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ENVIRONMENTAL ROAD IMPROVEMENT MANAGEMENT SYSTEM BASED ON GEOGRAPHIC INFORMATION SYSTEM (GIS) IN KUPANG CITY

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ABSTRACT

The city government through the Regional Development Planning Agency (BAPPEDA) of Kupang City continues to strive to meet the needs of the community on road infrastructure, especially environmental roads. The purpose of this study is to apply a GIS application in compiling a database of environmental roads and determine priorities for improving environmental roads using 3 (three) parameters, namely: what is the percentage of road damage, how many houses access the road and how much is the budget plan. Through the method of classifying and weighting parameters, a priority recommendation for environmental road improvement will be obtained for the next 2 (two) years. As well as from this whole process, a systematic and sustainable environmental road improvement management system concept will be developed. From all stages, priority recommendations for environmental roads will be obtained for physical activities to be carried out in 2022 and 2023. From the 43 environmental roads survey results, 33 environmental roads are recommended for carrying out physical activities in the 1st year with a total budget plan of IDR. 11,880. 336,911 and 10 environmental roads that are recommended for carrying out physical activities in the 2nd year with a total planned budget of IDR. 2,341,913,108.

KEYWORD: Environmental Road, Improvement, Geographic Information System.

1. INTRODUCTION

According to Law No. 34 year of 2006 on Roads, it is defined that the Road is a transportation infrastructure that covers all parts of the road including its complementary buildings intended for traffic, which are on the surface, above ground level, below ground and or water, and above water level, except railways, lorry roads and cable roads. Meanwhile, according to Sukirman (1994) mentioned that roads are paths that are above the surface made by humans with various shapes, sizes and constructions to channel people, animals and vehicles that transport goods from one place to another quickly and easily.

Road is a land transportation infrastructure that is very important to facilitate economic activities (Ali, 2016). Transportation infrastructure is the core of a region and it is very instrumental in encouraging the acceleration of the development of a region in order to move the economy through the cycle of goods flow and human mobility from one area to another (Grigg, 1998). Improvement of environmental roads is also implemented in densely populated residential areas, with the better road conditions increasingly triggering the spread of new settlements and the expansion of existing settlements so that residents are not concentrated in residential areas (Yulianto, 2017).

The definition of maintenance is all kinds of work needed to maintain and repair roads in order to remain in good condition or work related to both (Ali, 2016). So that it can prevent deterioration or decrease in quality with the rapid rate of change that occurs immediately after construction is implemented. Road improvement and rehabilitation is also carried out in densely populated residential areas, with the better road conditions will trigger the spread of new settlements and the expansion of existing settlements, so that the population is not concentrated in residential areas only (Yulianto, 2017).

The City Government through the Regional Development Design Agency (BAPPEDA) of Kupang City continues to strive to meet the needs of the community in the field of road infrastructure, especially environmental roads along with the increasing population and growth of the region and to realize the improvement of the quality of basic infrastructure of residential environments. But until now the handling of environmental road construction has not been able to be done optimally with a good management system. Every year BAPPEDA Kupang City receives proposals from the community to improve environmental roads, one of which is in the TDM Village area which has an area of 1.20 km² and a fairly dense population of 11,494 people. (BPS Oebobo District 2020).

The purpose of this study is compiling an Information system device that can display a combination of road technical data as a road data bank and supporting information through data analysis by using the ArcGIS Program or SIG to determine the road segment that is the priority of road improvement in accordance with the scale of needs based on the parameters used, namely existing road conditions, the amount of homes that have direct access to the environmental road and how much it costs to improve the road. This digital spatially (map) based on Geographic Information System (GIS) application can prepare development planning management for the maintenance and improvement of environmental road infrastructure efficiently and effectively and is expected to facilitate monitoring and evaluation over time in a sustainable manner (Prahasta, 2009).

2. MATERIALS AND METHODS

Data Analysis Techniques

1. Quantitative Descriptive Analysis

In this study, the analysis used is quantitative descriptive where the research leads more to the disclosure of a problem or circumstance as existence and reveals the facts (Sugiyono, 2018).

1.   Analysis Using GIS

Data processing analysis using GIS was chosen because of the ability of GIS programs that can answer the needs of information systems efficiently and able to manage data with complex and geographically based structures such as environmental road networks and because GIS is able to store, analyze, present data both spatial data and data attributes (tables), able to answer spatial questions and non-spatial questions so as to provide more informative data. it is compared to other computer-based Information Systems and can ultimately help with a quick and precise decision-making process (Jamalurrusid, 2009).

2.   Process of Classifying and Weighting Parameters of Environmental Road Prioritization

a.   Road Damage Parameters

The classification of road damage according to the standards of the Director General of Bina Marga for environmental roads is divided into 3 (three) classes based on the percentage of damage to the road surface. Weighting assessments in each class are given grades 1 through 3 based on the level of road damage. Standards of classifying road damage and weighting are found in Table 1.

Table 1: Standards Classification of Road Damage and Weighting.

Extent of Damage	Type of Damage	Weight
≤ 10 %	Lightly Damaged	1
11% - 30%	Moderately Damaged	2
> 30%	Heavily Damaged	3

Source: Directorate General of Highways, 1990

b.　Parameter Total of Houses

Classification of the total of houses begins by knowing the density of the total of houses on each road segment with varying lengths and total of houses (Yuliato, 2017). The class division of the total of houses can be seen in Table 2.

Table 2: Classification Total of Houses and Weighting.

Total of Houses (TH)	Class	Weight
0 < TH ≤ 5	Rarely	1
6 < TH ≤ 10	Slightly Dense	2
> 10	Very Dense	3

Source: Yulianto, 2017

Weighting the total of houses is given a value of 1 to 3. Road segments with a large total of houses or densely valued because the denser the total of houses, the greater or urgent the needs of the community or road users. Conversely, if the total of houses is still small or rare then it gets a smaller value because the urgency rate is smaller.

c.　Cost Requirements Parameter

Weighting for each class is given 1 to 3 based on the level of cost. The weighting of this cost requirement is different from the weighting of the level of road damage, lowcost values are given high weights and high-cost values are given low weights. So that the value of a smaller cost has a greater opportunity for priority handling. The division of cost classes and weighting can be seen in Table 3.

Table 3: Cost class division and weighting.

Value	Class	Weight
Maximum 200 million	Low	3
200 Million to 5 Billion	Medium	2
Above 5 Billion	High	1

Source: Presidential Decree No. 70 Year of 2012

3. Determination of Maintenance Priority

a. Priority Recommendations

After the weighting of the three parameters above, it is continued with the addition of weights (weight of damage + weight of total of houses + weight of cost requirements) and the results are classified into 3 (three) recommendation classes (Yuliato, 2017). The classification of recommendations for determining road improvement priorities based on the total of weights can be seen in Table 4.

Table 4: Classification of recommendations for determining the priority of road sections

Priority	Weight	Class Recommendation
Year 3	4 - 5	Postponed
Year 2	6 - 7	Immediately
Year 1	8 - 9	Urgent

Source: Yulianto, 2017

3. RESULT AND DISCUSSION

Classifying and Weighting Parameters of Environmental Road Prioritization.

a. Road Damage Parameters

From the analysis results 43 environmental roads the number of parameters Damage to roads that are classified as lightly damaged are 1 road segment with a weight obtained of 1, then those that are classified as damaged are 1 road segment with a weight obtained that is 2 and those that are classified as heavily damaged are 41 roads with a weight obtained that is 3.

b. Parameter Total of Houses

From the results of the analysis of 43 environmental roads, it can be concluded that the parameters of the total of houses that are in the very dense category are 25 roads with a weight obtained of 3, then those that are in the rather dense category are 13 roads with a weight obtained of 2 and those that are in the rare category. as many as 5 roads with the weight obtained is 1.

c. Cost Requirements Parameter

From the analysis results of the 43 environmental roads above it can be concluded that the budget parameters The costs that enter the low classification are 16 roads with a weight obtained of 3, then those that enter the moderate classification are 27 roads with the weight obtained is 2.

Determining the Priority of Maintenance

a. Priority Recommendations

From the analysis of the sum of the weight of road damage, the total housing and budget, then priority recommendations are obtained for improving environmental roads. It can be concluded that for recommendations that are in the urgent category as many as 33 environmental roads, while priority recommendations that are in the immediate category are 10 environmental roads.

b. Implementation Scenario

From the analysis of determining the priority of road handling, a plan for 3 (three) years will be obtained. For the handling in the 1st year, the total budget plan for improving environmental roads is IDR 11,880,336,911 and the roads handled are 33 sections of environmental roads. In the second year, the total budget plan for the improvement of environmental roads is IDR 2,341,913,108 and the number of roads handled is 10 environmental roads. In the 3rd year there are no recommendations for road improvement work and the total budget plan for environmental road improvement because all the results of the analysis are in the 1st and 2nd years.

Analysis Process Using Geographic Information System (GIS)

The database created in this program includes 2 (two) databases, namely the administrative database and the transportation database. The administration database created is data that explains the boundaries of the area that are the reference for the work process, while the road database created is data that explains the status of roads and other complementary information (Rizki, 2012). The reference map used in this research is the Indonesian Earth Map from Ina-Geosportal and the road network map from Street Map Data.

a. Creating Administrative Spatial Data

Administrative spatial data for TDM Village was made using a map issued by Ina-Geosportal, then the map taken was a map of the City of Kupang. Following are the steps taken to create administrative spatial data using maps obtained from Ina-Geosportal. The steps are:

- Inserting the Kupang City administration map above into the ArcMap work layer by adding data - select ADMISTRASIDESA_AR

- Then create an Oebobo District administration map layer using ArcToolbox - Analys tools - Select.
- Then create a TDM Village layer in Oebobo District by selecting - select by attribute - select TDM village administration - ok. Right-click on the Oebobo District Administration layer - data - export data - save output with the name TDM Village layer.

b. Creating Road Spatial Data

Road spatial data is created by entering a road network map from StreetMap. Transportation type data with administrative maps that have been made previously (Rizki, 2012). The following are the steps taken to create spatial data for environmental road transportation

- Add data - select aerial photo of TDM Village - add previously created TDM Village administration - add point (coordinates) of environmental road survey results.
- Making environmental road layers by digitizing the survey results - catalog - new shappfile line - edit fatures - star editing - create features - stop editing. You will get digitized results for the survey results for environmental roads.
- Making the environmental road parameter database, add data - select the environmental road layer that has been digitized - editor - start editing - open attribute table - add field - type the name of the road damage, the total of houses. Cost requirement - type text - ok. The map of these three parameters and the attribute table data can be seen in Figure 1 to Figure 6.

1. Map of Environmental Road Damage Parameters and Data Attribute Table

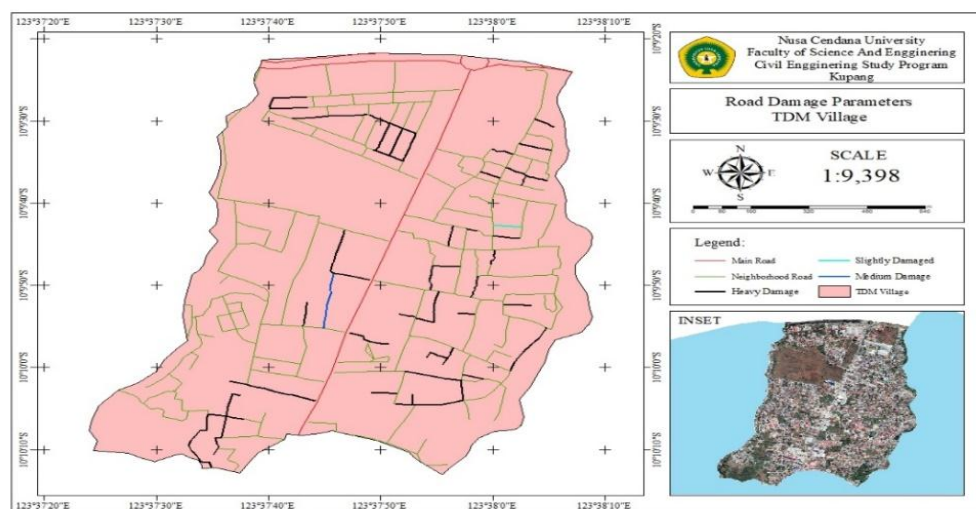**a. Environmental Road Damage Parameter Map**

Figure 1: Map of Environmental Road Damage Parameters.

In Figure 1. above, a map is made for the survey results of road damage parameters. On the map, the types of road damage are distinguished based on the colors contained in the map, the number of parameters of road damage that is classified as lightly damaged is marked with 1 green road, then those that are classified as moderately damaged are marked with 1 blue road and 1 road segment. classified as seriously damaged are marked with black roads as many as 41 roads.

b. Table Attribute Data

Table

Kerusakan_Jalan

FID	Shape*	Province	Districts	Ward	Location	Pavement Type	Road Length (m)	Road Width (m)	Damage Type	Damage Length	Damage Width	Damage Width (m2)	Road Damage	Classification	Weight
0	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. Komodo	Land	50 m	3 m	Rocky	50 m	3 m	150 m2	67%	Heavily Damaged	3
1	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. Gunung Egon	Lapen	100 m	3 m	Grain Release	100 m	3 m	300 m2	100%	Heavily Damaged	3
2	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. Ile Mandir	Lapen	57 m	3 m	Grain Release	57 m	3 m	171 m2	57%	Heavily Damaged	3
3	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 003, Rw 001	Rabates (Steps)	33 m	1 m	Dirt Road	33 m	1 m	33 m2	66%	Heavily Damaged	3
4	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 004, Rw 001	Rabates (Steps)	15 m	0.5 m	Elongated Crack	15 m	0.5 m	7.5 m2	8%	Light Damage	1
5	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 004, Rw 001	Lapen	57 m	3 m	Grain Release	57 m	3 m	171 m2	57%	Heavily Damaged	3
6	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. G. Sirung	Land	27 m	3 m	Dirt Road	27 m	3 m	81 m2	54%	Heavily Damaged	3
7	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 005, Rw 002	Land	51 m	3 m	Rocky	51 m	3 m	153 m2	100%	Heavily Damaged	3
8	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 007, Rw 002	Land	50 m	3 m	Dirt Road	50 m	3 m	150 m2	100%	Heavily Damaged	3
9	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 007, Rw 002	Land	70 m	3 m	Dirt Road	70 m	3 m	210 m2	70%	Heavily Damaged	3
10	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 008, Rw 002	Land	47 m	3.5 m	Dirt Road	47 m	3.5 m	164.5 m2	63%	Heavily Damaged	3
11	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 008, Rw 002	Lapen	75 m	3 m	Grain Release	75 m	3 m	225 m2	100%	Heavily Damaged	3
12	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 009, Rw 003	Lapen	83 m	3 m	Grain Release	83 m	3 m	249 m2	83%	Heavily Damaged	3
13	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 011, Rw 003	Land	43 m	3 m	Dirt Road	43 m	3 m	129 m2	86%	Heavily Damaged	3
14	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 015, Rw 004	Lapen	178 m	3 m	Grain Release	178 m	3 m	534 m2	89%	Heavily Damaged	3
15	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 018, Rw 005	Land	35 m	3 m	Dirt Road	35 m	3 m	105 m2	58%	Heavily Damaged	3
16	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 018, Rw 005	Land	50 m	3 m	Dirt Road	50 m	3 m	150 m2	100%	Heavily Damaged	3
17	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 019, Rw 005	Lapen	125 m	3.5 m	Grain Release	125 m	3.5 m	437.5 m2	71%	Heavily Damaged	3
18	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 019, Rw 005	Land	120 m	3 m	Dirt Road	120 m	3 m	360 m2	96%	Heavily Damaged	3
19	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 019, Rw 005	Land	33 m	3 m	Dirt Road	33 m	3 m	99 m2	83%	Heavily Damaged	3
20	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 020, Rw 005	Land	80 m	3 m	Dirt Road	80 m	3 m	240 m2	62%	Heavily Damaged	3
21	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 020, Rw 005	Lapen	145 m	3 m	Grain Release	145 m	3 m	435 m2	83%	Heavily Damaged	3
22	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 020, Rw 005	Land	45 m	3 m	Dirt Road	45 m	3 m	135 m2	100%	Heavily Damaged	3
23	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 021, Rw 006	Lapen	50 m	3 m	Dirt Road	50 m	3 m	150 m2	71%	Heavily Damaged	3
24	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 021, Rw 006	Lapen	175 m	3 m	Grain Release	175 m	3 m	525 m2	88%	Heavily Damaged	3
25	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 021, Rw 006	Rabates (Steps)	40 m	1.5 m	Dirt Road	40 m	1.5 m	60 m2	87%	Heavily Damaged	3
26	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 021, Rw 006	Land	67 m	3 m	Dirt Road	67 m	3 m	201 m2	89%	Heavily Damaged	3
27	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 026, Rw 007	Lapen	175 m	3 m	Grain Release	175 m	3 m	525 m2	83%	Heavily Damaged	3
28	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 026, Rw 007	Land	38 m	4 m	Dirt Road	38 m	4 m	152 m2	76%	Heavily Damaged	3
29	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 026, Rw 007	Lapen	167 m	4 m	Grain Release	167 m	4 m	668 m2	84%	Heavily Damaged	3
30	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 027, Rw 007	Land	65 m	3 m	Dirt Road	65 m	3 m	195 m2	78%	Heavily Damaged	3
31	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Jl. Fetor Saubaki	Lapen	210 m	3 m	Grain Release	210 m	3 m	630 m2	76%	Heavily Damaged	3
32	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 027, Rw 007	Lapen	80 m	3 m	Grain Release	80 m	3 m	240 m2	78%	Heavily Damaged	3
33	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Jl. Rantai Damai III	Lapen	200 m	3 m	Grain Release	200 m	3 m	600 m2	73%	Heavily Damaged	3
34	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 028, Rw 008	Lapen	50 m	3 m	Grain Release	50 m	3 m	150 m2	29%	Medium Damage	2
35	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 029, Rw 008	Land	70 m	3 m	Dirt Road	70 m	3 m	210 m2	78%	Heavily Damaged	3
36	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 031, Rw 009	Land	75 m	3.5 m	Hollow & Rocky	75 m	3.5 m	262.5 m2	75%	Heavily Damaged	3
37	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 031, Rw 009	Land	60 m	4 m	Rocky	60 m	4 m	240 m2	60%	Heavily Damaged	3
38	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 032, Rw 009	Lapen	65 m	3.5 m	Grain Release	65 m	3.5 m	227.5 m2	65%	Heavily Damaged	3
39	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 032, Rw 009	Lapen	75 m	3.5 m	Grain Release	75 m	3.5 m	262.5 m2	75%	Heavily Damaged	3
40	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 033, Rw 009	Lapen	155 m	4 m	Grain Release	155 m	4 m	620 m2	89%	Heavily Damaged	3
41	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 033, Rw 009	Lapen	200 m	4 m	Grain Release	200 m	4 m	800 m2	100%	Heavily Damaged	3
42	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Rt 034, Rw 009	Lapen	245 m	4 m	Grain Release	245 m	4 m	980 m2	100%	Heavily Damaged	3

**Figure 2: Database of Road Damage Parameters in the Attribute Table.**

In Figure 2. above, after the environmental road damage map is created, then create a database on the attribute table. The data from the road damage survey will be stored in an

attribute table so that when the road works process the required road damage data already exists so that the work can be more efficient.

2. Parameter Map of Total Houses and Attribute Table Data

a. Parameter Map of Total Houses on Environmental Road
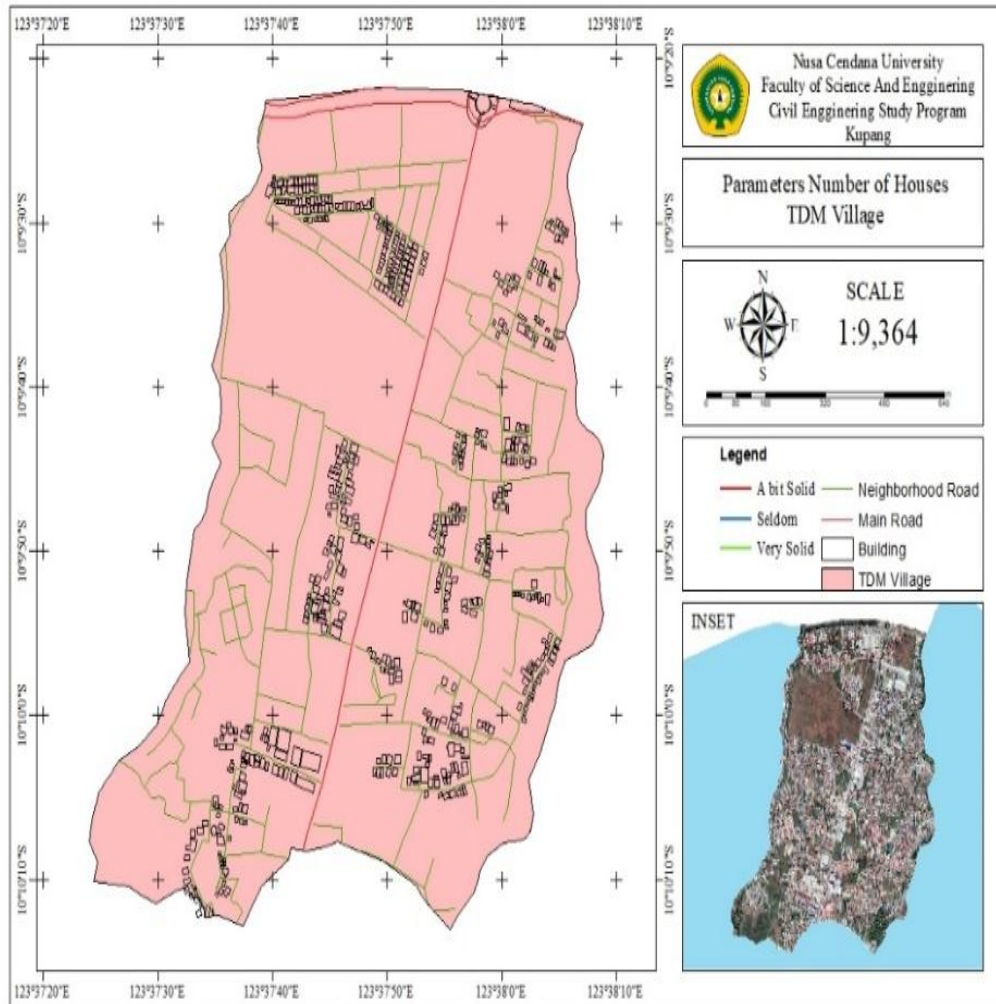
Figure 3: Parameter Map of Total Houses on Environmental Roads.

In Figure 3. above, a map is made for the parameters of the total of houses surveyed, the parameter for the total of houses that fall into the very dense category marked with light blue roads is 25 roads, Then those that fall into the rather congested category marked by dark blue roads are as many as 13 roads and those that are in the rare category marked with black roads are as many as 5 roads.

b. Table Attribute Data

Table

Jumlah_Rumah

FID	Shape	Province	Districts	Ward	Location	Treatment Plan	Road Length (m)	Width Road (m)	Number of Houses	Classification	Weight
0	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. Komodo RT 001 RW 001	Land	75	3	9	A bit Solid	2
1	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. Gunung Egon RT 002 RW 001	Lapen	100	3	10	A bit Solid	2
2	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. Ile Mandiri RT 003 RW 001	Lapen	100	3	14	Very Solid	3
3	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 003 RW 001	Rabates (Steps)	50	1	3	Seldom	1
4	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 004 RW 001	Rabates (Steps)	100	1	5	A bit Solid	2
5	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 004 RW 001	Lapen	100	3	13	Very Solid	3
6	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Gg. G. Sirung RT 005 RW 002	Land	50	3	8	A bit Solid	2
7	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 005 RW 002	Land	51	4	4	Seldom	1
8	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 007 RW 002	Land	50	3	6	A bit Solid	2
9	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 007 RW 002	Land	100	3	11	Very Solid	3
10	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 008 RW 002	Land	75	3.5	9	A bit Solid	2
11	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 008 RW 002	Lapen	75	3	9	A bit Solid	2
12	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 009 RW 003	Lapen	100	3	13	Very Solid	3
13	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 011 RW 003	Land	50	3	9	A bit Solid	2
14	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 015 RW 004	Lapen	200	3	34	Very Solid	3
15	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 018 RW 005	Land	50	3	11	Very Solid	3
16	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 018 RW 005	Land	50	3	6	A bit Solid	2
17	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 019 RW 005	Lapen	175	3.5	15	Very Solid	3
18	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 019 RW 005	Land	125	3	13	Very Solid	3
19	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 019 RW 005	Land	40	3	6	A bit Solid	2
20	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 020 RW 005	Land	130	3	4	Seldom	1
21	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 020 RW 005	Lapen	175	3	18	Very Solid	3
22	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 020 RW 005	Land	42	3	4	Seldom	1
23	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 021 RW 006	Lapen	70	3	3	Seldom	1
24	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 021 RW 006	Lapen	200	3	27	Very Solid	3
25	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 021 RW 006	Rabates (Steps)	46	1.5	6	A bit Solid	2
26	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 021 RW 006	Land	75	3	9	A bit Solid	2
27	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 026 RW 007	Lapen	210	3	13	Very Solid	3
28	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 026 RW 007	Land	50	4	12	Very Solid	3
29	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 026 RW 007	Lapen	200	4	27	Very Solid	3
30	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 027 RW 007	Land	83	3	11	Very Solid	3
31	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Jl. Felor Saubaki RT 027 RW 007	Lapen	275	3	17	Very Solid	3
32	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 027 RW 007	Lapen	102	3	9	A bit Solid	2
33	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	Jl. Rantai Damai II RT 028 RW 008	Lapen	275	3	33	Very Solid	3
34	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 028 RW 008	Lapen	175	3	24	Very Solid	3
35	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 029 RW 008	Land	90	3	13	Very Solid	3
36	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 031 RW 009	Land	100	3.5	22	Very Solid	3
37	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 031 RW 009	Land	100	4	11	Very Solid	3
38	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 032 RW 009	Lapen	100	3.5	23	Very Solid	3
39	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 032 RW 009	Lapen	100	3.5	20	Very Solid	3
40	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 033 RW 009	Lapen	175	4	35	Very Solid	3
41	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 033 RW 009	Lapen	200	4	26	Very Solid	3
42	Polyline	East Nusa Tenggara	Oebobo	Tuak Daun Merah	RT 034 RW 009	Lapen	242	4	34	Very Solid	3

Figure 4: Database Parameter Total of Houses in the Attribute Table.

In Figure 4. above, after making a map of the totoal of houses on the neighborhood road, then create a database in the attribute table. The data from the environmental road survey will be stored in the attribute table so that when the road construction process the data on the total of houses needed already exists so that the construction can be more efficient.

3. Budget Parameter Map and Data Attribute Table

a. Budget Parameter Map
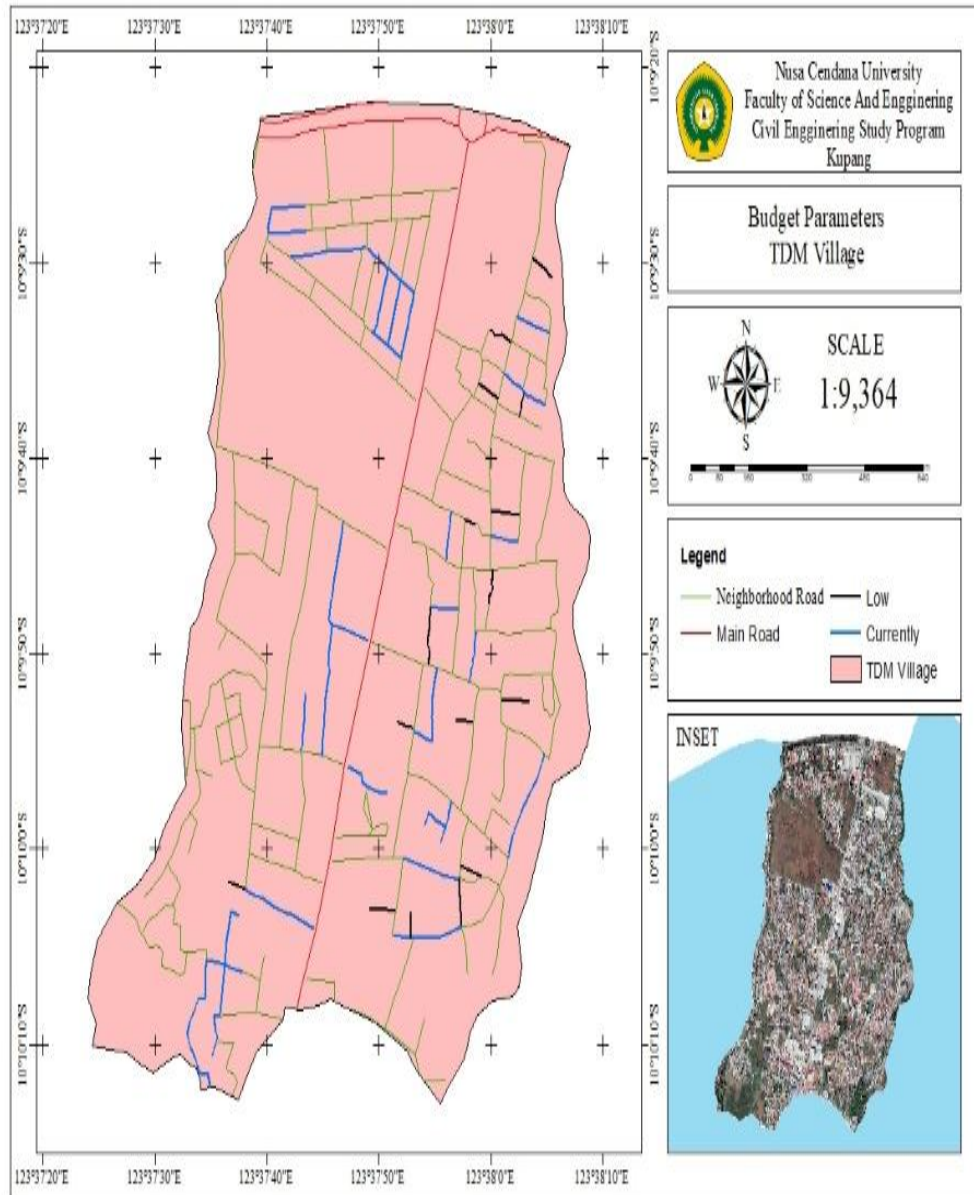
Figure 5: Map of Budget Parameters on Environmental Road.

In Figure 5. above, a map for budget parameters is created. On the map, the cost budget parameters are distinguished based on the color of the road. The budget parameters that enter the low classification marked with black roads are as many as 16 roads, then those that enter the moderate classification marked with blue roads are 27 roads.

b. Table Attribute Data.

FID	Shape *	Province	Districts	Ward	Location	Treatment Plan	Road Length (m)	Width Length (m)	Budget	Classification	Weight
0	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	Gg. Komodo RT 001 RW 001	Lapen	75	3	Rp 193,992,648	Low	3
1	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	Gg. Gunung Egon RT 002 RW 001	Lapen	100	3	Rp 244,174,533	Currently	2
2	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	Gg. Ie Mandiri RT 003 RW 001	Lapen	100	3	Rp 244,174,533	Currently	2
3	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 003 RW 001	Rabates (Steps)	50	1	Rp 14,001,227	Low	3
4	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 004 RW 001	Rabates (Steps)	100	1	Rp 24,162,464	Low	3
5	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 004 RW 001	Lapen	100	3	Rp 244,174,533	Currently	2
6	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	Gg. O. Srung RT 005 RW 002	Lapen	50	3	Rp 130,611,766	Low	3
7	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 005 RW 002	Lapen	51	4	Rp 130,611,766	Low	3
8	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 007 RW 002	Lapen	50	3	Rp 130,611,766	Low	3
9	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 007 RW 002	Lapen	100	3	Rp 257,373,530	Currently	2
10	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 008 RW 002	Lapen	75	3.5	Rp 225,603,089	Currently	2
11	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 008 RW 002	Lapen	75	3	Rp 184,093,400	Low	3
12	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 009 RW 003	Lapen	100	3	Rp 244,174,533	Currently	2
13	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 011 RW 003	Lapen	50	3	Rp 124,012,257	Low	3
14	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 015 RW 004	Lapen	200	3	Rp 484,499,067	Currently	2
15	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 018 RW 005	Lapen	60	3	Rp 140,627,510	Low	3
16	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 018 RW 005	Lapen	50	3	Rp 130,611,766	Low	3
17	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 019 RW 005	Lapen	175	3.5	Rp 484,512,589	Currently	2
18	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 019 RW 005	Lapen	125	3	Rp 320,764,413	Currently	2
19	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 019 RW 005	Lapen	40	3	Rp 105,259,412	Low	3
20	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 020 RW 005	Lapen	130	3	Rp 333,430,590	Currently	2
21	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 020 RW 005	Lapen	175	3	Rp 424,417,934	Currently	2
22	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 020 RW 005	Lapen	45	3	Rp 117,935,589	Low	3
23	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 021 RW 006	Lapen	70	3	Rp 172,077,173	Low	3
24	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 021 RW 006	Lapen	200	3	Rp 484,499,067	Currently	2
25	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 021 RW 006	Rabates (Steps)	46	1.5	Rp 13,189,129	Low	3
26	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 021 RW 006	Lapen	75	3	Rp 193,992,648	Low	3
27	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 026 RW 007	Lapen	210	3	Rp 508,531,520	Currently	2
28	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 026 RW 007	Lapen	50	4	Rp 172,865,687	Low	3
29	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 026 RW 007	Lapen	200	4	Rp 644,715,423	Currently	2
30	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 027 RW 007	Lapen	83	3	Rp 243,413,896	Currently	2
31	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	Jl. Fetor Saubaki RT 027 RW 007	Lapen	275	3	Rp 664,742,467	Currently	2
32	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 027 RW 007	Lapen	102	3	Rp 248,901,024	Currently	2
33	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	Jl. Rantai Damai III RT 028 RW 008	Lapen	275	3	Rp 664,742,467	Currently	2
34	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 028 RW 008	Lapen	175	3	Rp 424,417,934	Currently	2
35	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 029 RW 008	Lapen	90	3	Rp 232,021,177	Currently	2
36	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 031 RW 009	Lapen	100	3.5	Rp 299,627,452	Currently	2
37	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 031 RW 009	Lapen	100	4	Rp 257,373,530	Currently	2
38	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 032 RW 009	Lapen	100	3.5	Rp 284,228,622	Currently	2
39	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 032 RW 009	Lapen	100	3.5	Rp 284,228,622	Currently	2
40	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 033 RW 009	Lapen	175	4	Rp 554,607,745	Currently	2
41	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 033 RW 009	Lapen	200	4	Rp 644,715,423	Currently	2
42	Polyline	East Nusa Tenggara	Oebobo	Tusk Daun Merah	RT 034 RW 009	Lapen	245	4	Rp 788,910,143	Currently	2

Figure 6: Database of Budget Parameters in the Attribute Table.

In Figure 6. above, after making a budget map for the environmental road, then creating a database in the attribute table. The data from the budget survey results will be stored in an attribute table so that when the road works process the required data already exists so that the construction can be more efficient.

Creating a database for determining environmental road priorities, add data - select the environmental road layer that has been digitized - data - export data - name the road segment priority determination - editor - start editing - open attribute table - add field - add road damage weight column, weight total of houses, weight of cost requirements, total weight, recommendation type text - ok. Priority determination maps and attribute table data can be seen in Figures 7 and 8 below.

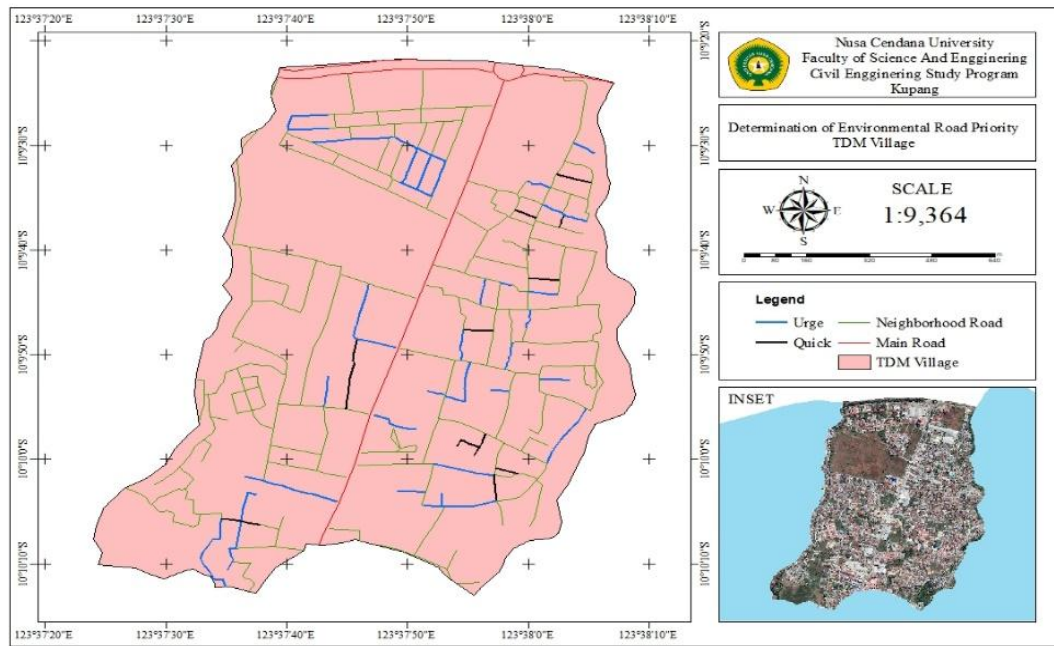### a. Environmental Road Priority Determination Map

Figure 7: Map of Environmental Road Priority Determination.

In Figure 7. above, a map is made to determine the priority of environmental road works. From the map, it can be seen that for recommendations that are in the urgent category marked with green roads are 33 roads, while priority recommendations that are immediately categorized as black roads are 10 roads.

b. Table Attribute Data

Figure 8: Environmental Road Priority Determination Database on the Attribute Table.

In Figure 8. above, after making a priority determination map for environmental road work, then create a database in the attribute table. The data from the work will be stored in the attribute table so that when the road construction process the required data already exists so that the construction can be more efficient.

Environmental Road Improvement System Scheme

The information system in the form of an environmental road database using the GIS program will result in accurate data. The overall process of drafting the management system concept for environmental road improvement in the TDM sub-district of Kupang City can be seen in Table 1.

Table 1: Schematic of Environmental Road Improvement Management System.

Stages	Activities	Results Achieved
Database	Conducting direct field survey	Data on roads and their problems
Planning	a. Type of handling	a. Kinds and types of pavement.
	b. Estimated Budget Plan	b. List of volumes, unit prices, costs.
Programming	Priority Scale	Road sections that are immediately handled in order of priority.
Preperation	Implementation schedule	Annual program of activities according to targets
Operation and Evaluation	Physical work	Improvement of environmental roads is targeted and efficient. Evaluation of work results.

4. CONCLUSION

Based on the analysis that has been carried out, the following conclusions are obtained.

1. Data on environmental road improvement survey results obtained 43 environmental roads located in TDM Village, Kupang City. The results of determining the priority of environmental roads in TDM Village obtained 33 environmental roads that are recommended for carrying out physical activities in the 1st year (urgent) with a total budget plan of IDR. 11,880,336,911 and 10 environmental roads that are recommended for carrying out physical activities in the next 2nd year (soon) with a total planned budget of IDR. 2,341,913,108.

2. From the entire analysis process using GIS, the concept of an environmental road improvement management system is obtained which includes: Database preparation, planning, programming, preparation for implementation, implementation and evaluation. This concept has good potential for implementation for the Kupang City Public Works and Public Housing Agency in preparing an effective, targeted and efficient environmental road improvement activity plan in terms of time and cost.

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