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Disposal Sites Determination for the Purpose of Solid Waste Management Optimize by using Geographic Information System (Gis)

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Abstarct: ***Solid waste is a waste generated every day. The amount of solid waste generation depends on the total area of housing and services, the area of the places, and activities. The increase in population, housing and services in the area has resulted in the generation of solid waste. The solid waste should be disposed of to prevent the spread of disease and to keep the environment clean. Normally, solid waste will be disposed of in landfill sites. In four districts in Negeri Sembilan that is Jelebu, Jempol, Kuala Pilah and Tampin, the existing landfill in these areas have reached semi-critical status and the capacity is about to reach the maximum level. Therefore, this study was undertaken to proposed the most ideal and effective new solid waste landfill based on the distribution of housing in an area using the Geographic Information System (GIS). GIS serves as a hardware device that stores information and databases of the area and analyzes data to produce the output required by the user. In addition, this study was conducted to investigate and determine the criteria and weighting factors taken into account in determining the location of landfill sites. In addition, this study also conducted to identify the optimization of disposal of solid waste and the type of new landfill proposed. Some analyzes such as Analysis Geoprocessing, Model Builder, OD Cost Matrix, Network Analyst and Service Area has been carried out to obtain an ideal location to serve as a solid waste disposal site. Based on the analysis, the new landfill can cover 242 of housing areas within 25 kilometers from the landfill compared to the existing landfill that only covered 165 of housing areas only. Finally, the siting of the landfill using GIS application is the best system in helping the user to determine the new landfill in such a fastest way.***

Keywords: GIS, Landfill, Spatial Analysis, Landfill, Waste Management

I. INTRODUCTION

Generation of solid waste in rural or urban areas is the result of human activity. The rate of waste generation increased every day as the population increased (Bah & Tsiko 2011). Solid waste must be disposed of to prevent the spread of diseases that can threaten the health and also can preserve the environment for future generations. There are several methods that can be used to dispose the solid waste such as sanitary landfill, incineration, recycling, open dumping, and sea dumping (Younes 2015). In Malaysia, the management system of solid waste is carried out by building the solid waste landfill. The landfill is the area where solid waste is disposed of safely and also the physical facilities for the disposal of solid waste in the ground (Younes 2015).

Many countries already have their awareness in solid waste management. To improve waste management system, there is a number of technology has been developed and one of them is Geographic Information System (GIS). This system helps to manipulate data in computer software to simulate alternatives and produce the most effective results in the determination of solid waste disposal sites or known as landfill (Ahmed 2006). Nowadays, the use of GIS by local authorities in the determination of solid waste landfill is proved to be helpful in resolving problems. GIS converts geo-referenced maps to a computerized map while GIS map analysis tools can speed up the process of manipulating a map and also shortened the time. GIS can incorporate a variety of data such as demographic data, transportation, slope, land use, and geology (Nasir 2016).

II. METHODOLOGY

A. Submission of the paper

This study was conducted in four selected districts in Negeri Sembilan that are Jelebu, Jempol, Kuala Pilah and Tampin as shown in figure 1. The problems are waste disposal must be managed properly so as not to affect the cleanliness of the environment and health of local residents. Therefore, the system must be structured so that the solid waste management system in a particular place can be carried out effectively and efficiently.The data such as land use, slope, roads, gas lines, trail TNB, rivers, housing areas, geological and land ownership in the study area is used in this research to get the most suitable places to build the new solid waste landfill.

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In selecting the new landfill, some weighting factors should be taken into account in selecting the new landfill. The weighting factors are the distance of the new landfill should be more than 1 kilometer from the gas lines, road, trial TNB, housing area, and more than 500 meters from rivers. Open space is the most suitable land use and the slope should be less than 15degree. All of the criteria and weighting factors should be combined and analyzed to produce the best landfill.Besides that, the data of the existing landfill an the services area also used in the analyses. The result are shown in figure 2-9.

Figure 1:Location of the study area in Negeri Sembilan

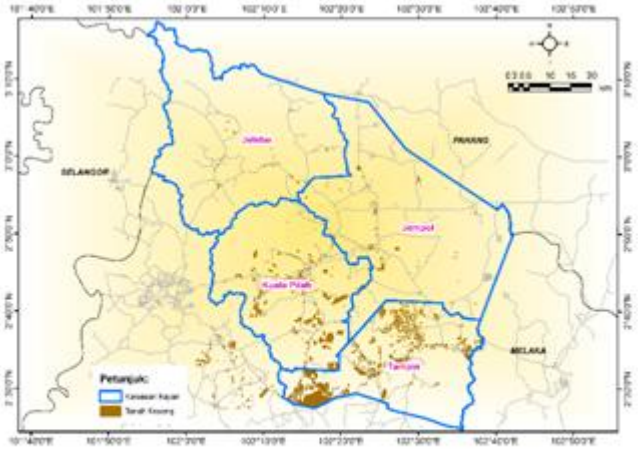

Figure 2: Land use map

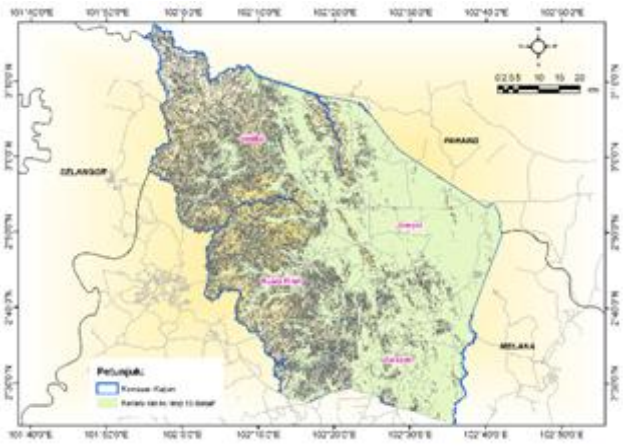

Figure 3: Slope less than 15° map

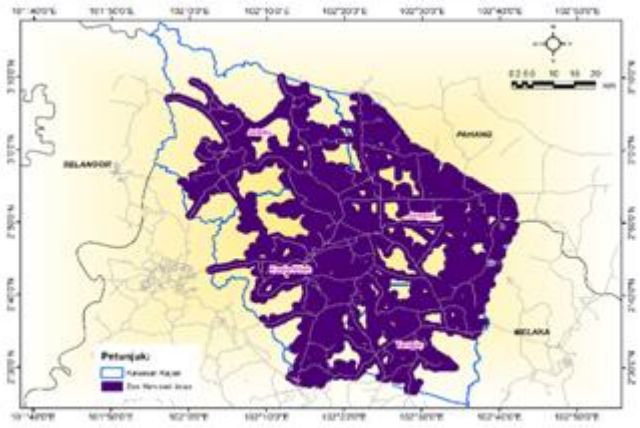

Figure 4: Road map (1 km)

Figure 5: Gas line map

Figure 6: Trail TNB map (1 km)

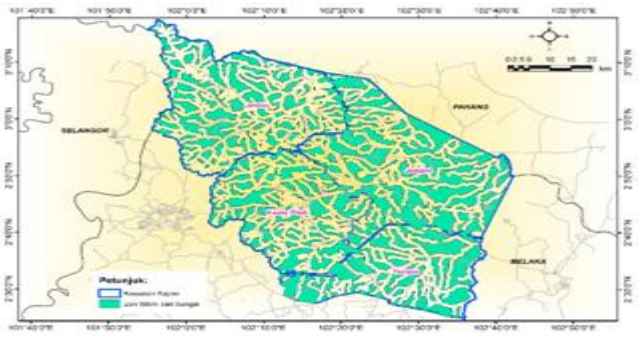

Figure 7: River map (500 m)

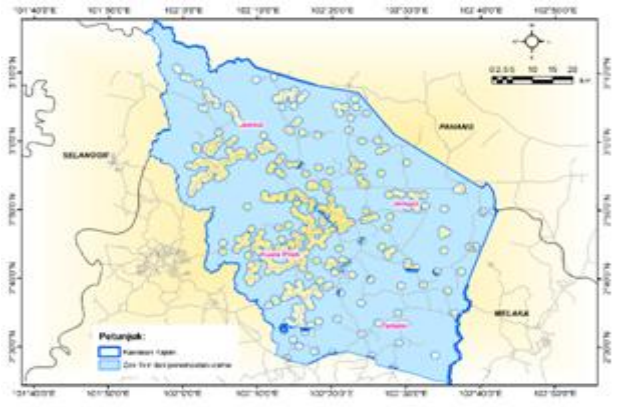

Figure 8: Housing area map (1 km)

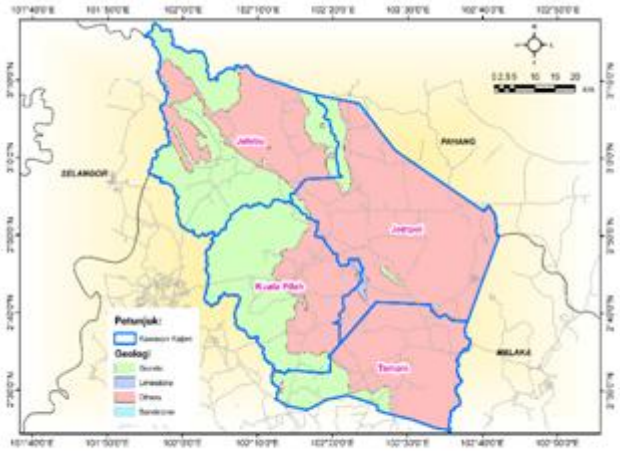

Figure 9: Geology map

All the data shown in the figure has been analysed using 3D Analysis to get the buffer area. Then the results were analysed using Model Builder Analysis to get the distributions of potential areas to build the new landfill as shown in figure 11 and 12.

Figure 10: Model Builder Analysis

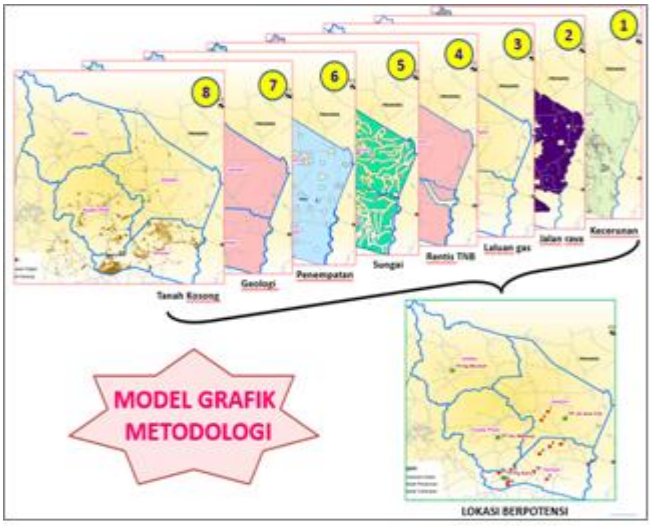

Figure 11: Spatial model were overlaid

Next, the potential areas were analysed using Analysis Geoprocessing, Model Builder, OD Cost Matrix, Network Analyst and Service Area to get an ideal location for the new landfill

III. RESULT AND DISCUSSION

Based on the analyses conducted using all the data and weighting factors, there are 13 areas identified as having a potential to be used as the new landfill. Figure 2 shows the potential areas of existing landfill and the potential area of the new landfill. OD Cost Matrix Analysis has been conducted among 13 potential areas and the services area in 25 kilometers distance to get an ideal location for the new sanitary landfill. Table 1 shows the location of the potentialareas of the new landfill, the number of services area and residential areas covered within 25 kilometers.

Table 1: Potential areas, size, and number of services and residential areas covered in 25 km

Potential areas	Area (acre)	Number of services area in 25 km from the potential area of landfill	Number of housing area
1	102.983	17	99
2	55.4681	17	99
3	31.4848	13	69
4	42.7096	12	72
5	33.189	12	72
6	120.406	9	47
7	162.6053	13	72
8	172.348	10	51
9	35.1343	12	81
10	89.9248	10	51
11	95.0182	10	42
12	55.4681	7	48
13	178.2982	6	26

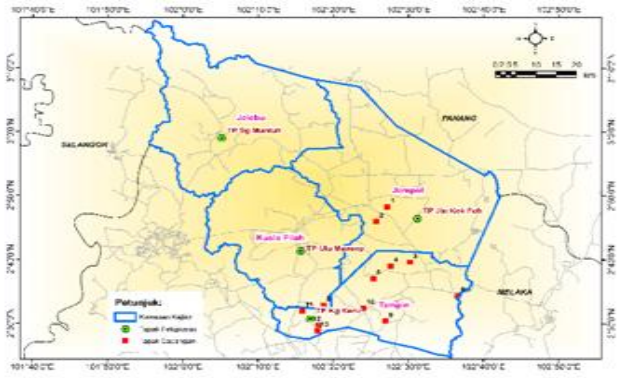

Figure 12: Location of potential areas of new landfill and existing landfill

From the table constructed, there are 3 potential areas that have been detected which are A (1, 2), B (3, 4, 5) and C (7, 9, 10) based on the size and the number of services and residential area covered within 25 kilometers from the potential area. Then, Network Analyst has been carried out on the 3 locations to get the total of services and residential areas covered in 25 kilometers. The location that shows the highest number of the residential area covered will be selected as the area for new sanitary landfill. Figure 3 shows the locations of A, B, and C and the services area covered.

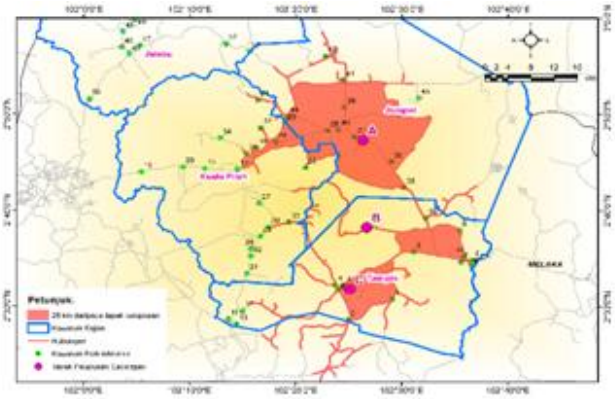

Figure 13: Service area analysis based on 3 locations identified

The number of residential areas covered by the 3 proposed locations in 25 kilometers is shown in table 2 below. Location A shows the highest number of the residential area covered that is 99. Therefore, location A has been selected as the site for the new landfill. Besides that, the location A is located in the middle of the study area can help to expedite the waste delivery process.

Table 2: The proposed location of new landfill and the number of residential area covered

Proposed Location	Number of housing area covered (25 km from proposed locations)
a) Location A	99
b) Location B	71
c) Location C	52

The new landfill area is determined based on the optimum area covered by the landfill within 25 km. Figure 4 shows the result of selection of an ideal location to serve as solid waste disposal sites and some of the existing landfills will be converted as a transfer station to facilitate and increase the efficiency of the solid waste management system. Site A will be the new sanitary landfill, the existing landfill that is Sg. Muntoh Landfill will be maintained its status as landfill in Jelebu, while Ulu Masop Landfill and Kg. Keru Landfill will be converted into transfer stations. The new landfill and transfer stations covered 242 residential areas and did not cover 52 services area compared to the existing landfill that only covered 165 residential areas and did not cover 58 services area. This shows a good improvement in siting the new landfill.

Figure 14: The services area that can be covered by the new landfill and transfer stations in 25km

IV. ADVANTAGES IN GIS MAPPING

In this project, GIS is the main tool in mapping the proposed landfill. By adding the data needed such as the study area into ArcMap 10.2, a full map of study area produced. Besides, by using GIS, the collected data can be presented in a table. The attribute table was flexible and the users can edit it anytime. Figure 5 shows the attribute table of the services area in ArcMap10.2. There are a lot of data that can be stored in the attribute table up to more than 10000 data. The interesting part is, by clicking on the points in the attribute table, we can know the location of the point in the map. It is easier for us to make the analysis of some point such as the service area analysis for the proposed landfill in 25 km range. All these functions can help the users to make fast discussions and decisions about the matter.

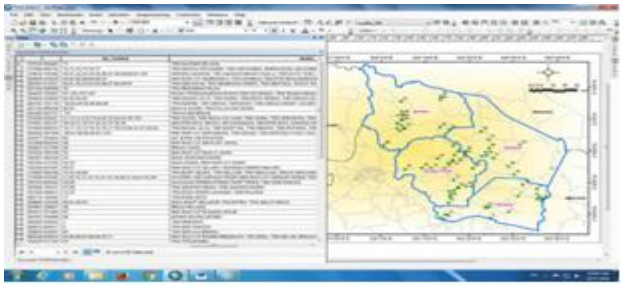

Figure 15: Attribute table of the

V. CONCLUSION

Determination of solid waste disposal sites or known as landfill using GIS application is systematic and helps the user in determining the new landfill easier. The uses of GIS is not limited just to determine the landfill but can be applied for other uses too. GIS can be applied in sewage systems, road maintenance management system and light rail transit management system. In short, GIS is a system designed to help users to record, analyze, troubleshoot, and store data for their purpose.

Data such as existing landfills, services area, residential areas, roads, trails TNB, land use, slope, gas pipelines, rivers, geology, and land ownership has been analyzed using GIS applications and successfully produced a map analysis which displays the ideal location for the new landfill in the study area. The result of map analysis has improved and upgraded the siting of solid waste disposal system from the collection and storing data of weightage factors and parameters used in the research until the determination of an ideal landfill.

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