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ReCAP is pleased to present a first blog-post in a series on trends in the road sector that affect the development and implementation of low volume roads and rural transport services in Asia and Africa. This first blog is by **Dr. Dipanjan Basu**, who is an Assistant Professor at the **University of Waterloo, Canada**. He is a civil and geotechnical engineer, and obtained his PhD from Purdue University, U.S.A. He has over 75 publications in peer reviewed journals and conference proceedings, and has won several awards and honours. Dr. Basu is the chair of the Sustainability Committee in the International Society for Soil Mechanics and Geotechnical Engineering and the vice chair of the Sustainability Committees in the Canadian Geotechnical Society and the Geo-Institute of the American Society of Civil Engineers.

Sustainable Development and Low Volume Roads

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Sustainability is a paradigm that questions the traditional practice of technological development in which the focus is only on the technical and financial aspects of engineering design and construction. Sustainability advocates a balanced approach in which the detrimental effects of engineering practices on the ecology and environment are minimized and the quality of life of the present and future generations is not compromised. It promotes harmony between nature and humans by advocating against excessive consumption of natural resources and generation of toxic wastes. At the same time, it discourages activities that lead to economic downturn and societal distress. Thus, sustainability can be approximated by the triple bottom line concept of balancing the 3 E's – environment, economy and (social) equity. Engineering and technological practices are at the core of the sustainability problem because they deplete natural resources, generate wastes, and cause societal imbalance by redistributing wealth and power. Yet modern society cannot survive without technological advancements. Therefore, practices within engineering have to be an integral part of the solution for sustainable development. Responsible and ethical engineering practices are required that produce reliable and robust engineering products, which are economically viable, socially acceptable, and environment friendly. Sustainable development is possible by balancing the 4 E's – engineering, environment, economy, and equity.

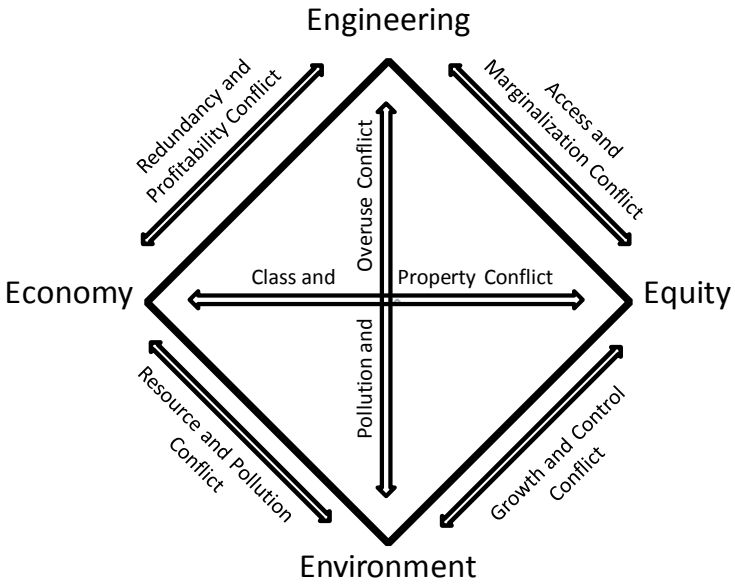

Figure 1. Balancing of 4 E's key for sustainable development.

Low volume roads (LVRs) provide an encouraging solution for sustainable development in developing countries particularly for rural or remote communities. For countries with low budget for infrastructure development, LVRs are a good solution because the cost of construction of LVRs is much lower than that of conventional roads. LVRs require less material for construction and less compactive effort to densify the in situ soil than those required for conventional pavements, and often can be constructed by using locally available materials and with light construction equipment. Consequently, the consumption of natural resources and fuel, and emissions to the environment (i.e., carbon footprint) are less for LVRs than conventional pavements. Clearly, the construction process of LVRs satisfies the sustainability agenda from the environmental and economic points of view.

The social and economic benefits of LVRs are rather compelling. LVRs physically connect remote and rural communities and provide them access to medical facilities, education, human resources, and economic resources. These roads boost tourism, and can significantly help develop the local infrastructure and economy. LVRs may lead to lower cost of transport and freight because of shorter distance and increased connectivity. In times of natural disasters, LVRs may serve as lifelines for evacuation and access to medical supplies, food, and temporary shelter. Thus, LVRs can increase the resilience and reduce the vulnerability of a remote community against disasters. LVRs encourage pedestrian or non-motorized traffic, and contribute to environmental sustainability as well. There are several benefits of LVRs and these roads can certainly improve the quality of life of people belonging to remote communities.

As with any engineering (or human) solution, LVRs too have limitations. It is often questioned if construction of LVRs through remote areas degrades the natural environment. Increase in flooding and erosion, alteration of surface and subsurface water flow patterns, removal of wild animals from their natural habitats, affecting the movement of wild animals, poaching of endangered species, alteration in vegetation, introduction of invasive species, and increase in dust and pollution are some of the detrimental effects that can be attributed to LVRs. Further, maintenance of LVRs can be critical because they are prone to degradation quicker than

conventional pavements, and the actual and environmental costs of repair work may offset some of the environmental and economic benefits of LVR construction. Maintenance is particularly important in mountainous terrains with possibilities of landslides and slope failures, in areas with soft soils where land subsidence can occur, and in regions with heavy precipitation, active seismicity, and extreme diurnal or seasonal fluctuations of temperature. It is important to mention here that the effects of climate change have made the prediction of natural events rather difficult with extreme weather patterns like very intense rainfall with short duration and extensive periods of drought prevailing. Such weather patterns often lead to multi-hazards like flooding and landslides occurring at the same time. Naturally, LVRs are more susceptible to failure and collapse than conventional pavements under extreme weather and difficult ground conditions.

Sustainability is a complex concept that has spatial and temporal dimensions because what is sustainable for a society may be unsustainable for a subsection of the society or for another society, and what is considered sustainable today may not be sustainable a few decades from now. Therefore, there is no absolute correct answer to the question whether LVRs really provide a sustainable solution to development or not. Perhaps, we will get different answers to this question if we ask an environmentalist, an activist, an engineer, and a politician.

Communication is essential in upholding sustainability values. It is important to involve all stakeholders (e.g., owner, lawmakers, engineers, architects, users, and members of the affected community) at the planning stage of an LVR project so that a consensus is reached regarding whether an LVR should be constructed or not, and if constructed what the steps are (such as controlling pollution, minimizing detrimental effect on the wild life during and after construction, preventing negative financial impact on the affected community, choosing environment-friendly materials, ensuring aesthetic acceptability of the project to the local community, etc.), to achieve a sustainable solution. Transparent flow of information during the stages of planning, design, construction and maintenance is required to gain consensus on any required change from the initial plan. Enhanced monitoring techniques may be considered a part of a sustainable LVR project particularly along the stretches vulnerable to natural hazards and/or on difficult ground conditions so that failures can be anticipated and prevented, and overall cost (both actual and environmental) can be minimized. In addition, the possibilities of abandoning or deconstruction of the LVR and of converting the LVR into a conventional pavement with heavy traffic flow (which can happen because of changes in demographics, economic conditions, political situations, etc.) in the future should be considered and the effects of such a future activity on the environment, economy, and society must be predicted before the LVR project is started. It is expected that these prudent steps will lead to sustainable choices for an LVR project and result in sustainable outcomes for the society and environment.

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