International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

The Role of Tropical Cyclone Cempaka System Toward Spatial Daily Rainfall Total in Indramayu District, West Java Province, Indonesia

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Abstract

A Tropical Cyclone (TC) as a low air pressure system which grows in the tropical region, has a significant role to the pattern of spatial daily rainfall total condition in certain places. Especially, places where located near this TC system position. The TC Cempaka system which had occurred over Southern part of Java Coast during 25-29 November 2017, has a significant role as well in relation to the spatial condition of daily rainfal total in Indramayu District, West Java Provinced, Indonesia. The spatial condition of daily rainfall total in Indramayu District happens spreading evenly when the Cempaka TC system is still in Low Pressure Area (LPA) and Tropical Depression (TD) states. This daily rainfall total shows having higher variation from very light intensity of less than 5 mm/day up to heavy intensity of 21 - 50 mm/day. This daily rainfall total condition has a good agreement with the season condition as Rainy Season (Wet Season) from October to March. In contrary, when the TC system had already declared to be a TC Cempaka system in mature state, the spatial condition of daily rainfall total over Indramayu District shows less variation and intensity.

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Commonly the spatial intensity of daily rainfall total during the mature state of TC Cempaka system activity seems only for very light (less than 5 mm/day) and light intensities (5 - 20 mm/day). This less daily rainfall total condition has clearly relationship with the wind speed condition over the region. Higher intensity in wind speed influences less developping potential convective cloud formation which is able to produce rainfall.

Keywords: Water Vapour; Cloudiness; Daily Rainfall; Tropical Cyclone.

1. Introduction

The region of Indramayu District [1] located on Northern part of West Java Province, Indonesia. This region included factually in Eastern part of Northern Java Island Coast. The border line of Indramayu District is Java Sea in the Northward and Eastward, Subang District in the Westward, others Sumedang District, Majalengka District, and Cirebon District in the Southward as seen on Fig. 1. As a domain of interest to be discussed in this paper, Indramayu District has a unique condition. This district surface condition is mostly flat. Only around 4% of land has a little bit highly more than 100 meter above Mean Sea Level (MSL). There are oftently happening flood during Wet Season (Rainy Season) and drought during Dry Season in contrary [2, 3, 4]. Eventhough no heavy rainfall happening in Indramayu District during Wet Season, but this district could experience flood coming from adjacent region. This is caused by the mostly flat surface over Indarmayu District. Meanwhile during Dry Season, some parts of the land of Indramayu District experienced drought very fast because of no irrigation facilities over there. Geographycally [5], the region of Indramayu District is located over Southern Hemisphere of Indonesia Territory. This district is spread out between 06°15' - 06°40' S and 107°52' - 108°36' E. The area of Indramayu District consist of 204,011 hectoacres land with the coast line of about 147 kilometers. The Indramayu District has 31 Sub-Districts (SD) and 309 villages. The average slope territory of Indramayu District is 0 - 2% with total of 96.03% with the commonly land type of Alluvial (63%), Clay Grumosol (24%), Podsolic (12%), and other ones (1%). This district has had commonly lower topographic condition in Nortern part, especially areas where face to the Java Sea [see on Fig. 1]. Places with elevation of less than 5 m above MSL seem available dominantly. There are available around 60% of total land of Indramayu District. Commonly the low land of Indramayu Distric (0 - 6 meter) above MSL is useful for swamps, fishponds, and yards [4]. By the way, there are also some areas having a relatively highly elevation more than 100 meters above MSL in Southern part ajacent with the Middle Limestone Moutainous range in the middle of Java Island [5]. There are around 10% of total land of Indramayu District. Generally speaking, the Indramayu District has relatively flat mainland. There are approximately 80% mainland elevetion less than 20 meters above MSL.

Based on normal value of monthly rainfall total data taken from 1981 up to 2000 [6], the Wet Season in Indramayu District happens during October up to March. On the other hands, the Dry Season in this district occurs during April up to September. The average of yearly rainfall total in Indramayu District has been computed as 1.418 mm/year. The maximum monthly rainfall total is recorded as 364 mm/month happening in the month of January. But, the minimum monthly rainfall total is observed as 10 mm/month occurring in the month of August.

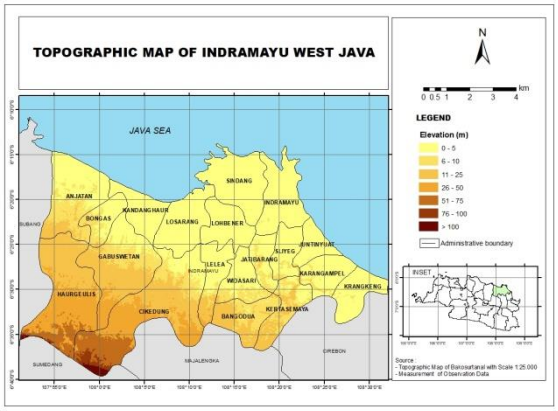


Figure 1: The topographic condition in Indramayu District, West Java Province, Indonesia as a domain of interest in this research.

The monthly rainfall total pattern in Indramayu District, generally included in Monsoonal Category [7, 8]. There are one minima curve of monthly rainfall total during Dry Season and one maxima curve of monthly rainfall total during Wet Season. But the occurences of those minima and maxima monthly rainfal total could be recorded somehow in different months. Based on average values, for example in Anjatan Station (6,36°S 107,92°T) case, the minima monthly rainfall total has been recorded reaching up to 10 mm/month in September [9] and the maxima monthly rainfall total reaching up to 300 mm/month occurred in January. Meanwhile in Juntinyuat Station (6,43°S 108,44°T) case, the minima monthly rainfall total of 10 mm/month happened in September and the maxima monthly rainfall total of 275 mm/month occurred in January. Those rainfall conditions in Indramayu District are highly influenced by weather activity phenomena happening in it's surrounding. Weather activities in such global, regional, synoptical, messo, eventhough local scales have different effect to the rainfall condition in Indramayu District. The example of global scale weather activity phenomena are El Nino and La Nina [10]. Then the example of regional scale weather activity phenomena are Asian Winter (Summer) Monsoon and Australian Winter (Summer) Monsoon. The example of synoptical scale weather activity phenomena are Tropical Cyclone (TC), Tropical Depression (TD), Tropical Storm (TS), and Low Pressure Area (LPA) systems. The example of messo scale weather activity phenomena are Land Breeze, Sea Breeze, Mountain Breeze, and Valley Breeze. The example of local scale weather activity phenomena are Conditional Instability of the Second Kind (CISK) and Orographic Forcing. In relation to the weather interaction in this region, a bigger weather phenomenon activity scale may influence strongly to a smaller weather phenomenon activity [10]. The synoptical scale weather activity phenomena has closed relatioship to the domain of interest are LPA, TD, TS, and TC systems. Among of them can easily be differed based on the maximum sustained surface wind speeds such as LPA or TD system (less than 34 knots), TS system (34-64 knots), and TC system (more than 64 knots) [11, 12]. Theoritically, a TC system is a weather activity phenomenon which has been included in atmospheric disturbance criterion [13, 14]. This TC system is so called as a low atmospheric pressure system because of the avaiability of low atmospheric pressure in it's center [15] that begin as a collection of unorganized thunderstorms over the Tropical Ocean. It can manage the atmospheric circulation and grow rapidly in the Warm Tropical Waters. Understanding about TCs system, there were mostly seen extremely high wind speed, torrential rainfall, and storm surge which destructed and threatened the earth

surface [16]. The range of development of a TC system may widely reach between 200 - 2.000 kilometers. The range of existence of this TC system is a couple days up to weeks. This relies on the moist air masses entering to support the TC system. The successfull development of the TC system depends on the atmospheric and oceanic favourable conditions. The atmospheric condition should be unstable. Concergence in the lower level was neccessary and coincided with divergence in the higher level. The sea surface temperature could not less then 26.5°C in order to maintain the support of water vapour continuously. The destructive effect of this TC system over the earth surface depends on the values of the atmospheric pressure in it's center, the wind speed emerging from the TC system, the range of TC system from the inhabitting land, and the availability stuff in the earth surface [17]. Totally, there were around 24% of the occurrences of TCs system where developed and strenghtened in Indian Ocean for both Northern and Southern the Hemispheres every year [18]. Based on the 1983-2017 data [19], there were 51 TCs system developing between the latitude of 0° - 10°S over Southern Hemisphere, especially closing to Indonesian territory. Commonly the TCs system occurred during November - April. The TC Cempaka system was growing and moving closer to Indonesian Archipelagoes especially to the Special Region of Yogyakarta during the end of the year of 2017. This TC Cempaka system was recorded as the most influencing daily rainfall total intensity (225 mm/day on 28 November 2017) of Gunungkidul Sub-District of the Special Region of Yogyakarta. This value was recorded as an extreme event with increasing of daily rainfall total up to 750% of the historical averages. Not only delevering bad weather condition of strong wind and heavy rainfall, but the TC Cempaka system was also causing 11 people dead on the date of 28 November 2017 [20]. The influencing of TCs system to the daily rainfall total data could be identified well in the case of TD Cempaka system. The characteristic of daily rainfall total seemed increasing because of the existence and influence of TC Cempaka system, especially over mostly Java Island [21]. The closer to the position of the TC Cempaka system means the higher intensity of daily rainfall total recorded. The most deteriorate places where experienced maximum daily rainfall total record at that time, were the closest places to the location of TC Cempaka system. In this case was the Special Regian of Yogyakarta Province. Other TCs which were influencing the condition of wind speed and distribution of daily rainfall total, happened in Indonesian Region. TC Quang system [22] was developed over Eastern part of Indian Ocean waters, generally influenced the condition of oceanographic parameter over Southern part of Java Island Coast as well. The maximum high wave and wind speed conditions increased along with the increasing intensity of the TC system activity. TC Iggy system from 26 January 2012 up to 2 February 2012 influenced extreme daily rainfall total over East Nusa Tenggara Province. The existence of shearlines and convergence zones influenced very intensively before forming the TC Iggy system [23]. TC Saola system from 28 July 2012 up to 3 August 2012 affected the Molluca Island and its surrounding with heavy daily rainfall total. The existence of shearlines and LPA over Northern part of Papua Island were contributing for the development and strengthening to form TC Saola [24].

2. Data and Method

2.1 Data

The primary daily observed rainfall total data taken from the region of Indramayu District, have been utilized in data processing for preparing this paper. Those data which have been collected from 35 rainfall stations. In order to know the distribution of rainfall station in Indramayu District, one is able to see on Fig. 2. The avaiability

rainfall stations were purposed for checking the occurences of daily rainfall insitu over there. The pattern of rainfall distribution spatially could be monitored day by day in relation to the activity of TC Cempaka system, starting from the emerging of TC Cempaka system up to the dissipating of the TC Cempaka system. All daily observed rainfall total data then were plotted spatially using Geographycal Information System (GIS) application [25, 26, 27]. A GIS is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. Some portion of those data would be produced spatially.

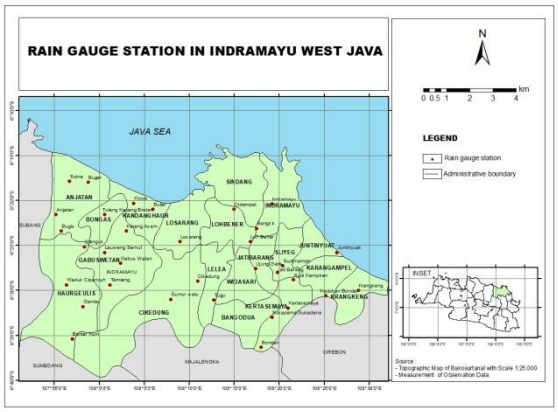


Figure 2: The 35 locations of rainfall stations (red dot) in Indramayu Disrict, West Java Province, Indonesia.

Total of 35 rainfall station data as mentioned above which have been used in data processing for contributing to this paper, have been taken from namely such as: Anjatan (6.36°S 107.92°E), Tulang Kacang (6.36 108.01), Bugis (6.39 107.93), Bugel (6.30 107.98), Gantar (6.53 107.97), Bantarhuni (6.59 107.95), Bulak (6.35 108.10), Wanguk (6.42 107.97), Cipancuh (6.49 107.94), Gabuswetan (6.45 108.04), Karangasem (6.39 108.05), Kroya (6.34 108.06), Leuweng Semut (6.43 108.01), Tamiang (6.49 108.02), Indramayu (6.34 108.32), Bondan (6.61 108.30), Juntinyuat (6.43 108.44), Cidempet (6.35 108.25), Losarang (6.41 108.15), Bulak (6.35 108.10), Cikedung (6.48 108.18), Sumurwatu (6.52 108.13), Tugu (6.52 108.21), Bangkir (6.39 108.29), Lohbener (6.41, 108.28), Sudikampiran (6.48 108.36), Jatibarang (6.47 108.33), Kertasemaya (6.53 108.35), Sukadana (6.55 108.32), Ujungaris (6.46 108.29), Sudimampir (6.45 108.34), Krangkeng (6.50 108.48), Kedokanbunder (6.51 108.42), Kroya (6.34 108.06), and Temiyang (6.49 108.02). In order to monitor the continuous condition of wind speed occurrences and it's fluctuation in line with the activity of TC Cempaka system development in Indramayu District, here the authors have utilized the Global Forecast System (GFS) 0.5 model output. This GFS 0.5 is one of weather forecast model which have been populary used by scientist worldwide to monitor the condition and fluctuation of weather dynamics and its prediction as well. The data resolution of the GFS 0.5 model output was used 0.5° of resolution [28]. Further, the Himawari-8 meteorological satellite images of Infra Red (IR) canals [29] have been utilized to monitor the live cycle of cloudiness development in line with the dynamica of TC Cempaka system along the Southern coast of Java Island. By monitoring the development of TC Cempaka system for every 10 minutes using these satellite imageries, the weather forecasters are able to decide the state of this atmospheric disturbance and also able to monitor the movement of this TC system precisely.

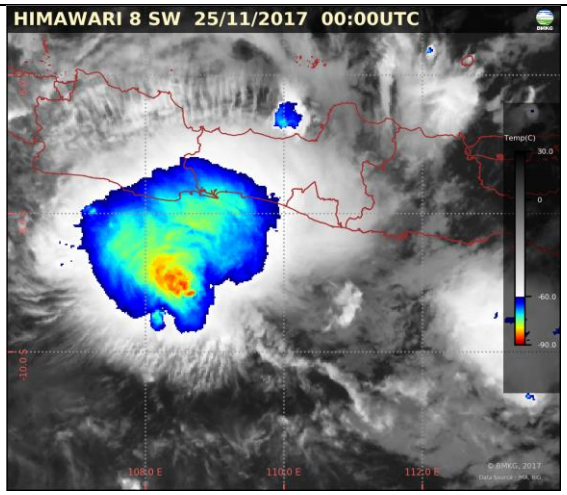
2.2 Method

Firstly, collecting and analysing the Himawari-8 meteorological satellite imageries utilizing IR canal should be done in order to easily monitor the start and development of TC system states. These satellite imageries utilized starting from the date of 25 November 2017 up to 29 November 2017. The categories of the atmospheric disturbances or TCs system can be decide precisely by analysing these satellite imageries. These TC categories further are able to be utilized to understand the daily rainfall total potential condition in Indramayu District in relation to the existence of TC Cempaka system. To plot observed daily rainfall total data taken from Indramayu District in order to understand better about the influenced strength of TC Cempaka system to the rainfall occurrences in this region. Starting from LPA system, TD system, and then TC system, the daily rainfall total data should be analysed step by step spatially and temporally. By monitoring and analysing continuously the fluctuation of spatial observed daily rainfall total data, the role of TC Cempaka system to the spatial daily rainfal condition in Indramayu District can be known and understood well. The observed daily rainfall total data can be spatially categorised such as follow: less than 5 mm/day denoted as very light rain, 5 - 20 mm/day as light rain, 20 - 50 mm/day as normal or moderate rain, 50 - 100 mm/day as heavy rain, and more than 100 mm/day as very heavy or extreme rain [30]. Those categoeries of rainfall intensity have normally been used in applied hydrological purposes. Plotting and analysing the GFS 0.5 model output reanalysis especially for wind speed element for every day. These step should be done in order to detect the change of wind speed spatially over Indramayu District. These wind speed conditions will be corresponded with the daily rainfall occurences in relation to the different categories of TC Cempaka system which have influenced the daily rainfall total spatially condition over there.

3. Analysis

3.1 Cloudiness Distributions

In order to understand well about the influence of TC Cempaka system to cloudiness distribution over the domain of interest Indramayu District, West Java Province, Indonesia, the wether forecasters should pay attention to the tropical cyclone genesis. It is starting states from LPA, TD, TS, up to TC. The analysis of cloudiness distribution over the region of Indramayu District can be seen started from 25th November 2017 up to 29th November 2017. On 25th November 2017, especially at 00.00 UTC, a system as so called as a Low Pressure Area (LPA) system [see Fig. 3(a)] has been verified developing in monitoring area of the Jakarta-Tropical Cyclone Warning Center (Jakarta - TCWC) specifically over Indian Ocean and Southern Coast of Java Island. This perturbation was monitored continuously by BMKG's meteorological forecasters at Jakarta-TCWC in case the LPA system would intensify to become a TC system. This is a standar operating procedure to be relied on, especially for monitoring the development of a TC system. Factualy, this LPA system intensifies to become a TC system. This condition has been proven by detecting the wind speed and air pressure values in it's center of this LPA system. The wind speed commontly tends to increase and it's air pressure decreases gradually.



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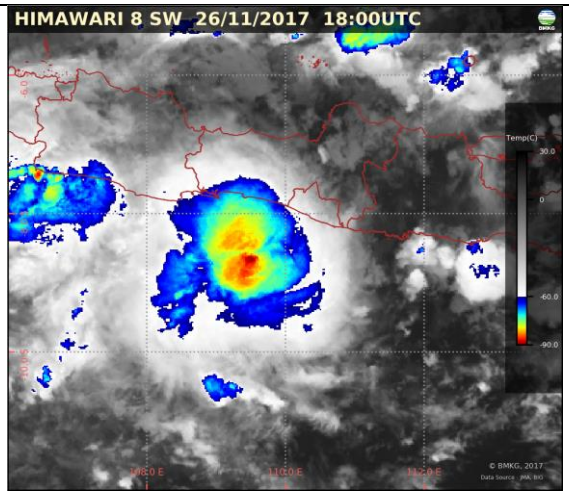
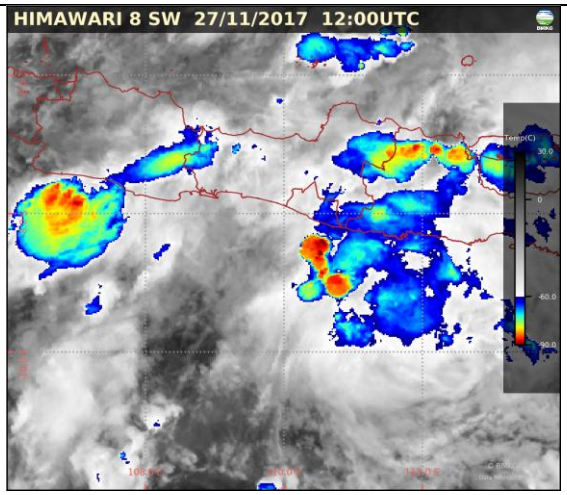


(b)

Figure 3: The Low Pressure Area (LPA) system preceded the activiy of TC Cempaka system origin (a) and (b) the location of TD system of 95S and it's coordinate of 109.4°E and 09.6°S have been observed over Southern Coast of Java Island using the Himawari-8 satellite imageries of IR canal on 25th November 2017 at 00.00 UTC and on 26th November 2017 at 18.00 UTC.

In the early morning of 26th November 2017 at 18.00 UTC, the LPA system above has been declared as a TC seed system and has namely designated as 95S [see Fig. 3(b)]. This TC seed system was so called as Tropical Depression (TD). The center of this 95S as a TD system was observed at the location of 109.4°E and 9.6°S with the wind speed in it's center was 25 knots. This TD system continuously moved Eastward from the preceded position. Furthermore, in early date of 27th November 2017 at 12.00 UTC [see Fig. 4(a)], the Jakarta-TCWC has verified that the TD system of 95S reached the TC system intensity. This TC system has been named as **TC Cempaka** system. TC Cempaka system was located around 100 kilometers of South-Southwest of Cilacap District, the Central Java Province, Indonesia. The surface atmospheric pressure of this TC system was recorded as 999 hPa and the wind speed in it's center of TC Cempaka system was known as 35 knots or 65 km/hour. The TC Cempaka system intensified and moved Eastward closely along the Central Java Coast approaching along the coast of the Special Region of Yogyakarta Province [see Fig. 4(b)]. This TC Cempaka system has an significant role to the weather element condition especially for daily rainfall total spatially. The efect of TC Cempaka system has not only recorded in the Special Region of Yogyakarta Province as the nearest region where the origin of TC Cempaka system available, but can also be seen in the region of Indramayu District, West Java Province, Indonesia. Further the fluctuation condition of spatial daily rainfall total during the activity of TC Cempaka system in the region of Indramayu District will be disccussed later. Meanwhile, the atmospheric dynamics analysis of TC Cempaka system has been described by Swarinoto et. al. [31]. The concentration of daily rainfall total with high intensity up to extreme ones even to become a daily new record, had already happened commonly over location which closed to the TC Cempaka system origin.



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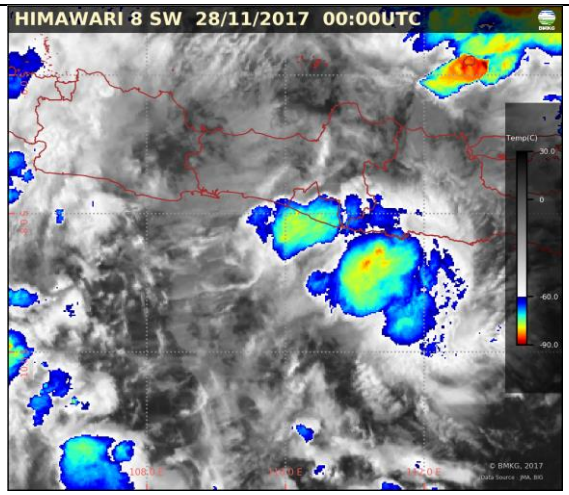


(b)

Figure 4: The TC Cempaka system was (a) observed and declared on 27th November 2017 at 12.00 UTC and (b) intensify detected moving Easward on 28th November 2017 at 00.00 UTC by using the Himawari-8 satellite imagery of IR canal.

The life time of this TC Cempaka system was not so long. On 29th November 2017 at 00.00 UTC [see Fig. 5], the intensity of the TC Cempaka system has decreased gradually. The air pressure of the TC Cempaka system has increased reaching up to 1003 hPa. The TC Cempaka system gradation has become weaker and weaker. The formation of convective cloud has already had no more available. The rest of cloudiness available were dominated by medium and high level clouds. Then finally TC Cempaka system has fully dissipated this day.

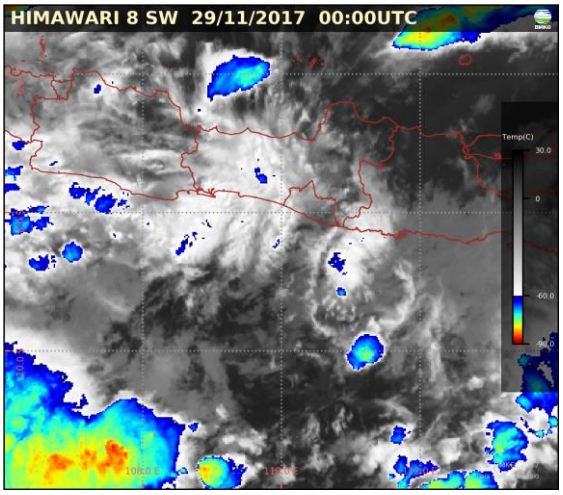
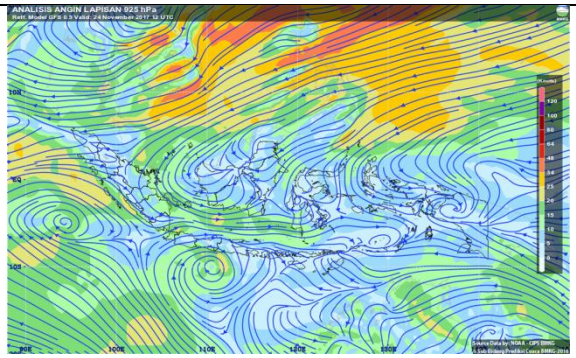


Figure 5: The TC Cempaka system has already dissipated on 29th November 2017 at 00.00 UTC, observed using the Himawari-8 satellite imagery of IR canal.

3.2 The Wind Speed Fields

The wind speed and direction fields during the activities of TC Cempaka system could be detected utilizing the model output of Global Circulation Model (GCM). In this case, the use of Global Forecast System (GFS) 0.5 -

Global Spectral Model (GSM) model output re-analysis [32] was very usefull in order to trace the condition and fluctuation of the wind speed and direction availabilities in Indramayu District for every 6-hourly in relation to the activity of TC Cempaka system from 24 November 2017 up to 29 November 2017. Factually, the wind direction for the level of 925 hPa over the domain of research Indramayu District (see Fig. 6) during the activity of TC Cempaka seemed Westerly up to South-Westerly. These wind directions agreed with the wind climatology during the month of November. Meanwhile, the wind speed over Indramayu District varied 5 knots up to 15 knots during the week. The existences of doubled cyclonic patterns over Indian Ocean, South-Western part of Sumatera Island and Southern part of Java Island, had important role to maintain this wind direction and wind speed conditions. Also the activity of Asian Winter Monsoon with high air pressure occured over Asian Continent to maintain the wind blowing from Northern part toward Soutern part of Indonesia Region via the South China Sea. The existence the Tropical Eddy over West Kalimatan Province or the South China Sea became a barrier of the air flow from Asian Continent toward Australian Continent so that the cross equatorial flow of colder air masses from the Northern part of Indonesia Region had weakened. On 24th November 2017 at 12.00 UTC over Indramayu District as seen on Fig. 6(a), the wind direction field taken from the GFS 0.5 re-analysis was Westerlies. The wind speed of 0 - 5 knots occured zonally over Southern part of Indramayu District. Meanwhile, the wind speed of 5 - 10 knots also happened zonally over Northern part of Indramayu District. The next day of 25th November 2017 at 12.00 UTC see Fig. 6(b), the wind direction field taken from the GFS 0.5 over Indramayu District was known as South-Westerlies. It was a little bit shift wind direction from a day before. The wind speed was zonally detected of 5 - 10 knots over Southern part of Indramayu District and 10 - 15 knots over Northern part of Indramayu District. This to day wind speed condition was increased around 5 knots comparing with it on a day before. As seen on Fig. 6(c), on 26th November 2017 at 00.00 UTC, the wind direction field taken from the GFS 0.5 model output over Indramayu District showed Westerlies. It was similar with the wind condition of 24th November 2017. But the wind speed condition at that time seemed similar with the wind speed condition on 25th November 2017 of 10-15 knots. On the date of 27th November 2017 at 12.00 UTC as seen on Fig. 6(d), the wind direction field over Indramayu District was still South-Westerlies. The wind speed of 5 - 10 knots have recognized over Southern part of Indramayu District and 10 - 15 knots over Northern part of Indramayu District. As seen on Fig. 6(e) for 28th November 2017 at 12.00 UTC and Fig. 6(f) for 29th November 2017 at 12.00 UTC, the wind direction over Indramayu District was notified as South-Westerly. The wind speed was zonally detected 5 - 10 knots over Southern part, 10 - 15 knots over the middle of Indramayu District, and 15 - 20 knots over Northern part.



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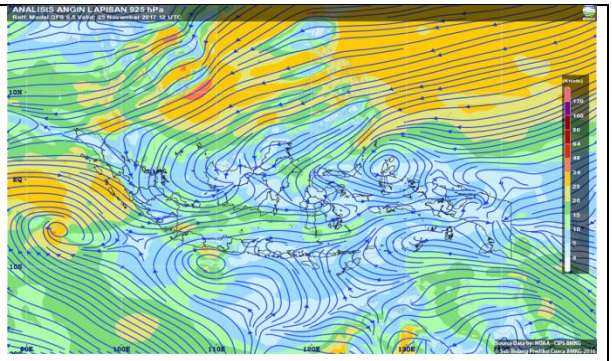

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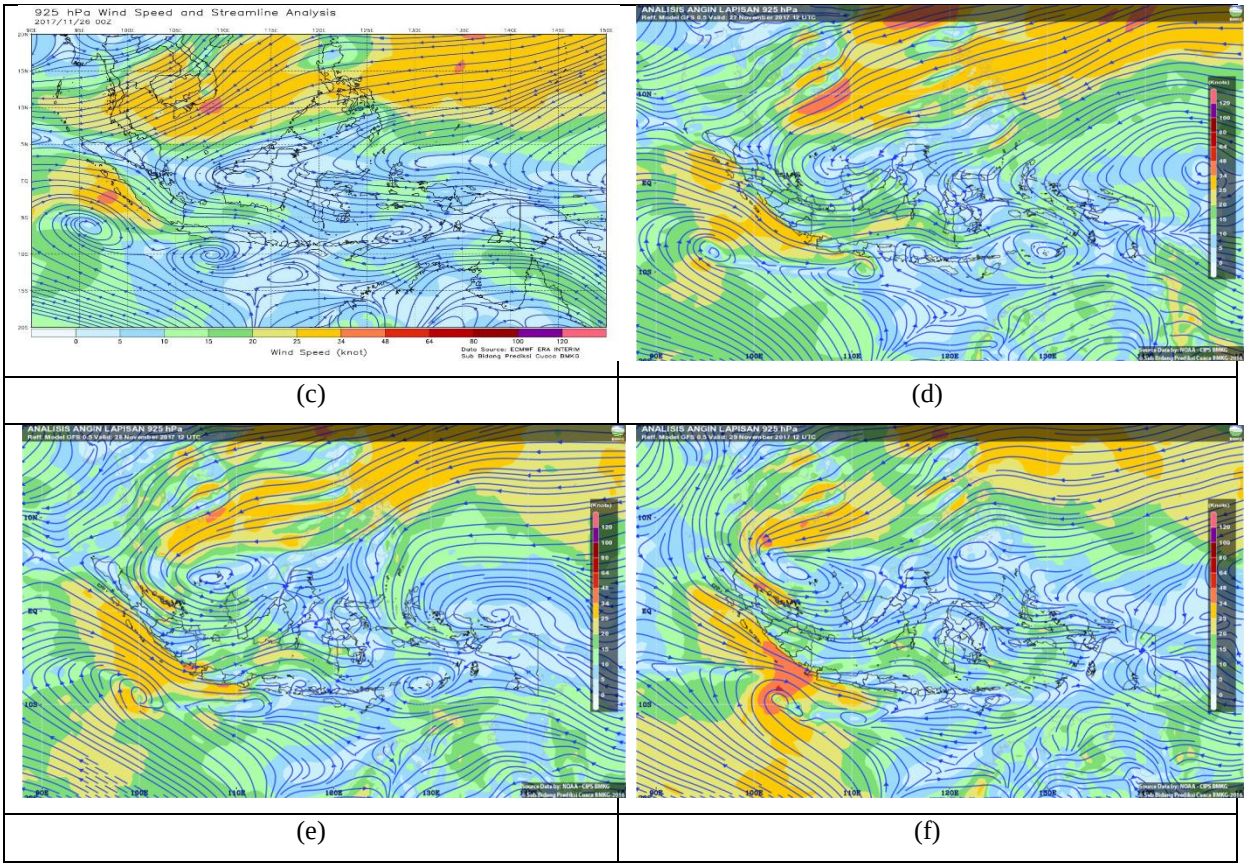

Figure 6 (a, b, c, d, e, f): The wind speed and direction taken from the GFS 0.5 model output over Indonesian Region during the activity of TC Cempeka system of 24th - 29th November 2017.

3.3 Rainfall Distributions

During the activity of TC Cempaka system in southern part of Central Java Province coast, the daily observed rainfall total data in Indramayu District, West Java Province, Indonesia, have been recorded continuously. The observed rainfall data will be ready daily for every 00.00 UTC. Started from the date of 25th November until 29th November 2017, the spatial maps of daily observed rainfall total data have been provided. Based of these daily rainfall data maps, analysing the role of TC Cempaka system to the spatial daily rainfall total data in Indramayu District can be proceed. The daily rainfall analysis are based on the Sub-District (SD) rainfall condition. On 25th November 2017 at 00.00 UTC, the TC cempaka system was still in LPA category. In relation to the LPA system above, the condition of spatial daily rainfall total occurences in Indramayu District can be seen in Fig. 7(a) and Fig. 7(b) as follow.

The very light rainfall intensity of less than 5 mm/day only happens in a small area especially over southern part of Hargeulis SD. The spot of very light rainfall intensity also occurred around Sukra and Bangkir stations. This very light rainfall intensity was mostly recorded in place with elevation of 26 - 75 meter above MSL. The light rainfall intensity of 5 - 20 mm/day has been recorded over some places such as Anjatan SD, northern part of Hargeulis SD, western part of Kandanghaur SD, western part of Bongas SD, western and southern parts of Gabuswetan SD, south-western part of Gabuswetan SD, and south-western part of Cikedung SD.

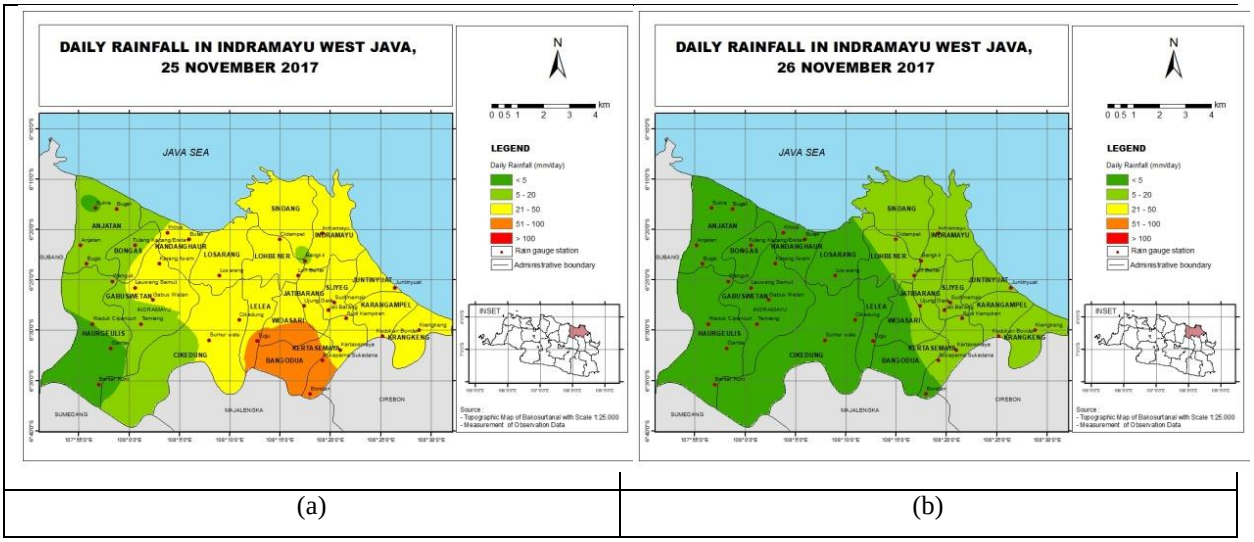

Figure 7: The spatial daily rainfall total maps in Indramayu District, West Java Province, Indonesia, (a) on 25th November 2017 and (b) 26th November 2017 at 00.00 UTC.

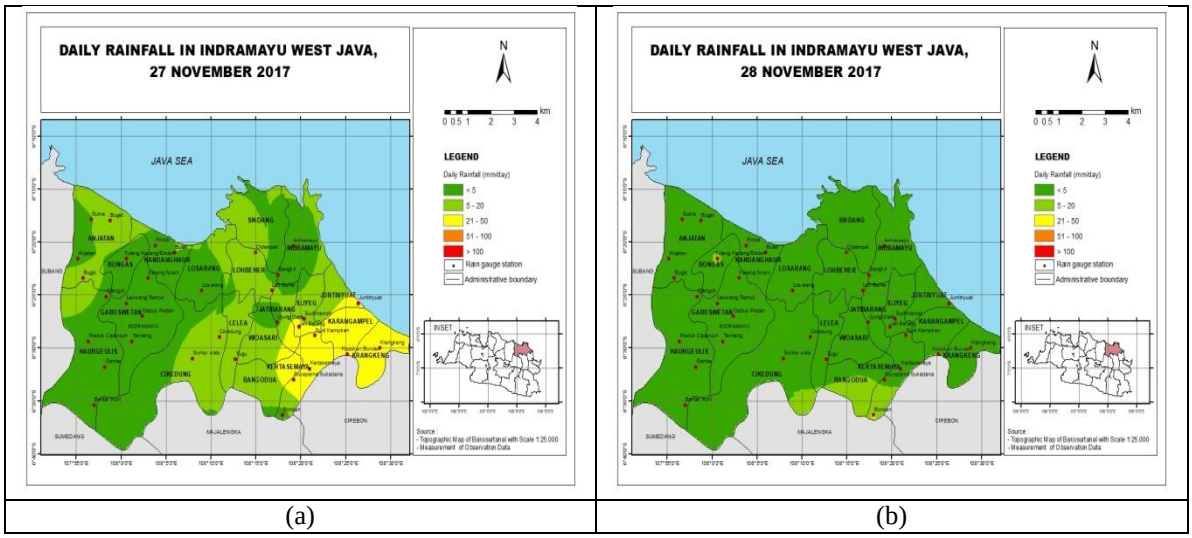

Figure 8: The spatial daily rainfall total maps in Indramayu District, West Java Province, Indonesia, (a) on 27th November 2017 and (b) on 28th November 2017, at 00.00 UTC.

Mostly of moderate rainfall intensity of 20 - 50 mm/day has taken place over Kandanghaur SD, northern part of Gabuswetan SD, Losarang SD, eastern part of Cikedung SD, Sindang SD, Lohbener SD, Lelea SD, Jatibarang SD, Indramayu SD, northern part of Widasari SD, Sliyeg SD, northern part of Kertasemaya SD, Juntinyuat SD, Karangampel SD, and Krangkeng SD. Commonly the occurrences of moderate rainfall intensity took place over places with 21 - 50 meter elevation above mean sea level except over northern part of Cikedung SD. The spatial daily rainfall total distribution within Indramayu District on 26th November 2017 could seen in Fig. 7(b). Those daily rainfall distributions were dominated by very light and light rainfall intensities. More than 2/3 domain of Indramayu District experienced very light rainfall intensity of less than 5 mm/day. This rainfall intensity was pictured especially in the middle dan western parts of Indramayu District. The rest domain of Indramayu District seemed experience light intensity of daily rainfall of 5 - 20 mm/day. This rainfall intensity

occurred in eastern part of Indramayu District. The location of experienced SD's could be mentioned such as north-eastern part of Losarang SD, northern and eastern parts of Lohbener SD, eastern parts of Widasari SD and Bangodua SD, north-eastern part Kertasemaya, Indramayu, Jatibarang, Sliyeg, Juntinyuat, Karangampel, and Krangkeng SDs. The spatial daily rainfall total maps within Indramayu District, East Java Province, Indonesia on 27th November 2017 and on 28th November 2017 can be seen in Fig. 8(a) and Fig. 8(b). On the date of 27th November 2017 as seen in Fig. 8(a), the occurrences of rainfall happens through out the domain of interest of Indramayu District. Recording the daily rainfall total categories started from very light intensity (less than 5 mm/day) up to moderate or normal intensity (21 - 50 mm/day). The very light intensity of daily rainfal total (less then 5 mm/day) happened in western part of Anjatan SD and Cikedung SD, central and western parts of Losarang SD, northern part of Jatibarang SD, southern part of Bangodua SD, mostly Indramayu SD, and eastern part of Sindang SD. Meanwhile, the same intensity of daily rainfall total also occurred in the whole of Kandanghaur SD, Bongas SD, Gabuswetan SD, and Haurgeulis SD. The light intensity of daily rainfall total (between 5 - 20 mm/day) was recorded in mostly Anjatan SD, Lohbener SD, Lelea SD, Bangodua SD, Sliyeg SD, Juntinyuat SD and Jatibarang SD. The same intensity also happened in western part of Kandanghaur SD and Sindang SD, eastern part of Losarang SD, Indramayu SD and Cikedung SD, southern part of Widasari SD and Kertasemaya SD. The moderate or normal intensity of daily rainfall total (between 21 - 50 mm/day) occurred in the whole Krangkeng SD and Karangampel SD, mostly Kertasemaya SD, eastern part of Bangodua SD, Juntinyuat SD and Widasari SD, southern part of Sliyeg SD and Jatibarang SD. On the date of 28th November 2017 as seen in Fig. 8(b), mostly of Indramayu District experienced the very light intensity of daily rainfall total (less than 5 mm/day) with exception for sourthern part of Cikedung SD, Lelea SD, Bangodua SD and Kertasemaya SD which experienced the light intensity of daily rainfall total of 5 - 20 mm/day.

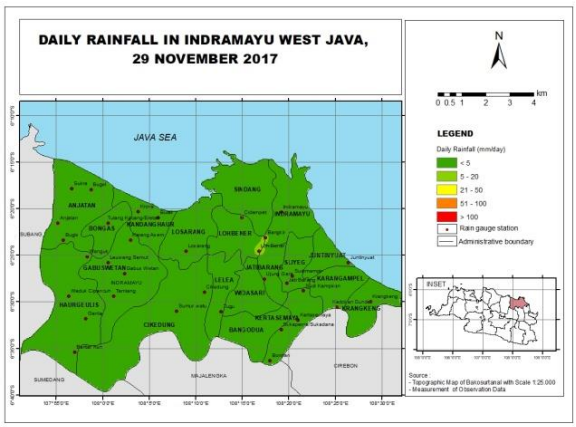

Figure 9: The spatial daily rainfall maps in Indramayu District, West Java Province, Indonesia, on 29 November 2017 at 00.00 UTC.

Especially on the date of 29th November 2017, mostly of Indramayu District experienced very light daily rainfall total of less than 5 mm/day. Only at Lohbener station recorded light daily rainfall total of 5 - 20 mm/day (see Fig. 9).

3.4 Discussions

Phisically Indramayu District of West Java Province, Indonesia is surrounded by waters surface especially in the Nortern part direction of the low land because the existing of Java Sea. The contribution of water vapour coming from the Java Sea is very important as one of sources to support the cloud development over here. Without any support of enough water vapour avaialility, the development of cloud will be obstructed so that the rainfall occurrences will be difficult to happen. The cloud formation over Indramayu District as the domain of interest, can be seen easily forming because of the season. During the month of November, Indramayu District commonly experience Wet Season. During the Wet Season, the air masses with colder temperature coming from the North Hemisphere induces air masses with higher temperature over Indramayu District. The higher temparature of air masses over here are easier lifted. This process is able to develope the convectived clouds for producing rainfall clouds. In this case, the avaiability of water vapour coming from Java Sea especially is very important to support the developing of rainfall clouds over Indramayu District. The existing of TC Cempaka system could be distinguished clearly by analysing the cloud formation using satellite imageries taken from the Himawari-8 as seen on Fig. 3, Fig. 4, and Fig. 5 above. Started from the beginning when the TC Cempaka system was still in early state, the cloud formation had already showed its shape and condition as LPA on 25th November 2017 at 00.00 UTC and to become TD namely as 95S on 26th November 2017 at 18.00 UTC. Intensifying the TC Cempaka system has been identified further especially by seeing the wind speed availability in the central or eye of TC system. The wind speed increased from 25 knots during TD system on 26th November 2017 at 18.00 UTC to become 35 knots during the TC Cempaka system on 27th November 2017 at 12.00 UTC. Increasing of te wind speed in the eye of the TC system could be indicated as the more intensive activity of the TC system which was able to produce results bad weather or even extreme ones such as strong wind and heavy rainfall, over surrounding places of TC Cempaka system. This TC Cempaka system has significantly influenced the wind speed condition over Indramayu District. The wind speed over Indramayu District could be identified by using the GFS 0.5 resolution model output as seen on Fig. 6(a, b, c, d, e, f). The increasing or decreasing of wind speed over Indramayu District could be seen clearly using those model output. To monitor the change of wind speed was able to be distinguished well. During developing the TC system from LPA, TD and up to TC, the wind speed of 925 hPA over Indramayu District increased gradualy from 0 - 10 knots, 5 - 15 knots, and up to 5 - 20 knots. The more increasing in wind speed over Indramayu District means the more difficulty in growing the cloud formation. As stated on the energy balance law, if the potential energy increased then the kinetic energy would decreased in vise versa. The less value of potential energy means the less growing cloud formation which was able to produce rainfall. Increasing in wind speed woul be compesated by the less rainfall to be recorded over Indramayu District then. The daily rainfall total experience within Indramayu District, West Java Province, Indonesia has a unique condition. The intensity of daily rainfall total seems to be available significantly before the TC Cempaka system to be declared by the Jakarta TCWC forecasters. As long as the state of TC Cempaka system has significantly actived during its development so that the daily rainfall total with its variabilities happened in Indramayu District. After dissapering the TC Cempaka system, consequently that the daily rainfall total has no recorded anymore within Indramayu District. The TC Cempaka system has significantly influenced to the availability of the daily rainfall total in Indramayu District.

4. Conclusions

Based on the weather condition over Indramayu District, West Java Province, Indonesia as diccussing above

during the activity of TC Cempaka system from 26 up to 29 November 2017, we can conclude such as follow:

4.1 The formation of clouds for developping of TC Cempaka system could be identified clearly using satellite imageries product of Himawari-8. The cloud formations started from early state of TC Cempaka system developping such as LPA, TD, and TC, have been distinguished very well.

4.2 The wind speed condition during the development of TC Cempaka system very influenced over Indramayu District. The wind speed showed less velocity during early state of TC Cempaka system and gradually increasing upto the mature state of TC Cempaka system. After decaying the TC Cempaka system, the wind speed gradually decreased also.

4.3 The daily rainfall total records showed a little bit highly before the mature state of TC Cempaka system. The vaiability of daily rainfall total record seemed having more variably as weel before the mature state of TC Cempaka system. After mature state of TC Cempaka system, the daily rainfall total decreased abruptly over this land of Indramayu Dstrict.

Acknowledgement

The authors thank to the Agency of Meteorology, Climatology, and Geophysics of the Republic of Indonesia (BMKG) in relation to the use of observed rainfall data, Himawari-8 meteorological satellite imageries, and the GFS 0.5 model output to be processed in preparing this paper. Especially thanks as well to the Climatological Station of Dramaga, Bogor, West Java Province, Indonesia, in relation to the compilation of daily observed rainfall data for Indramayu District, West Java Province, Indonesia.

5. Author Contributing

YSS : data analysing, writting, reviewing, finalizing

TAN : data processing, data analysing

ALP : data analysing, writting

AWP : data analysing

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