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## ANALYSIS OF COMMUNITY-BASED ROAD MAINTENANCE TO OVERCOME CHANNEL EROSION IN RURAL AREAS

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### Abstract

This study aimed to analyze community-based road maintenance to overcome channel erosion in rural areas. This research uses descriptive qualitative research. The data used in this study were primary and secondary data; preliminary data was collected through in-depth interviews with the community and village heads through socialization activities regarding rural road maintenance techniques, while secondary data was collected through literature study to determine the condition of village facilities and infrastructure in Cianjur district, and data presentation using descriptive method. Based on the results of the research analysis, it can be concluded that in road maintenance, a Road Maintenance Acceleration Control Team has been formed as a supervisor and person in charge of activities, it is necessary to add water gates to rice fields and plantations in rural areas. In addition, it is also essential to plant a Vetiver System to prevent erosion around the road with the help of the community, some of whom have an understanding of the management of road facilities and infrastructure but are still not optimal.

**Keywords:** *Analysis, Road Maintenance, Community, Channel Erosion, Rural.*

### A. INTRODUCTION

Based on the regional autonomy policy in Indonesia's territory, this impacts the shifting of responsibility for the maintenance and development of the road network in the restricted area to the authority of the regional government (Yulianti, 2018). This dispute should be balanced with increasing the government's capacity in engineering, financing, and road construction management. With the completion of construction, the next task in road management has changed its focus, which is more inclined to maintenance. This is very important to emphasize because roads that have completed the construction process and are entering the operating period will undoubtedly experience a deterioration condition after their time of use until their peak can no longer operate due to severe damage (Kristiawan et al., 2020).

The role of the road will be higher along with the physical mobility of the community, which also increases; this role is not only to facilitate access to transportation for people, goods, and services, but more than that, it also plays a role in the approach to developing an area to achieve equitable development in the region, as well as strengthen unity. On a national scale to determine security and realize national development goals such as the regulations contained in Law number 38 of 2004 concerning Roads. Based on these regulations, it can be seen that the authority for road administration in district areas, city streets, to village roads includes various things such as supervision, law, development, guidance, and routine maintenance (Uguy & Romphis, 2021).

Routine maintenance can be understood as the maintenance carried out every year and includes patching work by first doing the preparatory work of cleaning and cutting holes and cleaning drainage. At this stage, testing is carried out by field testing on the pavement structure object and reviewing qualitative engineering parameters (Mahapatni et al., 2019). The hierarchy of routine road maintenance is described in the following table:

**Table 1. Distribution of Road Routine Maintenance**

Routine Maintenance			
Road Pavement Section	Shoulder Section	Drainage	Road Equipment
Asphalt Melting	Hole filling	Silt discharge	Sign repair
Closing road cracks	Bush cleaning	Leaf removal	Peg repair
Hole patch	Tree cutting	Dirt or grass removal	Observation rail repair
Small dig	Graveling the way back		Mark painting

It is necessary to form a group for empowering drainage management and maintenance in rural areas. Empowerment Group Management and maintenance of roadside drainage are needed to provide stability and durability of the road structure from scouring water during rain and discharge. The cleanliness of the roadside canal has an essential role in supporting the durability of the road structure. Water runoff from the edge channel will easily damage the pavement structure, both flexible and rigid pavement (Susanti, 2018). So that in the management of road infrastructure, the role of managing the carrying capacity of the edge canal is significant to reduce runoff water to the road body.

This is very important to note because roads are vital infrastructure in distributing goods and services and opening access to remote areas, especially in Cianjur Regency. This is an indicator of the movement of the wheels of the economy, which is a link in the development chain towards the community's welfare. Road maintenance activities in the city include patchwork and repair of road supporting buildings by cleaning road shoulders, ditches, painting, and others.

A building or improving village road infrastructure will create or improve the lives of rural communities at large. With the construction of this road infrastructure, the community can use the road with the various needs needed (Conterius, 2018). Because of this, roads are the lifeblood of the smooth flow of land traffic; the smooth flow of these roads will be very supportive for regional economic development. If this is done correctly, it will facilitate and accelerate national growth.

The people around the road segment can handle damage to the road body and its complementary buildings. The economic sector's sustainability and other sectors are not hampered by damage to roads and complementary buildings (Wangania et al., 2018). For this reason, a road maintenance method that is simple and easy to understand by the community is needed so that public awareness of environmental and regional infrastructure will increase. This method is designed not to burden the surrounding community financially so that the road maintenance method and its complementary buildings are proposed to come from the surrounding natural resources. There were several main problems before the committee was formed to take care of routine road maintenance, including the following:

**Table 2. Road Maintenance Management Problems**

Factor	Explanation
Organizational Institution	Under existing institutions, ownership of the road network is often unclear, especially when owners are dependent on others for funding amounts.
Human Resources Problem	Weak maintenance policies also have a relationship with the quality and quantity of human resources in most road services. Typically, many road agencies experience problems from a lack of competent staff and at the same time employ a large number of unskilled personnel.
Lack of Clarity of Responsibilities	Clear responsibility means ownership, and who is responsible if the road appearance does not meet the specified standards.

Insufficient Budget Provision	Effective management of the road network requires at least adequate funds to maintain the main road assets in a stable condition for a long time.
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Source: Results of interviews with village heads

Maintenance of rural road infrastructure certainly involves the community in every stage from planning to maintenance, because it will have several significant impacts, including the following: 1) the quality of work resulting from collaboration with the community; 2) operational continuity and maintenance of road infrastructure and complementary buildings; 3) the ability of the community to build a partnership with other parties and strengthen the capacity of the village community to be able to be independent in fulfilling facilities in their area (Hutagalung, 2019). This is considered very important because infrastructure maintenance is a determining factor in development activities, including achieving national development targets in the economic field so that the prosperity of rural communities can be achieved.

Due to many road damages in most rural areas in Cianjut Regency, the government is considered less than optimal in building roads according to technical standards. For this reason, it is necessary to conduct an engineering audit of the road operator immediately. Three critical factors influence road structural damage: First, heavy vehicles with overloading; Second, the condition of road surface drainage; and Third, the quality of road construction implementation. Another factor that is no less important is the quality of road construction implementation (Mathew, 2016).

Based on previous research conducted by Ratu (2020), the important thing about maintaining roads and infrastructure is that maintenance is carried out routinely two or three times a year to ensure the roads are in good condition. Various minor problems that are not ignored can be managed and addressed before they become a bigger problem. Periodic maintenance is carried out with less frequency. Still, it is not recommended for roads in rural areas because the mobility of its use is very high, so it is recommended for routine maintenance. In the research village, there are problems with road infrastructure such as flood-prone areas, lack of culverts, the channel's position being higher than the road, lack of connections in concrete and poor quality of concrete. Based on this description, the authors are interested in researching community-based road maintenance to overcome channel erosion in rural areas.

## **B. LITERATURE REVIEW**

### **1. Rural Road Maintenance**

Village roads can be categorized as roads with local functions in rural areas. Based on Law No. 38 of 2004, village roads are public roads that connect areas and between settlements within the village and environmental roads. This means connecting between towns or marketing locations to liaison for housing and adjoining villages to higher-level activity centers (sub-districts). The construction of village roads is recommended to improve the existing old roads. This is to avoid the large volume of work and difficulties in land acquisition (Yulianti & Hasanah, 2018).

However, sometimes it is unavoidable to create new paths or upgrade paths. Road construction in rural areas, in addition to paying attention to the technical aspects of road construction, also needs to consider aspects of soil conservation considering the condition of the room with a topography that is often hilly and with soil that is sensitive to erosion (Sitompul et al., 2021). Observations in the field show that there is not much soil erosion from roads, especially in landslides from road cliffs.

Based on the regulations contained in the Regulation of the Minister of Public Works Number: 13 / PRT / M / 2011, road maintenance is a road handling activity, in the form of

prevention, maintenance, and repairs needed to maintain road conditions so that they continue to function optimally to serve traffic so that the planned life span set can be achieved.

## **2. Road Complementary Infrastructure**

Complementary road infrastructure is buildings that can support road the function and safety of road construction, such as retaining walls and drainage channels built following the technicalities, including complimentary road buildings. Complementary road infrastructure has several primary functions: traffic lanes, construction support, and road user support facilities (Sitompul et al., 2021).

Drainage Channels prevent inundation by draining runoff water so that the power of flowing water does not damage soil, plants, and other conservation structures. In landslide-prone areas, the construction of drainage channels is intended to reduce the rate of infiltration and percolation so that the soil is not too saturated with water as the main factor triggering landslides. The form of drainage channels, especially in farming land, can be divided into escape channels, terrace channels, drainage channels (including waterfall buildings). Gates are used to regulating, open, and close water flow in both open and closed channels (Karim et al., 2019).

The essential parts of the sluice gate are: a) ate leaf, which is the part of the sluice that withstands water pressure and can be moved to open, regulate and close the flow of water; b) guide frame, which is a groove of steel or iron that is installed into the concrete used to keep the movement of the door leaf as planned; c) anchorage, which is steel or iron embedded in concrete and used to hold the frame regulating the direction of movement to transfer loads from the sluice gate into the concrete construction; and d) Hoist, which is a tool to move the sluice gate so that it can be opened and closed quickly (Akbaridin et al., 2021).

Another example of other supporting infrastructure is a bridge in a building structure that connects transportation separated by lakes, rivers, or other crossings. In rural areas, many bridges use wood as the primary material. Wood is a natural resource that has recently been widely used in the plywood and furniture industries. It can be said very little use in the field of bridges directly as the main construction. At least the use of wood as formwork for bridges (Djunur et al., 2020). The availability of wood materials will be closely related to the forest potential in an area.

Like Indonesia, which has a large enough tropical forest, it will undoubtedly be very supportive in constructing simple bridges made of wood. Wood has several advantages, both directly and indirectly, including the following: a) Wood is relatively light, transportation and construction costs are relatively cheap, and can be worked with more straightforward tools; b) Detailed work can be done without the need for special equipment and high expertise. For example, steel bridge construction requires equipment and labor skills. The wooden construction can use a hand drill; c) Wooden bridges prefer wooden decks, which is advantageous for remote locations and away from ready mix concrete production sites. The wooden deck can be installed without formwork and reinforcement, thus saving costs; d) Wood is not easily affected by corrosion as in steel or concrete; and e) Wood is a very aesthetic material if adequately designed and combined with the surrounding environment (Juantero & Lakawa, 2020).

## **C. METHOD**

This research uses descriptive qualitative research. The data used in this study were primary and secondary data; preliminary data was collected through in-depth interviews with the community and village heads through socialization activities regarding rural road maintenance techniques, while secondary data was collected through literature study to determine the condition of village facilities and infrastructure in Cianjur district, and data presentation using descriptive method.

#### D. RESULT AND DISCUSSION

The researchers found several facts and problems based on observations with the village and the community through outreach activities and the provision of materials on rural road maintenance techniques. The condition of village facilities and infrastructure is described in the following table:

**Table 3. State of Village Facilities and Infrastructure**

Village Facilities and Infrastructure	Condition
Road	The rural road has been given a layer of rock sand, but the condition is not comprehensive, only 3 Km long, while the village area reaches 5 Km in total.
	The community hopes that this matter can be resolved soon to facilitate access to activities.
Drainage Channel	Drainage channels in rural areas are in reasonably good condition, but silting often occurs due to erosion of the main channel.
	Drainage channels are essential because they are used for irrigation canals in rice fields and plantations.
Retaining Wall	Drainage channels do not have retaining walls, so erosion and siltation often occur.
	The community often does cooperate, but the mud still blocks it and builds up sediment.
Wooden Bridge	The wooden bridge is still in good condition
	The cliff section of the channel near the bridge abutment has begun to experience erosion and sediment deposition.
Sluice	Waterways used for rice fields and plantations are not optimal.
	It is necessary to build floodgates at several central points

Source: Interview and Observation Data

Based on this, the village head invited the community to repair village road facilities and infrastructure, so the result of this deliberation was an agreement that some of the aid money from the government would be used for road maintenance. An estimated cost of around IDR 6-7 million/km can be used for an initial discussion. This result is based on the calculation of routine maintenance, which is two times a year. These estimates are used until accurate cost estimates are prepared based on road inspections. Discussions continued to set aside a routine maintenance fund that had to be set at the start of the meeting held to discuss provincial government assistance. Community participation is closely related to the power or rights of the community, especially in decision-making and the stage of problem identification, finding solutions to problems, and implementing various development activities. Community participation involves the community in the actions of administrators who directly influence them.

The definition of community participation in road maintenance is the community's involvement in participating responsibly, both passively and actively individually, families, community groups to maintain urban road infrastructure. Maintaining rural roads has become a problem/burden for all village governments, so the central government considers that road management in road maintenance in rural areas is the responsibility of the village government concerned and the responsibility of the community. Based on the agreement, there are several main tasks for routine maintenance that are carried out alternately in community groups; these activities are as follows: 1) clearing bushes and cutting grass; 2) clearing debris or debris from the bridge; 3) cleaning the

culvert parts including the inlet and outlet; 4) cleaning the sides and drainage holes; 5) repairs due to erosion on the shoulder of the village road; 6) roadway cleaning; and 7) grass planting.

The plan can run well if it is also good in road maintenance planning management. Planning is based on the work that needs to be done to record road inspection forms. Next, a calculation is made of how many working days it will take to complete the maintenance, which will provide two things: the basis for cost estimation and the base of the agreement signed with the maintenance work team. In the financing estimate, the following should be noted: 1) the total number of working days required; 2) the rate of wages per working day; 3) the number of workers required by the team; 4) preparation of work equipment and the number of costs required; and 5) necessary materials such as cement, stone, and sand.

Equipment purchased for maintenance or special equipment available from the construction site must be stored at the village office; the Road Maintenance Acceleration Control Team will provide the work equipment to the workers for maintenance and record what materials will be provided. Giving and returning work equipment must be documented and signed by the team leader and labor team members who received the kit.

In addition, the Road Maintenance Acceleration Control Team is also responsible for planning and maintenance work to be in a position to assist the team in ensuring that the planning work is carried out. The Road Maintenance Acceleration Control Team must also check the completion and quality of the work. If unsatisfactory parts are not up to standard, they must be immediately submitted to the team leader, who is given a note on the request to complete the task. In general, it's important to involve someone other than the Routine Maintenance Team, as they should discuss and resolve issues among their team.

After the analysis, the erosion in the channel occurs because of water; water is the leading cause of deterioration, while for dry, hot areas, the wind is the main factor. Soil erosion caused by water includes three stages, namely: 1) The stage of releasing single particles from the soil mass; 2) Transport stage by erosive media such as water flow and wind; 2) The deposition stage, in conditions where the available energy is no longer sufficient to transport the particles.

Soil erosion models can be classified into three: empirical, physical, and conceptual models. The practical model is based on essential variables obtained from research and observations during the erosion process. Erosion prediction models generally use empirical models, especially gray-box models. The universal soil loss equation model occurs in the village where the study is located. MUSLE (Universal Soil Loss Equation Model) is a development of the USLE method. MUSLE does not use the rain energy factor to cause erosion but uses the surface runoff factor. MUSLE does not need a sediment delivery ratio (SDR) factor because its value varies from place to place. The runoff factor represents the energy used to destroy and transport sediment. Sedimentary processes include erosion, transport, deposition, and sediment compaction. Starting from the fall of rain produces kinetic energy, which is the beginning of the erosion process. Once the soil becomes fine particles and rolls along with the flow, some will be left on the ground while the other part enters the drainage channel carried into the sediment. The sedimentation that occurs causes the drain beside the road to becoming shallow and the channel's capacity becomes reduced so that it can no longer accommodate the runoff. In addition to these efforts, the Controlling Team for the Acceleration of Road Maintenance also proposed planting vetiver grass for erosion control to prevent accelerated erosion caused by activities that can have a negative impact on the environment, especially since the village where this research is located is on a steep road slope and without vegetation, and has a high level of erodibility.

After the slopes are completed, geotechnical planning is carried out according to procedures and taking into account safety factors, followed by well-executed slope protection to ensure long-term stability, mainly because this village is an area with high rainfall and has sensitive erosion soil like Indonesia. There are several approaches taken by the Road Maintenance Acceleration Control Team, namely the following: a). chemical method, namely

the use of soil conditioner; and the vegetative process, namely by using specific plants, which is a cheaper approach, affordable for rural communities, aesthetically also environmentally friendly. One of the vegetative method's erosion management efforts is the vetiver system. The Vetiver System (VS) is a simple, low-cost technology that utilizes live Vetiver Plants (*Vetiveria zizanioides*) for soil and water conservation and environmental protection. Planted vetiver is not allowed to be harvested for its roots because if this happens, it can have a contradictory effect, where soil damage occurs.

Vetiver grass was chosen by the Road Maintenance Acceleration Control Team for the following reasons: a) This plant is an annual plant that grows upright with a height of 1.5 – 2.5 meters; b) The root system is deep and massive, able to go very deep into the soil. Some can even penetrate to a depth of 5.2 meters; c) The trunk is stiff and rigid, resistant to deep water flow (0.6 – 0.8 m); d) If planted close together, form a tight row/fence. This reduces the flow velocity, diverts running water, and can be a very effective filter; and e) Does not produce flowers and seeds that can spread wildly like reeds or other grasses. Furthermore, when planted on hard and rocky slopes, the tips of the roots of the vetiver can penetrate and become a kind of solid anchor. The way these roots work is like an iron column that goes deep into the soil layer and at the same time holds the soil particles with its fibrous roots. Such conditions can prevent erosion caused by wind and water.

However, the Controlling Team for the Acceleration of Road Maintenance is also aware that there are several weaknesses in this method, including the following: a) Due to the growth pattern of vetiver which is perpendicular or vertical to the soil, it is recommended that it be planted in combination with other types of ground cover plants, such as bahia Bitter grass (carpet grass) or types of legumes (legume). So that the cover crop can reduce splashing and runoff, especially at the beginning of vetiver growth; b) On the front, you can see Bahia grass covering the ground, before the vetiver shoots grow closer and the leaves are lush; and c) Since vetiver is a living plant, it cannot function appropriately in dealing with surface erosion immediately. This plant still needs time or a process, namely the growth process.

Stability analysis needs to be carried out with multi-parameter observations, such as observing the influence of climate on erosion and soil characteristics against failure so that prevention methods can be carried out appropriately. Prevention of erosion and landslides using structural methods generally uses concrete, geotextiles, and anchors, while prevention using vegetation methods (non-structural) is carried out by biotechnical methods, which are widely known as green infrastructure.

Transportation infrastructure generally faces many environmental challenges, such as emissions, decreased water availability, floods, droughts, erosion/slides, and seawater intrusion. Development policies oriented towards improving environmental quality can be carried out by applying the concept of green infrastructure (Boonsong & Chansiri, 20018). The environmentally friendly idea carried out by the Road Maintenance Acceleration Control Team for road erosion control was chosen to be very economical compared to concrete construction. Vetiver can also contribute to the environment by reducing carbon levels in the earth's atmosphere, so it is necessary to conduct a study related to the benefits of vetiver in controlling erosion and landslides.

The implementation of vetiver with the biotechnical method requires an interdisciplinary scientific approach; therefore, the Controlling Team for the Acceleration of Road Maintenance focuses on two main points, namely: (1) selection of vegetation types and (2) methods of implementation, biotechnical work involves combining biological systems and engineering principles. The biotechnical approach also requires partnerships with disciplines including soil scientists, hydrologists, botanists, engineering geologists, civil engineers, and architects (Lavania, 2004).

This is following the research conducted by Darajeh et al. (2014) argue that the application of vegetation systems in stabilizing slopes can be used as a prevention and control measure widely in engineering practice. Living plants and natural elements such as tree

trunks or stones can be used as reinforcement media to achieve the desired engineering objectives. Vegetation systems using living plants in conjunction with traditional reinforcement measures are more cost-effective and environmentally friendly.

The steps taken by the team were following previous research conducted by Keshtkar et al. (2016), which states that vetiver leaves function (1) to reduce the kinetic energy of rainwater by minimizing direct collisions by rainwater to the ground surface, falling water turns into surface runoff which can partially infiltrate well until when the soil becomes saturated, vetiver functions (2) as a fence that reduces surface runoff energy so that soil displacement can be minimized, in addition to the hydrological function of vetiver, it can also function (3) mechanically through root performance which can increase the value of soil cohesiveness. Vegetation roots are the most critical part where roots can absorb water in the soil and reduce pore water stress; besides, roots can bind the soil, which functions as biological anchors for slope landslide control systems.

The community is asked to participate because the community has great potential in every development. Society does have multiple aspects; besides being the recipient and actor of all kinds of decisions, the community also plays a role as the ultimate target of various rules, instructions, and all types of policies from the upper class effectively. One approach to the community used by the village government and socialization programs to assist government programs in maintaining city roads is to change the community's mindset about understanding that all road management is the responsibility of the government. Several aspects that can change the mindset of the community are as follows: a) Encouraging the participation of the community and community organizations in the village road maintenance program; b) Provide information/counseling on the importance of road management, in this case, road maintenance to maintain the level of road service to facilitate the mobilization of village economic activities; and c) Changing the mindset that road maintenance is only the responsibility of the government.

## E. CONCLUSION

Based on the results of the research analysis, it can be concluded that in road maintenance, the purpose of the socialization carried out by the government is to participate in the routine program, with the formation of the Road Maintenance Acceleration Control Team as the supervisor and person in charge who provides several alternatives to repair the retaining wall and prevent erosion of the channel walls. It is necessary to add floodgates to the rice fields and plantations in rural areas. In addition, it is also required to plant a Vetiver System to prevent erosion around the road with the help of the community, some of whom have an understanding of the management of road facilities and infrastructure but are still not optimal.

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