

# Topographic Mapping of Road Network and Damage in Langsa Lama District using Geographic Information System (GIS)

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## Abstract

Roads are land transportation infrastructure and are a very vital transportation route. One of the functions of roads is as a driving factor in the development process and equitable development of an area, apart from that, roads also play an important role in the transportation process. Langsa Lama District is one of the fastest growing districts in Langsa City. This research aims to model the topographic mapping of the road network and road damage in Langsa Lama District using GIS and determine the damaged road network in Langsa Lama District. This research method is in the form of analyzing routes where there is road damage using a Geographic Information System which is divided into main stages, namely database development and data analysis starting from data collection and supporting maps. The final results of this research obtained a topographic map of the road network and road damage in Langsa Lama District, Langsa City.

**Keywords:** *road damage, topographic maps, geographic information systems, langsa*

## Abstrak

Jalan merupakan prasarana transportasi darat dan merupakan jalur transportasi yang sangat vital. Salah satu fungsi jalan adalah sebagai faktor pendorong dalam proses pembangunan dan pemerataan pembangunan suatu daerah, selain itu jalan juga memegang peranan penting dalam proses transportasi. Kecamatan Langsa Lama merupakan salah satu kecamatan yang berkembang pesat di Kota Langsa. Penelitian ini bertujuan untuk pemodelan pemetaan topografi jaringan jalan dan kerusakan jalan di Kecamatan Langsa Lama dengan menggunakan SIG dan mengetahui jaringan jalan yang rusak di kecamatan Langsa Lama. Metode penelitian ini berupa analisis jalur yang terdapat kerusakan jalan dengan menggunakan Sistem Informasi Geografis yang dibagi dalam tahapan utama yaitu pengembangan database dan analisis data dimulai dari pengumpulan data dan peta pendukung. Hasil akhir dari penelitian ini memperoleh peta topografi jaringan jalan dan kerusakan jalan di Kecamatan Langsa Lama Kota Langsa.

**Kata Kunci:** *kerusakan jalan, peta topografi, sistem informasi geografis, langsa*

## 1. Introduction

Roads are a vital land transportation infrastructure and transportation route. One of the functions of roads is as a driving factor in the development process and equitable development of a region, in addition roads also play a very important role in the transportation process. For the government, roads are a means of transportation that is influential in running the wheels of the economy and government (Sofyan et al., 2017). Road conditions greatly affect activities that require road accessibility as an intermediary. If the road conditions are good, economic and transportation activities will also run smoothly. For this reason, monitoring and management of road conditions are needed so that damaged roads can be easily identified for further repairs (Lauryn & Ibrohim, 2019).

ArcGIS is a very popular and reliable tool for performing Geographic Information System (GIS) tasks. The reliability of ArcGIS is not only in terms of making maps, but more importantly, it helps GIS practitioners analyze, model, and manage spatial data effectively and efficiently. Although there are quite a lot of alternative software that are cheaper and even free, ArcGIS is still the main GIS software (Falih & Nabilah, 2021). Langsa Lama District is 1 of 5 Districts in Langsa City. And the author is interested in doing it in this District because many immigrants come as a result of the presence of 2 State campuses in Langsa Lama District so that Langsa City must provide the best facilities, one of which is by repairing damaged roads.

This study was conducted based on the problems of comfort in the use of transportation due to road damage in Langsa Lama District which was caused by several factors of road damage in Langsa Lama District, so this researcher used Geographic Information System (GIS) for Topographic Map of Road Network and Road Damage in Langsa Lama District. This study only covers Langsa Lama District, especially the Collector road in Langsa Lama District and creates road damage points in Langsa Lama District along with its topography using Geographic Information System (GIS).

## 2. Material and Methods

### Survey method

The survey method is direct observation of field conditions to collect data from the main research or problem. In this study, road damage coordinates are needed.

### Method of collecting data.

In this study, supporting data is needed in the form of primary data and secondary data used for data processing and analysis. Primary data is collected from research results or field observations and secondary data in this study requires administrative mapping from the PU Office of Langsa City and Elevation Data from DEM Data (Digital elevation modeling).

### Data Analysis Methods

The data analysis method used is the qualitative method where the qualitative method aims to describe the analysis data in a narrative/narrative manner. This method is used to explain the procedures for modeling road damage and road topography. At this stage, the data that has been collected will be analyzed with the help of ArcGIS 10.8 software. The inputted data are primary data from road observations and secondary data from PU Langsa City, namely the Regional Administration Map for modeling road damage maps and Topographic maps. The inputted data are data from PU Langsa City, namely the Regional Administration Map and elevation data from DEM (Digital elevation modeling) data for modeling Topographic maps.

## 3. Results and Discussion

Langsa Lama District, Langsa City, Aceh Province, which has an area of 31.32 Ha. The road conditions in Langsa Lama District in several points have experienced road damage caused by many factors, namely starting from large loads and high rainfall intensity causing weakening road conditions.

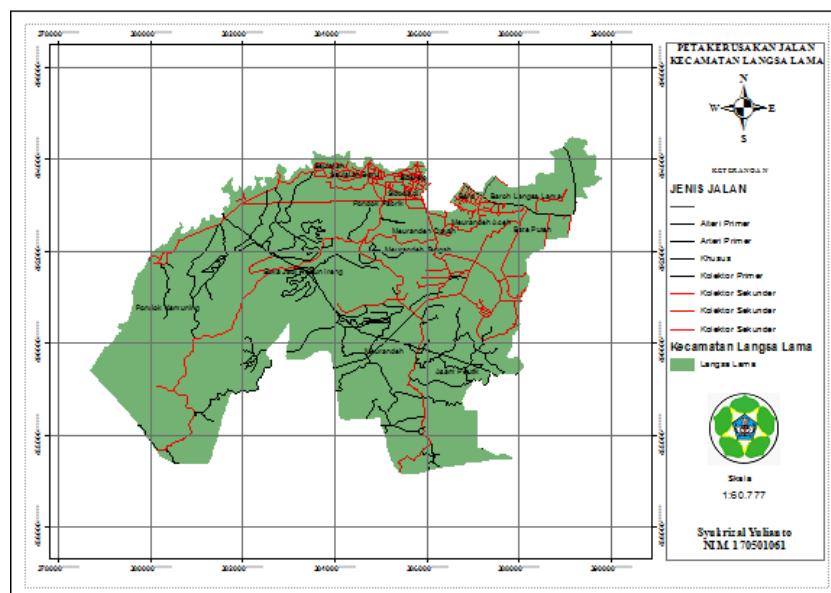


Figure 1. District Langsa Lama

Source : Arcgis 10.8

Following the research flowchart, there are several steps that can be taken to obtain the results of Topographic Mapping, Road Networks and Road Damage Using Geographic Information Systems (GIS), (Case Study: Langsa Lama District), namely:

### *Topographic Mapping Model of Old Langsa District Using Arcgis 10.8*

After the secondary data is collected, the data is then processed and arranged into a road database structure in the ArcGIS 10.8 software. The database created in this program includes 3 (three) databases, namely the administration database, the road database and the DEMNAS database..

### *Data Collection Process*

In the process of collecting topographic mapping data, only secondary data is needed and primary data is not needed. Secondary data collection can be taken through the DEMNAS website which provides and gives information in the form of regional elevation in the form of soft files throughout Indonesia. The downloaded DEMNAS data and the sub-district administration data are input into the ArcGIS 10.8 application and the topographic mapping model stage process begins.

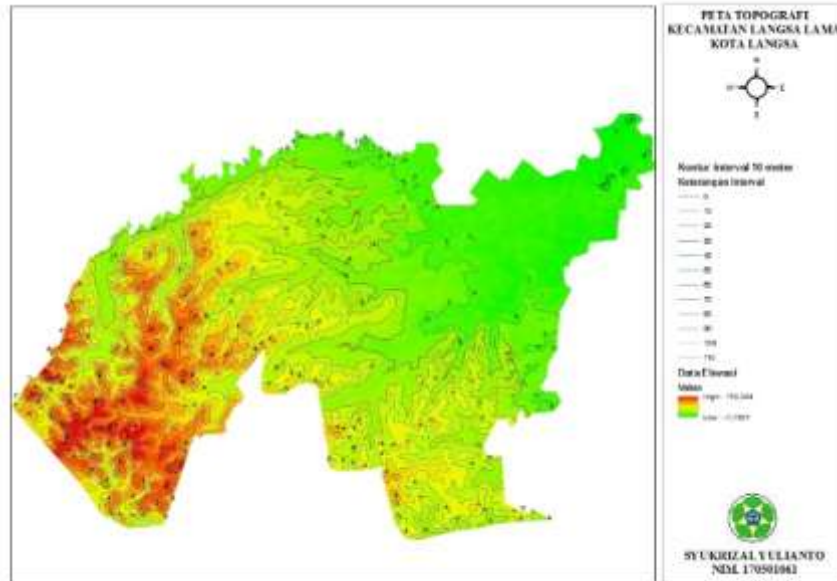
### *Stages of Topographic Mapping Model*

The process of making topographic mapping includes several stages, namely:

1. Secondary data retrieval can be taken through the DEMNAS website which provides and gives topographic map information in the form of soft files and then downloaded.
2. After the DEMNAS data is downloaded and the administrative map of the District is input into the ArcGIS 10.8
3. Langsa Lama District to measure the boundaries of the district, by right-clicking the layer on the ArcGIS menu, clicking the downloaded data, clicking add.
4. To combine the elevation maps into 1 map, click ArcToolBox, click raster, click raster data set, click mosaic to new raster after the mosaic to new raster menu appears, enter 4 elevation map files, select the file location where you want to save it, click 16 bit unsigned, click mean and last for the last menu and click ok.
5. The next step is to create an elevation map as large as the District boundary, click select features, click on the district map, click window, select image analysis, select the elevation file, click clip/cut ok.
6. The next step, to change the color to match the elevation, right-click on the layer file, select properties then select color ramp, click ok.
7. The next step, to add a 3D effect to the Map, click ArcToolBox, click raster surface, click hillshade in the hillshade menu select layer, click ok, and to combine and display the 3D effect right-click on the layer file click properties, click the display menu and make the transparency 15%, click ok and become a 3D map.
8. The next step, to divide the size into 10 meters above sea level, click ArcToolBox, click raster reclass, click reclassify, a menu appears and click the elevation file, click classify, click ok.
9. The next step, change the map into a Polygon/Contour shape, click ArcToolBox, click conversion tools, click from raster, click raster to polygon, in the menu click the elevation file, click ok.
10. The next step, Enter the height size into the map attribute, right-click on the Polygon layer, click open attribute table, click the table option menu, click add field, type the height in the add field menu, click select type double, click ok, then enter the number per 10 meters above sea level manually.
11. The next step, Display the color with a height distance per 10 meters above sea level, right-click the layer on the polygon layer, click properties, click symbology, click categories, click value field select height, click add all values, click ok.
12. The last step, Click Layout view at the bottom left, click on the print menu, click properties to set the paper to landscape and for the accessories menu, click the insert menu select according to your needs and finish.

### *Topographic Map Results of Old Langsa District*

Determination of contour topography mapping with elevation data comes from Digital Elevation Model (DEM) data from 10 meter intervals. There are 11 contour lines in Langsa Lama District with the highest elevation.



**Figure 2.** Topographic Map Results of Old Langsa District  
 Source : ArcGIS 10.8

#### *Road Damage Mapping Model in Langsa Lama District Using ArcGIS 10.8*

After the primary data and secondary data are collected, the data is then processed and arranged into a road database structure in the ArcGIS 10.8 software. The database created in this program includes 2 (two) databases, namely the administrative database and the road database. The road database created is data that is the status of the road and other complementary information.

#### *Road Damage Data Collection Process*

In this data collection process, primary data and secondary data are required. In primary data, direct inspection and survey of the roads in Langsa Lama District are required. In this process, tools are also needed to facilitate data collection in the form of smartphones, vehicles and GPSMap Cameras.

#### *Road Damage Model Stages*

The process of making road damage mapping has several stages, namely:

1. The first step, make sure the photo used has coordinates in the photo file, open the ArcGIS 10.8 application, click the catalog menu, click an empty folder for where we save the file, right-click and select new, click the geodatabase file.
2. The next step, the geodatabase file is renamed as needed, click ArcToolbox, click Data Management Tools, click Photos, click Geo Tagged Photos To Points.
3. The next step, the Geo Tagged Photos To Points menu appears, click the input folder menu, enter the folder where the input photo file is stored, click the output feature class menu, enter the file that has been created in the catalog menu and create a file name as needed, click the check mark add photos as attachments, click ok.
4. Next step, the coordinates that appear along with the photo are edited for size and color coordinates, left click 2 times on the coordinate layer, in the layer properties menu click the symbol menu, then in the symbol selector menu click color, size and shape as needed, click ok, and to display the photo in the coordinates click the HTML popup menu on the homepage, click the coordinates you want to click and the results appear. The last step, to enter the X and Y points in the coordinate table, click ArcToolbox, click Data Management Tools, click features, click add XY Coordinates, in the add XY Coordinates menu input the coordinate layer, click ok and finish.

#### *Results of Road Damage Mapping in Old Langsa District*

From the road damage map modeling of Langsa Lama District above, from the secondary collector road, 26 points of road damage were found, from each point of road damage that occurred, there were different cases of damage from moderate damage to very fatal damage which could result in insecurity in

driving. The results of the analysis showed 26 points of road damage in Langsa Lama District. The condition of road damage in Langsa Lama District based on field surveys is found in several villages. Namely, Asam Peutek Village has 4 road damages, Meurandeh has 6 road damages, Sidodadi Village has 3 road damages, Seulah Village has 5 road damages, and Pondok Keumuning Village has 9 road damages

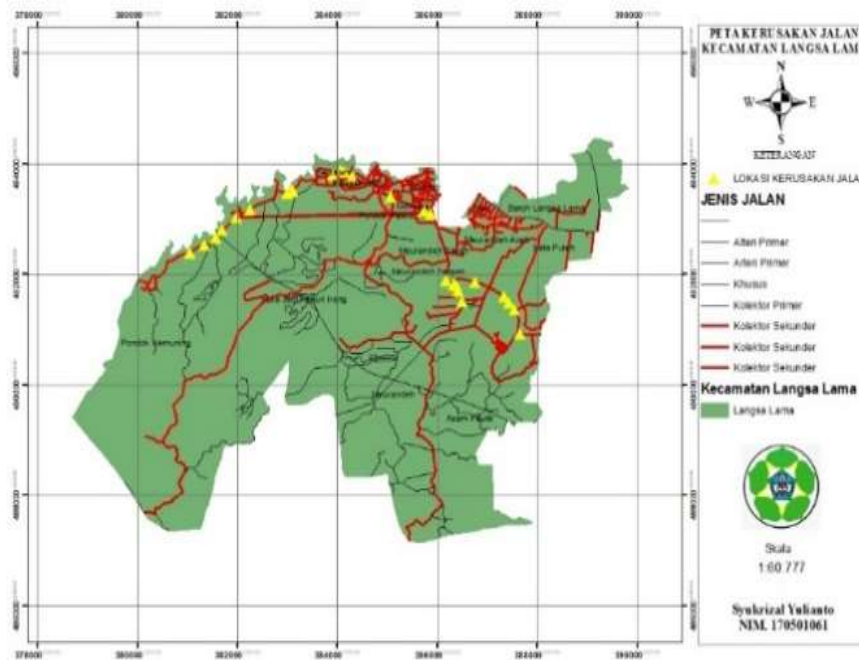


Figura 3. Road Damage Mapping in Old Langsa District  
Source : ArcGIS 10.8

Results of Mapping the Distance of Road Damage in Old Langsa District

Determining the distance of the coordinate points of road damage in Langsa Lama District using Arcgis 10.8 on a tool called measurement and classified based on the village in the following table:




Table 1. Distance of Road Damage in Old Langsa District


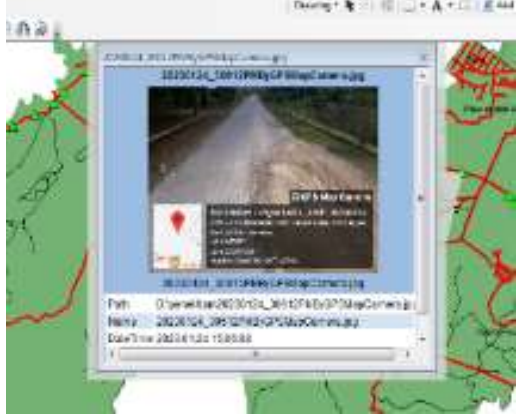
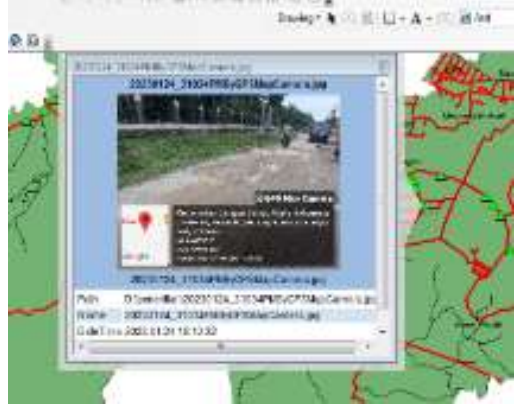
Lokasi Gangguan	Nomor Titik Kerusakan (TK)	Koordinat Kerusakan		Jarak Kerusakan Jalan	Jumlah Jalan	Lokasi Gangguan	Nomor Titik Kerusakan (TK)	Koordinat Kerusakan		Jarak Kerusakan Jalan	Jumlah Jalan
		Garis Bujur	Garis Lebar					Garis Bujur	Garis Lebar		
Asam Peutek	TK.1	4.4447°S	97.3913°E		1	Asam Peutek	TK.1	4.4450°S	97.3910°E		1
	TK.2	4.4450°S	97.3910°E				TK.2	4.4450°S	97.3910°E		
	TK.3	4.4413°S	97.3811°E				TK.3	4.4413°S	97.3811°E		
	TK.4	4.4413°S	97.3811°E				TK.4	4.4413°S	97.3811°E		
Meurandeh	TK.1	4.4422°S	97.3919°E		1	Meurandeh	TK.1	4.4434°S	97.3885°E		1
	TK.2	4.4410°S	97.3752°E				TK.2	4.4410°S	97.3752°E		
	TK.3	4.4410°S	97.3752°E				TK.3	4.4410°S	97.3752°E		
	TK.4	4.4174°S	97.3920°E				TK.4	4.4174°S	97.3920°E		
	TK.5	4.4198°S	97.3948°E				TK.5	4.4198°S	97.3948°E		
	TK.6	4.4388°S	97.3723°E				TK.6	4.4388°S	97.3723°E		
Sidodadi	TK.1	4.4644°S	97.3712°E		1	Sidodadi	TK.1	4.4611°S	97.3697°E		1
	TK.2	4.4656°S	97.3953°E				TK.2	4.4656°S	97.3953°E		
	TK.3	4.4611°S	97.3697°E				TK.3	4.4611°S	97.3697°E		
Pondok Keumuning	TK.1	4.4454°S	97.3885°E		1	Pondok Keumuning	TK.1	4.4454°S	97.3885°E		1
	TK.2	4.4410°S	97.3811°E				TK.2	4.4410°S	97.3811°E		
	TK.3	4.4410°S	97.3811°E				TK.3	4.4410°S	97.3811°E		
	TK.4	4.4174°S	97.3920°E				TK.4	4.4174°S	97.3920°E		
	TK.5	4.4198°S	97.3948°E				TK.5	4.4198°S	97.3948°E		
	TK.6	4.4198°S	97.3948°E				TK.6	4.4198°S	97.3948°E		
	TK.7	4.4174°S	97.3920°E				TK.7	4.4174°S	97.3920°E		
	TK.8	4.4198°S	97.3948°E				TK.8	4.4198°S	97.3948°E		
	TK.9	4.4198°S	97.3948°E				TK.9	4.4198°S	97.3948°E		




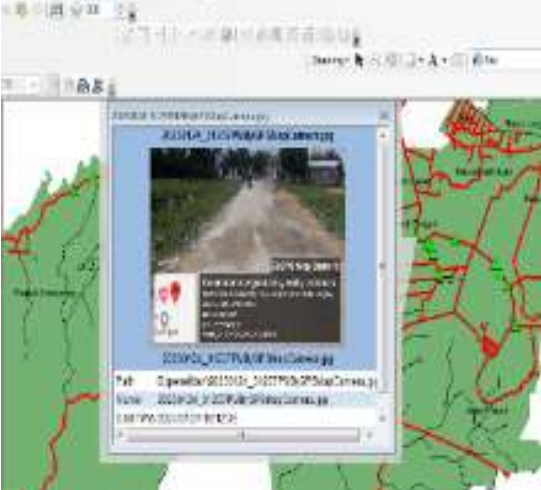
Source : ArcGIS 10.8

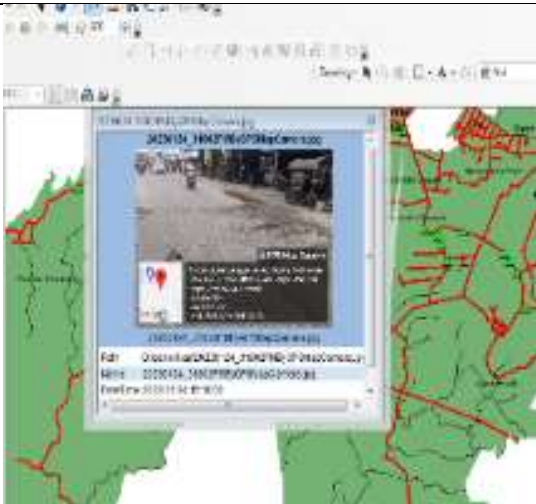

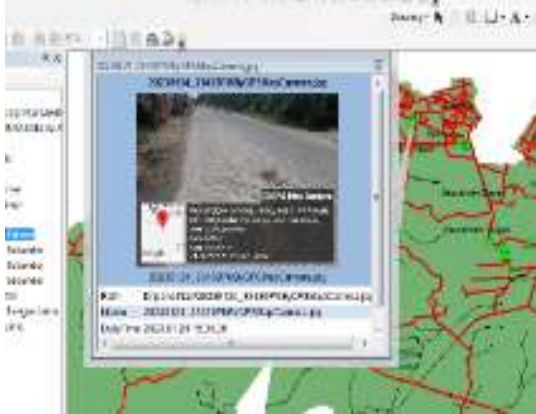
After conducting research and inputting coordinate points into ArcGIS 10.8, the results are in accordance with the following table:

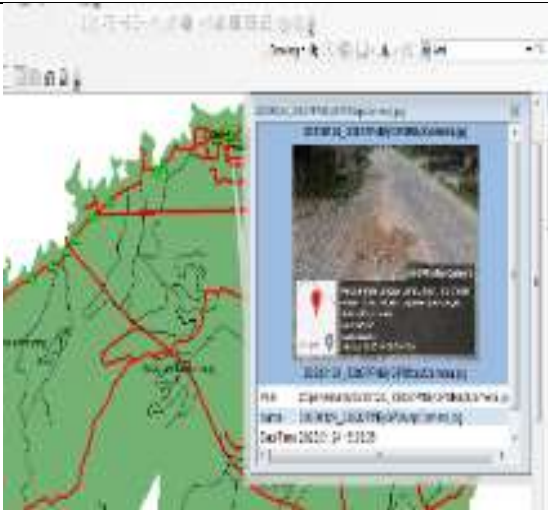
**Table 2.** Road damage point

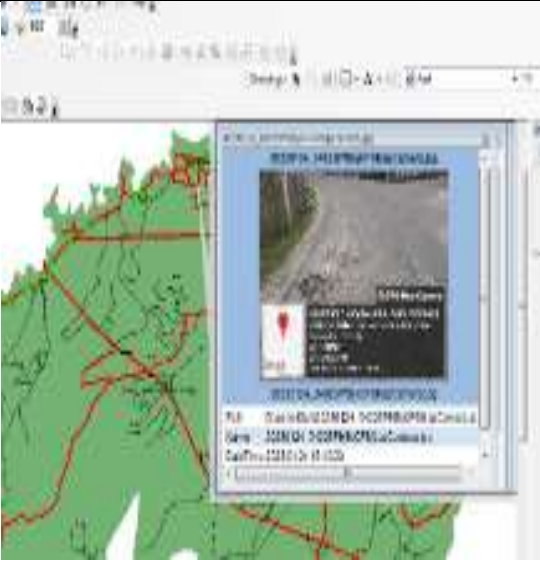


No	Name of Village/Village	Picture	Types of road damage
1.	Asam Peutek		Granular discharge surface defects
2.	Asam Peutek		Edge Rubbing Defects
3.	Asam Peutek		Hole surface defects

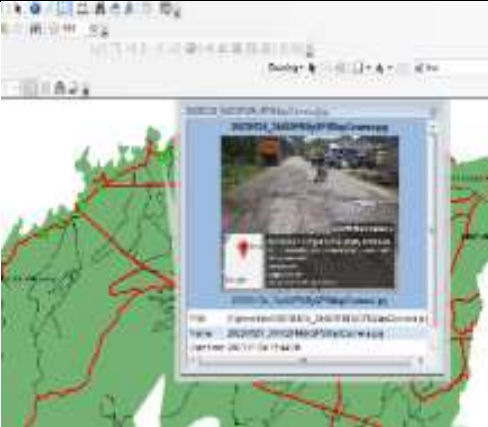

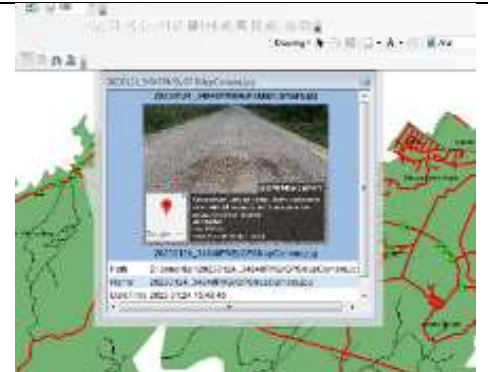
No	Name of Village/Village	Picture	Types of road damage
4.	Asam Peutek		Hole surface defects
5.	Meurandeh tengah		Edge erosion defects
6.	Meurandeh tengah		Edge erosion defects

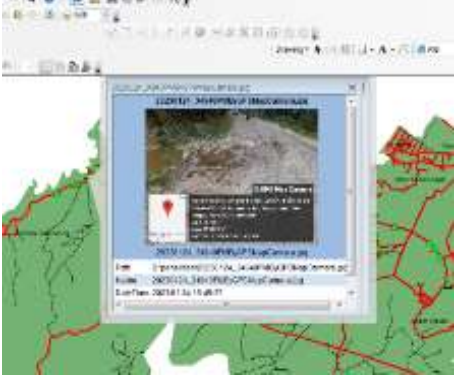
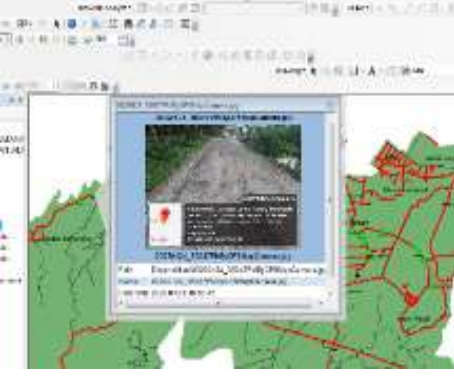

No	Name of Village/Village	Picture	Types of road damage
7.	Meurandeh tengah		Granular discharge surface defects
8.	Meurandeh tengah		Hole surface defects
9.	Meurandeh tengah		Granular discharge surface defects
10.	Meurandeh tengah		Granular discharge surface defects

No	Name of Village/Village	Picture	Types of road damage
11	Sidodadi		Edge erosion defects
12	Sidodadi		Hole surface defects
13	Sidodadi		Hole surface defects

No	Name of Village/Village	Picture	Types of road damage
14	Seulalah		Edge erosion defects
15.	Seulalah		Edge erosion defects
16.	Seulalah		Hole surface defects

No	Name of Village/Village	Picture	Types of road damage
17.	Seulalah		Hole surface defects
18.	Pondok keumuning		Collapse deformation
19.	Pondok keumuning		Granular discharge surface defects

No	Name of Village/Village	Picture	Types of road damage
20.	Pondok keumuning		Granular discharge surface defects
21.	Pondok keumuning		Granular discharge surface defects
22.	Pondok keumuning		Hole surface defects
23.	Pondok keumuning		Hole surface defects

No	Name of Village/Village	Picture	Types of road damage
24.	Pondok keumuning		Edge erosion defects
25.	Pondok keumuning		Granular discharge surface defects
26.	Pondok keumuning		Granular discharge surface defects

Source : ArcGIS 10.8

And here is a combination of the road damage point map and topography in the following image:

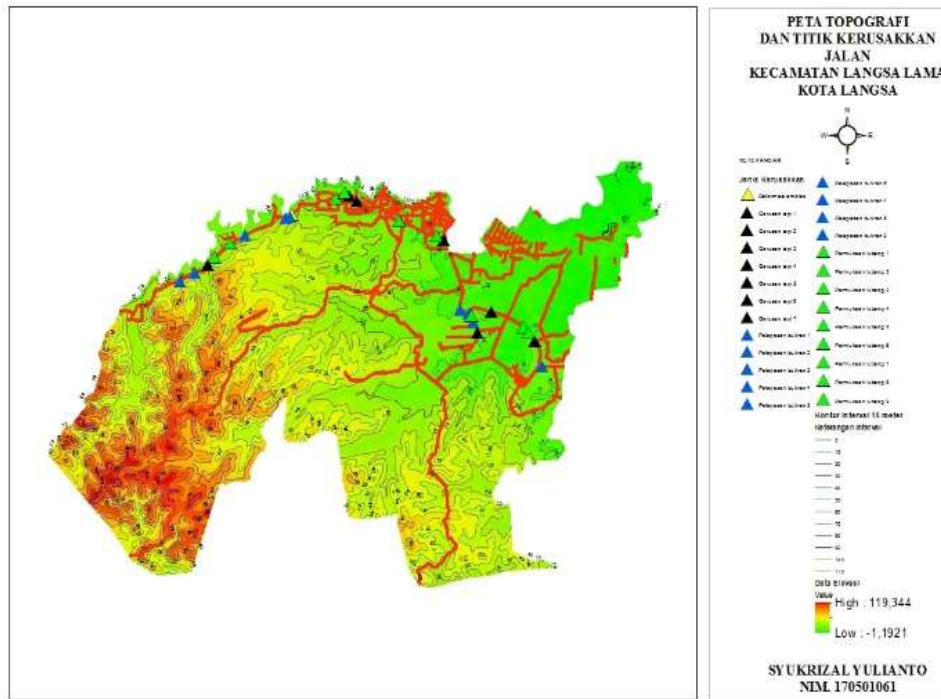


Figure 4. Combination of road damage point map and topographic map  
Source : Arcgis 10.8

#### 4. Conclusion and Suggestions

Based on field surveys in Langsa Lama District, 26 road damage points were identified across five villages. Pondok Keumuning Village had the highest damage concentration with 9 points (34.7%), followed by Meurandeh Tengah with 6 points (23.1%), while Asam Peutek and Seulalah Villages each had 4 points (15.3%), and Sidodadi Village had 3 points (11.6%). The most common damage types were surface defects from grain release and surface holes, each occurring at 9 locations (34.7%), followed by edge scour defects at 7 locations (26.8%), and deformation sinking at 1 location (3.8%).

Topographic analysis using DEM data processed in ArcGIS 10.8 revealed 11 contour lines with elevations ranging from 119.344 meters above sea level to 1.192 meters below sea level. The low road elevation causes rainwater from higher surfaces to stagnate, contributing to road deterioration.

The suggestions that can be taken from the conclusions are road infrastructure improvements are essential in Langsa Lama District to enhance overall facilities and infrastructure quality in Langsa City, requiring targeted repairs at multiple damaged road sections. Additionally, comprehensive feasibility studies should be conducted to assess the long-term viability and maintenance requirements of the road network in Langsa Lama District.

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