Physical Factor Analysis of Juata Laut Landfill's Planning Location in Tarakan City, North Kalimantan

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Keywords: *Landfill Planning, Sanitary Landfill, Physical Factors, Juata Laut, Tarakan City*

Abstract: The increasing amount of waste has an impact on the capacity of existing landfill in Tarakan City, North Kalimantan. The land allotment is planned by the Regional Government of Tarakan City, covering an area of 40 Ha for the new landfill in Juata Laut sub-district, North Tarakan District. Juata Laut Landfill is planned to use Sanitary Landfill system in accordance with Law No.18 of 2008, as well as an effort to minimize the environmental impact and the realization of Sustainable Development Goals (SDG's) in solid waste sector. The criteria for determining the location of the landfill consider the physical factors of landfill land planning related to natural conditions. Physical factors analyzed in this study include climatology, geology, land type, watershed, flood-prone areas, and topography (slope and land height). The methods used in this study are area observation, collecting secondary data about the area of landfill planning, literature study, and making comparisons with SNI 03-3241-1994. The analysis employed descriptive qualitative analysis. The results indicate that the physical factors studied for Juata Laut Landfill are in accordance with the regulations and provisions of the landfill planning with the sanitary landfill system.

1 INTRODUCTION

The increasing amount of solid waste in Tarakan City has an impact on the existing landfill capacity that cannot meet the needs for daily solid waste disposal. Based on Tarakan City Spatial Plan No. 04 of 2012, the TPA development is planned in Juata Laut Sub-District, North Tarakan District. The Government of Tarakan City provides a 40Ha landfill area.

New landfill that meets the standards of sanitary landfill provisions is needed, because the existing landfill still uses the Open Dumping system. Law No. 18 of 2008 requires all Landfills in Indonesia to be managed by sanitary landfill. Sanitary landfill is a system with lower environmental impacts compared to other thermal processing (inseneration and gasification), where gas produced from this system can be used for fuel by controlling the emission (Zaman, 2010). Environmental pollution from solid waste can disrupt the comfort and health of the community. Therefore, the planning of a new landfill is important and urgently needed. Another goal of planning is to manage solid waste disposed by the population, as well as to achieve Sustainable Development Goals (SDG's) in terms of solid waste.

The determination of landfill must follow the terms and conditions set by the government. The process of selecting landfill site consists of three stages, namely the regional stage with decent and unworthy regional outputs selected for the location of the landfill, the selection screening stage determining the most recommended location, and the determination stage (Hasibuan, 2014).

Fulfillment of criteria to determine the location of landfill should be able to minimize the impact of environmental damage and pollution around the landfill site because it considers many aspects of the environment, health, and cleanliness, such as geological conditions, springs, residential locations, and locations of productive land (Maulidah, 2013). In addition, the selection of landfill locations also takes into account the physical factors of landfill planning in relation to natural conditions (Rainda, 2017).

Natural conditions that are considered in the physical factor analysis of landfill planning locations include rainfall (climatology), geology, soil type, watershed, flood-prone areas, and topography (land slope and land height). The analysis of physical factors can be used as a major consideration in determining the location of the new landfill with a

Auvaria, S., Oktorina, S., Nilandita, W. and Nengse, S.
Physical Factor Analysis of Juata Laut Landfill's Planning Location in Tarakan City, North Kalimantan.
DOI: 10.5220/0008907700002481
In *Proceedings of the Built Environment, Science and Technology International Conference (BEST ICON 2018)*, pages 219-225
ISBN: 978-989-758-414-5

sanitary landfill system in Juata Laut Sub-District, North Tarakan District.

2. METHODS

There are some method can give the good result, overall we can use basic step to get initial condition

2.1 Qualitative Analysis

The methods used in this study are area observation, collecting secondary data about the area of landfill planning, literature study, and comparison study based on SNI 03-3241-1994. The analysis used is qualitative analysis in the form of descriptive analysis by describing the data obtained through the field observations and outlining and interpreting the data. In other words, qualitative analysis was very clear with regard to the situation or phenomenon existing in the study area.

2.2 Research site

This research was conducted in Tarakan City which is located between 3.399 North Latitude and 117.560 East Longitude. Specifically, the landfill location was planned to be in Juata Laut Sub-District, North Tarakan District. The location of landfill area provided by the local government of Tarakan City is an area of 40 hectares. The planned area for the development of Landfill location can be seen in figure 1.

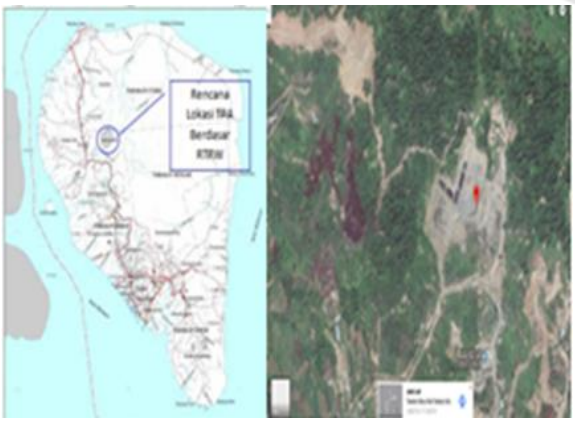

Figure 1: Plan for the Development of Landfill Locations in Tarakan City

3 RESULT AND DISCUSSION

Result and discussion will explain about all condition on research.

3.1 Climatology

Weather condition is one of the factors that should be considered in determining the location of the landfill. Weather is a physical event that takes place in the atmosphere at a certain time and place / space. The weather will continue to change and differ between other locations. This is influenced by several factors, namely: altitude, latitude, spread of land and waters, areas of high and low pressure, ocean currents, atmospheric disturbances, or more weather and climate (especially solar radiation) (Zetly, 2009)

Air temperature is determined by the height of the place from the surface of the sea and the distance from the beach. In general, Tarakan has a hot climate with an average air temperature in 2015 reaching 24.8'C to 31.3'C. In addition, as a tropical climate, Tarakan City has a relatively high average air humidity, ranging from 56.0 percent to 98.0 percent throughout 2015. The lowest air humidity occurred in March which only reached 47.0 percent. Meanwhile, the highest air humidity occurred in June which reached 100 percent. The average air humidity throughout 2015 was recorded at 84.0 percent. Rainfall somewhere is influenced by climatic conditions, geographical conditions and velocity of air flow (BPS Kota Tarakan,2017).

Therefore, the rainfall varies according to the month and location of the observation station. Rainfall in Tarakan City varies greatly from time to time. The highest average rainfall which occurred in November was 375.1 mm and the lowest average rainfall was 197.4 mm which occurred in January. The average rainfall during 2014 was recorded at 264.5 mm with an average rainy day of 20 days per month. In addition to the climatological indicators above, there are other indicators such as solar radiation where the average in 2015 was 56.3 percent. The highest air pressure in Tarakan City in March was 1,013.5 mb with an average of 1,011.7 mb (BPS Kota Tarakan, 2017).

Rainfall analysis is very important in determining the location of the landfill because it greatly influences the risk of flooding. According to the SNI

Decree, flood hazard parameters and rain intensity parameters are different things. In the landfill site that has relatively high rainfall, the likelihood of flooding will be higher, so that it will cause solid waste to move and cause landslides. Landfill location should be placed in a low rainfall area, so that the lower the better for landfill site (Maatuil and Fibriani, 2016).

Based on the BPS data of Tarakan City in 2017, the average rainfall is relatively low, So, this could be the reason for the construction of the landfill site. the smaller the intensity of the rain, the better the construction of the landfill site is (Antonius Arik Rumbruren, 2012). This is because if the rain intensity is high, the risk of flooding is also greater. Therefore, the construction of landfill sites should be carried out in locations with low rainfall.

3.2 Geology of landfill locations

Geology is basically the study of the earth and the phenomena that occur. In science, the the results of geological survey discuss the earth-forming material and all the processes that will occur both within the earth and above the surface of the earth. Therefore, the description of the geological conditions in the planned area of a construction that will be built, including reviewing the dangers that will arise in the development process, to provide information on the level of security of the development results on a construction and efficiency of costs will be used during development takes place (Treman, 2014).

Most of Tarakan City consists of geological elements in the form of units (TPQS) namely quartz sandstone, clay stone, siltstone, lignite and conglomerate. The composition of the geological structure is spread in Tarakan City covering an area of 16,058 Ha (64.03%) of the land area of Tarakan City. Meanwhile, the rest is in the form of units (Qa), namely mud, silt, sand, gravel and greed covering an area of 9,022 Ha (35.97%) of Tarakan City's land area (BPS Kota Tarakan, 2017).

In general, the geological condition of Tarakan City is in the form of hilly areas with wide lowlands. Geological layers that exist in the city of Tarakan generally are in the form of clay stones and are followed by sandstone, coal, quarter sediment, conglomerates, lemung montmorillonite, and clay sand. The landfill area is an area with a land type in the form of a conglomerate area (BPS Kota Tarakan, 2017)

Conglomerate rocks are one type of sedimentary rocks formed from small particles that form sedimentation. The conglomerate rocks are rough and large textured. The composition of conglomerate stones is derived from sand, gravel and soil. Besides that, it also comes from weathering of rocks from conglomerate rocks. Basically, conglomerate rocks are not strong rock types. So, they cannot be used as the foundation or structure of a building. However, if the conglomerate rocks are destroyed, they can be used as a support for the building. The geological condition of Tarakan City can be seen in Figure 2.

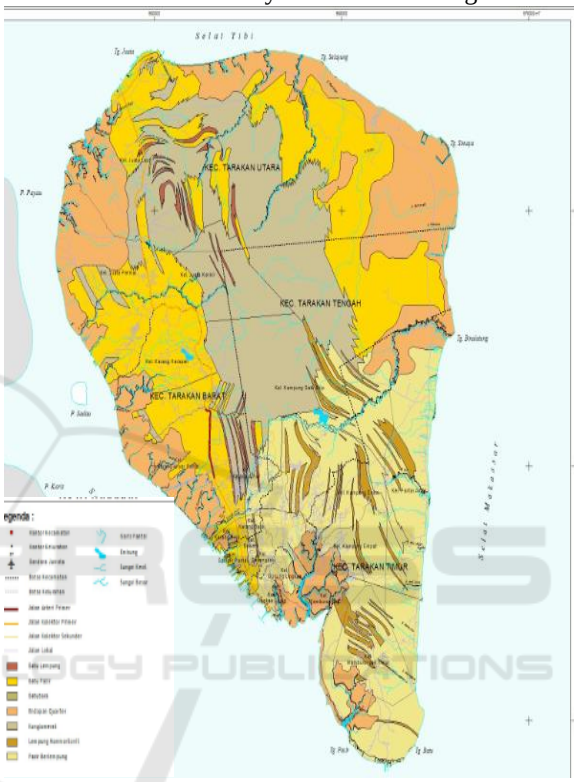

Figure 2: Geological Conditions of Tarakan City

Geological location with soil conditions that are quite hard are very desirable for Landfill. Usually, clay or other compact rocks are considered feasible for landfill locations. Hard/cracked or permeable hard rocks will increase the potential for leachate that spread outside landfill area (Damanhuri, 2008). It means that geological condition in Tarakan City has fulfilled the criteria for landfill location.

3.3 Soil type on landfill location

The condition of soil types is one of important factors in the study of landfill planning. Land is a basic material that is very important as the foundation structure of buildings, highways, and others. Damages of roads, buildings, and bumpy road

surfaces are commonly caused by problems related to the soil under the structure of a building (Gunarso et.al., 2017).

Formation of land involves many processes, but in general it can be divided into four parts, namely the addition of material into the soil, loss of material from the soil, changes in shape and displacement in solum (from the top soil layer to the soil layer) (Iskandar, et.al., 2017).

The dominant soil type in Tarakan City is the latosol soil type in the central part of the island with a few podzolic soil types, and the most abundant part is the alluvial soil type. The landfill area is an area with podsolic soil type (BPS Kota Tarakan, 2017).

Podolic soil is a soil that has an argillic B horizon, having a base kill. Podolic soil has the broadest distribution in Indonesia compared to other types of soil. Podsolic soil is part of ultisol soil. According to the USDA (United States Department of Agriculture), ultisol is soil that has been washed.

One of the characteristics of podzolic soil is that it has a very low nutrient storage capacity so that it is not suitable for agriculture. Thus, it is classified as infertile soil, both physically and chemically (Basuki, 2009).

In addition, there are several factors that affect land conditions, including land productivity and land status. The more unproductive the land, the better it is in doing the development, such as landfill (Zetly, 2009).

The land area of Tarakan City with an area of 25,080 Ha is largely unused and is still in the form of thickets (34%). The next largest land use is a mixture of shrubs with agricultural cultivation in the form of lading and moor (31.79%). Meanwhile, the urban built area is only 6.1% of the total land area of Tarakan City which is an area of 1.376 Ha. This shows that the soil conditions in Tarakan City include unproductive soil conditions (BPS Kota Tarakan, 2017).

The soil types of landfill location in Tarakan City are shown in figure 3. From figure 3, it can be seen that most of Tarakan City is dominated by Latosol. The second largest area is Podsolik, followed by Aluvial type.

Assessment criteria according to SNI 03-3241-1994 based on the productivity aspects of landfill land, the lower the productivity of the land, the better the land is used for landfill. It means that based on the soil criteria, this area is good for landfill site.

3.4 Watershed

There are twenty-four watersheds in Tarakan City area, with 2 types of rivers, namely large rivers and small rivers. The watershed in Tarakan City is very crucial because the river is a source of raw water for freshwater in Tarakan City. Map of the location of the watershed (Watershed) of Tarakan City can be seen in figure 4.

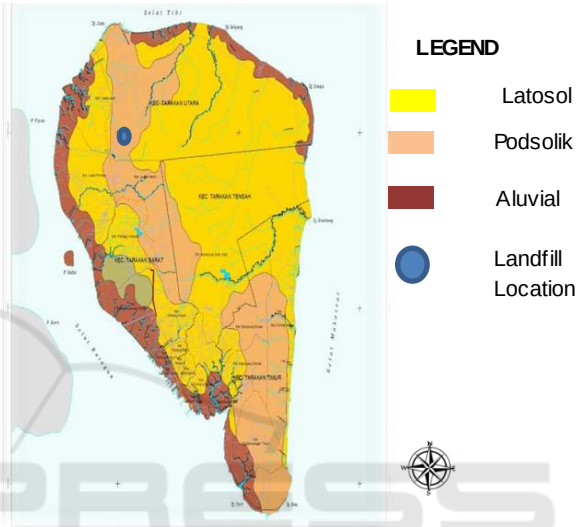

Figure 3: Land Type of Tarakan City

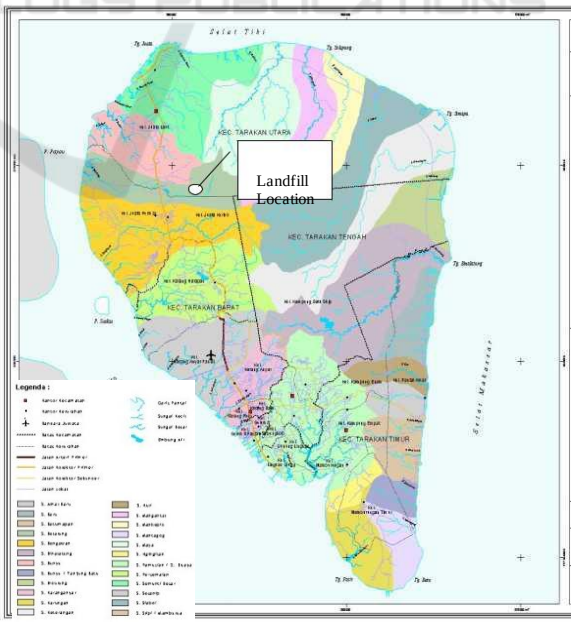

Figure 4: Map of Watershed in Tarakan City

Based on Figure 4. the location of Juata Laut landfill is in Baru Watershed. The distance of Juata Laut Landfill to the nearest river is the small river flow towards the sea. It is quite close to the landfill site area. This must be considered, though this river is not used as a water source. That was considered, because landfill location should not be close to water source (Maatuil and Fibriani, 2016). In landfill location, there is also a flooded swamp source. This must be considered in developing the landfill later.

3.5 Flood Risk Area

Some areas in Tarakan City are identified as flood-prone areas, and there is a possibility that this flood disaster will have an impact on the solid waste collection process, so that transportation engineering on solid waste is needed. The landfill plan area is safe from the threat of flooding. Map of the potential locations of flood disaster in Tarakan City can be seen in figure 5.

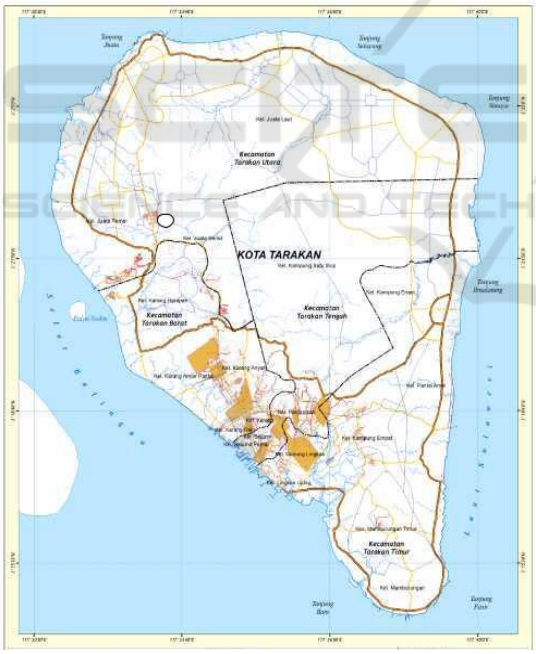

Figure 5: Map of the potential locations of flood disaster in Tarakan City

The assessment criteria from the aspect of flooding is that landfill land which has a low risk of flood is considered better than landfill land that has a high risk of flood. This is related to the landfill operational process, water pollution by leachate and the possibility of solid waste that is being washed away by the flood. This flood protection is carried out up to a 25-year flood period.

Based on the condition of the landfill land, the potential for flooding is relatively small. It can be seen from the relatively hilly area and there is no puddle area in this landfill land.

3.6 Topography

Tarakan City has flat to hilly topographic conditions. There are hills longitudinal curved in Northwest – Southeast direction with an altitude of about 110 meters above sea level.

The height of Tarakan City is classified into four classes, namely 0-7 m asl, 7-25 m above sea level, 25-100 m asl and > 100 - 110 m asl. Most of Tarakan City is a flat area with an altitude of 25-100 m above sea level with an area of 13,092 ha (52.20% of the total area of Tarakan City). In height classification 7 - 25 m asl as wide as 8,940 Ha (35.65% from Tarakan City).

3.6.1 Land slope

Almost 80% of Tarakan City area has a slope in steep conditions. This condition must be taken into consideration in planning the location of the landfill because the topography of the landfill is steep. Land slope is one of the main factors to determine possible locations for landfill. The slope is closely related to the ease of construction work and Landfill operations. More steep area will result in difficulties in activities/work of construction and operation (Irawan dan Yudono, 2014).

Land use for functional areas such as built areas requires land with a slope below 15%, while the land with slope above 15% will be very suitable for the use of plantations, tree crops and forests. Tarakan City area has a dominant land slope from 0 - 5%, so that it is quite good for landfill area. Map of the land slope of Tarakan City is shown in figure 6.

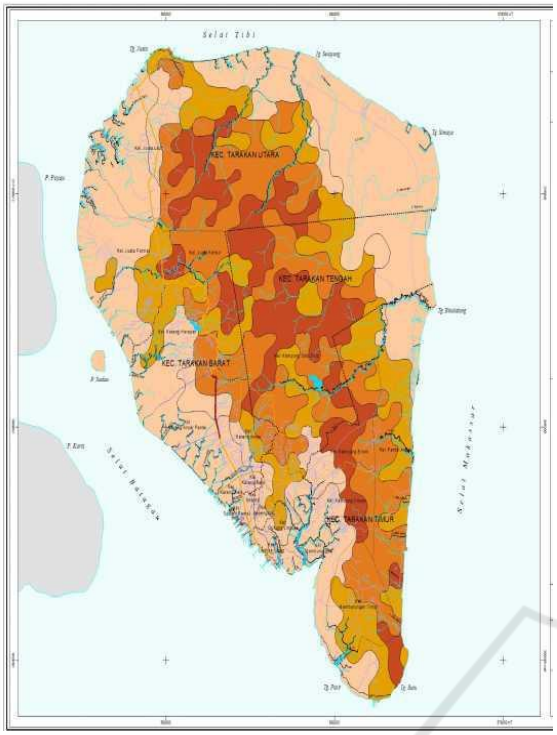

Figure 6: the land slope map of Tarakan City

The assessment criterion of the slope aspect of landfill area is that landfill land that has a sloping slope is considered better than land that has steep slopes. The constructed landfill is also expected not to be located in areas that has landslide potential or in high soil movement vulnerability zones. This is closely related to the protection against the possibility of land sliding or landslides. The permissible tolerance of slope is between the range 0-5%, 5 - 10% and 10 - 20%, or the slope of the zone must be less than 20%. Juata Laut landfill has a relatively steep slope, because of the shape of the landfill site which has a height difference that is relatively large and steep.

3.6.2 Land Height

Tarakan city has a flat land contour pattern, where the highest area in Tarakan City only has a height of ± 87.5 meters above sea level and the lowest area is 0-25 masl. The landfill plan has an elevation of 50-90 masl. The height of Tarakan City area can be seen in Figure 7. The land height in Tarakan City (plan area) is quite good for landfill site, considering its location which is far from residential area.

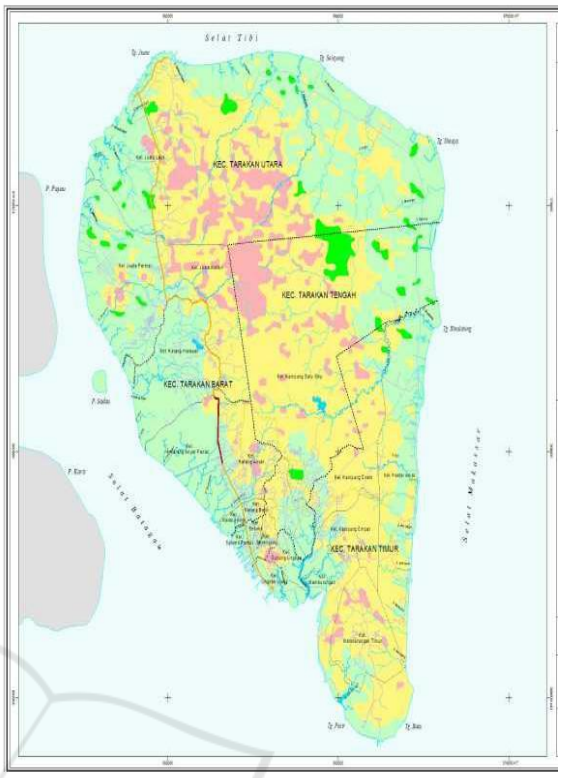

Figure 7: Height Map of Tarakan City

4 CONCLUSIONS

Based on the results of the analysis of physical factors from the location of Juata Laut landfill plan area, several point can be concluded

1. The climatology factors in Tarakan City quite vary. Considering the temperature (24,8-31,3 Celcius degree) and average rainfall (264,5mm), the landfill area is still possible to be developed in this area.
2. Tarakan City is in the form of hilly areas with wide lowlands. The The distance of Juata Laut Landfill to the nearest river is the small river (not used as a water source) that flows towards the sea. It is quite close to the landfill site area.
3. landfill area is an area with a land type in the form of a conglomerate area.
4. Landfill area is an area with polycolic soil type and soil conditions in Tarakan City including unproductive soil conditions.
5. The potential for flooding is relatively small, which can be seen from the relatively hilly area and there is no puddle area in this landfill land
6. Juata Laut landfill has a relatively steep slope, because of the shape of the landfill site which has

a height difference that is relatively large and steep. It has flat land contour pattern, where the highest area in Tarakan City only has a height of ± 87.5 meters above sea level and the lowest area is 0-25 masl. The landfill plan has an elevation of 50-90 masl.

7. The results of the analysis show that the aspects of physical factors for Juata Laut Landfill are in accordance with the regulations and provisions on the landfill planning with the sanitary landfill system.

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