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Study on the Phenomenon of Flood Characteristic in DKI Jakarta

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ABSTRACT

Since Dutch era, flood has become serious issues faced by DKI Jakarta. Study on prevention flood program has also been conducted since Dutch era. In rainy season, common flooding is caused by several factors as follows: lowland areas in the northern part of Jakarta below sea level, urbanization rate, irregular population density, slum neighborhood where scattered rubbish where quickly provoke the flood to stagnate and increase rather than receding. This flood is mainly caused by not only above factors but also land subsidence an average of 5-10 cm every year. This paper discusses on flood characteristics in DKI Jakarta. In the study, firstly history of flood was discussed started in Dutch era until after independence. It was founded that floods occur in continuous heavy rains like in January and February. There is a combination of floods caused by rain in the upstream and downstream. Previously heavy rains can cause flooding in subsequent heavy rains.

KEY WORDS: *Japanese's River Culture; Flood; Jakarta*.

NOMENCLATURE

WFC	West Flood Canal
EFC	East Flood Canal
DKI	Daerah Khusus Ibukota
RTH	Ruang Terbuka Hijau
KK	Kepala Keluarga
$BMKG$	Badan- Meteorologi-Klimatologi-Geofisika
$JABODETABEK$	Jakarta-Bogor-Depok-Tangerang-Bekasi
$BPBD$	Badan Penanggulangan Bencana Daerah
BKB	Banjir Kanal Barat

1.0 INTRODUCTION

The high level of urbanization in DKI Jakarta has caused complex problems such as unemployment, crime, economic equality, housing, floods, traffic congestion, poverty, slums, water supply and urban planning. In addition, DKI Jakarta also faces some infrastructure challenges for water regulation caused by 13 rivers like Ciliwung, Kalibaru, Pesanggrahan, and other rivers caused by its unique topography. DKI Jakarta has topography that most of the city over the sea, with some sinks 25 cm per year with an average of 5-10 cm as shown in Figure.1.1.

Coupled with heavy rain during the rainy season, floods become a perennial problem that occurs every year in the rainy season. The floods in DKI Jakarta are commonly caused by several factors as follows: lowland areas in the northern part of DKI Jakarta below sea level, high urbanization level, irregular urban planning and slum environments coupled with scattered waste where, thus rapidly triggering flooding stagnation and rising rather than receding. Flooding occurred on the northwest coast of Java, at the mouth of the Ciliwung River in Jakarta Bay. Floods have occurred recently in the Dutch era and after independence such as 1996, 2002, 2007 and 2013, 2014, 2017. During the rainy season, floods occur in DKI Jakarta due to the above factors causing rivers full of garbage, clogged waterways, river sedimentation the high, and the overflowing seawater. Mixing flood water with a pile of waste in a narrow residential area can spur disease, including skin infections and diarrhea,

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especially in children under 5 years of age.

In order to overcome the complex problems as mentioned above, since 2015, the government of DKI Jakarta has made a program for resettling the population, especially the area adjacent to the river. This government program provides pros and cons at the general public level. This paper reviews the population evictions program and proposes a solution that may provide satisfaction to the government and the community.

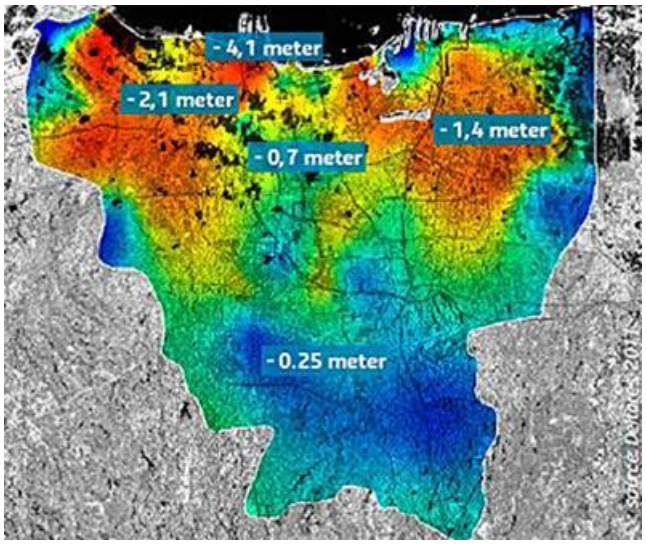

Figure.1.1: Land subsidence in Jakarta in period 1974-2010 [Indonesian & Dutch].

3.0 DKI JAKARTA

3.1 History of Jakarta

Jakarta is the capital city of Indonesia as well as the largest city which is located on an estuary of the Ciliwung River. Short story, Jakarta was called Sunda Kelapa in the Kingdom of Sunda period then it was changed to be Jayakarta in 22 June 1527 during period of the Sultan Banten. In 4 March 1621 during Dutch colonial period (1619–1949), it was called as Batavia as shown in Figure.1.1, and then it was changed to be Jakarta Tokubetsu Shi in 8 August 1942 during the Japanese occupation. As Japan's defeat in World War II, Indonesian declared its independence on August 17, 1945 at Jalan Pegangsaan Timur No. 56 (Jalan Proklamasi), Jakarta Pusat and the position was immediately changed to the National Government of Jakarta or Provincial Government of DKI Jakarta.

3.2 Geography of Jakarta

Jakarta lies in a low and flat alluvial plain, ranging from -2 to 50 metres with an average elevation of 8 metres above sea level with historically extensive swampy areas. 40% of Jakarta is below sea level particularly the northern areas, while the southern parts are comparatively hilly.

There is thirteen rivers flow through Jakarta. Firstly, river of Ciliwung divides the city into the western and eastern districts. The river of Ciliwung is across the city northwards towards the Java Sea which flows from the Puncak highlands to the south of the city. Other rivers include as follows: Kalibaru, Pesanggrahan, Cipinang, Angke River, Maja, Mookervart, Krukut, Buaran, West Tarum, Cakung, Petukangan, Sunter River and Grogol River. These rivers flow from the Puncak highlands to the south of the city, then across the city northwards towards the Jakarta Bay as shown in Figure.1.3

Figure.1.2: Batavia under the Dutch colonial period, 1780 [Wikipedia].

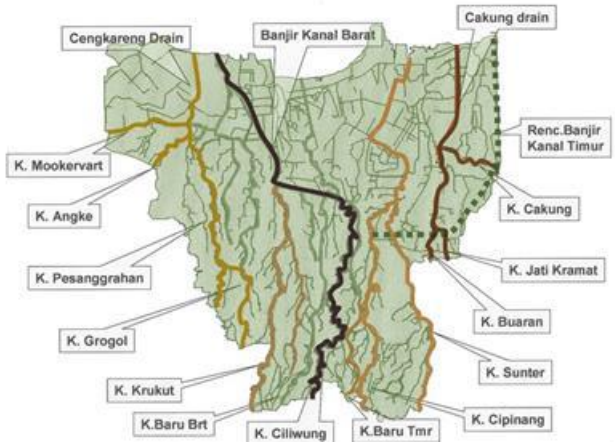

Figure.1.3: List of rivers in Jakarta [Pemprov DKI].

3.3 Population of Jakarta

Since 1950, Jakarta has attracted the attention of many people from all over Indonesia. The large number of migrants came to Jakarta for economic reasons and job vacancies. Based on the 1961 census shows only 51% of the city's population is born in Jakarta. Megacity Jakarta increased from 11.91 million people in 1980, 17.14 million in 1990, and 20.63 million in 2000 to 28.01 million in 2010. In 2010, broader Jakarta accounted for 11.79 percent of the total population of Indonesia, but with this population is below 0.3 percent of the total area of the country. Jakarta has an estimated population of over 10 million people in 2016 as shown in Figure.1.4.

DKI Jakarta covers an area of 662.3 km2 of land area and 6,977 km2 of sea area. The Greater Jakarta metropolitan area has an area of 6,392 km2 as shown in Table.1.1. DKI Jakarta consists of five Administrative Cities as follows: Jakarta Pusat, Jakarta Barat, Jakarta Selatan, Jakarta Timur, Jakarta Utara as shown in

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Figure.1.5 and an Administrative Regency: Kepulauan Seribu.

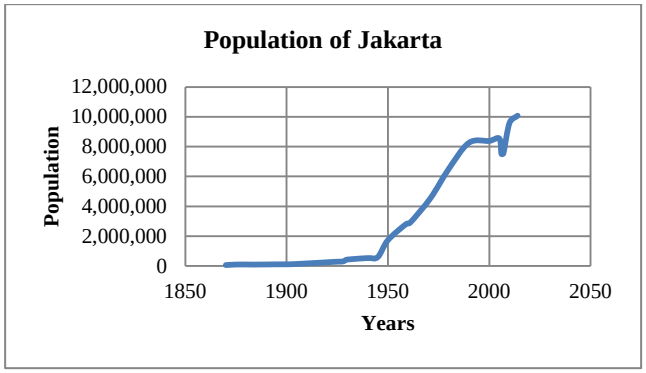

Figure.1.4: Statistic population of Jakarta in 1860 – 2014.

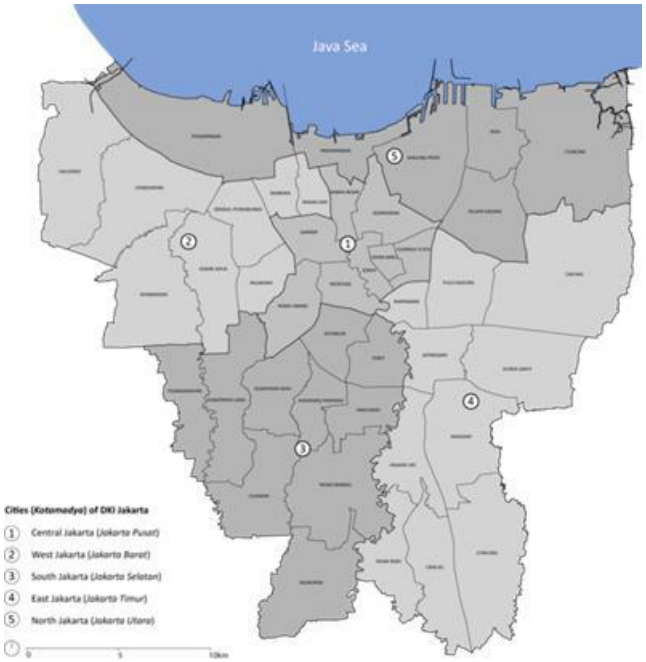

Figure.1.5: Map of the municipalities in Jakarta [DKI Jakarta].

4.0 FLOODS IN JAKARTA

Severe flooding has been reported to have plagued Jakarta in the past, including 1621, 1654, 1918, 1942, 1960, 1976, 1996, 2002, 2007, 2013, 2014, 2016, 2017 and 2018. This important part of the flooding problem is caused by that most of Jakarta Capital City is low or below sea level. Approximately 24,000 hectares of the main part of Jakarta is estimated to be below sea level. Flooding can be severe if heavy rainfall coincides with the ups and downs. When this happens, the tides tend to push the water into the lowlands such as escape from rain in upland areas such as around the area of Bogor that flows down into the Jakarta area.

Flood events have for many years hit the capital, without a definite exit from the government. In fact, there have been many activities such as clearance, drainage construction, and so on, but none seems to work.

4.1. Flood in Jakarta in Dutch Era

Flood disaster in Jakarta has been started since the Dutch era. A few years after the Dutch landed, the colonial administration had already felt the complexity of dealing with the floods in Batavia. The first big floods they felt in 1621, followed in 1654 and 1876. Only three years after the construction of the flood retainer channel in the Netherlands, in 1621, Batavia was flooded.

Often flooded the Dutch government feels the need to start managing water seriously. Flood of study occurred since then. In 1918 the Dutch Government began to build canal. Furthermore, due to the increasing complexity of the abundant water problems, Colonial Government forced to build the West Canal Flood (BKB) in 1922.

Although already built BKB, does not mean the problem of flooding in Jakarta can be immediately resolved. In January 1932 again a massive flood paralyzed the city of Jakarta. Hundreds of houses on Jalan Sabang and Thamrin are flooded with water. When the government turned to the Republic of Indonesia the problem of flooding in Jakarta was never completed. Tercata since the independence of several major floods occurred in Jakarta, such as in 1976, 1984, 1994, 1996, 1997, 1999, 2002, 2007 and 2008. Figures 1.6 - 1.9 show flood during Dutch era,

Figure.1.6: Flood at Jl. Ir. H Juanda, Batavia in 1920 [Detik forum]

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Figure.1.7: Children play floods during flood in 1920 [Detik forum].

Figure.1.8: Flood at Tanah Abang, Batavia in 1920 [Detik forum]

Figure.1.9: Flood at Merdeka Barat, Batavia in 1920 [Detik forum]

4.2 Floods in 1960 and 2002

In February 1960, a flood occurred in a new area of Grogol. Although there is plans for flood hills in the suburbs of Grogol, but flooding in this area is knee-deep and waist-deep. Another major flood was in 1996 when 5,000 hectares of land were flooded.

Torrential rains resulting in serious flooding have swamped the greater Jakarta area over the last five days, leaving the city paralyzed. The intensity of rainfall in Jakarta was very high at greater than 100 mm in 2002 as shown in Figure xxxxx. The water has reached up to nearly 10 feet in some places. 43 suburbs of Jakarta out of 250 are affected by the floods so far and 15 to 20 percents of Jakarta is under water, according to the city's flood control agency. Some 400,000 people are affected and 250,000 had to flee from their inundated houses. At least 57 people are dead and 365,000 have been made homeless in one of the worst floods in the Indonesian capital of Jakarta in decades.

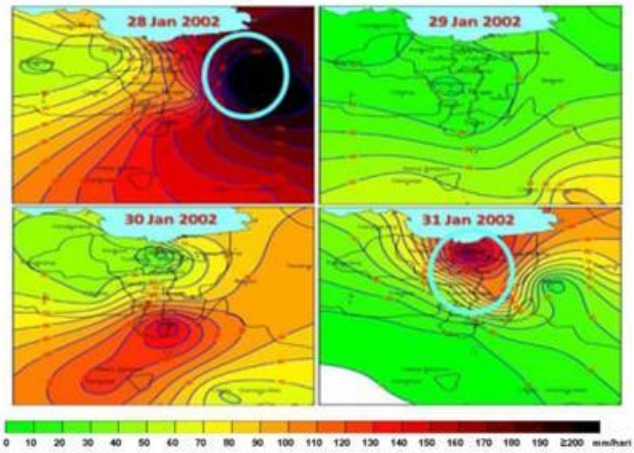

Figure.1.10: Mapping of rainfall in 2002 in DKI Jakarta [BMKG]

Figure.1.11: Pedicabs carry passengers in the flood of 2002, DKI Jakarta [BBC]

4.3 Floods in 2007

The flood in February 2007 was a major flood in Jakarta, the capital city of Indonesia and this affected several other areas around Jakarta, such as West Java and Banten. The floods that

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started on February 2, 2007 were caused by very heavy rain, deforestation in the southern part of Jakarta, and worsened by the drains being clogged with rubbish debris.

The most important reason of the disaster is the high level of rain, because the rainy season in Indonesia starts in December and ends in March. In 2007, rain intensity peaked in February, with the greatest intensity towards the end of the month.

The flood affected 80 separate areas in and around Jakarta. More than 70,000 houses were hit by floods. The flood caused the displacement of about 500,000 people. There was a high rate of illness, with 1,066 patients hospitalized for diarrhea and 329 for dengue fever. The flood has caused a loss of Rp 8 trillion (US $ 879.12 million). About 190,000 people are affected by flood-related diseases. The nature of the flood that stretches from the banks of the river to the surrounding areas has led to lower-class people, many living on the banks of their own rivers in wooden houses, to take the strongest impact of the flood. The latest official casualty figure is 80 people.

Figure.1.12: A Jakarta taxi submerged by flooded water

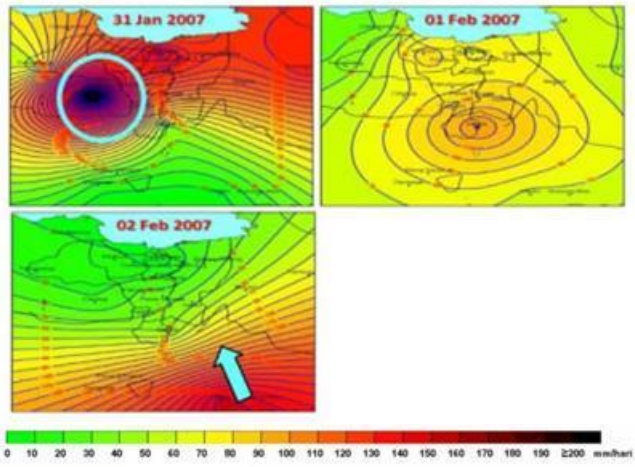

Figure.1.13: Mapping of rainfall in 2007 in DKI Jakarta

4.4 Floods in 2008

Hours of heavy rains that started Thursday night (January 31, 2008) continued Friday afternoon caused most of main roads in the capital submerged in knee-deep water, bringing traffic to a near standstill. One of the major impacts of this year's flood is the inundation of the Sedyatmo toll road leading to the Soekarno-Hatta International Airport which resulted in the cutting off the highway for a few days. On February 5, 2007 that nearly 1000 flights were delayed or diverted and 259 flights were cancelled. The loss of such delays and cancellations could reach billions rupiah. This year's flood is due to the local heavy rainfall and is not combined with the rain in the outskirts of Jakarta. The annual floods in Jakarta are strong evidence that Jakarta has not been able to sustainably accommodate its growth.

Figure.1.14: Motorcycles were caught in the flood in 2008, DKI Jakarta.

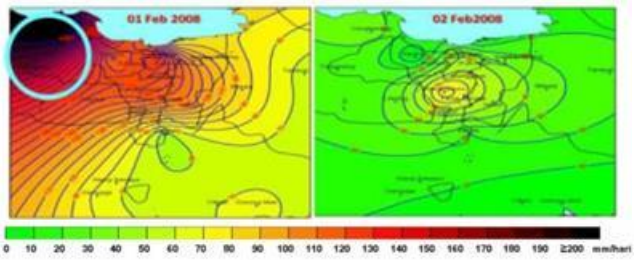

Figure.1.15: Mapping of rainfall in 2008 in DKI Jakarta

4.5 Floods in 2013

Flood January 15, 2013 occurred in some parts of the city due to heavy rain and water channels clogged by garbage and others. Serious floods occur in some of the main streets of Jakarta. West Flood Canal Bank (KBT) embankment along the 30 meters of Menteng collapsed. This violation quickly causes flooding in nearby areas. Military personnel, Jakarta public works agencies, and public servants joined forces to immediately replace the collapsed levee part with temporary retaining walls made of stone and sandbags. Workers finished rebuilding part of the channel embankment.

Land clearing above Jakarta has been identified as a major contributor to water tables and flooding in Jakarta. Jakarta has a very bad sewage system due to garbage disposal in roads, sidewalks, ditches and rivers. Evacuations were carried out in

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parts of Jakarta. An estimated 20,000 people were evacuated 17 January 201. There were 47 reported deaths.

Figure.1.16: People walk through Jakarta's flooded streets, Indonesia, January 17, 2013.

4.6 Floods in 2014

Torrential rains that have continued in Jakarta in recent days widened the number of flooded areas on Sunday 19, January 2014. The flooding, caused by days of heavy rain, has blocked roads and forced businesses in the capital to close. The flood area is mostly in Jakarta Timur, Jakarta Barat and Jakarta Utara as shown Figure 1.18. The flood areas including the central business district (CBD) were inundated and traffic was grid-locked as residents struggled to move around the city.

It is predicted approximately 134,662 persons or 38,672 households in 100 urban villages are directly affected by floods, with 12 casualties. At least 62,819 persons are displaced and staying in 253 displacement centers.

Figure.1.17: Flood in DKI Jakarta, 2014 [BNPB]

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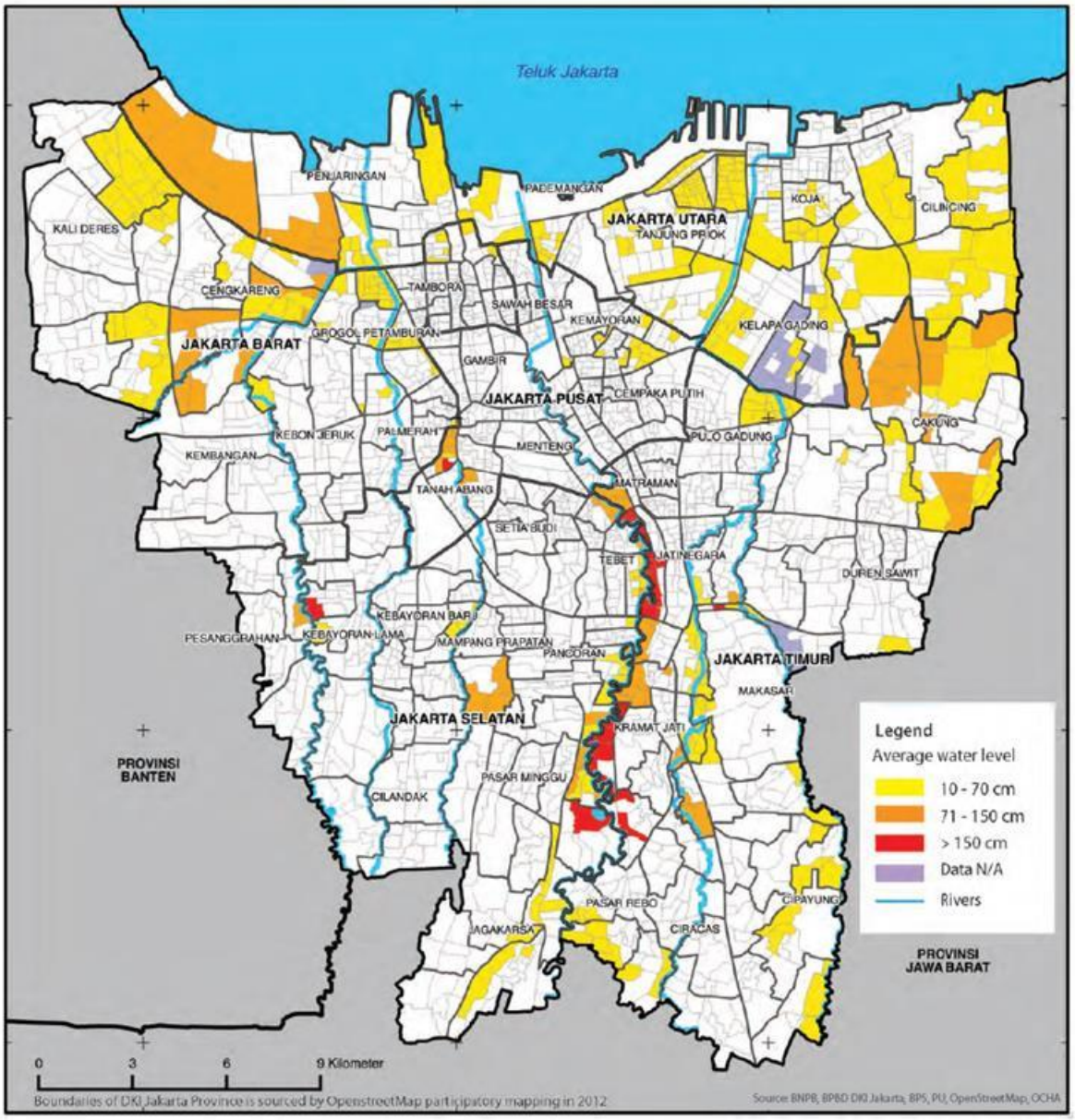

Figure.1.18: Mapping of flood in 2014 in DKI Jakarta [OCHA].

4.7 Floods in 2015

Flooding has been reported in at least 40 different locations in Jakarta, Indonesia, after torrential rain that began to fall early on Sunday 08 February 2015. Some areas were said to have flood water up to 80cm deep. West, north and central areas of the city have been worst affected. Even the president got to experience the flooding, as areas in front of the presidential palace in central Jakarta's Medan Merdeka Utara area were under 30cm of water.

Jakarta often experiences severe flooding during January and February. Local observers say that Indonesia is currently experiencing the peak of this year's rainy season.

The floods have caused chaos on the city's already chaotic roads. Cars were held up in deep flood water, while both the train and bus systems have been severely disrupted as the heavy rain and flooding made roads and tracks impassable.

There have been no reports of casualties or evacuations. However, there could be more rain and flooding to come. Sutopo Nugroho, spokesman for the BNPD, Indonesia's National Disaster Management Agency, said "We expect flooding to worsen in several places because of continuing rain." In anticipation, BNPD and Jakarta authorities have set up relief centres deployed personnel to help the victims of any flooding in the city.

BNPD warned residents along river banks should be wary of flooding, in particular the Ciliwung river.

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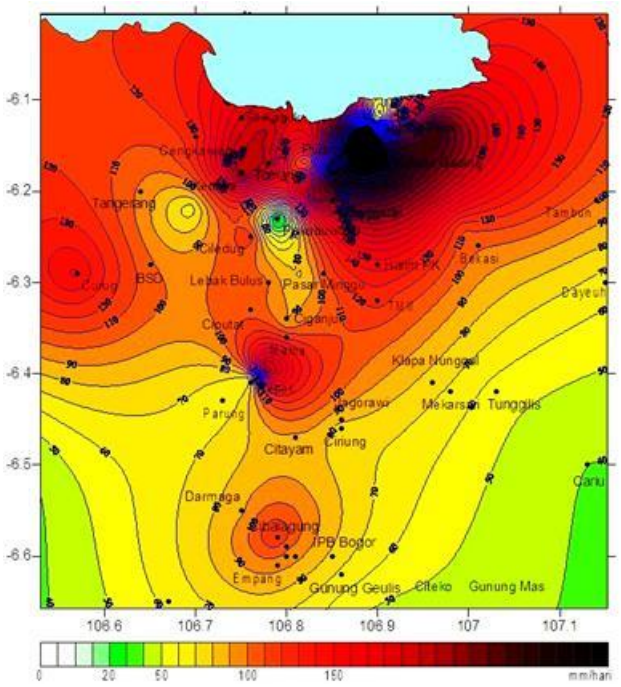

Figure.1.19: Rainfall map in DKI Jakarta in 2015 [BMKG].

Figure.1.20: Flood in DKI Jakarta, 2015 [BNPB]

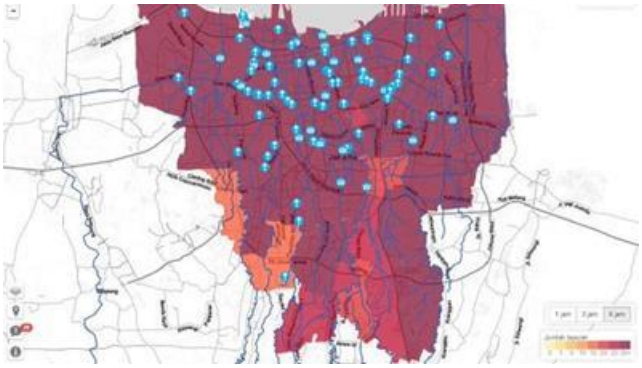

Figure.1.21: Map of flood reports in Jakarta. Map source [Peta Jakarta]

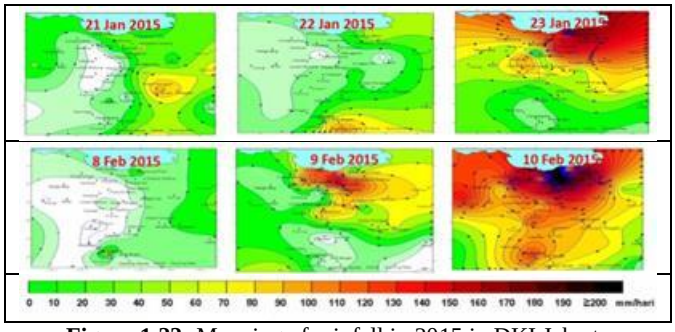

Figure.1.22: Mapping of rainfall in 2015 in DKI Jakarta

4.8 Floods in 2016

Jakarta Disaster Management Agency, BPBD, reported that heavy rainfall in Greater Jakarta and surrounding areas has caused flooding in some parts of the city, causing traffic problems and some damage to buildings.

In East Jakarta, the rain left a flood of water up to 90cm. BPBD said that about 40 people have been evacuated from their homes in Cakung.

Flooding has also occurred in the areas of West and South Jakarta, as well as in North Jakarta, especially Kelapa Gading and Cilincing.

According to figures from WMO, Soekarno-Hatta International Airport recorded 119 mm of rain in a 24-hour period between 25 and 26 February 2016.

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Figure.1.23: Flooding in the streets of Jakarta, 26 February 2016 [BPBD].

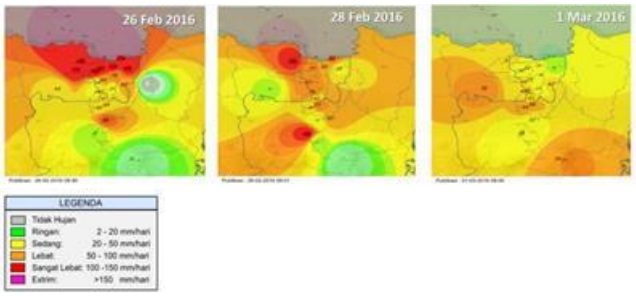

Figure.1.24: Mapping of rainfall in 2016 in DKI Jakarta

4.9 Floods in 2017

The torrential rains that hit so many flooded thousands of homes and streets in Jakarta, with some waterlogged areas as high as 1.5 m on Tuesday, 21 February2017.

High water levels forced many workers to stay home, while some schools were temporarily closed for security reasons. Floods hit the city after the drainage system was unable to accommodate a huge influx of water.

Figure.1.25: Flood along a highway in Jakarta on Tuesday, Feb 21, 2017 [Asia]

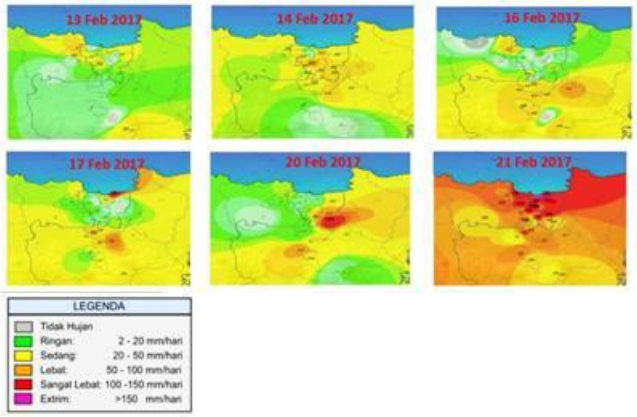

Figure.1.26: Map of rainfall on February 2017 in DKI Jakarta

4.10 Floods in 2018

On 5th February 2018, floods have hit Jakarta. Based on a report from Jakarta Disaster Mitigation Agency that there are more than 11,000 residents in three areas affected by the flood, and half must be evacuated.

A total of 7,288 families or 11,450 people spread across 12 districts in East, South and West Jakarta have been affected by the flood. Data from the National Disaster Management Agency (BNPB) showed thousands of homes were inundated.

There were 6,532 residents evacuated to 31 shelters in South and East Jakarta, but many refused to be evacuated and stayed at home. The water level at the Katulampa dam in Bogor, West Java, reaches 240 centimeters. This causes puddles in some areas of the city.

In East Jakarta, 1,575 Kramatjati residents were evacuated, followed by Jatinegara district with 1,057 people. While in South Jakarta there are most affected people that is 3,200 people, live in Pancoran District and in Tebet district with 700 people. The Jakarta government has prepared 450 water pumps to anticipate more floods.

Figure.1.27: Flood and garbage in Rawa Jati area, South Jakarta, February 5, 2018.

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5.0 CHARATERISTIC OF RAINFALL IN JAKARTA

As many other cities, Jakarta has many urban problems. One problem is floods. Hazardous, annual floods inundate Jakarta every rainy season from December to February, engulfing tens of kilometers of residential city areas with up to four meters of sewage-infused floodwater for days. Floods occur repeatedly in Jarkarta, usually during the rainy season. This phenomenon indicates a problem in water management in Jakarta. During the rainy season floods are common, while in the dry season water scarcity is a major issue. Effective water management ensures that the excess water during the rainy season does not cause disasters, whereas in the dry season, water that is primarily drinking water is adequately available.

Jakarta is a city prone to flooding with high rainfall resulted in flooding in some areas due to flow and absorption actors. Based on data retrieved from BMKG in 2011-2014, the rain starts in October to its peak in January and February as shown in Figure 1.12 and 1.13. In 2014, the rainfall was peaks at 1075 mm and 26 days. According to the Meteorology, Climatology and Geophysics Agency (BMKG), DKI Jakarta area was medium to heavy rain in February. Data from the Jakarta Disaster Mitigation Agency (BPBD) showed the number of evacuees increased to 18 503. Floods on Tuesday drowned mostly areas in West Jakarta.

Figure.1.28: Statistic of rainfall in Jakarta in 2011-2014.

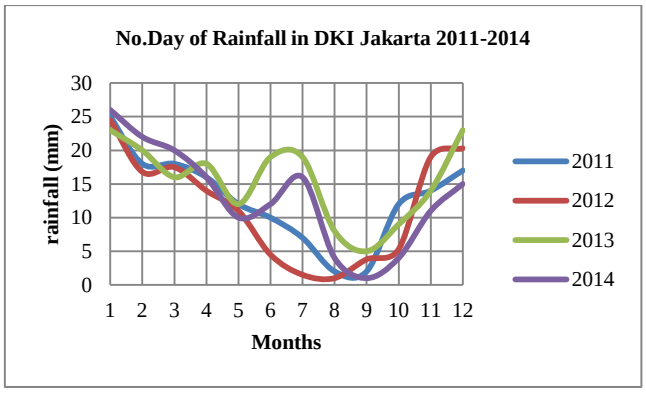

Figure.1.29: Statistic of number of day rainfall in Jakarta in 2011-2014.

Based on data from Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG), in 2015-2016, rainfall in February is in the range of 100-150 mm per day, falling into the category of very dense. Figure.1.14 shows map of the rain distribution in JABODETABEK in 2015. JABODETABEK is an acronym from Jakarta-Bogor-Depok-Tangerang-Bekasi, a megapolitan area of Jakarta and its surroundings.

Under assumption rain evenly throughout Jakarta, the volume of rainfall in Jakarta can be calculated by using equation 4.1. Result of calculation is shown in Figure.1.15.

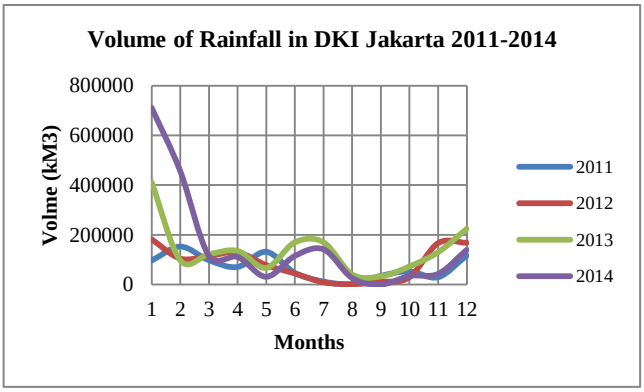

Figure.1.30: Volume of rainfall map in DKI Jakarta in 2011-2014.

6.0 ANALYSIS OF FLOOD IN DKI JAKARTA

Since ancient times until now, the river has become an important part in human life. Around the world, rivers are used in addition to transportation, many people use the river for various purposes such as washing, bathing, sanitation, even cooking. There are also a variety of fish in the river that can be caught and consumed to meet the nutrients that humans need. It can happen if the river is clean and free of pollutants.

As discussed above, from several major flood events that occurred in 2002, 2007, 2014, 2015 and 2016, there are some points that can be rose with regard to both hydrological and weather issues.

- In rainy season, in the months of January and February is high rainfall potentially causing flood.
- Flooding in Jakarta is often caused by heavy rain continuously dropping. The rain that only fell once usually did not make Ciliwung River abundant.
- In the river sedimentation theory, previous large rains could create problems in subsequent heavy rains. This is seen in the 2002 flood case. Rainfall in early January brought a lot of material and caused sedimentation in the river bed. As a result, when the same rain re-emerged on January 31, flooding is difficult to avoid.
- The sea level did not affect the floods that occurred in 1996, 2002 and 2007.
- The floods of 2002 and 2007 were caused by extreme rainfall that fell more than two days. This causes the Ciliwung River water level in the Manggarai area to reach its peak. For 2007, there was a combination of flooding caused by rain in upstream and downstream areas.

7.0 CONCLUSION

In conclusion, the paper discusses on flood characteristics in DKI Jakarta. In the study, firstly history of flood was discussed started in Dutch era until after independence. It was founded that floods occur in continuous heavy rains like in January and February. There is a combination of floods caused by rain in the upstream and downstream. Previously heavy rains can cause flooding in subsequent heavy rains.

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