



Green Road Approach in Rural Road Construction for the Sustainable Development of Nepal

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Abstract

Transport infrastructure provides a basis for economic activities in the rural areas in the long term. But the environment consequences cannot be neglected only foreseeing long term economic benefit. Difficult topography and unstable geology make the road construction difficult in the rural hills of Nepal. Beside, the predominantly absolute poverty in the region realizes the essence of the appropriate approach in the rural road construction. With its approach of constructing rural roads considering environment and rural poverty alleviation measures, Green road approach is proving to be a sustainable way of constructing rural roads. Environment friendly construction techniques, participatory and decentralization approach, optimum utilization of local resources, simple technology, local capacity building and self help efforts justified Green road approach as a best way of constructing rural roads in hill districts of Nepal. The study analyze the different aspects of green roads in Nepal on the basis of the basic themes define in the dictionary of the sustainable development.

Keywords: Sustainable, Environment, Participatory, Green roads, Poverty alleviation

1. Introduction

Nepal is a predominantly a mountainous country with about 77% of its area lie in the hill and mountain regions. The country is approximately rectangular in shape having an area of 147,181 square kilometers. The north-south length is up to 200km and the east-west length up to 800km long. It has the greatest variation in altitude on earth which ranges from 60m to 8848m a.s.l. The country consists of the snow and ice covered Himalaya in the north. The southern plain is about 30km wide and the altitude ranges from 75m to 280m high with fertile lowland (also swampy) which is known as Terai. The country has a great diversity in climate, vegetation, culture and religion.

According to the United Nation, Nepal counts to the 'Least Developed Countries' and to the "Most Seriously Affected Countries" The country economy grow merely 2% in FY 2004/05. Within the region of South-Asia Nepal's income is low and remains dependent on the agricultural sector, providing employment for 80 % of the population. Poverty is deep and pervasive in Nepal, with wide disparity across regions. According to the 1995–1996 Nepal Living Standards Survey (NLSS), 45% of Nepali households are poor. Poverty is predominantly rural; rural poverty rates of 47% are more than twice those of urban areas (18%), and more than 90% of the poor live in rural areas. On the disparity basis of ecological region, the poverty incidence goes significantly from terai (37%) to hill (50%) to the mountain region (63%). However, the latest estimate for 2001/2 by the National Planning Commission "based on economic growth, population growth and the estimate of Gini index in the last few years" indicates a decrease of poverty incidence to 38%. However, the absolute number of people below poverty line has increased from about 4 million in 1976/77 to around 8.8 million in 2001/2.

According to the data of Department of Roads, up to March 2005 Nepal has 17,217 kilometers of road. Of these 4871 kilometers are black topped, 7403 kilometers are graveled and 7643 kilometers are fair weathered road. Up to that period only 60 districts headquarter out of the 75 have the access to the road facility. So, the country has a road density of about 12 kilometers per 100 square kilometers. Tenth plan target of accessing 70 district headquarter does not seems to be meet under the present condition. Road or transport infrastructure is the major indicator of economic growth. Research has show that several important indicators of economy like trade, electricity, communication, health are positive correlated with the road infrastructure. So, it is a today's essence to invest in road infrastructure for future prospects of the country with the best possible way.

2. Problem and issues of rural road construction in Nepal

There are still fifteen districts in the country which are not connected to the national road networks. All the fifteen districts which are not connected to the National Road network are lies in the hilly and mountain region. The Himalayas constitute one of the most tectonically active fold mountain belts and experience some of the highest rates of erosion in the world. The difficulties presented by conditions of adverse geology, topography and land use are made more accurate in the humid sub tropical and humid warm temperature zones where rapid rock weathering and heavy rainfall act to induce land sliding and erosion. So the construction needs a proper consideration of the geology of the country. With that physical structures and topography, transport infrastructure development is considerably difficult in the country. The geology of the Nepal is weak and in the phase of stabilization. Even a small wrong development can cause the destabilization of the natural environment. Especially in the context of mega projects with the wider catchments can cause a lot of problems, social economical and environmental. In the past, plans were formulated aimed at increasing production of economic value and environment was not incorporated in the planning and implementation of the development activities. The development activities with potential of economic benefit were liable to carried serious risk of environmental adversities. Environment considerations were undermined because it was considered constraints to development. But the result of past negligence of environment is seen today. Losses of land, siltation, landslides, soil erosion, and loss of biodiversity are some of the adverse consequences. In the context of Nepal, lots of environment problems can be cited out that emerged out of developing transport infrastructures by neglecting the environment. Like, Landslide of Krishna Bhir located in the Prithvi highway is well known to all of Nepali and popular among international community, which is a result of defective construction methods and overlook of the environment. Department of Roads had spent a significant budget to control landslide of Krishna Bhir which is really a costly approach for a Least Developed Country like Nepal.

The conventional approach of developing transport infrastructure least considered the environment, Excessive use of blasting results the wider mass movement and slope instability. Construction methodology is costly and the works are carried through the contractors in the conventional approach and thus least considered the social aspects like poverty alleviation. So, with due consideration to difficult topography and wide pervasive poverty, it is very much essential to adopt a sustainable approach in developing transport infrastructure in rural areas.

So, the sustainability of infrastructure development is an issue of growing concern and calls for close examination of the design, construction and maintenance of road infrastructure. In developing countries, particularly in least developed countries (LDCs) like Nepal, the technical knowledge for infrastructure development in rural mountainous regions is still limited, which results in technical shortcomings and significant environmental impact. In the context of Nepal, the development of infrastructure is characterized by high initial costs, frequent damages due to harsh terrain and/or heavy monsoon rain, long construction time and low economic returns. Therefore, there is an urgent need for serious rethinking about infrastructure development strategies and practices. Decades of experience of infrastructure development in the mountainous region has amply created awareness among engineers and planners that development of infrastructure in mountainous regions requires a multidisciplinary approach which considered social, gender equity issues, economic, engineering, environmental and bio-technical factors for the sustainable economic development.

The study critically examines the road construction using Green road approach in the rural part of Nepal. The objective of the study is to relate the different principles and methodology adopted by road construction using Green road approach with the universally accepted themes of sustainable development.

3. Sustainable approach in road construction

The traditional or conventional development focused only on the final product. The method exploited the nature and the people. The wider exploitation of the nature leads to the environmental problems, land degradation and the climatic changes. Likewise it has generated the wider disparity between the haves and have not that have created the hierarchies of people, gender and culture. Figure 1 address the need of sustainable development approach of doing any works. The sustainable development model addresses all the issues which are not addressed by the conventional form of development. Poverty alleviation measures, consideration of basic needs of people. Productive employment, environmental consideration, appropriate technology are some of the paradigm considered by the sustainable development models which contributed in reducing the gap between the haves and have not.

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.” In general, Sustainable development comprises of the three broad pillars social, environmental, and economic accountability, often known as the ‘triple bottom line’ these themes/pillars are also shown in Figure2.

The Agenda 21, Rio Conference on the Sustainable development 1992 identified the environment, social development and the economic development as the cornerstones of the sustainable development. The conference emphasized on the need to integrate and balance between the three cornerstones (Figure 3). The UK Government Uses the Sustainable

Development Commission which evaluates the sustainable development based on 15 different sustainable development indicators they are economic output; investment; employment; poverty and social exclusion; education; health; housing; crime; climate change; air quality; road traffic; river water quality; wildlife; land use; waste.

Conventional approach of the road construction doesn't satisfy the issues under the different themes of the sustainable development. The conventional road construction approach doesn't consider social inclusion of the people. Sustainable approach should be one which considered the wider socio-economic condition of the place where infrastructure is developed. Sustainable road project is the one which aim to reduce the rural poverty in the rural areas by extending the network of rural transport infrastructure and more importantly provide the employment to the community, empowering them, increase the institutional capacity building and improve the sense of accountability and transparency. The sustainable approach is the one which move a step forward beyond developing only basic infrastructure. It is essential to adopt the appropriate technology based on the need of people and stage of development.

3.1 Emergence of green road approach

The construction of low cost and low volume rural road with participatory and labor based approach was started in Palpa district of Nepal with the technical and financial assistance of Swiss Agency for Development and Cooperation (SDC) and German Technical Cooperation (GTZ). The approach includes community participation, financing, technical support, management and provision for the operation and maintenance of the completed road. All of these are integrated to form a new road construction and management approach that was given a name of Green Road Concept (GRC). The concept focus on conserving the delicate mountain ecology, in particular the protection of vegetation cover as means of soil conservation but also brings benefit to the local peoples by providing the off-farm employment opportunities during construction. The concept principles, a design approach and implementation procedure of the green road concept is best adaptable to rural road construction in Nepal. Simple technologies, use of local resources, participatory approach from planning to implementation, proper technical supports, and environment consideration are the important principles of Green road concept. The concept is also used as the labor based, environmental friendly and participatory (LEP) approach in the ADB and SDC funded rural road projects and RAP approach in the DFID funded roads, RAIDP approach in World Bank funded projects. Many road projects are formulated with the same approach till date. While for some the name may be different but the concept and principles are similar. Some of the major international funded rural road programs in Nepal which follow the principles similar to the green road approach are listed in the Table 1.

4. Why Green road approach “a sustainable approach”

It is the matter of the debate and discussion to define whether the Green roads approach as a sustainable approach in the context of Nepal. It had been a long time that the approach was started in Nepal. However, in this study I have tried to indicate some of aspects of green roads on the basis of themes of the sustainable development and internationally accepted sustainable development indicators to define green road as a sustainable approach for the Least Developed Landlocked country like Nepal. The principles, implementing procedures, outputs of the green road projects are the important verifiable indicators.

4.1 Environment Sustainability

One of the important aspects of the Sustainability is the protection of the environment. GRC is based on the environmental friendly approach. The Figure 4 listed the major environmental friendly indicators of green roads which prove the approach environmentally sustainable.

4.1.1 Minimization of slope cutting and preservation of the vegetative cover

The conventional road construction practice of developing the road width by full cutting and throwing the excavated material downhill is a wastage of valuable mass and can cause a damage to the vegetative cover. Instead a proper cut and mill method of mass balancing is used in the green road approach, the excavated materials are used for fill on the valley side by constructing toe wall (Figure 5). Similarly, the trees along the alignment are not cut till the road is operation. Suitable plants are collected and assessed for the bioengineering purpose. The roads under RIDP promoted the planting of soil-stabilizing plants such as bamboo along the sides of the project roads. These crops have helped stabilize the slopes along the road. Besides, once they grow up the local people can cut these bamboos to generate an economic income out of it. They can be used for the construction of the local houses and animal huts. (ADB, 2006)

4.1.2 Mass balancing

The conventional method of road construction by the use of the bulldozer and other heavy equipments ignores the mass balancing approach hence increases the significant height of the cutting which leads to the instability in the hill slope. The cut and throw by the conventional methods have the major environmental impact of loss of the agricultural and forest land. The excavated mass thrown downhill damages the agricultural land and covers the vegetation. In the mass balancing method, cut slope height becomes as smaller as half compared to the cut and throw approach, thereby making the cut slope much more stable and safe (Figure 6). Mass management should be considered in three dimensions, which

means mass management can be maintained not only in a single section but also in three dimensions. Box cutting should be avoided as much as possible. It can be avoided or at least minimized by shifting the centerline to the extent of the allowable horizontal curve radius. Excavated stone blocks, for instance, are stockpiled at the time of collection and re-used for constructing stone structures such as dry stone walls in the later phase. If these stones are rolled down the hill at the time of excavation, existing natural resources are wasted. Later, at the time of need, significant amount of financial resources is required to procure the same, which was once wasted

Deoja (1994) estimates that 400-700 cubic meters of landslides occurs per kilometer per year along the mountain roads and 3000 to 9000 cubic meters of landslide occurs per kilometer during the construction of mountain roads in Nepal. The study carried out among about 7900 cross section of 286 km of 18 hill roads of different regions by (Phuyal et al., 2008) found that while adopting mass balancing approach in green roads (GRs), from 3345 cubic meters to 2900 cubic meters can be managed in side slope filling and only about 465 cubic meters of the soil will be in excess per kilometer which is easily manageable along road to improve longitudinal gradient. The study concluded that about 6320 Sqm of excess virgin land per km will be cut if the conventional cut and throw is adopted.

4.1.3 Environment Friendly Construction methods

The construction of the green road considered environment in the best possible ways. Green road is constructed in phases with the objective of conserving the fragile mountain slope by minimizing the risk of landslide and soil erosion. Similarly, critical sections are identified and relevant adjustment is made. The phase wise construction (Table 2) help in assessing the local natural resources for utilization in construction phase. Construction material availability survey and Plant availability survey are done to assess the availability of local resources and plant respectively. Figure 7 shows a good representation of the phase wise construction of one of the road section of Hile-Bhojpur road.

Blasting which is frequently used in conventional approach is not allowed in Green road approach. Instead a simple method like Chiseling and Hammering, Heating and Breaking and Drilling is done to cut the rocks. The Local people employed during the construction works can easily use these simple tools and equipments. The approach did not use the dozers, excavators and other heavy equipments which consumes extensive amount of the fuels in the construction works hence there is no emission of the green house gases. The construction methods are environment friendly as it approach uses the labor intensive techniques that results almost zero carbon dioxide emission during the construction of the road

4.1.4 Proper water management

Water management is very much essential in the rural mountain roads. Green road approach adopts dispersed water management to avoid concentration of water along the road surface. Natural slope is used to disperse water towards the valley in a controlled manner Mountainside drains are generally only provided at the sections like steep road sections and hairpin bends. The road surface is generally provided with a 5% outward slope so that the surface runoff flows out of the road surface downhill. Diagonal surface drains are provided at the certain interval.

4.1.5 Environment appraisal

As mentioned earlier, careless planning and rapid engineering leads to the adverse environmental consequences in the form of slope stability, spoil disposal, water management and vegetation cover. GRC promotes the mitigation measures to reduce the negative environmental impacts. Use of substantial bioengineering measures, awareness raising among the communities of the consequences of environmental adversities are the part of the mitigation measures. More importantly environment appraisal has been an important part of Green roads. RAP projects use the standard procedures (Table 3) for the environmental appraisal before the implementation of any rural road projects.

Environmental Impact Assessment (EIA) study was performed to assess the likely impact on the environment and to offer recommendations to make the road environmentally and socially sound and sustainable. The EIA report is quite broad and covers various aspects of the physical, biological and socio-cultural-economic environments. It forms a legal obligation under the Environment Protection Act 1998. The EIA includes documentation of environmental baseline information of the project influence area, analysis of positive and negative impacts, recommendation of appropriate preventive and curative measures and environmental and social management plan to implement the mitigation measures.

4.1.6 Bioengineering

Bioengineering is the use of the living plants to reduce slope instability and soil erosion. Green road approach incorporates bioengineering as one of the important tools of environment conservation. Bioengineering is used as a preventive measure rather than a curative one. Local people having their indigenous skill are encouraged for the plantation works and establish the nurseries by providing the appropriate technical advice and support.

A plant availability survey was conducted simultaneously with the road alignment survey in the beginning. The local communities and farmers and landowners in the road corridors were included in the bioengineering process, to make it effective and sustainable as well as income-generating. They were trained to collect Bioengineering plants from the

surrounding areas, which included locally preferred fodder and fruit species, to plant along the road corridors. Their indigenous skills and knowledge of locally available and useful plants was sought. For example, plants such as Amliso (for making brooms), Uttis, and bamboo have the potential to start local cottage industries for income generation. Plantation works were carried out during the monsoons, after the completion of third phase of road construction. The overseers and engineers were trained in bioengineering techniques and local communities were trained in making coir nets from coconut fibers, which were used to stabilize the soil on cut slopes. (DRSP, 2006). Figure 8 shows the one of the landslide prone slope which is stabilized by the use of the bioengineering.

4.2 Sustainable Communities

One of the important aspects of the Sustainability is the sustainable communities. The Figure 9 listed the major social inclusive indicators of green roads which prove the approach socially sustainable.

4.2.1 Poverty alleviation through income and employment generation

For a rural area of like Nepal where most of the people is poor, a project initiated with green road approach brings benefits to the poorest. If a road can be built in an hour through conventional approach using dozer and blasting, then a same road finishing can take 15 days for a local to built using Green road (GR) approach. To make a comparison, for the purchase price of one bulldozer it would be possible to use 120,000 person days in labor-based road construction using the green road approach (equivalent to approximately 200.km of 1.5m wide trail, or .4 - 5. km of full width earthen road). (RRF, 2004) But the most important is the consideration of the livelihood of those people who are poor. The Green road approach facilitates the feeling of the ownership by the local people which ultimately contributes in the sustainable maintenance of the roads. Furthermore, the opening of the road brings the poorest an access to the local markets in addition to the opening of markets for the local products.

The construction of road is carried out in the agricultural slack season through labor intensive techniques generating off farm employment. The high percentage of the money spent on the construction stays actually in the local economy. It is estimated that a labor input of 12,000 person days per kilometer is required to construct a green road and payment to labor accounts for about 65 percent of the total cost per kilometer. (Sharma and Maskay, 1999). Likewise the project completion data of RIDP shows that 183,789 people were directly benefited through the improved access to the road network and other support services like access to hospitals (for child delivery, treatment following accidents, and other emergency situations) is faster and easier. The cost of transportation has been reduced by as much as 75%, and travel time to markets and services has decreased by up to 50%. Likewise, project generated unskilled and skilled employment for local poor people (about 4.2 million person days). New economic activities on the road corridors was emerged like emergence of new buildings and the development of enterprises as tea and snacks stalls, automobile repair shops, and other retail shops. Longer-term off-farm employment opportunities for local people were created, including maintaining existing roads, building new roads, driving vehicles, and working in automobile workshops. In Baglung, for example, the number of automobile workshops increased from two in 2001 to six in 2006. With the completion of the Baglung–Burtibang road, 7 dealers and 20 retailers have started supplying cooking gas. In the first 8 months of road usage, about 150 cylinders per month were sold. The forward and backward linkages of these activities have created jobs in and around the project areas and improved the quality of life of the project beneficiaries. About 67% of the project investment remained within the local economy. (ADB, 2006)

The first Phase of RCIW directly assisted about 250,000 poor and food deficit families (1.0 million people) to create productive assets and improve their self-help capacity. RCIW enabled the poor to Food for Work. (RCIW, 2001). Likewise, Rural Access Programme have estimates about 65% of the RAP road construction projects will be paid as wages to the poorer people, giving immediate benefits to a significant number of households. (RAP, 2003c) Till the July 2008 RAP have generated the employment of 1.61 million persons per day injecting 314 million in to the local economy. More than 8500 households are directly working as the road building groups along the RAP road zone. (MLD, 2008). Likewise DRSP phase II generated 1.2 million person days of the employment out of which significant number are from the disadvantage and vulnerable groups.

4.2.2 Decentralization and participatory approach

The approach adopts the decentralization strategy throughout the process of project cycle. The Green road approach uses a participatory involvement of local authorities and stakeholder communities throughout the formulation, planning, construction and maintenance phases to promote a sense of local road ownership for its operation and maintenance. The beneficiaries make the decisions on the selection of the project, road alignment, labor management, User group formation, and resource distribution and utilization.

Political consensus is developed with involvement of all stakeholders like DDC, VDC, political parties to prepare the District Transport Master Plan. The plan worked as the basis for prioritizing the demand of rural roads in the district. Thus this ensures the infrastructure development does not go in an independent direction and incorporated with the national plan. The participation of the community at each stage is fundamental to the green road approach. After the

master plan is formalized the next level of participatory consultation begins at the micro levels. Different Road management committees with different levels are formed. These committees formulate management policy and assign responsibilities to the different User groups. User groups that comprise of 10 to 15 workers are assigned the construction works. The committees facilitate the construction works along with resolving the local disputes. Since, the works is carried through the community participation, social mobilization support is important part of the approach. Usually NGO are assigned for a social mobilization task. They encourage local people on the active participation in the construction and help them to create sense a local ownership.

4.2.3 Local level capacity building

Local level skill development is one the integral part of Green roads. Local NGOs are assigned for the social mobilization support to develop the sense of ownership and involvement. Beside they promotes self help activities like group savings and credit operations, promotion of nontraditional farming practices, promotion of off-farm income opportunities. Various levels of training are provided during the construction process and trained local people become a source of local manpower for neighboring road projects, and for later maintenance, rehabilitation, and upgrading works. Using collective financing from the central, district, and village governments and institutions creates the attitude that it is possible to build and maintain infrastructures with local resources and to generate a sense of local ownership. Public audits make people aware of how the funds are utilized by providing information on project plans, and expenditures. These public audits were an effective tool to improve transparency and accountability. DRSP Phase II (2002-2006) has achieved good results of the capacity building in the form of providing long term economic benefit to the locals. Twelve of the saving groups have been converted in to cooperatives, local NGOs are trained for social development, and Over 200 income generating groups are formed. So, these indicators show that livelihoods of the local people are improved through the social interventions (beyond the road). So, Local level capacity building can be defined as the part of the community development aims to extend the benefits to people working in the road by raising awareness to improve their standard of living providing opportunities to maintain income generating activities. In the 2000 fifth year of RCIW program (Phase I) 11,100 User Groups members are involved in capacity building training, likewise 17623 user group members received capacity building training in 2000/01, 32,142 User groups received training in Capacity building for the year FY 2002/03. These trainings found to fruitful as many groups like micro project groups, saving and credit groups are able to secure and upgrade themselves for sustainable livelihood even after the withdrawal of the project support. Likewise, RAP emphasized on the skill development of RBGs members in order to effectively utilize the credit taken from group fund. RBGs have identified the opportunity available for income generation at their village and acquiring required skills and knowledge through local resource persons (LRP). RAP has capacitated 99 such LRPs in identified income generating options. More than 60 percent of members got training on on-farm and off-farm IGA options and nearly 50 percent have already started meaningful income generating activities earning a total of NRs. 2.3 million from those activities. (MLD, 2008)

4.2.4 Social equality and gender balance

The 1996 NLSS shows that income poverty incidence is correlated with caste / ethnicity, education and land ownership. In general the occupational caste group (Kami, Damai, Sarki -- traditionally considered the 'untouchables') have significantly high poverty incidence compared to the 'higher caste' group. Household heads who are either illiterate or have only primary education have the highest incidence of poverty and those with above secondary education have the lowest incidence. Similarly incidence of poverty has, in general, an inverse relationship with amount of land holding. (Ojha, 2004). Social conflicts arise because of the social disparity. Advantage group have the competitive advantage in the form of knowledge and control of resources over the disadvantage group (DAG), ethnic minorities and indigenous populations because of education, access to infrastructure, access to knowledge and property. And because of that DAG group are the poorest among the communities. The Green road approach emphasizes on the good participation of the low caste and disadvantage group. The approach addresses the social inequalities that are the root cause of the conflict. DRSP project operated in six districts on Nepal support activities start with opportunities for the poor families to engage in the construction work to bring in good wage in timely manner. The level of participation of the DAG groups on all the six districts under the DRSP project stay at average 71%. (DRSP, 2006)

Likewise Gender equality is principle aspect of GRC to promote the women participation in all the intervention areas. The project provides the equal opportunities for men and women; improved the integration of women into the decision making process; and enhanced the gender sensitivity of stakeholders in intervention areas. The women are not confined within the boundary of the house they are actively participating in the construction work. (Figure 10)The women received the same wages for the similar types of and same quantity of the work as men. Under the RCIW Phase I, District gender action plan was developed and integrated in the RCIW work plan to create awareness among all RCIW decision-makers so that they are able to identify and help solve problems arising from gender inequality and discrimination. The action plan mandated to include 50% women in each User's committee. (RCIW, 2003).

4.3 Sustainable Economy

Another important aspect of the Sustainability is the sustainable economy. The Figure 11 listed the major economy indicators of green roads which prove the green road approach economically sustainable.

4.3.1 Sustainable economic development

Creation of the employment opportunities have been the major objective of the development planning in recent days. GRC not only bring the off farm employment to the large number of the people but the mechanism development within the GRC projects contributing in the country economic growth. The mechanism promotes the local towards savings which provides them to involve in the enterprises and income development activities. The savings made by them provide the basis for the further investment, so GRC promotes the sustainable economic cycle (Figure 12). In the Hile-Bhojpur road constructed under the support of the RAP, Road building groups (RBGs) were encouraged to save a minimum of 10% to 20% of their earnings on the voluntary basis. RBGs are responsible for the preparation of group rules and regulations. The rules and regulations will cover the criteria for prioritization of borrowers, amount and range of loans, etc. Loan disbursements are mainly for cattle rearing, poultry, goat keeping, pigering, loan for domestic expenses and treatment of family members. Some borrowers have used the funds to start small grocery shops, set up trading activities, farm fish, and start up businesses such as tailoring, etc. (Dhaka IS, 2008) Figure 13 shows the different enterprise development activities performed by the locals through the group savings in the Hile-Bhojpur road. Beside these core benefits, GRC also generated the different quantifiable like transport cost savings, producer surplus benefits, appreciation of land values similarly non quantifiable benefits like faster and easier access to market, faster and easier excess to public services and access provision for other rural infrastructures that can be generated through the normal road project. (BN Acharya et al., 1999)

A rapid industrialization is not possible in the country like Nepal where large proportion of the development budgets still dependent on the donor countries. Several studies have shown that road infrastructure is positively correlated with the economic development. Easy access to markets, get rid from the physical isolation and better access to other complimentary infrastructure like health, education, communication is vastly possible after the development of the roads. Lamosangu-Jiri road which has been considered as the first green road constructed is an example. This road has brought long-term development such as tourism, better schooling, and improved health care to the area. In the district of Dolakha where this road was built, the literacy rate has jumped three-fold, i.e., from 17% in 1981 to 51% in 2001. Similarly, while the infant mortality rate in the district in 1989 was 108 for every 1000 births, it has now declined to 50 per 1000 births. The maternal mortality rate for every 100,000 also declined from more than 600 to 350 during the 1990s. Though all this improvement cannot be attributed to the Lamosangu-Jiri road alone, it is evident that the facilities the new road offered to the people has played a crucial role in this development. (SDC, 2008). However, from the experience of other countries, integrated model of investment in roads alongside the education and agriculture (Nepal is predominantly agriculture based economy) will be more effective to rapidity the economic development. Green roads are said to be economically viable if the internal rate of return is at least 12%. (BN Acharya et al., 1999). The overall economic internal rate of return (EIRR) over the 20 year economic life of the project on the basis of cost and benefit streams for the RIDP Project is estimated to be about 20%, against the appraisal estimate of 13% that was made on the 1997. (ADB, 2006)

4.3.2 Optimum utilization of local resources

Optimum utilization of local resources is one of the important indicators of the sustainable development. Green road concept encourages the optimum uses of the local resources in the form of the local labor, local materials and local finance. Suitable construction techniques (such as soft structures, etc.) are applied by using mainly local construction materials (excavated stone, chips, soil, plants, etc.) and locally produced tools and low-cost intermediate equipment where possible (i.e. suitable wheelbarrows and appropriate drilling equipment, etc.). Since off-farm employment opportunities are very rare in the rural areas, labor-intensive road construction methods (mainly manual work) are adopted rather than capital-intensive technologies (such as bulldozers) to generate local employment opportunities and to recycle financial resources at local level as "poverty alleviation" measure. A re-utilization of locally available natural resources obtained from excavation is strongly utilized in the construction process. This form of re-utilization of material is economic and environment-friendly. Excavated soil, rocks, and topsoil and vegetation are the primary construction materials for Green Roads. Excavated soil can be used in the filling works for mass balancing as well as for widening the roads at the passing bays and switch backs. Likewise the stone obtained during the construction works are stacked along the road so that they can be re used for the construction of dry stone masonry, gabion walls and water management structure. Vegetation and top soil can be used for turf and re-vegetation of the hill slopes. Local indigenous skill and knowledge are optimally utilized which makes the road construction not only cheaper but also maintainable. Flexible structures like dry stone and gabions are preferred over the masonry or concrete structures to utilize the local materials, skills and to promote the local workmanship.

4.3.3 Foreign Exchange Control

Steel, Cement, fuels, heavy equipment and machinery are the part of the industrial goods which needs to be imported for the construction works. Like in many hydropower projects, large numbers of the capital goods are imported in the form of turbine, equipment set up and others. Hence, high percentage of the money attributed by the international agencies (either loan or grant) return immediately back into the industrial world. Road construction using GRC rely on the optimal utilization of the local resources hence it contribute in the maintaining the foreign exchange reserve of the country.

4.3.4 Cost reduction

Heavy equipment is expensive to mobilize, difficult to deploy in site without excessive environmental damage and subject to excessive downtime due to the delay in obtaining spares and fuel from the capital. From the experience of the Department of Roads in Nepal, it was estimated that per km cost of construction of road by conventional method as NRs 5 to 8 million in 1998 which is expected to increase almost twice to date considering heavy price rises in the fuel, construction equipments and the construction materials. Earlier, Based on the series of the cost analysis mainly of the Palpa and Dhading Roads in 1985 per km cost was estimated as NRs 1.2 million/km which is equivalent to the 12000 labour/days. The Swiss constructed the Lamosangu-Jiri road at the cost of NRs 250 million for the entire 110km stretch in 1985; the road has been serving as a model for other mountain roads even after more than 20 year of its construction. (Shrestha, 2006)

The cost expenditure under the DRSP phase II (Table 4) shows the similar results, 18km new construction roads made in Okhaldhunga District under DRSP phase II cost around NRs 2.77 million per km. So, Cost does reduced if the road are constructed using the green road concept and the most importantly over 65% of the cost remains within the local economy, which in case of the dozer made construction will goes to the capital motivated Contractors. Generally, Green road projects adopt the cost cutting measures. The implementation of these projects minimizes the use of expensive items. Cost-cutting measures include using locally available workers and materials instead of bringing in technicians and construction materials such as cement and steel. This approach ensures projects are affordable and built within the financial limitations of local communities.

4.3.5 Sustainable maintenance

Road assets are the major assets and to conserve them maintenance is essential. Delayed maintenance works results the value of road in loss. The study has show that Nepal is losing the value of \$ 1 to 2 billion due to the lack of proper maintenance work in overall road network. The approach works to develop a maintenance culture and system within the proximate area to provide the sustainability of the infrastructure and also the long term employment for a proportion of the Road building groups. The principle behind the sustainable maintenance of the road constructed under GRC is the feeling of the ownership. Green Road Concept emphasizes road maintenance as the responsibility of the road owner. Roads are closed during the monsoon to prevent excessive vehicular destruction of the surface (e.g., formation of deep rills). Road Maintenance initiative was taken in 1989 in Palpa District and Dhading in 1993 and introduced the system of toll tax collection and routine maintenance. Length workers usually the locals from the nearby road corridors were employed for the routine road maintenance works.

5. Conclusion

Sustainable way is the best way of doing anything. Green road approach is a sustainable way of constructing the rural roads in the Nepal. The green road approach considered both environments, social and economic issues of the country. The GRs adopt the mass balancing as the environment friendly approach and more importantly it utilizes the various soil bioengineering techniques to ensure stability of slope and control of the erosion. GRs promote the optimum utilization of local construction materials, equipments and local people participation in each stage of the project. The data show that GRs can be constructed in relatively low investment cost and more than 65% of the total construction cost stay within the local economy. The GRs ensure the decentralized approach through the participation of the local stakeholders and communities throughout the project life cycle from planning to the implementation. The GRs approach strongly addresses the social inequalities and disparity within the society. It adopts the poverty alleviation measures through the employment generation during construction to the income generating activities through the self help promotion or local level capacity building. It encourages the local to take the ownership of the road for the sustainable maintenance of the roads. Green roads fully satisfied different sustainable development indicators defined under the three themes i.e. social, economic and environment of the sustainable development in the context of Nepal. So, if there is a situation of choosing a hare or tortoise for sustainability. Answer definitely will be tortoise with a sustain future a head at least for next 10 years. So the Green road approach is the best sustainable way of developing rural road infrastructures in rural Nepal.

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Table Legends

Table 1. List of the Major projects which follow the Green road approach or similar approaches

S.N	Major rural road project and duration	Funding agency	District covered	Project cost	Status
1	District Road Support Program (DRSP I) 1999-2002	SDC/GoN/DDC	3	NRs 95.2 million	Phase out
1	District Road Support Program (DRSP II) 2002-2006	SDC/GoN/DDC	6	NRs 395 million	Phase out
	District Road Support Program (DRSP III) 2006 to 2010	SDC/GoN/DDC	6	NRs 695 million	Running
2	Rural Infrastructure Development Program (RIDP) 1995-2005	ADB/GoN	3	NRs 1.24 billion	Phase out
3	Rural Access Program (RAP) 2001-2007	DFID/GoN	7	NRs 1.4 billion	Phase out
3	Rural Access Program (RAP) phase II 2008 – 2011	DFID/GoN	7	NRs 2.21 billion	Running
4	Decentralized Rural Infrastructure and Livelihood program (DRILP) 2005-2010	ADB/GoN	18	NRs 3.87 billion	Running
5	Rural Access Improvement and Decentralization Program (RAIDP) 2005-2010	WB/GoN	20	NRs 3.1 billion	Running
6	Rural community and Infrastructure Works (RCIW) 1996-2007	WFP/GTZ/GoN	30	NRs 3.37 billion	Phase out
7	Decentralized Finance and Development Program (DFDP) 2000-2007	UNCDP/DFID	20	NRs 320 million	Phase out

(Source: MLD, 2008)

Table 2. Phases of Green road construction

Phase 1	Opening of Trail	Average width up to 1.25m	
Phase 2	Gradual Widening to track	Average width up to 2.5m	
Phase 3	Road Construction	Full width with retaining and water management works.	
Phase 4	Finalization and bioengineering	Final shape of road, construction of passing bays.	

(Source: BN Acharya et al., 1999)

Table 3. Environmental appraisal procedures followed by RAP

Environmental activity	Purpose
District Environmental Brief	A profile of environmental conditions in each RAP district
Initial Environmental Examination	The first level of environmental study, required for all district roads and for other types of programme works such as major bridges
Environmental Impact Assessment	A full in depth study of potential impacts, carried out if an IEE finds that impacts might be significant. Also required for feeder roads.
<i>Environmental Management Plans and Environment Monitoring</i>	The process of making sure that the recommendation from environmental studies are applied in practice, both during the projects and afterwards.

(Source: RAP, 2003a)

Table 4. Actual cost expenditure under DRSP Phase II

District	New construction (km)	Rehabilitation (km)	Routine and periodic maintenance (km)	Upgrading (km)	Cost (NRs/km)
Okhaldhunga	18	NA	NA	NA	49,917,848
Sindhuli	32	20.5	58.5	16	53,271,618
Ramechhap	13.8	8.1	8.1	NA	61,482,652
Dolakha	8.5	44	51	16	50,257,786
Sindhupalchowk	13	66.9	76.9	10	50,094,537
Kavrepalanchowk	7.4	46.5	61.5	12.3	51,231,917
<i>Total Km</i>	92.7	186	256	54.3	31,825,639

(Source: DRSP, 2006)

Figure Legends

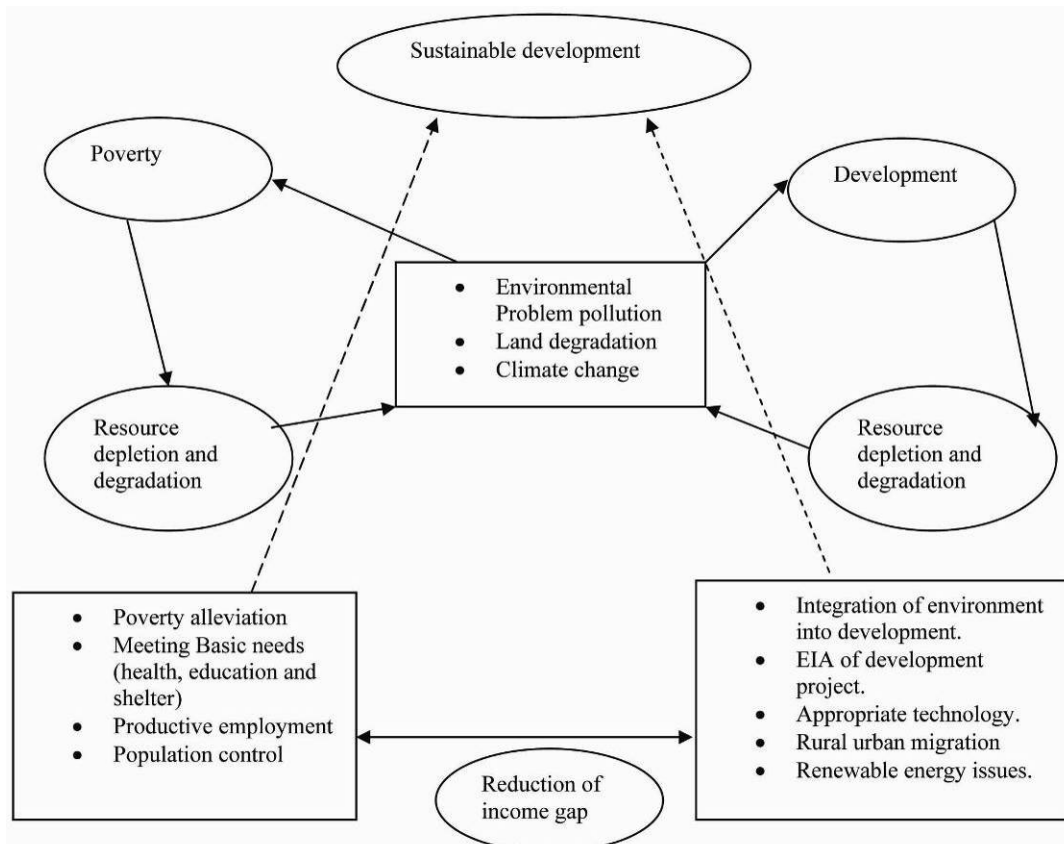


Figure 1. Need of sustainable development (Source: Uprety BK, 2008)

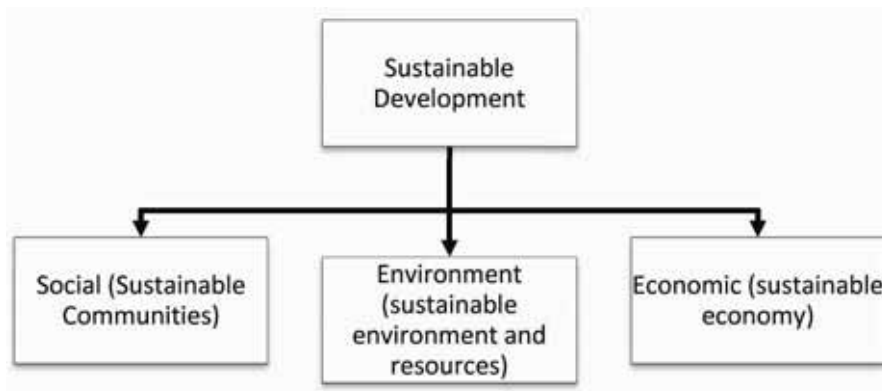


Figure 2. Pillars of sustainable development approach

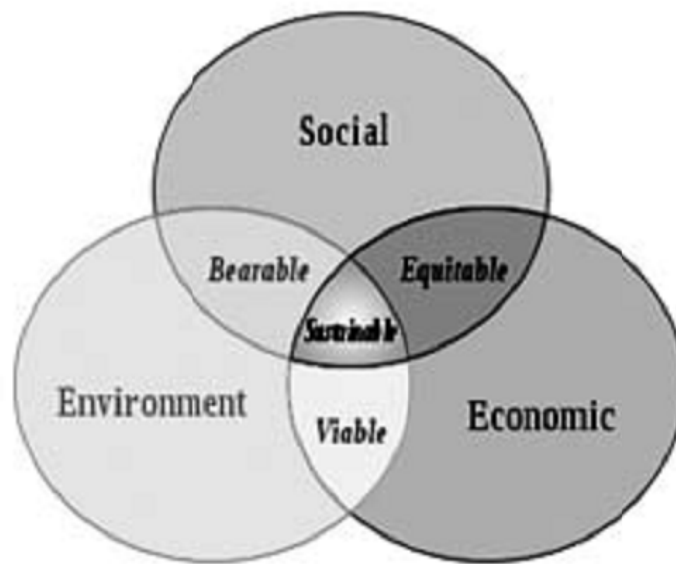


Figure 3. Interrelation between the 3 pillars of sustainable development, interdependent and mutually reinforcing (Source: Uprety BK, 2008)

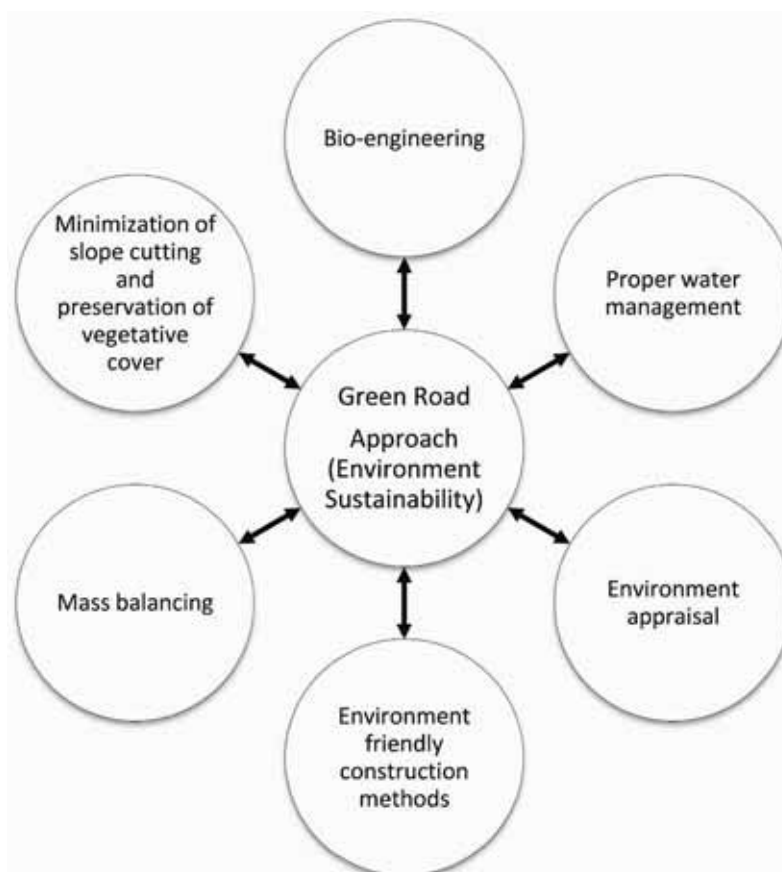


Figure 4. Green road approach for sustainable environment



Figure 5. Toe wall constructed for filling in the valley side

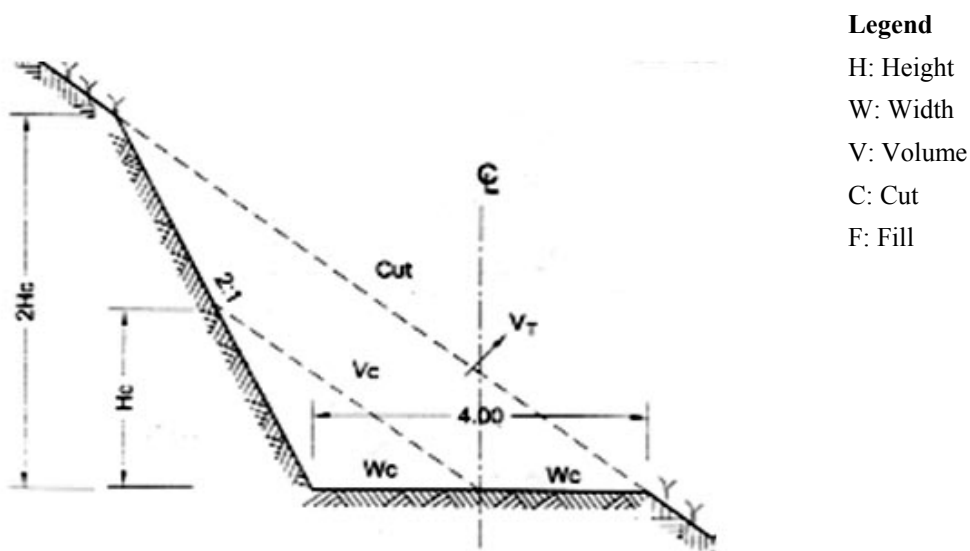


Figure 6. Mass Balancing (Source: BN Acharya et al; 1999 pp52)



Figure 7. Phase construction; first phase 2.5m track opening to gradual widening to 4.5m road length.
 (Source: Dhakal IS, 2007)

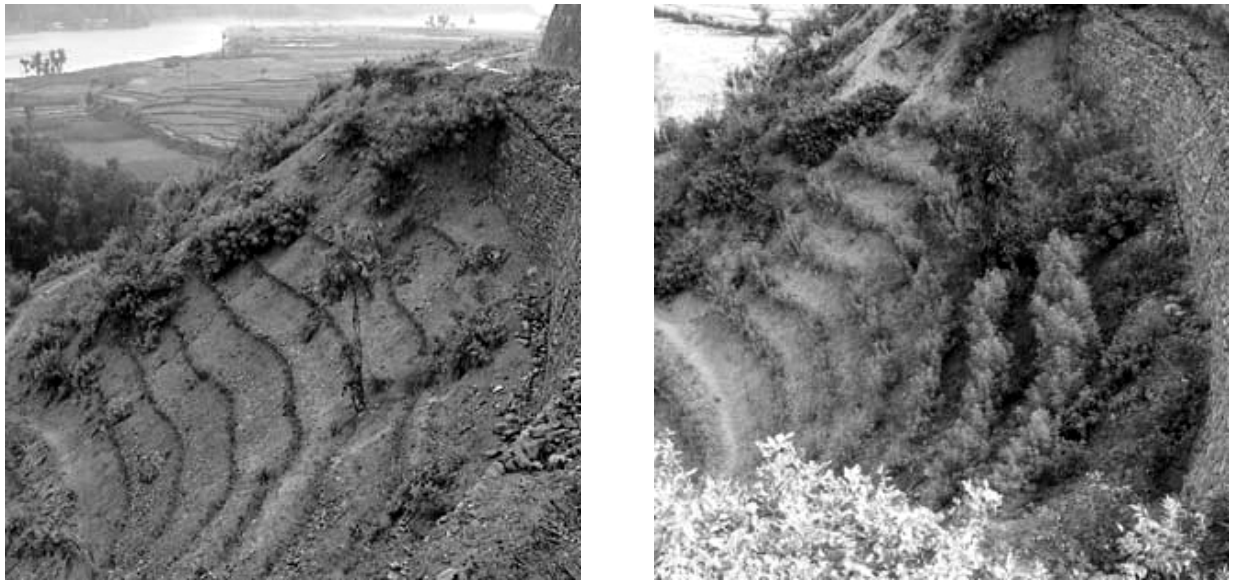


Figure 8. ensuring the slope stability after the bioengineering work downward the roadside.
(Source: DRSP, 2006)

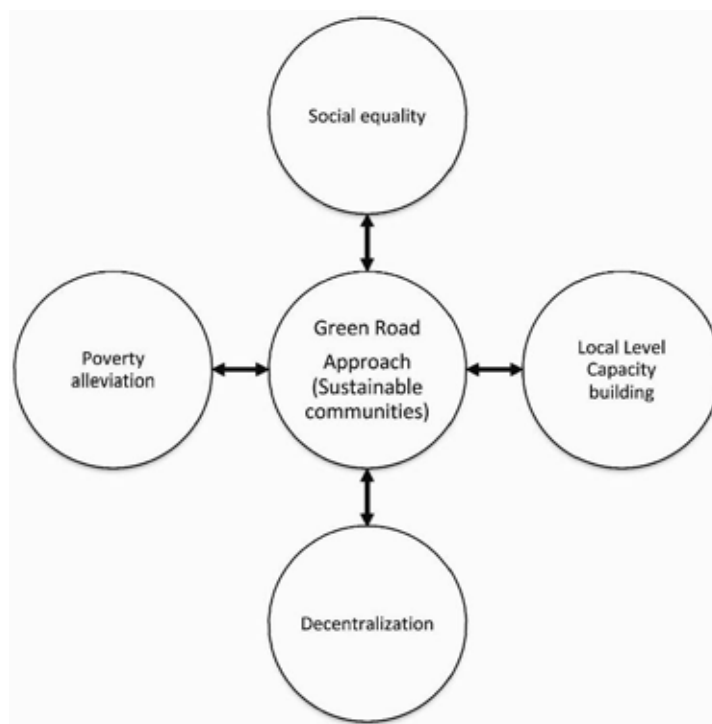


Figure 9. Green road approach for sustainable communities



Figure 10. Active participation of the women in construction work (Source: DRSP, 2006)

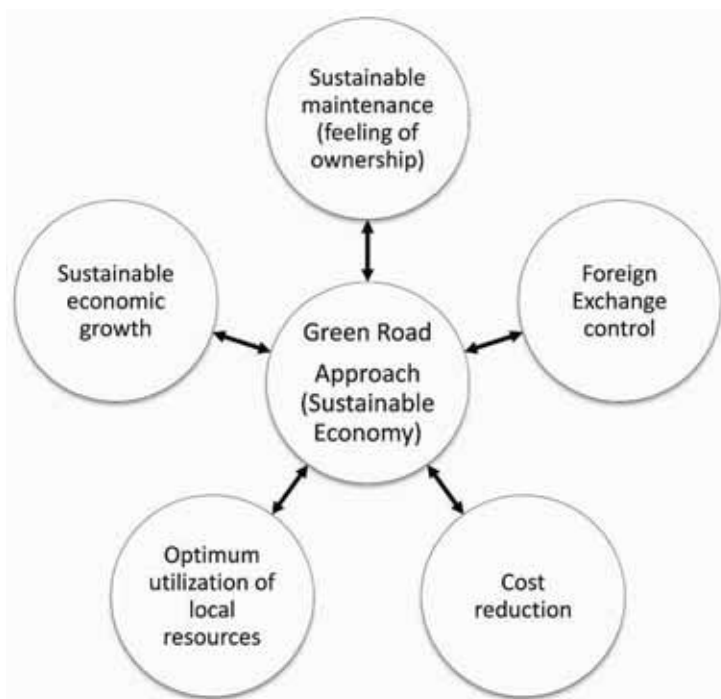


Figure 11. Green road approach for sustainable economy

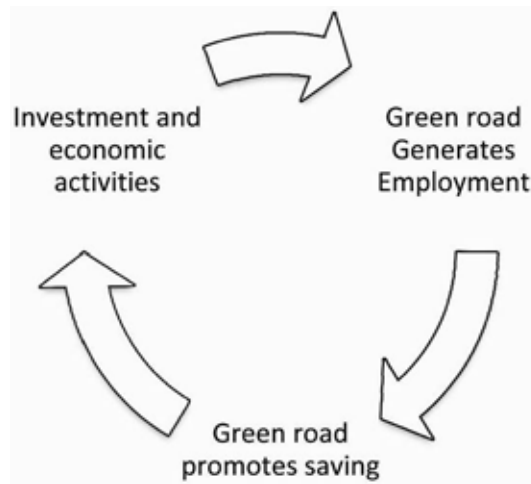


Figure 12. Green road economic cycle



Figure 13. Enterprise development activities through group savings delivering returns; in clockwise direction (a) Piging, (b) Cash crops (c) shops (d) goat keeping (Source: Dhakal IS, 2007)