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Study on the Possible Sustainable Solutions to Make a Stable Road Network in Rural Roads in Monsoon Seasons

Prajwal Sunar [a], Sangeeta Singh [b]

[a, b] *Department of Architecture, Pulchowk Campus, IOE, Tribhuvan University, Nepal*
[a] 076msess@pcampus.edu.np, [b] sangeeta@ioe.edu.np

Abstract
Road transportation is one of the most significant forms of infrastructure a country can have, if not the most important. It goes without saying that the socioeconomic growth of a country is accelerated by the expansion of a good road transportation network. The current state of Nepal's road network, however, is not far from sad circumstances. The majority of Nepal's roadways are in poor condition, with the exception of a small number of important thoroughfares in large towns. This issue requires immediate attention, yet the most likely solution is not feasible everywhere because of the Nepali government's spending capability and economic capacity restrictions. The main issues and difficulties with rural roads were discovered by this study, along with the causes of the roads' inefficiency. Through a self-sustaining process of participative approach that makes use of local resources, this study explored the role of nature-based solutions and developed a framework for potential sustainable solutions of rural roads.

Keywords
Sustainable rural road, Nature based solutions, Participatory approach

1. Introduction

Road transportation is one of society's crucial, if not the most important infrastructure. There is 29157 km road network in Nepal, among which 34.25% (9987km) is earthen or as quoted by the ministry "Fair Weather" road network. Apart from handful of major roads in big cities, situation of most of the road conditions in Nepal is discouraging. For the fiscal year 2078/79, Nepal Government allocated a Budget of Nrs 1647 Billion among which 347 billion was allocated for capital expenditure. Most of them are allocated for 'fixed assets' such as road and bridge construction and repairs as well as non-residential building construction and purchase. However, the current roads in rural parts of the country or most VDCs the road conditions tell a different story.

2. Problem Statement and Research Need

Roads are the starting point for the overall economic and social as well as other infrastructural transformations of the rural places in Nepal. There is an urgent need to address this problem, and the most likely way to solve this is not possible for all places due to the limitations in the economic capacity of the government of Nepal. So, there is a dire need to find an alternative way to make those rural mud roads in Nepal using sustainable and economic local materials and local participation.

3. Research Objectives

The main objective is to develop a framework for possible sustainable solutions for rural roads through the self-sustaining process of a participatory approach that uses local resources. To achieve the aim, other specific objectives are as follows:

- Identifying the existing problems and challenges of the study site and different causes of the rural road being the poor condition in monsoon season.
- Studying the possible sustainable nature-based solutions and indigenous technology to make the road stable.
- Uncovering the self-sustaining process through a participatory approach that uses local resources; manpower as well as materials with

low demand for energy and economy.

4. Research Question

Following research questions have been identified to address the research objectives.

- What are the existing problems of the site and the different causes of the rural road being in poor condition?
- What are the possible nature-based solutions?
- How do sustainable nature-based solutions and indigenous technology help to make roads stable?
- How the framework of self–sustaining process through participatory approaches adequately addresses the issues of the rural road.

5. Literature Review

5.1 Road Classification

Roads in Nepal are classified as follows:-

5.1.1 Administrative Classification

Administrative classification of roads is intended for assigning national importance and level of government responsible for overall management and methods of financing. According to this classification roads are classified into (NRS, 2070)

1. National Highways
2. Feeder Roads
3. District Roads
4. Urban Roads

5.1.2 Technical/Functional Classification

For assigning various geometric and technical parameters for design, roads are categorized into classes as follows (NRS, 2070)
Class-I
Class-II
Class-III
Class-IV
In Nepal, the overall management of National Highways and Feeder Roads comes within the responsibility of the Department of Roads (DOR). These roads are collectively called Strategic Roads Network (SRN) roads. District Roads and Urban Roads are managed by the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR). These roads are collectively called Local Roads Network (LRN) roads.

5.2 Sustainable approach in road construction

Only the finished product was the focus of traditional or conventional development. The approach abused both people and the environment. More extensive use of nature results in environmental issues, land degradation, and climate shifts. The hierarchy of people, gender, and culture has also been developed as a result of the larger difference between the haves and have-nots. All of the challenges that the traditional type of development does not solve are addressed by the sustainable development model efforts to combat poverty and respect of people's fundamental needs. The sustainable development models took into account factors including productive employment, environmental concern, and the use of suitable technology, which helped close the gap between the wealthy and the poor [1].

World commission on environment and development (WCED) in 1987 define Sustainable development as "a development, which meets the needs of the present without compromising the ability of future generation to meet their own needs." Social, environmental, and economic accountability—commonly referred to as the "triple bottom line"—are the three main pillars of sustainable development. The environment, social development, and economic development were defined as the pillars of sustainable development during the 1992 Agenda 21, Rio Conference on the Sustainable Development. The importance of integrating and striking a balance between the three foundations was underlined at the meeting [2].

5.3 Eco-safe rural roads

The use of vegetation, either by itself or in conjunction with traditional civil engineering structures, to reduce soil erosion and shallow landslides is referred to as eco-engineering or soil bioengineering. In eco-engineering systems, the environment is prioritized together with inert and active building materials in order to maintain soil slopes and prevent disturbances. The plant species employed in eco-engineering carry out an established

engineering function that offers a variety of sustainability advantages, such as short-term protection against soil erosion and long-term stability owing to the reinforcing action of the roots on the soil [3].

6. Methodology

This chapter presents the process with which the study was designed and conducted. It involves a description of how the adopted methodology meets the objective of the research. The justification for the choice of methods is given, followed by the research framework, showing a clear picture of the study process.

Methodology Social science Qualitative and Quantitative Research Methodology

Research Desigh Exploratory and Descriptive

Research Strategy Phenomenology, Ethnography

Research Approach Deductive/Inductive Methods

Data Collection This research is based on both the primary and secondary data collection method. The primary data collection techniques used in our study were observation, transect walk questionnaire survey, interview with key informants. Both structured and unstructured questionnaires were used and at the same time structured questionnaire survey was done by using kobo toolbox software. The key informants who involved in this study were vice president, engineer and ward president of both rural municipality. The secondary data collection methods are literature review, literature case studies, government's documents, district profile of Nuwakot district and CBS file etc.

Positivism is based on a comprehensive examination of all subjects. It has no intrinsic worth and is guided by the cause-and-effect principle. Positivism thinks that the truth may be discovered, regardless of the circumstances, such as time or location. The post-positivist is a positivist descendant who rejects the Theory of Absolute Truth and claims that the universe is not deterministic.

The Post-positivist paradigm proposes that reality is based on both scientific and common-sense thinking. Due to realistic limits in resources and time, it takes just a plausible population of the topic and interpolates the data to generalize. In contrast to the positivist paradigm, it believes objectivity cannot be achieved perfectly but can be approached.

Constructivism is the view that there are no universal principles or absolute truths; reality is created. Since research is bound by context, everyone's values are vital because they inform the study. It aids in understanding how and why things happen and allows the researcher to get additional knowledge about social processes. It gives for a thorough awareness of the surrounding circumstances.

7. Study Area

This study has been carried out in Nuwakot District of Nepal. Based on my previous work experiences, the Nuwakot district has been selected for my research work. I could get assistance from my previous work and other logistic support from friends and organizations to complete my research. Based on the goals of the research, the study location was chosen. Three separate categorized sites that cover all issues with rural roads were chosen for this project. During monsoon season, one location is fully closed, forcing individuals to utilize another route that raises their transportation costs overall, consumes more time and energy, and negatively affects their local economy. The other sites are chosen in a way that facilitates comparative case studies and also identifies additional issues with rural roads. The Kakani part is on a national route, but the condition of the road is bad and makes traveling difficult during the monsoon, which eventually demonstrates the state of our country's roads. The research was carried out using quantitative and qualitative approaches based on primary/secondary data and literature. For this study, the survey method has been applied for the gathering of data from the field. Because of the motives of the

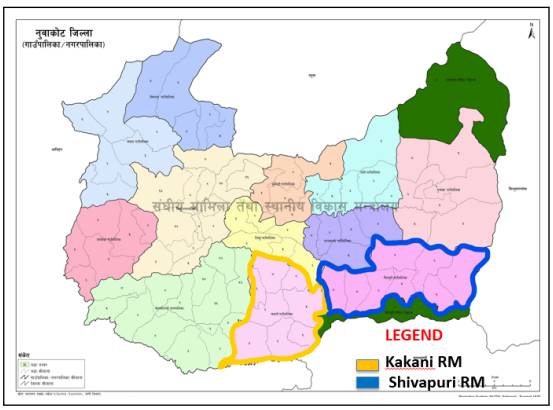

Figure 1: Study Area

research, the purposeful sampling method had been used for selecting sample groups.

The study has been carried out in two Rural Municipality (shivapuri and Kakani) of Nuwakot district. The Shivapuri rural municipality spans 101.5 square kilometers of area, with a total population of 20,769 according to a 2011 Nepal census. The Kakani rural municipality spans 87.97 square kilometers of area, with a total population of 27,073 according to a 2011 Nepal census.

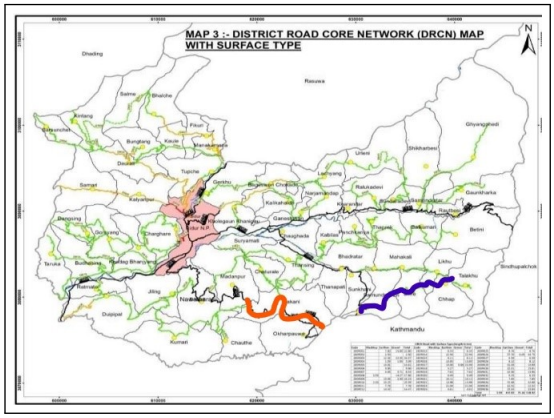

Figure 2: Road Network in Study Area

8. Discussion and Findings

For the study, three locations are selected to investigate various instances involving a mountainous road. Section I, also named as the Gurje section, runs from Gurje bhanjyang to Khole Gau and is part of the Shivapuri rural municipality. Gurje section's roads have double-bituminous surface treatments (DBST). Similar to section I, section II runs from Khole gau to Lapse and is known as the Lapse section. This stretch is likewise part of the Shivapuri rural municipality, and the road is made of earth. Both section I and II are shown in figure 2 by blue line. Section III, referred as the Kakani section, runs from Mudkhu Bhanjyang to Ranipauwa which is indicated by orange line in above figure 2 and is situated in the rural municipality of Kakani. This stretch of the road was once blacktopped, but it is now muddy. The sections I and II are classified as district roads while section III is part of Pasang Lyamu national highway.

This study tried to compare several aspects of rural roads using various road sections as cases. The respondents are divided into three different groups named as User group, technical personnel and authorize personnel and different types of questions were asked them in three different case area. The analysis is based on views provided by different respondents in different case area. The total respondents involved in questionnaire survey was 31. The data obtained from field was analyzed using the SPSS software and the corresponding charts are obtained which are described below based on the questionnaire survey.

8.1 Functionality of Road

Figure 3 demonstrates that the lapse section is inoperative during specific months of the year. The other half was similarly inoperative, though shortly. Figure 4 indicates that only during the monsoon season are all three portions inoperative.

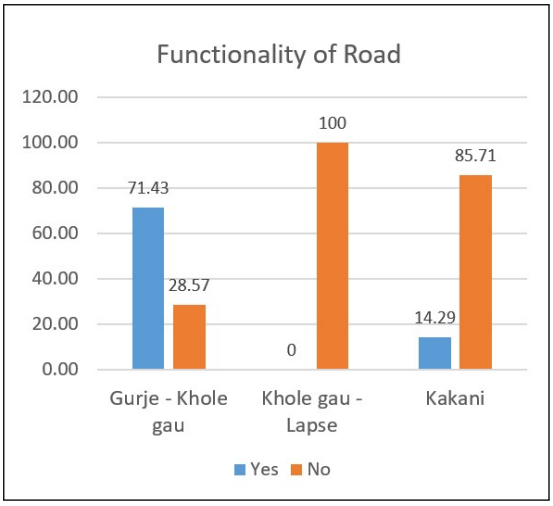

Figure 3: Functionality of Road

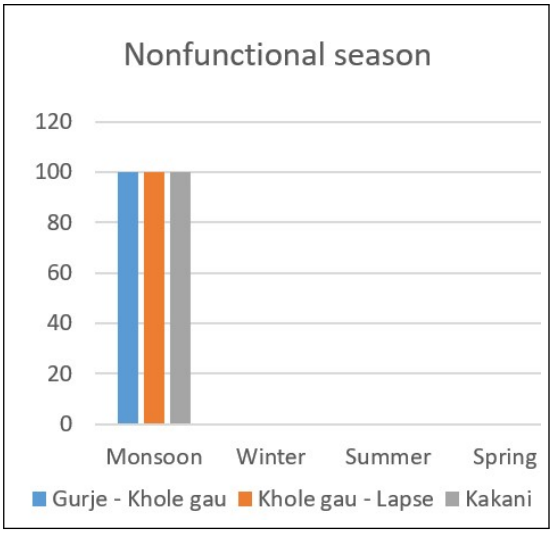

Figure 4: Nonfunctional Season

8.2 Reasons Behind the Road being inopeartive

Three categories—geological, technical, and administrative—are used to group the causes of a road's inefficiency. While technical factors are not discovered as a key cause in Gurje part, geological and administrative reasons are revealed in all three sections. Slope failure, erosion, soil type, and moisture are the geological causes. Similar to this, non-engineered practices, haphazard alignment selections, poor drainage management, and inappropriate construction methods are potential technical causes. The construction procedure, budget allocation, political interest, and lack of monitoring are other administrative issues.

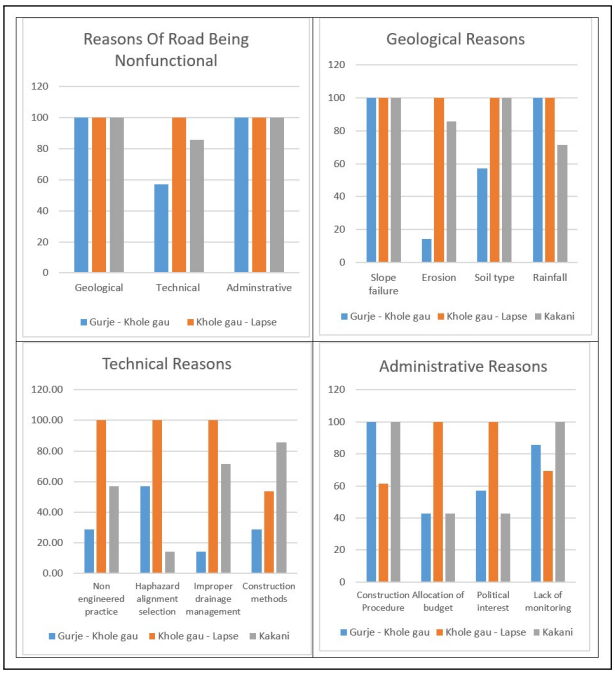

Figure 5: Reason for road to be inoperative

8.3 Nature Based Solutions (NBS)

Figure 6 illustrates that while all technical personnel are aware of nature-based solutions, the majority of respondents from the user group were unaware of them. Local resources are the most often employed nature-based solution in our case study areas.

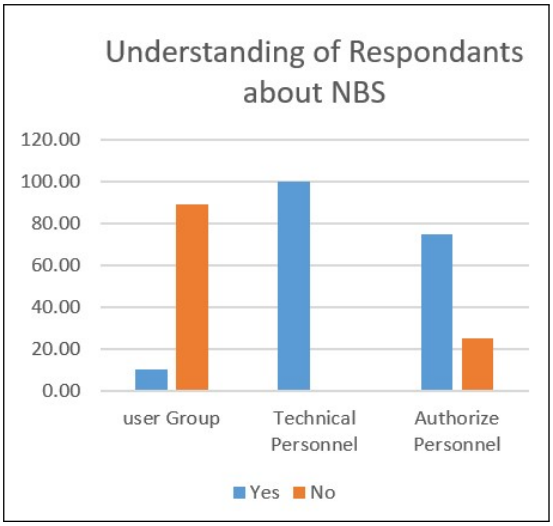

Figure 6: Understanding of respondents about NBS

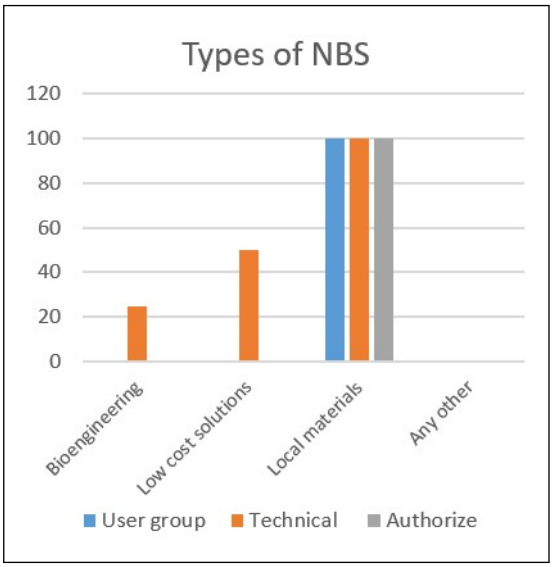

Figure 7: Types of NBS

8.4 Community Participation

The community participates in the process of road development using a variety of approaches in each study area. User committees, labor donations, and road development committees are some of the numerous ways that the community may participate. In every road segment, the user committee is a common way for the community to become involved. Additionally, there are many stages of involvement in which the community is involved. These stages include planning, construction, operation, and maintenance.

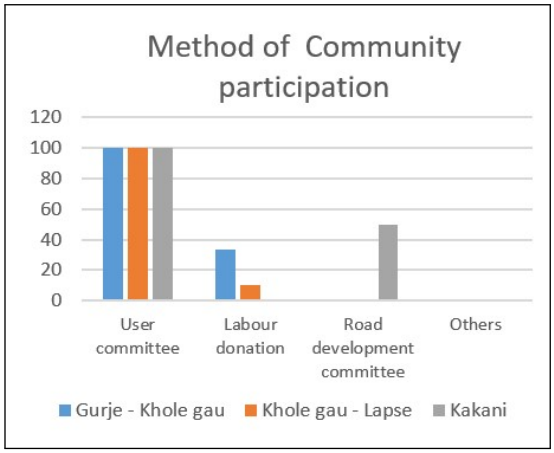

Figure 8: Method of community participation

This refers to the stage of road construction at which the community is involved. Planning phase, construction phase and operation and maintenance phase are the possible phases of community participation. In every cases, community participation mostly occurs in construction phase.

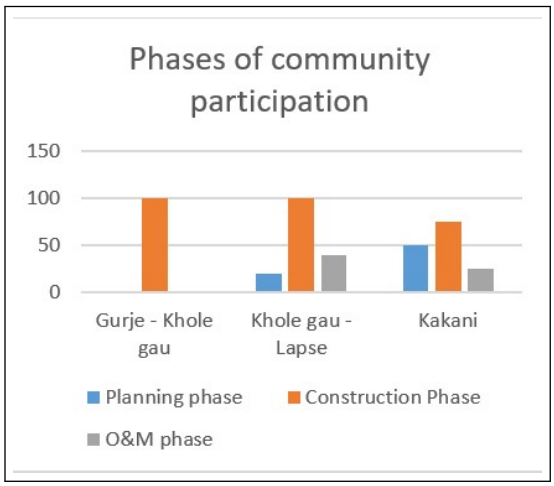

Figure 9: Phases of community participation

9. Conclusion

Currently, the issue of blocked roads during the monsoon season owing to hazardous road conditions affects the rural transportation sector every year. The trip gets exhausting in certain locations where they are still in operation for both the man and the machine. The total economic, social, and infrastructural change of rural areas begins with the road network system, thus the occasional interruptions do more than only slow down local growth. With the help of this investigation, we were able to identify current issues with rural roads as well as the many causes of the season's road closures. The many nature-based solutions are also identified by this study, which eventually aid the development of a road network in a sustainable manner. From the site research, I have obtained the understanding of how community involvement in the process of road building, and highlights the interlinkage between the self-sustaining process and the participatory method. The study comes to the conclusion that the issues with rural roads may be resolved by creating an overarching framework for natural solutions through a participative approach that harnesses local resources.

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