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Original Research

GEO-SPATIAL MODELING OF TRAVEL TIME TO MEDICAL FACILITIES IN MUNA BARAT DISTRICT, SOUTHEAST SULAWESI PROVINCE, INDONESIA

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ABSTRACT
Background: Health services are strongly influenced by regional topography. Road infrastructure is a key in access to health services. The geographic information system becomes a tool in modeling access to health services.
Objective: To analyze geospatial data of the travel time to medical facilities in Muna Barat district, Southeast Sulawesi Province, Indonesia.
Methods: This research used geospatial analysis with classification of raster data then overlaid with raster data such as Digital Elevation Modeling (DEM), Road of Vector data, and the point of Public Health Center (Puskesmas)**.**
Results: The result of geospatial analysis showed that the travel time to Puskesmas in Napano Kusambi and Kusambi sub districts is between 90-120 minutes, and travel time to the hospital in Kusambi sub district is required more than 2 hours.
Conclusion: The output of this geospatial analysis can be an input for local government in planning infrastructure development in Muna Barat District, Indonesia.

Keywords: Travel time, Puskesmas, GIS, SAGA, Muna barat, Indonesia

BACKGROUND

Health development is directed to improve health status (Tosepu, Effendy, Asfian, & Lestari, 2015) Health development plays a role for the development and fostering of Indonesian human resources (K. Kesehatan, 2015). One of the goals of health development is to raise awareness, willingness, and ability to live healthy for everyone to realize the highest degree of public health (D. Kesehatan, 1999).

Access and quality of health services, greatly affect the achievement of the final results in the implementation of health development (Ri, 2004). The effort of basic health services is a very important first step in providing health services to the community (Huda, 2007). With the provision of basic health services accurately and quickly, it is expected that most public health problems can be overcome (Nara, 2014). Ease in the field of transportation as well as ease of communication (Mao & Nekorchuk, 2013). The convenience of transportation makes it easy for people to visit many meetings of many activities or make it easier for someone to reach the destination (Bell, Bowie, Thorpe, & Levine, 2017). Ease of transportation provides convenience to

social mobility for social actors.(Bascom & Christensen, 2017)
Accessibility of health facilities can be viewed physically from distance and travel time. Distance can be analyzed using buffer analysis and network analysis using Arc Gis application (Wong & Lee, 2005). Travel time can also be calculated and modeled using the Access Mod application by combining land use maps, altitudes, road networks, rivers, barrier bars and existing travel scenarios (Organization). Access to health services is determined by two important things, namely distance and travel time (Schauder & Foley, 2015). There are several reasons for using travel time calculations more easily than using distance in accessibility of health services: people are more easily connected with travel time than geographic distance in decision-making services; the timing is easier than the distance because it can be used as transportation planning to be used; the level of service required in an emergency is usually measured by time (Ray & Ebener, 2008).

METHODS

This research method uses Geospatial Analysis with classification raster data and then overlay with other raster data such as Digital Elevation Modeling (DEM) and Vector data Road and point Puskesmas. This tool is almost the same as the Access Mod Plugin created by World Health Organization (Organization). For SAGA GIS to be very easy because the Raster data processing is directly generated on the same software (Olaya, 2004). While on Access Mod Plugin data of raster generated in other applications. Making of land cover grids combine vegetation, transport infrastructure and elevation data to produce a land cover grid including rivers and streams. The land cover grid used as a basis for calculating travel time in each type of land cover is allocated as a potential travel speed value. In the example shown here will be the pre-processed stage of the vegetation and road data as follows: (Organization)
(i) *Vegetation data* are generated from Landsat 8 imagery and classified into 4 main classes: forests, shrubs, grasslands and vacant lots. This set of data will be generated on a 50 meters grid of cells and become a basic grid system where other data generation will be resized into this grid size; and (ii) *Road data* are obtained in the form of data vector and attributed to 3 classes based on infrastructure quality: Class 1 = National road, Class 2 = Provincial road, and Class 3 = Local road.

The elevation data are generated from the SRTM digital elevation model (DEM) data and is used to generate river channel data. The water channel data of the river was created in the chains tool-making tool of the land cover grid in the form of a Strahler raster layer. (Hirt, Filmer, & Featherstone, 2010) The Strahler order is a measurement of the accumulation of drainage in a landscape and in the calculation of the travel time is used as a barrier model on the way based on different seasonal scenarios. Five Strahler classes will be generated in a grid analysis where the largest class will be a permanent or impassable obstacle throughout the year. Making a travel time grid tool will show the time required to a destination location (in units of minutes) and this data will be reclassified as travel time or remote or remote zones. The creation of this Time Roaming Grid tool will require input from the Land Cover Grid, destination point of destination in the form of data vector, as well as two reclassification tables.

(i) Destination data provided in the form of point vector data. This data can be edited and moved or added new points after being executed on the model to generate new output scenarios based on changes in location of placement; (ii) *The first reclassification* table (see Table 1) provides the travel speed value for each class of land cover calculated as the number of seconds required to move across 1 grid cell using the formula (Km/hour x 180) where 180 is the number of seconds required to move as far as 50 km at a speed of 1 km/hour. In the water-class class (8-12) the highest value (> 99999) is assigned to the class as an indiscriminate (indirect) marker due to flooding. This travel time value can be changed after being run on the model to

generate new output scenarios based on different travel conditions.

RESULTS

Two tools made with SAGA GIS are the first one is land use classification analysis. The process of making this land cover classification using Landsat 8 image and subsequently classified into 4 classes namely Forest Class, Bush Class, Grass Class and Tanah / River class which in this study using pixel size 30 meters. Vector data used is Road data by distributing in 3 classes namely class 1 for National road, Class 2 for provincial road and class 3 for Regency road. The following Raster data is Digital Elevation Modeling (DEM) which size 90 m will produce Strahler order Raster. This data is useful for measuring the accumulation of flow in a land cover. And the second is the calculation of travel time.

The second tool is to make the grid travel time. Data needed is data vector of destination location or point of Puskesmas which want to be analyzed. The calculation of travel time at this stage is determined by the table scenario created. Scenario table is instrumental in generating analysis travel time. That is the scenario of this table describes the quality of existing roads in the area to be analysis.

Table 1 Scenario of Time travel

ID	Class of Cover	Kilometers per hours	Travel time (seconds)
1	Forest	1	180
2	Bush	2	90
3	Grass	3	60
4	Soil	4	45
101	Class of stream 1	2	90
102	Class of stream 2	2	90
103	Class of stream 3	2	90
104	Class of stream 4	0	9999
201	Province road	50	3
202	District road	25	7
203	Environment of road	10	18

Table 1 shows that it can be changed according to the desired scenario and according to the quality of road infrastructure. The most influential of the above table is located on the road data with code 201 - 203. The more accurate the quality of the road data obtained the more accurate the resulting analysis results.

Table 2 Color of Travel time

Color	Name	Description	Minimum	Maximum
8388608	1	0 – 15 min	0	15
8421440	2	15 – 30 min	15	30
2280084	3	30 – 60 min	30	60
65535	4	60 – 90 min	60	90
33023	5	90 – 120 min	90	120
213	6	120+ min	120	999999

This time travel coloring is intended to be able to describe the travel time from and to the Puskesmas can be seen on the analysis of result map (See Table 2). The accessibility of the community to the health service center is influenced by two factors, spatial and non-spatial factors. Spatial access emphasizes the importance of geographic barriers, ie distance and time, whereas non-spatial access implies non-geographic barriers such as social class, income, ethnicity, age, gender. The results of the map geospatial analysis below indicate that the Eastern part of Muna Barat district needs to add Public Health Centers or road infrastructure improvements so that people can more easily access health services. For the archipelago, it is not the object of research as the conditions on land are very different from the conditions on land. From the results of geospatial analysis the map below also shows that the Sub district of Napano Kusambi and Kusambi Sub district still have an area that takes 90 to 120 minutes to get to Puskesmas. Geospatial analysis is strongly influenced by Table of Scenarios on Average Speed in each type of road. If the average speed increases then automatically access becomes faster.

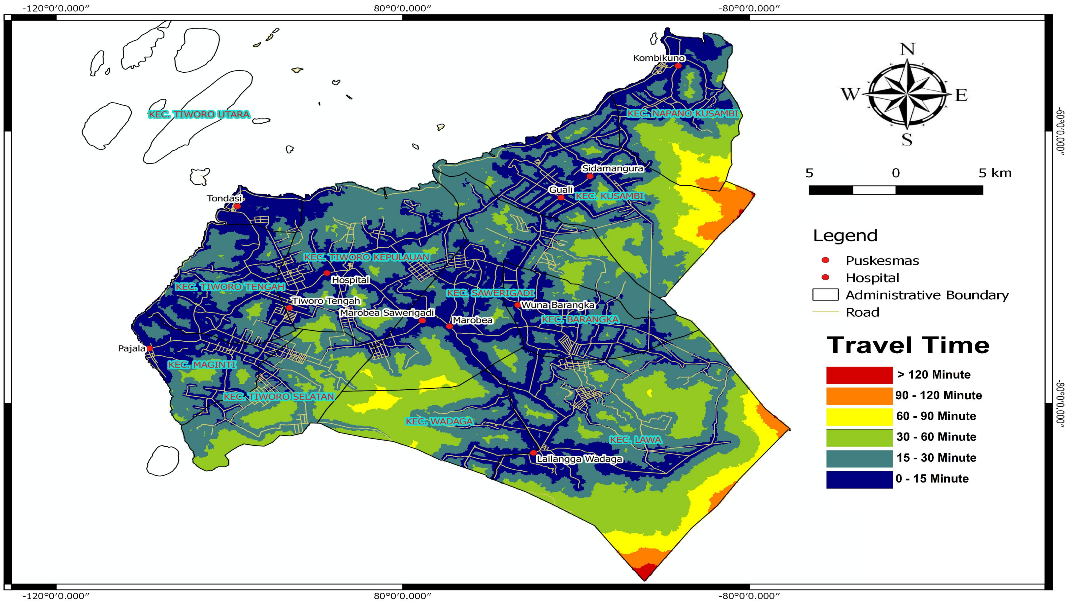

Figure 1 Analysis Geospatial

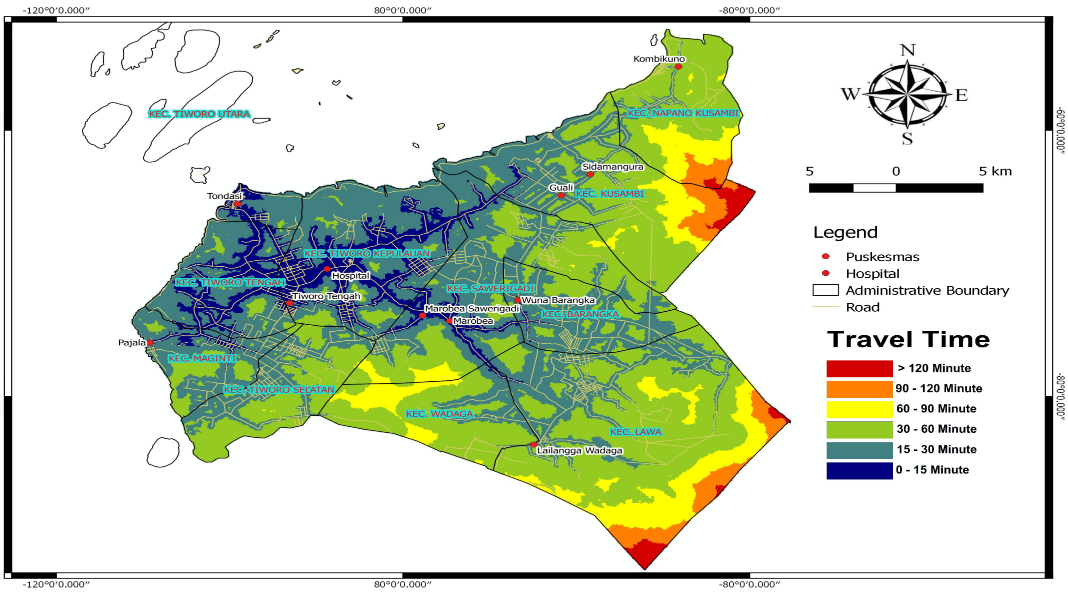

Figure 2 Analysis of the Geospatial travel time to Hospital

Figure 2 above shows that there are 3 areas of Kusambi Sub district, Napano Kusambi Sub district and Lawa Sub district of East and South which still have travel time over 2 hours and 90 - 120 minutes to go to Regional General Hospital.

DISCUSSION

The accessibility of the community to the health service center is influenced by two factors, spatial and non-spatial factors. Spatial access emphasizes the importance of geographic barriers, ie distance and time, whereas non-spatial access implies non-geographic barriers such as social class, income, ethnicity, age, gender (Wang & Luo, 2005) The research conducted by Semarang found that by using distance radius measurement of residence and place of birth is obtained: The most distance traveled by the respondent is 10001-11000 meters from the residence, while the average distance traveled 6706 meters. The minimum distance traveled is 120 meters (T. W. Sari, Agushybana, & Dharmawan, 2011).

Mileage to health care facilities is one of the important factors in the utilization of health care facilities. People tend to take advantage of the existing facilities in their neighborhood (R. M. Sari, Ambarita, & Sitorus, 2014).

Geospatial analysis results are very helpful local governments in doing development planning, especially the improvement of health services on the determination of Geographic inhibiting factors of distance and time. If this result can be obtained directly, the local government can plan the construction of physical infrastructure of the road or even the construction of new health facilities.

CONCLUSIONS

The travel time of Puskesmas shows the eastern area is still Kusambi and Napano Kusambi sub district which travel time between 90 - 120 Minute to go to Puskesmas whereas result of geospatial analysis of time travel of Hospital also same where there are 3 districts whose territory still have travel time over 2 hours. With this simple analysis, local governments can rapidly plan infrastructure improvements in line with central government policies that are now focused on improving infrastructure development.

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