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# Analysis of the influence of tropical cyclones on rainfall in Indonesia

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**Abstract.** Indonesia is a forming area for tropical cyclones. Because the geographical location of Indonesia is located at the Equator so that it is influenced by the Coriolis style. Most tropical cyclones are formed in between 10° and 20° areas from the equator. So that tropical cyclones only occur in the Indian Ocean and in the northern region of Indonesia (south China sea and western Pacific). Tropical cyclones are storms with great strength. The average radius of a tropical cyclone reaches 150 to 200 km. Tropical cyclones are usually sea surface temperatures, more than 26.5 C. Strong winds have speeds of more than 63 km / h which affect the intensity of rainfall in Indonesia [1]

## 1. Introduction

Tropical Cyclone is a meteorological disorder caused by the presence of a low pressure center in the ocean. The requirement for the formation of tropical cyclones in the waters is that the sea surface temperature (sst) is quite hot ( $T > 26^{\circ}\text{C}$ ) and the Coriolis parameter must be greater than the minimum value found in latitude  $5^{\circ}$  in the northern and southern hemispheres. The process of forming Tropical Cyclones is as follows ;

- a. The occurrence of a tropical depression where the wind speed is  $v \leq 20$  knots and there is a closed isobar.
- b. Tropical storms occur where wind speeds increase ( $34 < v < 64$ ) knots and there are several isobars closed around the eyes.
- c. Tropical cyclones are formed where wind speeds are  $\geq 64$  knots.

The conditions needed for both geographical and climatological conditions in the formation of tropical cyclones are:

- a. The surface temperature of the sea is quite hot, which is above  $26^{\circ}\text{C}$ . The air in the lower layer is moist, this air spreads up and is hotter than the atmosphere of the environment up to a height of 12 km.
- b. The Coriolis parameter must be greater than the minimum value found at the latitude of about  $5^{\circ}$  northern and southern hemispheres. If the Coriolis force is weak, the cyclone is not formed.

Tropical cyclone is a storm with great strength caused by a low pressure center in the water. The average radius of a tropical cyclone reaches 150 to 200 km. Tropical cyclones form on vast oceans which generally have warm sea surface temperatures, more than  $26.5^{\circ}\text{C}$ . Strong winds that rotate near the center have wind speeds of more than 63 km / hr. Technically, tropical cyclone is defined as a synoptic scale non-frontal low pressure system that grows over warm waters with convective flotation areas and a maximum wind speed of  $\pm 34$  knots in more than half the area encircling the center, and lasts for at least six hours (<http://meteo.bmkg.go.id/siklon/learn/01/id>). Tropical cyclones can cause damage mainly caused by strong winds, storm surge, and heavy rain. The area of tropical cyclone formation is approximately two-thirds occurring in the Northern Hemisphere. The number of tropical cyclones that grew in the northern hemisphere averaged 57.3 events in one year and in the southern hemisphere averaged 26.3 tropical cyclones in a year (based on data from 1968 - 1989).



Tropical cyclones can be formed with the following conditions:

- a. The surface temperature of the sea is at least 26.5 C to a depth of 60 meters
- b. Unstable atmospheric conditions that allow the formation of Cumulonimbus clouds. These clouds, which are clouds of thunder, and are strong convective region markers, are important in the development of tropical cyclones.
- c. The atmosphere is relatively humid at an altitude of about 5 km. This height is an intermediate parasitic atmosphere, which when it is dry cannot support the development of thunderstorm activity in the cyclone.
- d. Located at a distance of at least about 500 km from the equator. Although possible, cyclones rarely form near the equator.
- e. Disturbance of the atmosphere near the surface of the earth in the form of a whirlwind accompanied by gusts of wind.
- f. Changes in wind conditions to height are not too large. Changes in the conditions of a large wind will disrupt the process of developing a thunderstorm.

The tropical cyclone life cycle can be divided into four stages, namely:

#### 1.1. Formation stage

Marked by the presence of atmospheric interference. When viewed from weather satellite images, this disturbance is characterized by convective regions with cumulonimbus clouds. The center of circulation has not yet formed, but it appears at the end of the belt that forms a spiral.

#### 1.2. The bekum stage is mature

At this stage the strong convective region is formed more regularly to form a circular belt (in the form of a spiral) or form a region that is relatively round in shape. The intensity increases simultaneously marked by the surface air pressure that drops to less than 1000 mb and the maximum wind speed increases to reach a gale force wind (wind speed  $\geq 34$  knots or 63 km / h). Wind with maximum speed is concentrated in the ring that surrounds the center of circulation. The circulation center was clearly monitored and cyclone eyes were formed.

#### 1.3. Mature stage

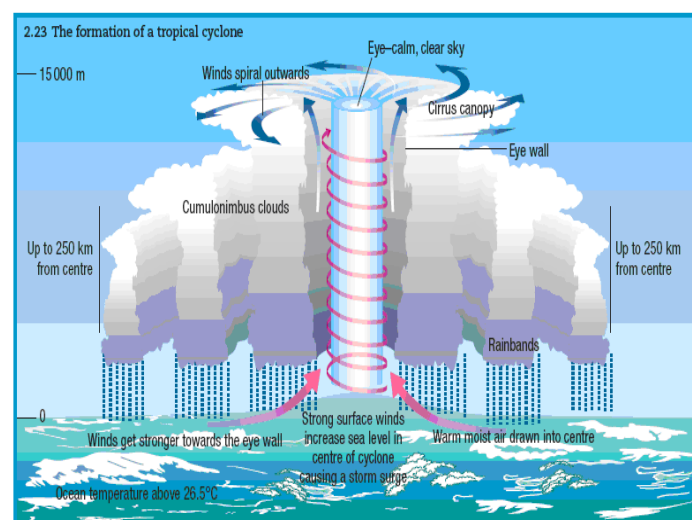
At the mature stage, tropical cyclones tend to be stable. Minimum air pressure at the center and maximum wind around it that does not experience significant fluctuations. Cyclonic circulation and areas with gale force winds are expanding, weather satellite images show regular and more symmetrical conditions of virginity. Stronger tropical cyclones can clearly see cyclone eyes. This phenomenon is characterized by the warmest areas of temperature in the midst of a system of resistance with calm surface winds and surrounded by thick convective walls around it (eye walls). Unless the tropical cyclone is in an area that is very supportive of its development, the mature stage usually only lasts for approximately 24 hours before the intensity begins to weaken.

#### 1.4. Weakening stage

At the extinction stage, the center of the warm cyclone begins to disappear, the air pressure increases and the area with maximum wind speed extends and extends away from the center of the cyclone. This stage can occur quickly if tropical cyclones pass through areas that do not support growth, such as entering high latitudes with cold sea temperatures or entering land. From satellite imagery it can be seen that the convective region of the tropical cyclone is diminishing, and the belt is slowly disappearing.

Tropical cyclones take 7 days in the formation process, ranging from growing to extinction. However, the variation can reach 1 to 30 days. Indonesia is not a region that forms tropical cyclones. Because of the geographical location of Indonesia which is located at the equator so that it is influenced by the coriolis style. Most tropical cyclones form in areas between 100 and 200 from the equator. So that tropical cyclones only occur in the southern region of Indonesia (Indian Ocean) and in the northern region of Indonesia (southern and western Chinese sea). Tropical Cyclones can influence the formation of convective clouds in the surrounding area. So that in the vicinity of tropical Cyclones more rainfall is obtained. This will disturb the weather in the area that is not passed by the shear. This paper will discuss the effects of tropical cyclones that occur in the waters south of Indonesia on March 21-25, 2014, especially in the Riau region, which at the time was being carried out Weather Modification technology reduces smoke haze.

## 2. Tropical cyclone structure



**Figure 1.** tropical cyclones stucture

Tropical cyclones consist of three main parts:

- a. Eye - The low pressure area which is the center of the cyclone circulation.
- b. Eye wall - This area is a strong wind around the eye that rotates around the center very quickly.
- c. Rain bands - the band area circulates thunderstorms in the outermost part of the eye which is where the evaporation / condensation cycle takes place which is the source of storm formation.

## 3. Tropical cyclone impacts

Wind is one of the abiotic components in the ecosystem. Its original form is air, but if it moves it will cause wind. Basically wind has many benefits for humans, but it is not uncommon for wind to become a disaster. So, there are positive and negative impacts. Some of the effects of cyclone winds include the following:

### 3.1. Positive impact

Positive effects of cyclone wind, namely:

- a. Maintain the balance of the Earth's heat atmosphere
- b. Ending drought and lack of water (read: type of water ) in the area it passes

### 3.2. Negative impact

The negative impact of cyclone winds, namely:

- a. Too much heat energy
- b. Causing high waves, heavy rain, and high-speed winds
- c. Interfering with shipping schedules
- d. Drowning ships that cross the ocean
- e. Cause the land to collapse
- f. Causes direct damage to the surface of the earth, through:
  - 1) High speed wind
  - 2) Heavy rain
  - 3) Sea wave
  - 4) Tornado
- g. Causes indirect impacts, such as:
  - 1) Inflict germs
  - 2) Absence of electricity
  - 3) Difficulty in transportation

### 4. Rainfall in Indonesia

Indonesian regions located in the tropics affect the amount of rainfall received. The average rainfall in Indonesia is high, which is 2,000 mm / year. The amount of rainfall received causes the atmosphere of the Indonesian region to contain a lot of water vapor. The pattern of rainfall in Indonesia is divided into three patterns, namely, monsoonal, equatorial, and local patterns [2], [3]. BMG Based on the average monthly rainfall data distribution, generally the Indonesian region is divided into 3 (three) rainfall patterns, namely:

- a. The monsoon rain pattern, whose area has a clear difference between the rainy season and the dry season, is then grouped in the Seasonal Zone (ZOM), unimodal rainfall type (one peak rainy season, rainy season DJF, JJA dry season).
- b. Equatorial rainfall pattern, where the area has a bimodal monthly rainfall distribution with two peaks of maximum rainy season and almost all of the year is included in the rainy season criteria. The equatorial pattern is characterized by a type of rainfall with a bimodal form (two peaks of rain) which usually occurs around March and October or during ecinox.
- c. Local rainfall patterns, whose territory has a monthly rainfall distribution in contrast to the monsoon pattern. The local pattern is characterized by a form of unimodal rain pattern (one peak of rain), but its shape is opposite to the type of monsoon rain.

In normal conditions, areas that have the type of monsoon rain will get an excessive amount of rainfall during the western monsoon (DJF) compared to the east monsoon (JJA). P The influence of monsoon in areas that have equatorial rainfall patterns is less firm due to the influence of insolation during ecinox, as well as in areas that have more local rainfall patterns. influenced by orographic effects.

### 5. Conclusion

The territory of Indonesia is located in the equator, which is free from cyclone crime because in Indonesia there is no coriolis style (close to zero). Generally when there are bulk cyclones rain area he passed by more than 140 mm per day. Average cyclone incidence for 7 days with variability of 1 to 30 days. Indonesia generally receives an indirect impact on changes in weather conditions. In the dry season, the incidence of tropical cyclones will increase the level of dryness in the Indonesian region, especially in Sumatra and Kalimantan. Rainfall tropical cyclones can cause during the wet season, especially in close to cyclone locations, for example in the regions of Kalimantan and northern Sulawesi.

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