Elucidating Flood Disaster Problems in the World Capital Cities: Analyzing the Role of Humantrain Supply Chain

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Abstract-Jakarta is one of the cities that is often hit by floods. The problem of flooding in Jakarta is actually not a new thing. Many factors make Jakarta city vulnerable to flooding. These factors are natural and anthropogenic factors. These natural factors are: (1) Jakarta is located in the lowlands near the coast, (2) there are 13 rivers flowing through Jakarta, and (3) the high annual rainfall in the Ciliwung watershed (> 3000 mm). While anthropogenic factors are: (1) landscape changes due to high competition in land-based economic activities, (2) poor urban and rural spatial planning, and (3) lack of integrated institutional capacity and arrangements, especially in cross-border administration (especially Jakarta and West Java provinces). Lastly, our study has highlighted the need and significance of humantrain supply chain during the flood and similar other disasters. It is believed that humantrain supply chain is entirely different from commerical supply chain and may play a big role while addressing the issue of flood risk as faced by the community members.

Keywords*: flood, anthropogenic, Ciliwung watershed, integrated, humantrain supply chain,*

1. INTRODUCTION

Indonesia is one of the most disaster-prone countries in the world, one of which is the danger of flooding [11]. Indonesia is a tropical country on the equator with around 17,000 islands. Tropical climate with high rainfall causes weathering in the soil. Unstable soil conditions cause opportunities for various disasters such as landslides and floods to increase. In the past decade, Indonesian regions have often faced repeated flooding [6; 26]. Compared to other countries, Indonesia is indeed far more vulnerable to flooding [7].

Floods in Jakarta have been recorded since 1621, where massive floods occurred in Jakarta with flood water depths of more than one meter. In 1876, the downstream area of the Ciliwung river had experienced severe flooding [14]. The Ciliwung watershed is about 347 km² wide, while the length of the Ciliwung main river is around 117 km [2]. To control the flow of the river, the Dutch government built 3 dams. Jago Dam and Udik Dam, both of which are located at the top of the river and Bendungan Hilir which are located downstream of the Ciliwung river (Jakarta) [10]. As a result of a massive flood in 1876, the Dutch government rebuilt the Flood Canal which stretched from the Manggarai area in the center of the city to the Muara Angke area in the coastal area of Jakarta. The existence of this canal is intended to prevent flooding in Jakarta. It is hoped that through this canal, flood water will flow faster to the Java Sea on the coast of Jakarta. Nevertheless, in 1996, 2002, 2007, 2013 and 2014, Jakarta continued to be hit by floods and suffered many losses [25;23]. In the 2013 flood disaster, 40 people died, 45,000 people were displaced, and economic damage [12]. The 2007 floods caused huge economic losses of between Rp 4.1 and 7.3 trillion [22]. The flood disaster in 2013 caused a loss of Rp 15 billion, and the flood disaster in 2014, losses due to flooding reached 100 million rupiah per day [19]. During the Jakarta floods in early 2020, losses due to flooding were estimated at up to Rp. 5.2 trillion. Although various efforts to reduce flooding have been carried out since the Dutch era until now, Jakarta is still not free from flooding. To examine the problem of flooding in Jakarta, it is necessary to pay attention to many things, including the morphological conditions, rainfall, the rivers that flow through the city of Jakarta, land level reduction, development in the upstream area (Bogor Area), population growth, and urban planning rural. So, this paper will discuss the problem of floods in the city of Jakarta.

Condition of Jakarta (Morphology and River)

Jakarta is located at coordinates -6º15 '(south latitude) and + 106º 50' (east longitude). For the terrain level, Jakarta is located in a flat area with a height of 0-20 meters above sea level. The city is located on the alluvial plains of North West Java (Figure 2). Some areas in Jakarta are 1-1.5 m below sea level. This is due to land subsidence 1–15 cm / year both spatially and temporally [13]. Jakarta is also in a typical flood-prone area, which is located in a large river delta area. In addition, Jakarta is also traversed by 13 rivers that bring rainwater into 40%

of Jakarta city area. The 13 rivers that flow through Jakarta are: Cisadane, Citarum, Ciliwung, Angke, Krukut, Sunter, Bekasi, Cakung, Karawang, Cikarang, Cirarang, Cimancuri, and Cidurian. (Figure 1)

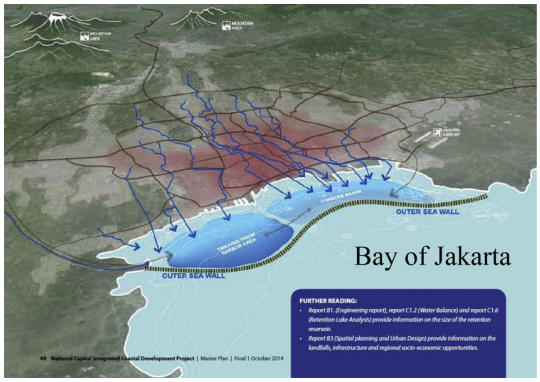

Figure 1. Map showing rivers flowing through the city of Jakarta [18].

Topographically, the Jakarta area is relatively flat, with slopes ranging between 0º and 2º in the north and center, and between 0º and 5º in the south. The southern area of Jakarta has a height of about 50 m above average sea level [1].

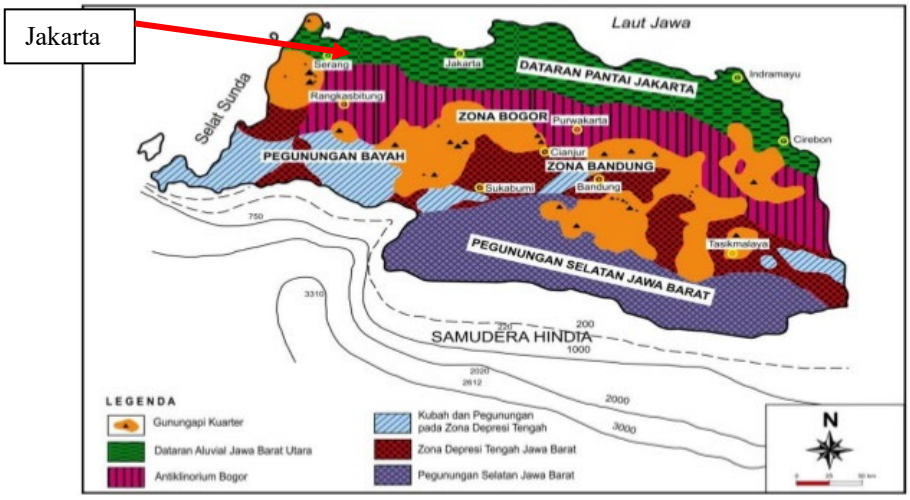

Figure 2. Location of the city of Jakarta on the North West Java Alluvial Plain

The city of Jakarta is located in a low-lying area that has five main landscapes, namely: (a) Volcanic alluvial fan landscape, which is located in the southern part; (b) Landscape originating from the sea, which is found in the north and close to the coastline; (c) coastal ridges, which are located in the northwest and northeast; (d) Swamps and mangrove swamps, which are found on the coast; and (e) The previous channel, which runs perpendicular to the coastline [20; 21].

HUMANTRAIN SUPPLY CHAIN

In recent time, different disasters like floods are targeting different corners of the world and even in the region of Indonsia. Due to these disasters, human loss along with unnecessary destruction to the infrascture has been occurred both in developed and developing economies. However, inadequate response towards these disasters have provided the evidence that there is an incredible need for the better mechanim in emergceny operations. Meanwhile, the role of humantrain supply chain is significantly required in order lower the losses through any type of disasters. Emergency relief involves various types of activities as performed by the huamns along with some operatonal tools to increase the operational efficiency during any type of natural disaster. To provide the relief to disaster victims, there are mainly six dimensions/components which are observed under the title of humantrain supply chain.

The first one is entitled as logistic centre which specifies an effective logistic system along with supply chain which are the key principles to humantrain aid during the provision aid at the time of natural disasters. Meanwhile, the production and distrubribution schelduing along with the inventory tool along with the amount and location of every raw material as needed during the time

of natural disaster is quite necessary. Besides, disaster relief commodities like meal and water, ready to eats or MREs, cots, blanekts, emergency eqipments like generators etc. are very much necessary to provide the humantrain aid through effective supply chain management.

Meanwhile, private storage sites are accepted as second component in humantrain supply chain during natural disasters. Such storage sites are mainly owned and control by private industry. In the meantime, vendors sites or VS are observed as thrid component in humantrain supply chain which indictes those vendors whom commodities are being purchased and managed during disaster period. furthermore, the fourth component is mobliztion vehicles which carry the non-perishable items and work under the control of the governmental agencies in any region. The fourth component in humantrain supply chain is entitled as temporary storage sites where new shipments for helping those who are in need during a disaster are stored and new stock is than directed to temporary storage sites. Finally, the six component for humantrain supply chain is reflected through regional distribution sites where goods and other materials are directly distributed among the needy people. Overall, different components of humantrain supply chain for the flood and similar disaster is reflected with the help of Figure 3.

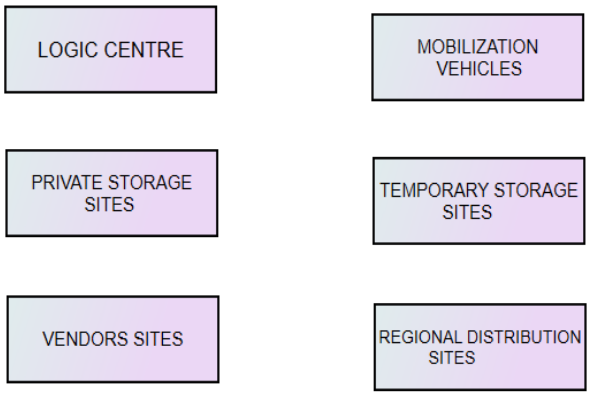

Figure 3: Components of Humantrain Supply chain during Flood/disasters

2. METHODS

The study of literature is looking for references to theories that are relevant to existing cases or problems. The reference contains about: a) morphological conditions, b) rainfall, c) rivers that flow through the city of Jakarta, d) land level reduction, e) development in the upstream area (Bogor area), f) population growth, g) planning rural cities, and h) institutional.

The data of this study were taken from various sources, both primary and secondary. Content analysis is also used in this research. After the data is collected, it is then analyzed to find out the real problem about the flood disaster in Jakarta that happens every year.

3. RESULT AND DISCUSSION

Water and Flood Management Issues

Based on the genealogy, as identified by the NCICD Master Plan (Coordinating Ministry for Economic Affairs of the Republic of Indonesia), there are three types of floods in Jakarta. First, floods that come from the sea or tidal floods. Second, floods that occur due to rain in the Puncak Bogor area then the water flows into Jakarta, or often referred to as "shipment floods". Third, floods that occur due to rain in the city and the capacity of the hydrological system are exceeded. This third type of flood is often also referred to as a flood that occurs because of "local rain". If examined further, then the occurrence of these three types of flooding cannot be separated from the spatial development that occurred in the Jakarta area and its surroundings.

For the first type of flood or tidal flood, the equilibrium balance whether or not a flood will occur depends on two things, namely sea level rise and land subsidence. The function of these two variables will produce flood. In terms of sea level rise, although it occurs, the figure is relatively small, which is below 0.5 cm per year. While the subsidence of the land, the rate at some points is relatively much larger, some reach above 20 cm per year. As such, priorities should be aimed at land subsidence. For the record, the state-of-the-art science in this field shows that the factor that has a major impact on land subsidence is the building load. While shipment floods occur because of the decreasing area of rain cover in the Puncak area.

Based on data from Forest Watch Indonesia (2012) in the Ciliwung River Basin in 2009, forest cover was only around 3,565.61 hectares, while the non-forest area was 25,620.93 hectares. Forests have several functions in the hydrological cycle. First, the leaves intercept the rain so that there is a volume of water held there. Second, the root network helps water to penetrate the soil and then seep into the rock and become ground water. Third, the root network strengthens the bonds of the soil to avoid erosion. Very thick material in the Ciliwung River, one of the causes is due to the presence of sediment as a result of very intense erosion in the Puncak area. The less forest cover means the three functions of this forest are also reduced. The overall effect is the greater runoff rate. When it rains, most of the water goes directly to the surface runoff, and this is the flow of "sent" water, causing the city of Jakarta in the lowlands to experience flooding. [14]. Floods in the city occur when rain falls in the city and the ability of the hydrological system to channel water is exceeded. A good hydrological system is useful for channeling water either surface water flow (rivers and canals), water that seeps into the soil, and as a retention basin. The reduced ability of the Jakarta hydrological system to deliver water,

due to the reduced green open space (RTH) in Jakarta. This is very reasonable, considering that green space has three hydrological functions (channeling water, water catchment sites, and also as a retention basin).

Rapid Changes in Land Use

The great flood that hit the city of Jakarta is also related to the Jakarta drainage system and landscape changes that occur in the middle and upper Ciliwung watershed (. The construction of buildings and settlements has an impact on the surrounding environment. Environmental changes caused by the construction of buildings and settlements. This kind of changes is called non-naturally changes, which is commonly referred to as land use change. Land changes often occur because of the demands of community needs that continue to grow in line with population growth. Changes in land use occur throughout many regions in Indonesia, with the same characteristics, namely the conversion of land from non-developed land to built-up land. One form of land use change is changing the water catchment area into a residential area and also changing the green open space to the central business district (CBD). In the last ten years, Jakarta has experienced a fairly massive land conversion. In 2009, the amount of land cover that was not built (there are no buildings) was still 34.39%, but in 2019 the amount of land cover that was not built was reduced so drastically that only 6.41% remained. This of course causes an increase in air temperatures in Jakarta, due to the reduction in green open space. This also means that the system that has been able to keep the temperature of the environment has been reduced, while increasing energy consumption for air conditioning, both in vehicles and in homes and buildings continues to grow.

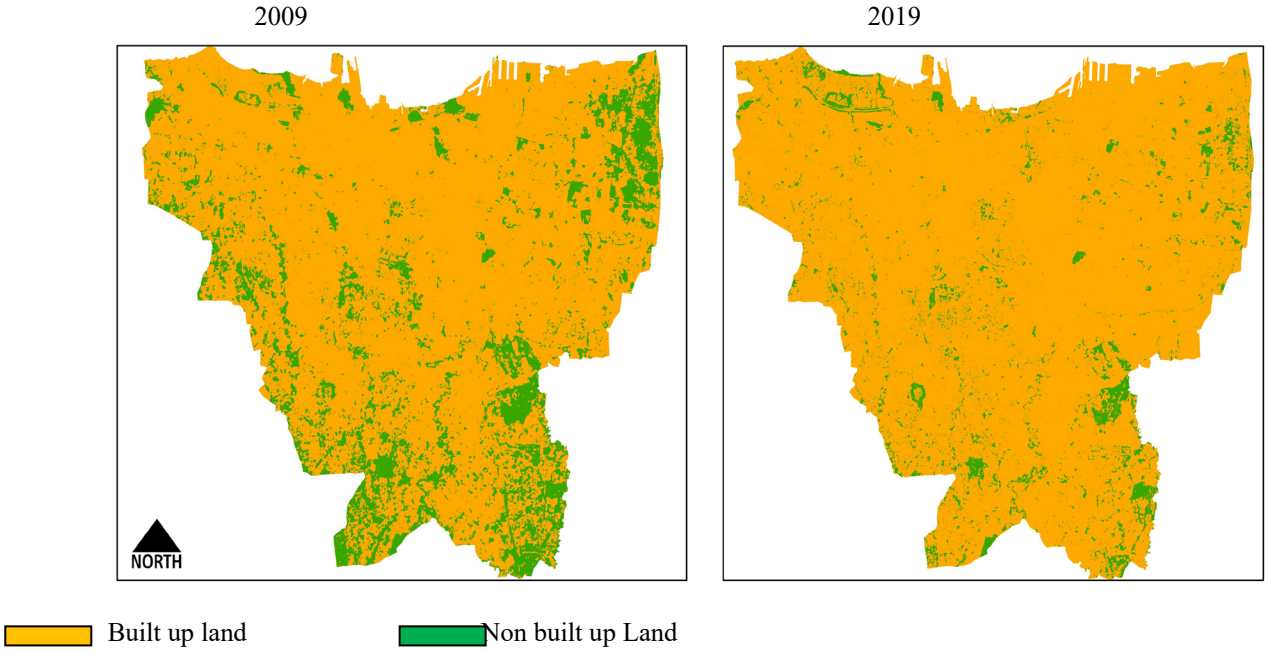

Figure 3. Changes in Jakarta land cover in 2009 and 2019

Jakarta's population growth in the last 10 years continues to increase. According to BPS data (2019), the average population growth rate of Jakarta in 2010-2018 is 1.09% (Table 1). With this increase in population, of course the need for land will also increase. This is what will trigger changes in land cover. Vegetable land will be threatened to be converted into built land.

Table 1. Jakarta Population Increase

No	Year	Jakarta Population
1	2010	9.640.406
2	2015	10.177.924
3	2018	10.467.630

Source: BPS (2019)

As the population continues to grow, the change in the area of Jakarta's land cover also increases. According to the analysis of Jakarta's land cover change from 2009 to 2019, it is known that land cover changes are quite significant (Table 2).

Table 2. Extent of Jakarta Land Cover 2009 to 2019

No	Year	Built up land (Ha)	Non-built up land (Ha)
1	2009	53412	10792
2	2019	60089	4118

The land that is built continues to grow each year in Jakarta. From the results of the analysis, it is known that the increase of land developed from 2009 to 2019 is 6677 hectares. Likewise, with vegetated land, it decreased quite a lot from the extent of 10793 hectares to only 4118 hectares.

Ciliwung River Factor

Watershed (DAS) is an area bounded by ridges or mountains that function to collect rain water that falls on the area, which will then be stored and flowed through small rivers to the main river naturally [4]. The Ciliwung watershed is based on a Joint Decree of the Minister of Home Affairs, the Minister of Forestry, and the Minister of Public Works No: 19 of 1984 - No: 059 / Kpts-11/1984 dated April 4, 1984 concerning the handling of soil conservation in the context of securing watersheds including the 20 super watersheds priority in Indonesia. This means that the Ciliwung watershed has been quite critical since the 1980s [24]. This is due to the rapid increase in population accompanied by an increase in income per capita of the community which has resulted in increased land needs.

Ciliwung River flows from the Puncak area, West Java Province to the Java Sea along 117 km. The Ciliwung River is the largest river system through Jakarta. The Ciliwung watershed is divided into 3 parts, namely the upstream (upper), middle and downstream sections. The upper and middle areas of the Ciliwung river are now experiencing major changes in land use. The land that was originally used to refill groundwater became the type of land use that produced runoff. The Ciliwung watershed is located in four different local government areas (Figure 4), namely (1) the capital city of Jakarta, (2) Bogor Regency, (3) Bogor City, and (4) Depok City [3].

4. Different Local Government Areas

The position of the Ciliwung River Basin which is located in the 4 regions is divided into 6 segment areas (segments 1-6) (Figure 4).

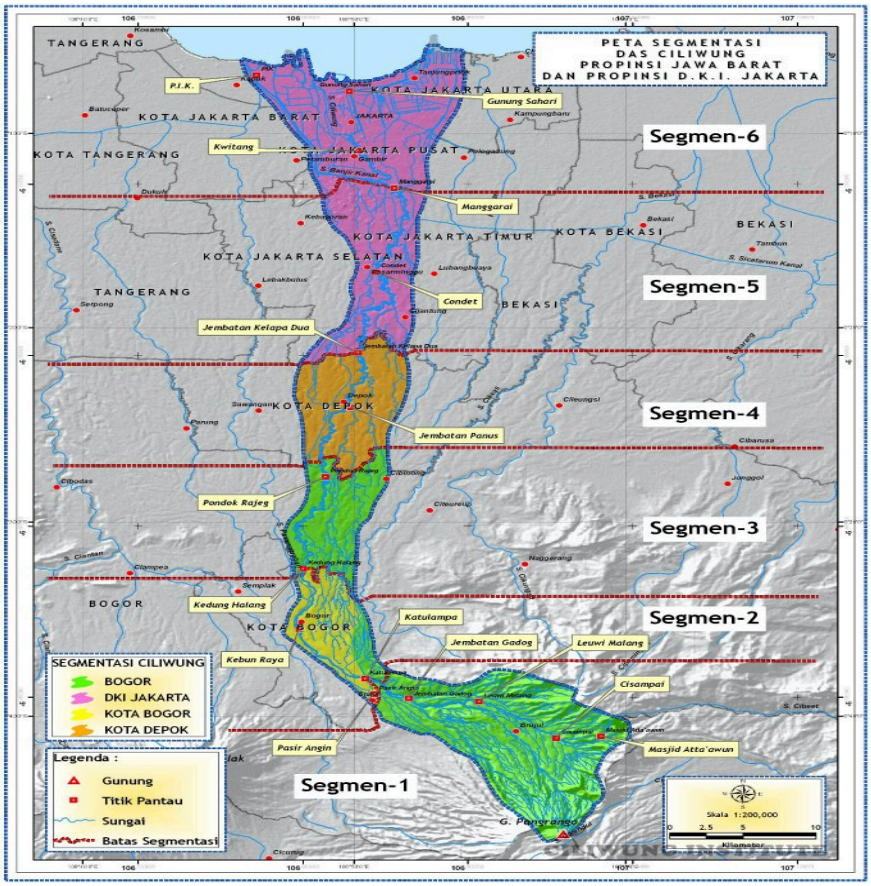

Figure 4: Map of Ciliwung watershed segmentation based on the KLH master plan divided into 6 Segment Areas

The six segments are divided into four regions, namely under the Bogor Regency Government, DKI Jakarta Government, Bogor City Government, and Depok City Government. In this case, Segments 1 and Segments 3 which include Ciawi, Cisarua, Megamendung and Sukaraja, Babakan Madang, Cibinong, Bojonggede, will become the Bogor Regency Government area. Meanwhile, Segment 2 will be the responsibility of the Bogor City Government, which covers the areas of South Bogor City, East Bogor City, Central Bogor City and Tanah Sereal. Meanwhile Depok City Government deals with Beji, Limo, Cimanggis, Sukma Jaya and Pancoran Mas, which are included in Segment 4. Finally, DKI Jakarta Government is in charge of Segments 5 and 6. Segments 5 covering the Jagakarsa, Pasar Minggu, Mampang Prapatan, Pancoran, Tebet areas, Setia Budi, Kebayoran Baru, Pasar Rebo, Ciracas, Kramat Jati, and Jatinegara. Meanwhile, Segment 6 includes Pulo Gadung, Matraman, Menteng, Senen, Tanah Abang, Johar Baru, Cempaka Putih, Kemayoran, Sawah Besar, Gambir, Tambora, Taman Sari, Koja, Penjaringan, Pademangan, Tanjung Priok, and Kelapa Gading. The area of the Ciliwung watershed is around 32,573 ha. In the middle of the Ciliwung watershed it is classified as a watershed that is experiencing degradation. The upper part of the watershed has a small area of forest cover (<15%) and high housing / building coverage (35%). This is due to the Ciliwung watershed being closed specifically for the capital city of Jakarta, as a center for economic development activities and also the upper reaches in upstream areas such as Depok, Bogor and Puncak (West Java). The scale of water catchment disturbance from the Ciliwung watershed, especially in the middle and upper watersheds can be seen during the 1990 and 1999 periods. During this period, land use changes occurred. Forest area is reduced by 10%. Plantations were reduced by 18%, mostly tea plantations at the top of the Ciliwung watershed. This decline in forest and plantation areas was followed by a sharp increase in agricultural dry land (169%) and housing / buildings (338%) in the 10-year time period. This change in land use (in the middle and upper part of the Ciliwung Watershed) has resulted in hydrological disturbance.

The hydrological disturbance that occurs can be explained as follows: In a watershed system, the upstream area is connected to the downstream area through river flow and sediment transfer. Changes in land use in the upstream area not only produce impacts on the site, in the form of increased runoff and soil erosion. Outside the location, there will be an increase in river flow and river sedimentation downstream. This increase in flow rates and erosion is a result of changing land use from forest cover to poor agricultural practices and / or housing / building coverage. Land use with good conservation will reduce runoff and soil erosion as also shown in [5] and [27].

Spatial Planning and Institutional Capacity

Uncontrolled land-based activities in the middle and upper parts of the Ciliwung River Basin cause flooding downstream of the Ciliwung River. This is mainly due to rapid population growth combined with urban-rural spatial planning that is not integrated in the watershed. Population growth in Jabodetabek increased from 4.5 million people in 1975 to 6.3 million in 1985, 9.0 million in 1995, and exceeded 9.6 million in 2010, plus around 2.5 million passengers every day from adjacent cities, with a total land area of only 662 km2 [8]. It is estimated that the population in Jabodetabek will reach 13 million by 2025 [9]. Difficult situations are increasingly intensified by the application of Law No. 23/2014 concerning Regional Government also known as regional autonomy law (decentralization). According to this law, the central government decentralizes most of its authority to regional governments including the management of natural resources. With this law, local governments (district and city governments) are autonomously responsible for the management and allocation of local resources for their regional income. With the new law, local governments no longer receive full funding from the central government, therefore, most local governments then intensify their economic activities without paying too much attention to the negative consequences on their neighbors.

Problems that have occurred in the last six years since the implementation of Law no. 23/2014 are:

a) Local governments have become too oriented towards the economics of managing their natural resources. Due to short-term economic orientation activities, many natural resources, such as forested areas, are converted into other commercial crops and / or settlements to get more fresh money.

b) Local governments become separate from the central and provincial governments and become more independent. This is a big problem for cross-border administrative boundary planning, because each local government now makes its own spatial planning without considering other regional government spatial plans and does not refer to provincial and national spatial planning.

According to Law No. 26/2007 on Spatial Planning, the spatial planning of each local government must refer to the province and national spatial planning. But this, in many cases, did not occur because there was no mechanism to force local governments to follow regulations and the lack of institutional capacity to facilitate the formulation of spatial plans within cross-administrative boundaries.

The problem with the current spatial planning system is that if the district / city spatial planning in the upstream

part of the watershed tends to increase polluted water flow, the downstream district / city will suffer without economic compensation from activities that have occurred in the upstream area. This is because there is no upstream-downstream compensation mechanism currently operating in Indonesia. Without this mechanism and adequate institutional capacity to carry out the mechanism, cross-border conflict will always occur. For example, in cases where downstream areas are sensitive to water shortages and / or floods, conflicts between upstream regional and downstream local governments are increasing. This kind of conflict should be prevented if urban-rural planning is properly designed, especially when these rural-urban areas are integrated into one watershed, one plan, and one integrated management (upstream-downstream). In the case of the Ciliwung watershed, the rural-urban planning system must cover the cities of Bogor and Bogor at the top, Depok city in the middle, and Jakarta at the bottom. At present, each of these administrative units has its own planning system, which is not adequately connected from the perspective of integrated watershed management. The problem is increasing with the distorted interpretation of Law no. 23/2014 on Regional Government, where many local governments ignore the importance of sequential land use planning from the provincial to the district level.

Flood Risk Management Through Humantrain Logestics

One of the key solutions to deal with the flood risk is based on the risk management through humantrain logistics. Such activities are defined through planning, implementing, and controlling the flow and storage of goods and material in an efficient and cost-effective way. It further specifies the flow of information to control the vulnerability due to any disasters like flood. The overall cycle of disaster management is based on four stages like mitigation, preparedness, responsece and finally the reconstruction. In all these four stages the humantrain logistic is very important to save the lives of the people who are affected by natural disasters like flood. The reason is that humantrain logistics during the emergency issues like flood work for the distribution of food and other medical supplies on which human's life is significantly depending. Additionally, a concept of "last mile relief distribution" covers the ultimate stage of disaster relief operations which indicates the delivery of supplies from warehouses to those who are majorly affected by the flood or similar other disasters. In this regard, four key factors may play their major role in determining the "last mile relief distribution". These are under the title of facility location, inventory mangements for eadibles and medical items, mode of transporation to deliver the food and medical services, and distribution decision respectively.

Furthermore, while using the humantrain logistic in supply chain for the risk management of flood, facility location decision is also very imporrant. It means that while planning for the reducdtion of risk of flood through humantrain logistic, it is important to highlight number and locations of distribution centers in overall relief neworks. Meanwhile, the capacity of the facility for addressing the risk management of flood through humantrain logistic is another point to consider.

5. CONCLUSION

Flood disasters have occurred for a long time in Jakarta. Flood disasters occur especially during the rainy season with high rainfall. Floods in Jakarta are related to the Ciliwung River Basin [4]. The Ciliwung watershed is located in four administrative regions. Therefore, mitigation efforts need to go through an integrated management strategy that involves all administrative areas. Analysis of anthropogenic factors is very important in efforts to overcome the problem of flooding in Jakarta. Based on spatial analysis, changes in landscape and hydrological data in the middle and upper parts of the Ciliwung watershed, can be said to play a big role as one of the causes of flooding in Jakarta. A comprehensive-integrative approach strategy needs to be done. Each local government needs joint agreement and coordination for flood control. In addition, the humatrain supply chain model as presented under present study can significnatly serve for the proper delivery and management of various items and equipments during the time of flood or similar other natural disasters. This may justify the argument that humantrain supply chain is entirely different from the commerical supply chain. It is beelived that humantrain supply chain reasonably works for the distribution of food, water, medinces, and other items to the people which are affected by some emergency issues.

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