Assessing green waste route by using Network Analysis

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Abstract. Green waste, such as waste from park need treat proper. One of the main problems of green waste management is how to design optimum collection. This research aims to determine the optimum green waste collection by determining optimum route among park. The route optimum was assessed by using network analysis method. And the region five of Semarang city's park within 20 parks in chose as case study. To enhancing recycle of green waste, three scenarios of treatment are proposed. Scenario 1 used one integrated treatment facility as terminal for enhancing recycle of green waste, Scenario 2 used two sites and scenario 3 used three sites. According to the assessment, the length of route of scenario 1 is 36.126 km and the time for collection estimated is 46 minutes. In scenario 2, the length of route is 36.471 km with a travel time is 47 minutes. The length of scenario three is 46.934 km and the time of collection is 60 minutes.

Keywords: Green waste, GIS, Network Analysis

1. Introduction

Green waste should be treated properly to ensuring the resilience of urban green space [1] Planning for green waste management is needed to ensure that urban green park sustainability is in line with many perspectives of function, such as ecology, aesthetic, recreation and leisure in city [2] Green waste management is important to maintenance the function of urban green space to mitigate high temperatures in urban landscapes [3]. Urban green waste management is also important for mitigating urban flood waste management that usually dominant in flood waste component such in flood waste in Bangkok Thailand, during huge flood in 2011[4]. Moreover, green waste optimum management, could be utilized to enhance biomass base-energy [5].

One of the critical factors to achieve the proper green waste management is the optimum condition of transportation system [6]. This study aims to examine the route of the green waste collection from park. Moreover, there are two sub systems on the green waste transportation that will be examined; the first is route and the second is time of green waste collection for enhancing recycling system.

2. Data and methods

2.1. Study area

Several studies concerning on the sustainability issues of Semarang city have been conducted. For example the challenging of sustainability in Semarang [7], inundated issues of Semarang [8,9]. Study

concerning on the leisure level in Semarang city that have been initiated in 2002 by Guntur Suworo [10], however an information concerning to the maintenance of urban green open space, such as park maintenance not yet discuss. This indicator is very important to analyze in growing cities such as Semarang.

The study area is park in Candisari and Tembalang district at which the two districts are as representative of Semarang Growth in recent year. Candisari has a unique characteristic housing while Tembalang district is one of the education centre zone in Semarang. 20 parks at which 13 in Candisari district and seven parks in Tembalang district (Fig 1) were selected to examine the model of green waste collection optimum route. The initially and preliminary study shown that there is no regular schedule of green waste colleting, sweeping. The transport of green waste is done around 10:00 to 12:00 pm, however there no route for enhancing the recycling process. The green waste directly transport to Jatibarang landfill that have been over capacity.

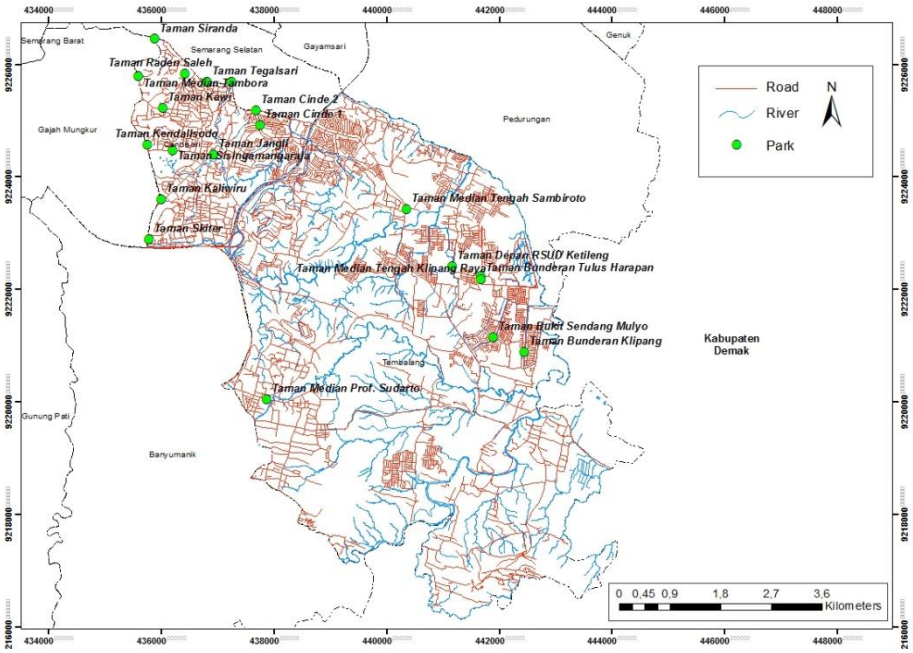


Figure 1. Study area and distribution of park in Candisari and Tembalang District Semarang

2.2. Method

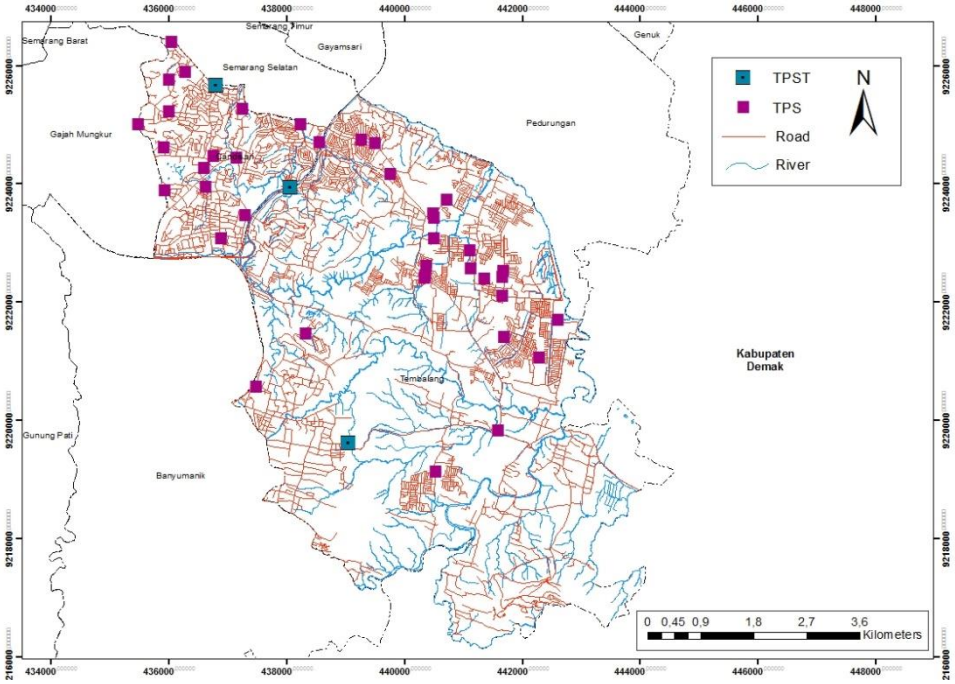
The approach of the study is spatial assessment by utilizing network analysis method to examine the optimum route of green waste collection and transport. Buchori at all, 2015 have initiated to analyze spatial change and growth in Semarang [11], This study used Network Analysis in GIS tools at district level to explore more detail of about spatial attribute such the length and distance of optimum route. The method of assessment run as follow: (1) determining integrated waste treatment unit location as the starting point of departure, (2) determining the transit point, (3) determining the end point or destination, and (4) determining the non-viable path.

3. Results and discussion

3.1. Determination of Integrated Waste Treatment Unit Locations

Spatial approach to analyze the location of integrated waste treatment unit for sorting, composting and recycling have been initiated by Teixeira et all [12]. It is one of the platforms to reduce the waste generation entering the landfill. Refers to the conception, recently, in Candisari and Tembalang districts have only one, call "Compost House" in Karanganyar Gunung Village. According to the

survey and measurement, the Compost House is over capacity to treat 105.785 kg of organic waste and 15.466 kg of inorganic in. According to the assessment of the 41 temporary sites, two sites were selected to be used as integrated waste treatment unit. Therefore, there are three units and three locations of integrated waste treatment facility (TPST) that were examined for the building the model, namely to Karanganyar Gunung, Tegalsari, Bulusan (Figure 2).



Source : Field Observation,2017

Figure 2. Distribution and location of selected integrated waste treatment facility unit (TPST) in Candisari and Tembalang District

3.2. Optimal Route of Green Waste Disposal

The analysis began with the determination of the starting point of the transport route, i.e. from the pool truck, then continued with the transit points in each of park and ends at the integrated waste treatment facility unit. The assessment of optimal route is conducted by selecting the road characteristic, park and the site of integrated unit facility. For example the "toll road and the road less than 3 meters is inserted into the restriction attribute of GIS tools, as code that road cannot be used to transfer green waste. According to the three temporary collection sites of integrated facility, three transport route scenarios were examined in this study. Scenario 1 used one site, Scenario 2 used two sites and scenario 3 used 3 sites, with advantages and disadvantages in each scenario.

The route on scenario 1 shows that the route for green waste disposal starts from pool truck, parks and temporary collection site in Tembalang. All of park waste which has collected is sorting before. Then, sorted inorganic waste is sold to collectors for recycling, while organic waste is brought to the landfill or to the composting site. The length of route is 36.126 meters and takes time about 46 minutes. The route on scenario 2 is similar to scenario 1. The difference is the route through two sites, starting from pool truck – parks – temporary collection site in Tegal Sari – parks – temporary collection site in Tembalang. The function of two sites is to divide that park waste, so it does not accumulate in one place. This route has a length of 36.471 meters with a travel time of about 47 minutes. The route on scenario 3 uses 3 sites, one of them is "Compost House". This site only accepts organic waste that has been sorted, so it is used as the end point of the waste transport route. The

length of route is 46.934 meters and takes time about 60 minutes. The result of the analisys is depicted in figure 3.

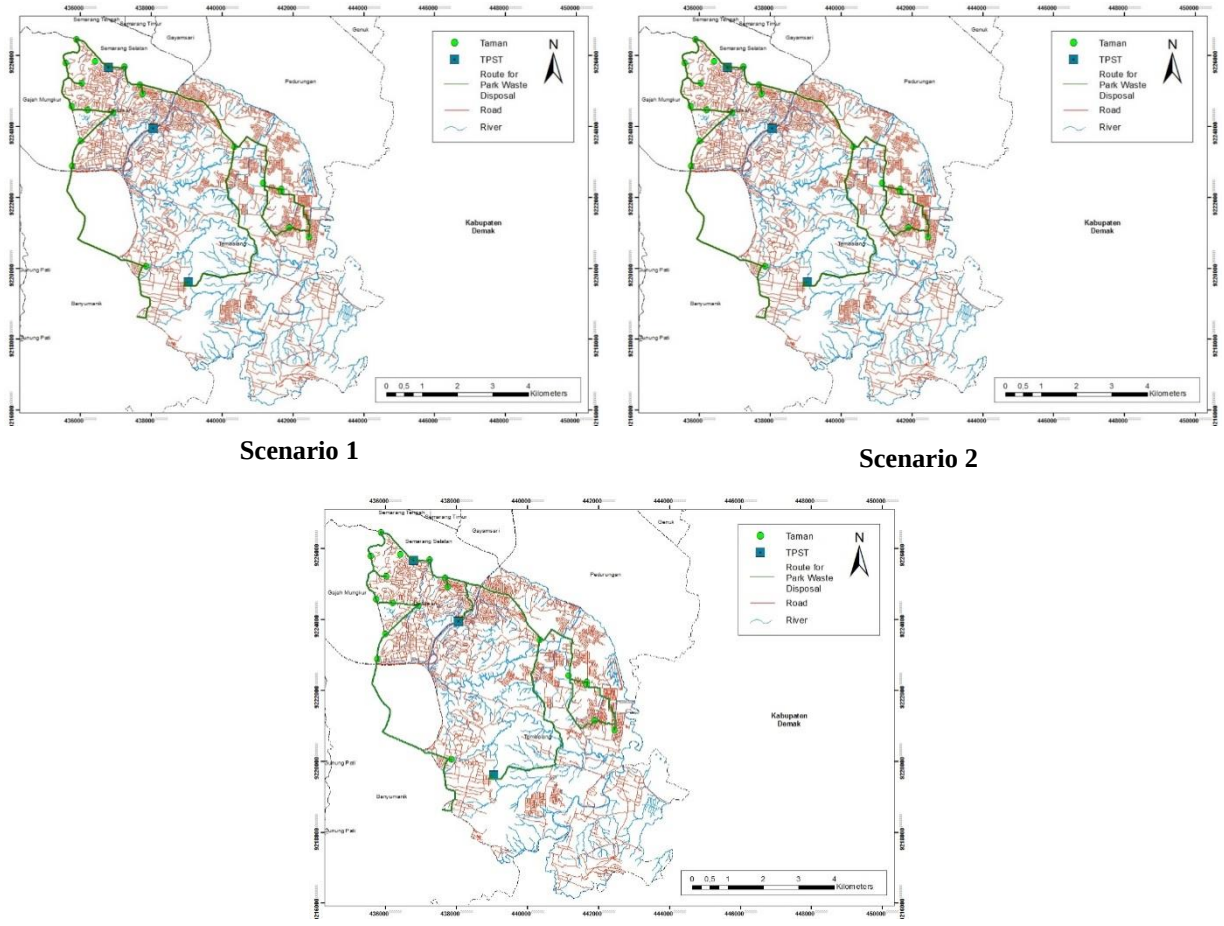


Figure 3. Result of three Green waste route scenario by using network analysis in Candisari and Tembalang, District, Semarang Indonesia

4. Conclusions

The optimum route of green waste collection can be determined by using Network Analysis method. According the study of green waste collection from park in Candisari and Tembalang, the method shown the good result. According to the optimum integrated green waste recycling scenario 2 is the best result comparison to scenario 1 and 3. In the case of green waste transport route, this analysis is able to show the shortest route and the fastest travel time, however understanding of the real situation such as toll roads or roads that are less than 3 meters wide, is needed to verify manually.

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6. References

[1] Tzoulas K, Korpela K, Venn S, Yli-Pelkonen V, Kaźmierczak A, Niemela J and James P 2007 Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review *Landsc. Urban Plan.* **81** 167–178
[2] Mukhtar S, Wafa W, Halimzai H and Shams A K 2016 Planning for the Solid Waste Management of Central Park in New Capital Development of Afghanistan *J. Environ. Prot. (Irvine,. Calif).* **7** 805
[3] Norton B A, Coutts A M, Livesley S J, Harris R J, Hunter A M and Williams N S G 2015 Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes *Landsc. Urban Plan.* **134** 127–138
[4] Nakayama H, Shimaoka T, Omine K, Patsaraporn P, Siriratpiriya O and others 2013 Solid waste management in Bangkok at 2011 Thailand floods *J. Disaster Res.* **8** 456–464
[5] Raud M, Mitt M, Oja T, Olt J, Orupõld K and Kikas T 2017 The utilisation potential of urban greening waste: Tartu case study *Urban For. Urban Green.* **21** 96–101
[6] Meisel F and Thiele N 2014 Where to dispose of urban green waste? Transportation planning for the maintenance of public green spaces *Transp. Res. Part A Policy Pract.* **64** 147–162
[7] Sugiri A, Buchori I and Soetomo S 2011 Sustainable metropolitan development: Towards an operational model for Semarang Metropolitan Region *Int. J. Environ. Cult. Econ. Soc. Sustain.* **7** 301–323
[8] Marfai M A and King L 2008 Potential vulnerability implications of coastal inundation due to sea level rise for the coastal zone of Semarang city, Indonesia *Environ. Geol.* **54** 1235–1245
[9] Khadiyanto P, Soetomo S and Hadi S P 2015 Settlement adaptation on a seawater tide overflow area at the north part of Semarang, Indonesia *J. Flood Risk Manag.*
[10] Guntur Suworo A D E 2002 *Leisure Center di Semarang* (Jurusan Arsitektur Fakultas Teknik Undip)
[11] Buchori I, Sugiri A, Hadi S P, Wadley D and Liu Y 2015 Developing a geographic information system-based assessment model for sustainable metropolitan development: The case of the semarang metropolitan region, Indonesia *Am. J. Environ. Sci.* **11** 62–75
[12] Teixeira J, Antunes A P and de Sousa J P 2004 Recyclable waste collection planning----a case study *Eur. J. Oper. Res.* **158** 543–554