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## Application of overlay method in interpreting of traffic noise distribution in land use

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Abstract. Overlay studies with geographic information systems (GIS) are usually only to describe the condition of land elevation points, and various situations in land use. The purpose of this study was to analyze the intensity of noise in various types of land use and visualization of noise distribution maps. The research method uses a mathematical and overlay approach. The results showed that the average traffic flow was 1931 veh/h with a composition of motorcycle 61%, light vehicle 35%, and heavy vehicle 4%. Traffic noise level on Tuesday is 75.2 dB, while on Sunday it is 75.5 dB. There is no significant difference in noise intensity on Tuesday and Sunday at Ahmad Yani, MT. Haryono, Sao-Sao, and Abunawas Street. On Tuesday the highest noise level occurs in front of the education area while on Sunday in front of the shopping area. The intensity of noise distribution that reaches the highest land use occurs in the shopping area, followed by the office area, and the lowest in the school area. This is due to the increase in distance from the roadside.

#### Introduction 1.

Traffic noise is one of the strategic issues that has become a transportation problem in urban areas due to the high growth of motorized vehicles. At a certain intensity, traffic noise can have a negative impact on human health and comfort in settlements and road users themselves. The impact is in the form of psychological disorders that tend to lead to stress and hearing loss. Therefore, prevention and control of environmental pollution should be carried out to meet the provisions of environmental quality standards. Where, the main source of noise in big cities comes from the noise of motorized vehicles whose number continues to increase every year [1]. In addition, noise pollution is an environmental problem in industrialized and developed countries. Industrial noise is a source of noise pollution that interferes with the daily activities of workers [2].

Previous studies conducted by Wedagama (2012) at bypass I Gusti Ngurah Rai and Sunset Road have identified factors that affect traffic noise levels using the variables of vehicle volume, speed, traffic density, and observation distance. The results showed that the motorcycles volume had the highest effect on the noise level, which was around 26.7% [3]. But theoretically, the intensity of noise on the highway is not determined by traffic factors but also other factors, namely physical characteristics and environmental conditions road, and building density.

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The density of buildings, whether in form of shops or housing, can influence the level of traffic noise on the highway. This is caused by the building uses quite hard material so that the sound that hits the walls bounces back. Likewise, air has mass, fills the empty space above the earth and used by sound to propagate. But that doesn't always happen. The highest traffic flow occurs when the density of truck vehicles is optimal. After this value, the flow starts to decrease, even with a lot of passing traffic queues form and speed drops [4].

Kendari City in the last five years, the vehicle growth is quite high an average of 19% per year. From the results of initial observations at several points on arterial and collector roads, it was identified that the noise level had reached a value of 72 dB, where this value had exceeded the noise threshold applicable in Indonesia, namely 55 dB for school areas, 65 dB for office areas, and 70 dB. for trading area [5].

All this time, information about traffic noise distribution on the highway is only based on numerical data by displaying trend data, Where the information is still poorly understood by most people. In addition, exposure to noise in various land uses using the overlay method, especially in Kendari City, has never been done. So this study will elaborate on the traffic noise variable as vector data that interprets the digitized noise elevation point, namely fluctuations in traffic noise exposure.

#### 2. Materials and methods

Highways are a source of noise in urban areas. This is due to the large use of motorized vehicles compared to other types of vehicles, both two-wheeled, four-wheeled, and those with more than four wheels. Heavy vehicles (truck, bus) and passenger cars are the main sources of noise on the highway, although motorcycles are more dominant in composition. The variability of the noise level is determined by vehicles volume of 75.2% for the roads of arterial and 77% for collector roads [6]. Heavy vehicles with a composition of 4% greatly affect noise on arterial roads. While on the collector road with a composition of 3% it does not really affect noise fluctuations. Noise is more dominantly influenced by motorcycles and light vehicles [7].

Noise has a bad effect on living things. The effects of noise include hearing loss, sleep disturbances, communication disorders, decreased efficiency and work disturbances. The effort that has been made is to develop a fuzzy-based model to see the effect of traffic noise in the city of Agartala, India. From the study shows that there is a correlation between traffic noise and everyday disturbances for residents on the roadside [8]. High-income households react more to noise exposure than low-income households [9]. Based on research, urban residents in the United States are at high risk of exposed to traffic noise. However, other research is needed to obtain information about the level of noise exposure. Therefore, it is very difficult to avoid traffic noise, especially in the big cities of the world [10].

Noise mapping that examines noise pollution due to heterogeneous traffic conditions and the effect of honking vehicles parked on the roadside in the Surat city (India). The mapping takes multiple points and the propagation distance to the receiver. The variables used are vehicle volume, speed, noise level, road geometry, illegal parking, and horn sound. The results showed that vehicle volume, speed, road geometry, and noise did not have a significant relationship with noise due to heterogeneous traffic conditions. Therefore, an integrated noise prediction model with multiple linear regression approach was developed for heterogeneous traffic conditions in India [11].

Development of a road traffic noise model with a graph theory approach, where the variables used include vehicle speed, traffic volume, road width, number of heavy vehicles, and number of horn sounds. The interaction of the selected variables is entered in the form of a permanent noise function in the form of a matrix. The model obtained gives satisfactory results, but the results are rather large. This method proves useful for predicting the noise level in the future [12].

The TNM 2.5 model is used to predict traffic volume and its distribution on Vakilabad highway, because it gives the same rating for areas with low or high noise, and produces a Leq value that is almost the same as the recorded noise value [13].

#### 2.1 Noise level

Noise is unwanted sound from an activity at a certain level and time which can cause disturbance to human health and environmental comfort. So that no matter how small the sound is heard, if it is not desired, it is called noise. The noise level standard is the maximum level of noise that is allowed to be discharged into the environment from a business or activity so as not to cause harm to human health and environmental comfort. The standard noise level in Indonesia which is intended for the area/environment of activities can be seen in Table 1.

Description	Noise Level (dB)
a. Appropriation of region	
1. Housing and Settlements	55
2. Trade and Services	70
3. Office and Commerce	65
4. Green open space	50
5. Industry	70
6. Government and Public Facilities	60
7. Recreation	70
8. Specifically:	
- airport *	
- Railway station *	
- harbor	70
- Cultural heritage	60
b. Surrounding Activity	
1. Hospital or the like	55
2. School or the like	55
3. Worship place or the like	55

Equivalent continuous noise level ( $L_{eq}$ ) is the value of the noise level that varies (fluctuating) over a certain time which is equivalent to the steady noise level measured at the same time interval. The equivalent noise level is a model used to express the average sound pressure level in a certain time interval, which is obtained from the results of field measurements using an SLM (Sound Level Meter) measuring instrument. Equation for calculating noise from motor vehicles (highways):

$$L_{eq} = L_{50} + 0.43 (L_1 - L_{50})$$
(1)

Where,  $L_{eq}$ : equivalent noise level (dB),  $L_{50}$ : noise indicator number 50% (dB), and  $L_1$ : noise indicator number 1% (dB).

#### 2.2 Overlay

Overlays are an important step in GIS analysis. The overlay overlays a digital map on another digital map and its attributes and produces a combined map of the two that has the attribute information of both maps. Overlay is the process of combining data from different layers. In simple terms overlay is referred to as a visual display that requires more than one layer to be physically combined.

There are two techniques used to overlay maps in GIS, namely union and intersect. If it is analogous to the language of Mathematics, then union is a union, intersect is a slice Geographic Information System can be broken down into several subsystems, namely input data, output data, management data, data manipulation and analysis [14].

Noise is a factor that must be considered in urban planning. Noise maps can be generated when data has been recorded, including map numbering, road facilities database, and traffic volume data [15]. Road traffic noise model using a graph theory approach with road traffic subsystem parameters. raffic subsystem variables include vehicle speed, vehicle volume, road width, horn sound. The model is quite

satisfactory although the results are somewhat higher. This method is very useful for predicting noise levels [16].



Figure 1. GIS sub system

### 2.3 Traffic survey and noise measurement

The traffic survey was conducted for 2 (two) days, namely routine days represented by Tuesdays and holidays represented by Sundays. Data sampling was carried out for 10 minutes at peak hours in the morning, afternoon, and evening along with the noise survey time at each predetermined sample point. Noise measurements were carried out simultaneously with a traffic survey for 2 (two) days. Data sampling was carried out for 10 minutes, with a reading time of 5 seconds. The SLM microphone is placed at a distance of 1 m from the edge of the pavement. The noise survey was carried out in conjunction with the traffic survey. The scheme for the placement of measuring instruments and equipment in noise measurement can be seen in Figure 2.





#### 3. Results and discussion

Ring road A. Yani, MT. Haryono, Sao-Sao, and Abunawas generally have a road type of 2/2 UD and 2/2 D with an average pavement width of 6 - 11 meters, a shoulder width of 2 meters and the type of land use in front of the road is a shopping area, offices, and schools. The distance from the building to the edge of the road pavement is between 9.3m - 91.2m. The traffic referred to in this study is the volume of motorized vehicles. Calculation based on the number of vehicles passing the research location during the observation time which has been converted in units of passenger cars per hour. Based on the results of traffic volume analysis, it can be visualized in the form of a bar chart as shown in Figure 3.



Figure 3. Tuesday Traffic Volume

In Figure 3 the traffic volume on the Ahmad Yani, MT. Haryono, Sao-Sao, and Abunawas street on Tuesday with an average of 1941 veh/h. Where the highest volume occurs in front of the MIS Pesri school, which is 2592 veh/h. This happens because the school is currently one of the main educational goals that are in demand by the community. Meanwhile, the lowest traffic volume occurred in front of the Southeast Sulawesi Province Education and Culture office, which was 1644 veh/h.



Figure 4. Sunday Traffic Volume

In Figure 4 the traffic volume on the Ahmad Yani, MT. Haryono, Sao-Sao, and Abunawas street on Sunday with an average of 1921 veh/h. Where the highest volume occurs in front of the Sanya shopping area, which is 2478 veh/h. This is because the shopping area is currently one of the main travel destinations that people are interested in. Meanwhile, the lowest traffic volume occurred in front of SMK 2 Kendari, which was 1332 veh/h. In general, it can be seen that the highest volume of motorized vehicle traffic on Tuesdays generally occurs in front of the education area, while on Sundays it occurs in the shopping area.



Figure 5. Tuesday Traffic Noise

In Figure 5 it can be seen that the level of traffic noise on the Ahmad Yani ring road, MT. Haryono, Sao-Sao, and Abunawas on Tuesday exceeded the environmental quality standards according to the Decree of the state minister for the Environment of the Republic of Indonesia Number: 48/MENLH/11/1996, both for the designation of school areas, office areas, and trade areas. Where the average noise level on the roadside is 75.2 dB.



Figure 6. Sunday Traffic Noise

In Figure 6 it can be seen that the level of traffic noise on the Ahmad Yani ring road, MT. Haryono, Sao-Sao, and Abunawas on Sunday had environmental quality standards in accordance with the Decree of the state minister for the Environment of the Republic of Indonesia, both for the designation of school areas, office areas, and trade areas. Where the average noise level on the roadside is 75.5 dB.



Figure 7. Noise Intensity in Land Use

Figure 7 shows that the noise intensity that reaches the highest land use occurs in the PT. POS Wua-Wua is 71.5 dB, while the lowest is in the SMKN 2 Kendari area, which is 63.4 dB. Overall, the shopping area ranks first in the highest noise area, followed by the office area, and the lowest in the school area.



Figure 9. Land Use Noise

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Through the overlay method, it can be seen that in Figures 8 and 9 there is a difference in the distribution of noise. Where the red color indicates a high noise value, while the green color indicates a low noise value. So that the arrangement of color gradations is adjusted to the noise level. Figure 8 shows a map of the noise distribution based on the value of noise level on the roadside, while Figure 9 shows a map of the noise distribution based on the value of noise level on land use. By using the overlay method in mapping noise, people will easily understand the distribution of noise in the surrounding environment.

The results of the analysis show that the farther the receiver is from the noise source, the smaller the noise intensity will be. Therefore, the determination of exposure to noise levels is seen based on the intensity that occurs in the area and the length of exposure time. The difference in noise reduction in the nine areas is not only due to the increase in distance and the amount of roadside noise level, it is also influenced by the type of soil surface from the roadside to land use, as well as the density and density of green arrangements/tree plants on the roadside.

#### 4. Conclusion

The average traffic flow is 1931 vehicles/hour with a composition of motorcycles 61%, light vehicles 35%, and heavy vehicles 4%. The traffic noise level on Tuesday is 75.2 dB, while on Sunday it is 75.5 dB. There is no significant difference in noise intensity on Tuesday and Sunday. On Tuesday the highest noise level occurs in front of the education area while on Sunday in front of the shopping area. The intensity of noise distribution that reaches the highest land use occurs in the shopping area, followed by the office area, and the lowest in the school area. This is due to the increase in distance from the roadside.

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