardization value for the percentage of accuracy for early warning extreme weather in 2018 is 84% where the results of the contingency test in the form of a percentage must meet a value of 84% or more than it is said to be accurate (Omer, 2015; Singh, 2017).

In January there were 135 extreme weather early warnings, 96 times in February, 76 on March, 12 on April, 6 on May, 37 in June 7 times in July, 69 times on August, 10 on September, 13 in October, 121 times in November and 121 in December 91 times. In general, the average percentage of accuracy in 2018 has reached > 84%, which is 92% per the year 2018. The graph above shows that in January the accuracy of extreme weather early warnings was 84%, the results of extreme weather early warning accuracy in February were 87%, for March the accuracy results show 90%, for April it is 98%, for May it is 99%, for June it is 92%, for July it is 99%, for August it is 91%, for September it is 96 %, 98% for October, 80% for November, 88% for December.

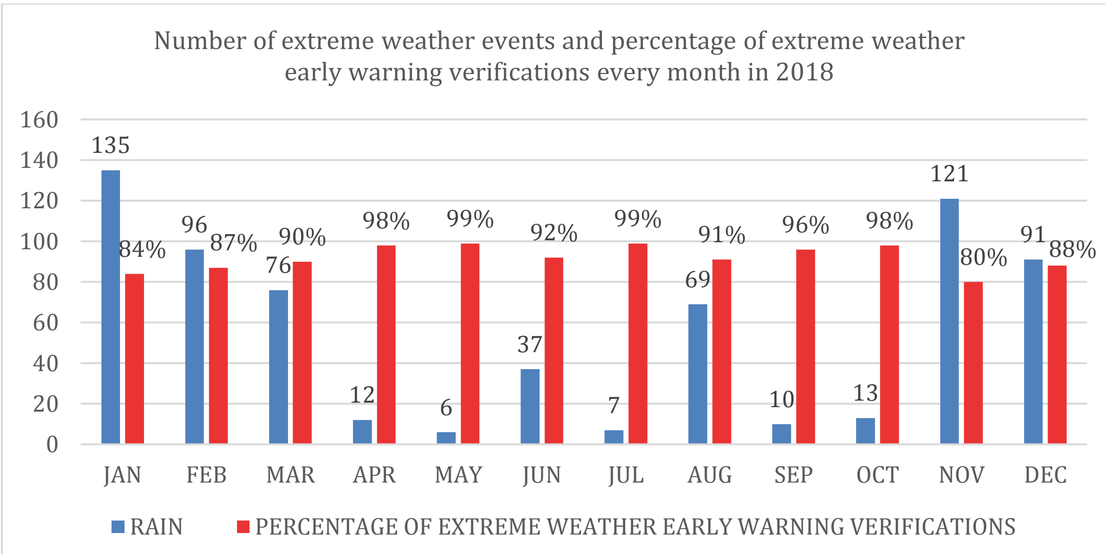

Figure 3. The graph of the comparison of the number of extreme weather events with the percentage of verification of extreme weather early warnings in the West Denpasar area in 2018

4 Conclusion

From January to December, there were 673 extreme weather early warnings in the West Denpasar area in 2018 and the average accuracy of extreme weather early warnings in 2018 was 92%.

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