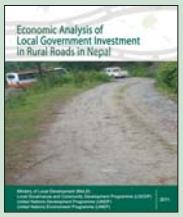
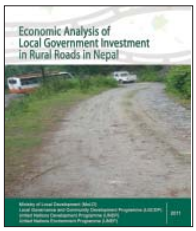


Economic Analysis of Local Government Investment in Rural Roads in Nepal

Empowered lives.
Resilient nations.

UNEP



Economic Analysis of Local Government Investment in Rural Roads in Nepal 2011

Published by:
Ministry of Local Development
Local Governance and Community Development Programme (LGCDP)
Pulchowk, Laliitpur, Nepal
http://www.lgcdp.gov.np

United Nations Development Programme (UNDP)
Environment, Energy & Climate Change Unit
UNDP, Nepal
G.P.O. Box 107, Kathmandu, Nepal
http://www.undp.org.np

United Nations Environment Programme (UNEP)
UNDP Asia Pacific Regional Centre
U.N. Building, 2nd Floor, Block A
Rajdamnern Nok Avenue
Bangkok 10200, Thailand
http://www.unep.org/

PEI Nepal Brief

The Poverty-Environment Initiative (PEI) in Nepal will support poverty reduction and inclusive development by integrating pro-poor climate and environmental concerns into development planning and economic decision-making. The PEI is not designed as a stand-alone project as such, but rather it aims to provide a programmatic framework for targeted support to national and local planning, budgetary and economic decision-making processes through ongoing UNDP-supported programmes, in particular, Strengthening Planning and Monitoring Capacity of NPC (SPMC-NPC) and the Local Governance and Community Development Programme (LGCDP). At the national level, the PEI will help strengthen the NPC's capacity to integrate pro-poor climate and environment concerns in the national planning, budgeting and monitoring processes. Similarly, at the local government level, it will provide technical support to the Ministry of Local Development (MoLD), and select District Development Committees (DDCs) and Village Development Committees (VDCs) to integrate pro-poor climate and environment priorities into local planning and budgeting processes with a particular focus on rural infrastructure. The proposed timeframe for PEI in Nepal is 35 months from February 2010 to December 2012. The PEI Programme Framework will complement the existing project documents of the above two projects, which will include the stipulated PEI activities in their respective project annual work plans (AWPs).

European Commission
NORWEGIAN MINISTRY OF FOREIGN AFFAIRS
UKaid
DANIDA
Irish Aid
Government of Ireland
Rialtas na hÉireann
Irish Aid
GOBIERNO DE ESPAÑA
MINISTERIO DE ASUNTOS EXTERIORES Y DE COOPERACIÓN
Sida

ACKNOWLEDGEMENTS

As a land-locked country, Nepal remained secluded from the rest of the world until the 1960s, with no motorable road connections. Considering the economic value of connectivity, roads have now become a priority at all levels. In a bid to build roads quickly, heavy-equipment-based construction has started to substitute traditional labour-based and green-road construction technologies. Both types of technology have their respective advantages and disadvantages. While labour-based road construction technologies are considered environment-friendly, they can be slow and expensive. Conversely, equipment-based technologies can generally open up roads quickly but are often environmentally damaging.

To assess how Nepal is faring in its use of these two technologies in rural road construction, the Government of Nepal's Local Governance and Community Development Programme (LGCDP) and the United Nations Development Programme (UNDP), under the Poverty-Environment Initiative (PEI), awarded a study entitled **Economic Analysis of Local Government Investment in Rural Roads in Nepal** to a team comprising Govind P. Koirala, team leader/economist, and Sudarshan Karki, environment expert. This team received external support from Hendrik Vessier, an expatriate expert. The team deserves accolade for completing the study in a timely and professional manner.

The study received technical guidance from Paul Steele, Mika Korkeakoski and Seon-Mi Choi from the regional PEI team in Bangkok, Thailand. The team was also provided with substantive support from the Ministry of Local Development and UNDP, particularly from Som Lal Subedi, Joint Secretary and former National Project Director, LGCDP; Gopi Krishna Khanal, National Program Manager, LGCDP; Vijaya P. Singh, Assistant Country Director, UNDP; Dibya Gurung, Programme Officer (Biodiversity), UNDP; Dinesh Karki, Environment Programme Analyst, UNDP; and PEI Advisors Mohan Wagley and Mukunda Raj Pandeya.

The preparation of this report has been made possible through generous financial support provided by all PEI development partners: Belgian Development Cooperation, Danish Ministry of Foreign Affairs, European Commission, Irish Aid, Norwegian Ministry of Foreign Affairs, Spanish Ministry of Foreign Affairs and Cooperation, Swedish Environmental Protection Agency, Swedish International Development Cooperation Agency, UK Department for International Development, and US Department of State. The support from these organizations is duly acknowledged.

It is hoped that the study will provide environmentally ethical suggestions and foundations for use by local bodies in Nepal (DDCs and VDCs) during construction of rural roads in the future.

Mr Teertha Raj Dhakal
Joint Secretary, Ministry of Local Development

ACRONYMS

ADB	Asian Development Bank
BCR	benefit/cost ratio
CD	cross-drainage
DDC	District Development Committee
DoR	Department of Roads
DTMP	District Transport Master Plan
EB	equipment-based
GTZ	German Technical Cooperation
IRR	internal rate of return
LB	labour-based
LGCDP	Local Governance and Community Development Programme
LSGA	Local Self-Governance Act
NPV	net present value
NRs	Nepali rupee (US$ 1 = NRs 75 in December 2010)
UNDP	United Nations Development Programme
VDC	Village Development Committee

EXECUTIVE SUMMARY

Roads are an important priority for local government bodies in Nepal. This is because, if operational, they will open up a multitude of opportunities to enhance local livelihoods. Historically, rural communities have created local roads and other necessary infrastructure using both voluntary and paid local labour. Since the early 1990s, when resources and authority began to be channelled through local government bodies, the use of heavy equipment for road construction such as bulldozers and excavators started to increase. Furthermore, the desire to establish road connections quickly also resulted in the increased use of unsustainable road construction approaches and methods. Unsustainable roads are those that have: (i) no drainage arrangements; (ii) high gradient; (iii) no protection structures in critical places; (iv) no biological protection; (v) no operation and maintenance arrangements or fund; etc.

The overall objective of this study is to inform policy-makers of the costs and benefits of alternative road construction approaches, including social and environmental concerns, and propose specific recommendations on sustainable rural road construction tailored to different stakeholders—central government agencies, District Development Committees, Village Development Committees (VDCs) and communities.

Two districts—Dolakha and Makwanpur in the Central Development Region—were selected for field work because they have the simultaneous presence of both labour-based (LB) and equipment-based (EB) technologies and processes for rural road construction in adequate numbers. A total of six roads were selected (see table below), of which analysis of financial and economic returns was done for five (Roads 1–5); vehicles were not yet plying Road 6. Data were collected from local bodies, construction contractors, members of user committees and general beneficiaries, using focused group discussions and individual interview tools. The study also reviewed relevant documents and secondary data.

Rural roads selected for detailed study in Dolakha and Makwanpur districts

	Road	Total length (km)	Length considered (km)	Technology
Dolakha				
Road 1	Mude–Melung	44	21	Mixed
	Mude–Deurali	11.5	11.5	EB
	Deurali–Bhainse	14	14	LB
Road 2	Bhirkot–Chhaunde	–	14	LB
Road 3	Barabise–Bigu	63	15	EB
Makwanpur				
Road 4	Dandabas–Pakani	15	15	LB
Road 5	Pakani Kharka–Baikuntha	13	13	EB
Road 6	Sitalchowk–Jatiya Pokhari	6	2.5	EB

The direct quantified costs of selected roads are presented in the tables below.

Direct financial costs of selected roads in Dolakha district and share of labour cost

	Mude–Melung (Road 1)			Bhirkot–Chhaunde (Road 2)			Barabise–Bigu (Road 3)		
	Cost ('000 NRs / km)	Share of labour (%)	Labour wages ('000 NRs)	Cost ('000 NRs / km)	Share of labour (%)	Labour wages ('000 NRs)	Cost ('000 NRs / km)	Share of labour (%)	Labour wages ('000 NRs)
Survey and design	18.3	18	3.30	14.1	20	2.82	26.1	15	3.92
Social mobilization	80.4	65	52.28	80.4	80	64.34	15.7	80	12.53
Track opening	633.9	70	443.71	690.0	90	621.00	–	–	–
3-m widening	788.8	65	512.73	861.0	80	688.80	–	–	–
5-m widening	1,408.6	65	915.59	1,530.6	80	1,224.49	522.0	20	104.40
CD* structures	283.1	30	84.94	308.2	30	92.45	41.8	30	12.53
Bioengineering	39.7	50	19.84	79.4	50	39.68	23.8	50	11.90
Supervision	75.0	–	–	125.0	–	–	10.0	–	–
Total direct cost	**3,327.9**	**–**	**2,032.39**	**3,688.7**	**–**	**2,733.58**	**639.3**	**–**	**145.28**
Routine maintenance	10.0	95	9.50	14.3	95	13.57	19.6	95	18.62
Periodic maintenance	53.6	65	34.82	28.6	95	27.14	142.9	20	28.57

*Note: *CD = cross-drainage.*

Direct financial costs of selected roads in Makwanpur district and share of labour cost

	Dandabas–Pakani (Road 4)			Pakani–Baikuntha (Road 5)		
	Cost ('000 NRs / km)	Share of labour (%)	Labour wages ('000 NRs)	Cost ('000 NRs / km)	Share of labour (%)	Labour wages ('000 NRs)
Survey and design	15.0	25	3.75	25.6	20	5.12
Social mobilization	74.0	80	59.20	30.7	80	24.59
Track opening	311.0	90	279.94	–	–	–
3-m widening	389.1	80	311.32	–	–	–
5-m widening	693.2	80	554.56	512.3	10	51.23
CD* structures	139.3	25	34.84	41.0	20	8.20
Bioengineering	75.0	50	37.50	–	50	–
Supervision	125.0	–	–	10	–	–
Total direct cost	**1,821.7**	**–**	**1,281.02**	**619.6**	**–**	**89.14**
Routine maintenance	16.0	95	15.20	22.7	95	21.57
Periodic maintenance	33.5	95	31.83	166.2	25	41.55

*Note: *CD = cross-drainage.*

The indirect costs including the environmental costs are also estimated for each road, and are considerably higher for EB roads than for LB roads. The sources of benefits include local peoples' movement and migration, incremental income from agricultural products, savings in food purchases, incremental income from business merchandise, income from labour during construction, etc. There are also some unaccounted benefits.

While financial analysis of each road has been done using the market prices, the costs are also converted to societal costs using economic prices. The results for net present value (NPV), benefit/cost ratio (BCR) and internal rate of return (IRR) are presented in the table below.

Findings from economic analysis

- All roads have a positive return on both financial and economic investments and returns to the country/society are more than returns to households in all cases. This justifies state investment in and support for development of rural roads.
- LB roads had higher returns (about 30 percent more) than EB roads. This is owing to the higher number of vehicles and days of movement per year on LB roads (3–7 months for EB roads and 7–12 months for LB roads).

Conclusions

- Roads are the number one priority for local communities and, rightly so, considering the spatial nature of poverty in rural areas. However, if roads cannot be plied or the poor do not adequately benefit from them (because the roads are not developed properly), the present high priority allocated to them can itself become a source of problems. LB roads are more pro-poor than EB roads and can provide employment to the poor. Hence, rural road construction can be made into a pro-poor initiative with the use of LB technology.

Estimated NPV, BCR and IRR from selected roads at financial and economic prices

		Financial			Economic		
		NPV (US$)	BCR	IRR (%)	NPV (US$)	BCR	IRR (%)
Dolakha							
Mude–Melung (Road 1)	LB+EB	73,183	1.83	15.9	85,712	2.27	18.9
Bhirkot–Chhaunde (Road 2)	LB	24,707	1.47	12.7	41,915	2.34	19.7
Barabise–Bigu (Road 3)	EB	1,880	1.05	9.5	7,328	1.24	14.3
Makwanpur							
Dandabas–Pakani (Road 4)	LB	18,644	1.60	14.6	29,764	2.71	24.6
Pakani–Baikuntha (Road 5)	EB	499	1.01	8.4	6,915	1.25	14.7

- Existing government processes, particularly budgetary processes, result in long delays in fund release, which limits the working season for road projects. This is not favourable for construction, especially with LB technology, and instead encourages or compels the choice of EB technology for 'last-minute' work.
- Current price trends (threefold increase in wages over the last 10 years and more than 50 percent reduction in heavy equipment rental rates in the same period) have increased the economic feasibility of EB technology.
- The use of EB technology has a strong correlation with the unsustainability of roads. This is caused by, amongst other things, higher risk of too-steep gradients; lack of adequate water-draining structures; an absence generally of road stabilizing and protection structures; significantly higher environmental damage which causes high environmental costs; and a high risk/occurrence (about five times higher) of landslides compared to LB roads.
- There are certain situations when EB technology can be efficient and less damaging. These situations are in (i) road widening; (ii) ridge alignments; and (iii) long alignments through unpopulated areas that require the establishment of labour camps under LB methodology. Similarly, EB technology allows for breaker attachments on excavators, which can be more efficient for breaking very hard rock than LB technology that often uses skilled labourers for tedious chisel-cutting.
- EB technology can be economical and is faster, but is still not necessarily associated with high rates of return. In contrast to this, the returns from LB methods are about 30 percent higher than for EB methods. In Nepal, most non-functioning and seasonal roads have been constructed using EB technologies.
- There are several known instances of corruption and other financial abuses, but none have been formally investigated or penalized. This indicates a clear state of impunity and lack of financial discipline. The risk of corruption is significantly higher with EB methods, since beneficiaries and communities in general have far less involvement in decision-making and in monitoring of alignment selection, tendering for work, and actual construction.
- Whenever and wherever possible, a blend of LB and EB technologies should be used for rural road construction to harness the positive features of each technology—cheaper and faster from EB technology, and sustainable and poverty-reducing from LB technology.

Recommendations

- Roads must be planned in a participatory way and should be a part of the District Transport Master Plan (DTMP). No road should be financed by local bodies, unless it is included in the DTMP. Special care should be taken that decision-making processes on road prioritization, the DTMP and road alignments are participatory and transparent. Community auditing needs to be instigated and an appeals process should be established.
- Feasibility and environmental assessments should be mandatory, and problems highlighted in environmental reports must be resolved within the road design.

- No roads should be started without sufficient funds at hand or without assured funding sources.
- Fund support from local bodies and the centre should be disbursed at the beginning of the lean season (November). For this, the following changes should be made.
  - Change the fiscal calendar in a way that allows development funds to be available for use at the local level by about the middle of November.
  - Expedite the budget release process.
  - Abolish the budget-freezing process at the financial year-end for development work.
- For road projects, an ensured multi-year budget should be allocated, so that the financial grant system does not negatively impact the capacity of local government bodies to construct roads.
- Social mobilization of communities in the influence area of roads should be mandatory for road building. This is important for developing local ownership and mitigating intentional tampering. Social mobilization messages and modes of delivery should be tailored to each community, depending on its level of social capital.
- The use of bulldozers and rock-blasting materials should be discouraged, as the tremor effect they produce impacts on surrounding geological formations and significantly increases the probability of landslides. Controlled blasting techniques, which have a higher efficiency and lower cost because of substantial savings on blasting materials, can be considered. The force of the blast should be directed outward so that remaining rock faces are stable. These techniques can also be used in combination with LB methods, if compressors and jack hammers are made available.
- LB technology should be encouraged and particularly emphasized in poverty-ridden areas. However, to harness some of the positive features of EB technology, the use of excavators and breaker attachments should be allowed in certain situations. Use of equipment should be complemented by water management structures (side and cross drains), other protection structures and bioengineering works in critical areas.
- The Department of Local Infrastructure Development and Agricultural Roads and local bodies should jointly institute a system of annual policy auditing for rural road construction by local bodies to assess policy compliance. Any failure to comply with policy should entail appropriate sanctions such as budget cuts.
- Operational guidelines need to be developed to ensure that transport does not damage roads and the maximum weight limit is enforced. This is especially relevant in relation to criteria for road closure, e.g., during the monsoon, when road surfaces are easily damaged.
- A concerted effort is needed to secure the participation of beneficiaries in all steps of the road project cycle in order to ensure ownership of the road and contributions for road maintenance. Different road maintenance models will need to be developed for different road standards and conditions to allow for communities to contribute within their capacity.

- All rural roads should have adequate operation and maintenance funds for timely maintenance. Such funds must be complemented by beneficiary contributions raised from the increased income resulting from the road. A system of reasonable taxing of vehicles and goods movement can also be developed for this purpose. The tariff fixed for such purposes should not be specified as an absolute amount in the Local Self-Governance Rules but should be left for local bodies to decide for themselves.
- Local road maintenance skills should be developed through training and work during road construction.
- Public service packages in agriculture and the social sectors (health, education, etc.) should be part of road design, so that benefits from the road are enhanced to their full potential. This is built into some projects funded by donors such the Asian Development Bank and World Bank, but not for roads built by local bodies themselves.
- Public forest and land needs to be protected from exploitation by (often) outsiders, who have easy access to natural resources through the expanding road network.
- Rent-seeking practices are anti-poor and should be strictly controlled. For this, public auditing should be mandatory.
- One of the reasons for unsustainable infrastructure at the local level is the shortage of technical manpower. Although resource availability within VDCs has increased by up to 10 times, the availability of technical manpower has remained the same. Therefore, a separate budget head for the outsourcing of technical manpower, e.g., for survey, design, construction and/or supervision, should be provided in grant funds. In addition, the possibility of using public–private partnerships for road development should be explored and tested.
- It is recommended that, in the new state structure for Nepal, the current *ilaka* are defined as the local body equivalent to the current VDC. If the *ilaka* is taken as the smallest local administrative body, then it will have adequate resources and capacity to have its own technical unit. There are currently about 700 *ilaka* compared to 3,915 VDCs.
- The foreseen transformation of democratic and public institutions in Nepal provides a good opportunity for developing clear roles and responsibilities and institutional arrangements conducive for rural road development. New guidelines for planning, design and construction as well as for operation and maintenance are needed, and beneficiary participation and monitoring and evaluation should be reinforced.
- Adequate compensation arrangements should be made for the losers of land to road alignments or of crops destroyed during construction, particularly since the losers are more often than not the poor.

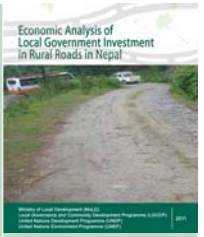
CONTENTS

LIST OF TABLES

LIST OF BOXES

LIST OF FIGURES

1 CHAPTER



INTRODUCTION

Background

Nepal is the poorest country in the South Asian region on a number of poverty measurement indices—on the Human Development Index (HDI) used by United Nations Development Programme (UNDP), by per capita income used by the World Bank, and on the Multidimensional Index of Poverty (MPI) recently introduced by Oxford University researchers, which shows nearly 65 percent of the Nepalese population fall below the absolute poverty line. A major form of poverty in Nepal is spatial—geographically concentrated poverty caused by remoteness, which leads to lack of competitiveness owing to high transaction costs both in input acquisition and output sales.

The occurrence of spatial poverty is demonstrated by the fact that 30 percent of the country's 3,915 Village Development Committees (VDCs) are yet to be linked to the road network. Hence, the development and expansion of road infrastructure in rural areas is obviously a consensus priority for local development at all levels from the centre down to VDCs and settlements. Although it has always been a major concern at the local level, it has gained added momentum since the promulgation of the Local Self-Governance Act 1999 (LSGA) and Local Self-Governance Rules 2000 (LSGR) that vested unprecedented development authority with local governments, along with the concomitant transfer of grant resources and the provi-

sion of taxing authority. This devolutionary policy intends and allows District Development Committees (DDCs) and VDCs to take charge of local development that contributes towards poverty reduction through inclusive, responsive and accountable local governance and participatory community-led development. Now, the conditional and unconditional annual budgetary grant to VDCs ranges from a minimum of NRs 1.5 million to a maximum of NRs 3 million (with an average of about NRs 2.1 million), based on 11 minimum compliance criteria. Having recognized the importance of access to markets, services and economic opportunities, a large chunk of resources available to local governments is being used to construct rural roads. In Nepal, nearly US$ 40 million (NRs 3 billion) has been spent annually in recent years on rural roads projects and programmes. In the past, local bodies used to transfer budgets from other heads (e.g., health, education, etc.) for road construction; however, this practice has now been stopped as other sectors have become more vigilant. In total, VDCs have spent an average of over NRs 1 million each on rural roads.

Road construction technologies defined

In Nepal, there are broadly two main road construction technologies in use for rural road construction/rehabilitation, operation and maintenance: labour-based (LB) and equipment-based (EB). These technologies have their own characteristics in terms of time taken, costs incurred, benefits/losses delivered, employment, poverty impacts, sustainability, etc. The extreme of LB technology, at one end of the scale, is the 'green road' where all operations are done by organized human labour groups with the use of appropriate small tools of mostly indigenous origin. The extreme of EB technology, at the other end of the scale, is 'non-engineered' roads built solely with heavy equipment. In between, there is a continuum of combinations of LB and EB methods. These combinations come in two forms: (i) separate technologies on different sections of the same road; and (ii) the mixing or blending of technologies on a single section of the road. This latter is less common, although improvements using LB technology such as stone pitching can be seen (e.g., on the Mude–Melung road in Dolakha) particularly when EB roads precede LB roads; this is because the performance of the LB road could be jeopardized by the preceding EB road.

In Nepal, the technological development of low-cost, environment-friendly, rural roads based on people's participation has been taking place since the mid-1980s. The Local Road Improvement Programme (LRIP), supported by GTZ and Helvetas in Palpa District, implemented the environment-friendly improvement and construction of 96 km of road in 1986. GTZ supported the construction of 65 km of environment-friendly road in Dhading District in 1987. After the successful outcomes of these pilot projects, the concept was widely adopted in other districts by various donor-funded projects. The Rural Community Infrastructure Works (RCIW) programme known as Food for Work (FfW) supported by the World Food Programme (WFP), GTZ and the government through the Ministry of Local Development started in 1995 and has implemented the concept in 20 districts. Other donor projects such as the Rural Access

Programme (RAP) funded by the UK's Department for International Development in seven districts, the District Road Support Project (DRSP) funded by the Swiss Agency for Development and Cooperation, the Upper Sagarmatha Agriculture Development Project (USADP), the Rural Infrastructure Development Project (RIDP) funded by the Asian Development Bank (ADB), and the Infrastructure for Income (INFRIN) project funded by the US Agency for International Development (USAID) also applied this concept. As of 2008, the length of rural roads in Nepal totalled more than 20,000 km, of which about 3,000 km were constructed following the green roads approach.

The steps for green road construction in Nepal are presented in Box 1, and the characteristics of roads built using this technology are presented in Box 2.

Box 1 Steps for green road construction in Nepal

The prescribed steps for green road construction in Nepal are as follows.

Technical

- Preparation of District Transport Master Plan (DTMP)
- Road alignment selection, survey, design and report
- Preparation of training materials
- Training of user committee members, local supervisors, foremen, masons and labour groups
- Preparation of project schedule and planning
- Supervision of construction work
- Facilitation for site office and store management
- Measurement and valuation of work done by road building groups
- Quality control of work
- Progress reporting and monitoring
- Assessment and implementation of preventive maintenance on road during construction period

Social mobilization

- Dialogue and meetings with VDC and community
- Formation of user committee
- Achievement of political balance and consensus
- Training of user committee, road building groups, record-keepers, etc.
- Facilitation of user committee for mobilization of road building groups and social welfare of workers
- Facilitation of user committee for payment of workers
- Assistance to user committee for maintenance of Project Book
- Guidance of road building groups to operate group saving schemes and income-generating activities

Source: *Shrestha, H.R., 2009. Harmonizing Rural Road Development with Mountain Environment: Green Roads in Nepal. In proceedings of International Conference on 'Making Globalization : Role of Consultant', 11–13 March 2009, Kathmandu, Nepal. Kathmandu: SCEAF Nepal, TCDPAP and FIDIC / ASPAC.*

Box 2 Features of green roads in Nepal

The green road concept is an approach that refers to an environmentally sound, participatory, technically appropriate, labour-based rural road or trail construction/maintenance methodology. The features of green roads constructed in Nepal are as follows.

- Minimum disturbance to vegetation cover along the road corridor
- Phased construction for natural compaction (track opening of 1.25 m in first phase, widening to 3 m in second phase and final widening to 5 m in third phase; then drainage, bypasses and bioengineering works phase). The gradient is kept to less than 12 percent.
- Additional vegetation cover developed on barren earth slopes
- Outward slope to ensure water drainage and establishment of dispersed drainage system
- Local labour organization and use
- No use of heavy equipment
- Excavated material transformed into construction material
- Mass balancing and controlled tipping
- Use of public audits and cost transparency
- Other social and poverty alleviation components emphasized along the road corridor

In contrast to green roads, EB technology in Nepal uses only bulldozers to construct roads in an unplanned way. More advanced EB methods—e.g., using excavators and tipper trucks for transporting excavated materials to safe dumping sites, using cut-and-fill methodology with retaining walls to minimize excavation of (unstable) slopes, using compressors and jack hammers for controlled blasting, and other environmental-friendly technology—is not used for rural road construction in Nepal as yet (see Box 3).

History of LB and EB technologies in Nepal

Excavators


Excavator demolishing a house

The use of labour for rural infrastructure construction including roads is historically at the core of Nepali rural communities. In the past, as in the present, community infrastructure has been constructed using voluntary and, to a certain extent, paid labour. Each community assigned a person *(urdi)* to inform everyone about the date and time for community infrastructure construction or maintenance work, and any failure to participate without an acceptable excuse was subject to a penalty. As Nepal was effectively isolated from the rest of the world, communities did not have access to heavy equipment for infrastructure construction or maintenance. Since the 1980s, they started to build green roads with support from donors in a more organized way by forming labour groups and user committees.

In contrast, the history of technology based on heavy equipment is quite short in Nepal—about 40 years for state infrastructure (national roads and others) and only about 15 years for rural roads. In the beginning, a Heavy Equipment Division was constituted within the Department of Roads (DoR). The DoR imported heavy equipment which was rented out to contractors as a package on infrastructure construction contracts. Most contractors retained the equipment for periods longer than the stipulated time and on-rented it to

Box 3 Features of EB roads in Nepal

The use of heavy equipment for construction of rural roads in Nepal started some 15 years ago when resources for local government bodies increased and local priorities became quick road construction. EB technology now is characterized by unplanned roads with no drains or protection structures. Road lengths are often unduly increased at the cost of forests and other resources in order to avoid agricultural land. This practice, however, has decreased in recent times as land values near operational roads have sky-rocketed. The tremor of heavy machines (particularly bulldozers) and the use of rock-blasting materials affect surrounding geological formations and hill slopes, causing destabilization. The cut–throw method is used, causing heavy mass wasting and substantial damage to slope vegetation cover, which in turn causes a significant increase in the occurrence of landslides. More advanced EB methods are used for national roads in Nepal but very seldom for rural roads construction as yet.

private individuals and communities at rates much higher than they actually had to pay to the DoR. When demand for heavy equipment for infrastructure construction began to escalate at the local level, the government allowed construction companies to import their own equipment, charging a highly subsidized customs tariff of only four percent in comparison to about 250 percent charged on private vehicle imports. Individuals were not allowed this privilege and were subjected to paying the same customs rate as for private vehicles. Hence, not a single piece of heavy equipment has been imported to Nepal by a private individual. To import goods, the government issues a letter of credit to the exporter, which can entail a process of 4–5 months. Some contractors could not wait that long and imported equipment directly, which cost them more than when it was imported with a letter of credit, for example, an excavator costs NRs 400,000 more. The number of heavy equipment importing companies has now reached 260, and they have recently formed the Heavy Equipment Association. Most of these companies have taken up the enterprise solely for the purpose of renting out to local bodies and user committees for road construction and, to some extent, to brick kiln operators, crushing industries, etc. Initial imports were reconditioned/used equipment from Japan at about half the original price. The Heavy Equipment Association has, up till now, been opposing the import of reconditioned equipment; however, they are rethinking their stand on this because reconditioned equipment is financially more viable.


Leveller


Bulldozer


Dozer-cum-excavator


Leveller at work


Bulldozer at work


Leveller and excavator at work

Multipurpose leveller


Giant tipper

Excavator at work

Initially, bulldozers were imported for use in rural road construction. This has now been almost fully substituted by excavators. Other heavy equipment includes rollers, tippers, levellers, and some attachments such as breakers. Photos of heavy equipment used in road construction are shown here.

Initial imports were solely from Japan, but heavy equipment supply has diversified and become fiercely competitive. Now, suppliers give incentives such as visits to selected foreign locations to encourage equipment purchase. Companies such as Hitachi, JCV (British), Caterpillar (American) and some Chinese brands have also appeared in the market. Currently, a popular brand is one that manufactures in India under a Japanese joint venture and produces an excavator with an attached loader. This is much cheaper than those imported from other countries. All heavy equipment have numbers such as PC 120 or PC 200, with these numbers representing the weight (or capacity) of the equipment, e.g., 120 means 12 t in weight. Surprisingly, however, prices are more or less the same for each weight group. Importers have to register imported equipment with the government by paying a fee of NRs 30,000. There is an annual insurance charge of NRs 50,000 per piece of equipment.

The practice for renting is to charge the cost of transportation from source up to use point and back, which is about NRs 192 per km. Heavy transporters are involved in the rental chain.

Decision-making processes, unsustainable roads and implications

There are broadly two modes of decision-making as regards rural road construction in Nepal: (i) well-planned, with complete feasibility and environmental studies and with transparent participation processes; and (ii) political or elite-influenced, without serious studies and without open and transparent processes.

In terms of the time for road construction/rehabilitation, Nepal's budgetary process, with budget release mainly at the end of the fiscal year (June–July) and budget freezing in mid-July, often forces roads to be constructed during the monsoon period when local people are busy with agriculture. This obviously discourages the choice of LB tech-

nology. The pressure to reduce time taken for construction is also increasing the tendency to choose EB technologies.

As a consequence of inappropriate technologies and poor construction timing (whether deliberate or from necessity), not only is the sustainability of most rural transport infrastructure uncertain but the social and poverty reduction impacts of rural roads are also questionable. Some roads are constructed without adequate economic feasibility and environmental studies. Road lengths are increased unduly to avoid agricultural lands. Construction methods cause substantial damage and increase the probability of landslides. Deoja (1994) estimates that 400–700 m^3 of landslide occur per km per year along mountain roads, and 3,000–9,000 m^3 occur per km during construction. Area damaged by thrown material is about three times higher than area actually covered by road. Around the world, faulty road construction is one of the principal reasons for deforestation and forest degradation, contributing to 18 percent of total greenhouse gas (GHG) emissions in developing countries (Stern 2006).

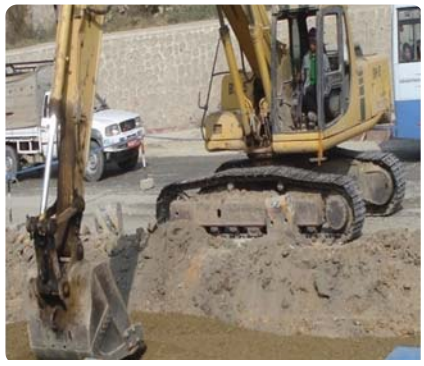
In the context of climate change, rainfall is expected to become increasingly intense in Nepal and, hence, unsustainable and unstable roads are likely to cause increasingly greater environmental damage.

Bulldozer at work


Roller or compactor

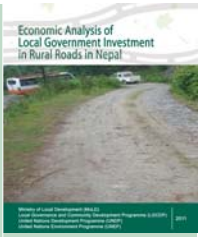

Tipper


Excavator




Excavators at work

2 CHAPTER



STUDY RATIONALE AND OBJECTIVE

Nepal is in a process of significant transition. A new constitution, being written for the first time by elected representatives of a Constituent Assembly, will soon be promulgated and is expected to be based on federal democracy with optimal state-restructuring, good governance and inclusive development. In view of this, it is an opportune time to study current policies and practices for rural infrastructure development, so as to bring to the fore the ones that are unacceptable and should be rejected as well as the beneficial ones that should be considered for adoption in the new constitution.

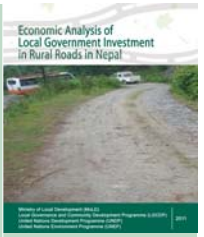
Studies have been done in many countries to evaluate technologies and practices appropriate for rural road construction. Some studies have found higher returns in both financial and economic terms from using LB technology rather than EB technology. In Nepal, no such study has been done to evaluate alternative technologies and processes. Hence, this study, commissioned by the Local Governance and Community Development Programme (LGCDP) and UNDP, endeavours to evaluate alternative technologies and processes deployed in rural road construction, rehabilitation, operation and maintenance in selected districts of Nepal, so

as to suggest and effectively disseminate appropriate technologies and processes not only for cost-effectiveness but also for sustainability and poverty reduction.

The overall objective of the study is as follows.

- To inform policy-makers of the costs and benefits of alternative road construction approaches, including social and environmental concerns, and propose specific recommendations on sustainable rural road construction tailored to different stakeholders—central government agencies, DDCs, VDCs and communities.

3 CHAPTER



METHODOLOGY

Desk review

The study began with a review of relevant documents. These included national and international studies, progress reports, and country data collected from the centre as well as from the selected districts. District Periodic Plans and DTMPs, where available, were reviewed.

Rural road selection and field inquiry

Two districts—Dolakha and Makwanpur in the Central Development Region—were selected for field work because they have the simultaneous presence of both LB and EB technologies and processes for rural road construction in adequate numbers. Dolakha is a mountain district and Makwanpur is a hill district adjoining the Terai[1]; both districts have massive road construction activities involving LB and EB technologies, thus allowing for good comparison between the two technologies. In each district, 2–3 rural roads built by the respective local governments were studied, with at least one road using LB and/or EB technologies. Where a road has been built using different technologies in different sections, one road can provide information on both technologies. This is particularly desirable in the current study, which uses a small sample, because comparability between different technologies is better in similar settings.

[1] The southern plains of Nepal, bordering India.

The roads studied were selected in consultation with officials from the DDC and relevant institutions as well as other knowledgeable individuals in the respective district headquarters. After selecting the roads, necessary secondary data on planning aspects and costs were gathered, along with any other physical and financial progress reports related not only to the selected roads but also to the entire rural road network constructed by the local government of each district in order to draw common conclusions about both technologies. The contractors involved in the construction of the selected roads were also approached and interviewed, where possible, to solicit their experiences, opinions and cost data. A checklist was prepared (see Annex 1), showing information sought for analysis. Data related to costs and return also included indirect and environmental variables using appropriate valuation methods.

The selected roads were traversed for a reasonable length, interacting with respective VDC officials, user committee members and communities along the corridor.

Small focus group discussions (FGDs) (4–12 participants), using a semi-structured checklist of questions (see Annex 1), were held with communities to explore average data and parameters and communities' attitudes, feelings and preferences. This was a compromise between participant observation, which is less controlled, lengthier and more in-depth, and pre-set interviews. Individual interviews were held with key informants, user committee officials, and district and VDC authorities.

Evaluation tools

The main evaluation tool has been the comparison of financial and economic costs and benefits for the two technologies, with complete enumeration and estimations including those related to environmental and social concerns. While financial analysis used market prices for inputs and

FGD with the local people and user committee members at Deurali of Mude–Melung road, Dolakha

Interview with the user committee chairperson of Barabise–Thingsang road, Sindhupalchok and Dolakha districts

outputs, the same prices were converted to societal or country terms (shadow pricing) using standard conversion factor (SCF) and unemployment-compensated labour wage rates. In both financial and economic analyses, the net present value (NPV), benefit/cost ratio (BCR) and internal rate of returns (IRR) are calculated for a 30-year life of the road. Subject to availability of cost information, analysis has been done separately for all roads.

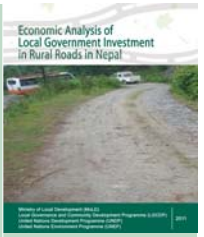
Detailed methodology for the economic analysis is presented in Chapter 6.

Limitations of the study

The findings of the study must be viewed in the context of the following limitations.

- The study was done during the peak monsoon season, which restricted the mobility of the study team during field visits and for taking macro pictures of features of various road alignments. However, this timing did enable the collection of accurate evidence of what can go wrong on roads built with environmentally insensitive methods. This limitation was partly overcome by extending the study period into the post-monsoon season.
- Another major limitation of the study was in the collection of data on costs and benefits, the records of which were scanty and, where available, not sufficiently disaggregated by appropriate cost heads. So, crude estimates had to be made in several cases.
- The third limitation was the small sample—six roads in two hill districts—which may have implications for the representativeness of study findings. This study must, therefore, be considered as a preparatory pilot for a larger study of rural roads in Nepal.

4 CHAPTER



FINDINGS ON RURAL ROAD CONSTRUCTION AND MANAGEMENT PRACTICES

Local planning process for rural infrastructure

General

The LSGA requires that all local bodies (DDCs, municipalities and VDCs) prepare a long-term periodic plan, with a duration of 4–6 years that matches national periodic plans. These plans are prepared with a fully participatory process using guidelines provided by the National Planning Commission. For example, Dolakha prepared its first District Periodic Plan in 2001 for a period of six years. In the case of VDCs, however, only a few have prepared such plans, despite the LSGA requiring them to do so. In the absence of elected government bodies at the local level, the preparation of periodic plans has become irregular. Periodic plans are the basis for annual plans prepared and endorsed by respective council levels. This function is currently being carried out at local levels by representatives of political parties.

Infrastructure development

The Rural Infrastructure Development National Strategy 1998 was approved by the Council of Ministers in November 1997. It is the basis for implementing rural infrastructure development coordinated by various line agencies, donor agencies and local bodies, using a participatory process. The strategy document envisions a 10-year institutional outline and funding projection. Based on this strategy, the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) was established at the central level in September 1998 and District Technical Offices were set up under DDCs in April 2001.

Policy on rural infrastructure development with emphasis on rural roads

Local infrastructure means plans, programmes and projects relating to creation, operation and maintenance carried out at the local level. The infrastructure includes local transportation, irrigation and river control, micro-hydro power and alternative energy, water supply, sewerage and sanitation, housing and urban development, solid waste management, and social infrastructure. Policies related to such infrastructure development include the following.

- Devolution of programmes relating to local infrastructure by sectoral ministries to local bodies
- Establishment of appropriate institutional structures and technical capacity-building for local infrastructure development
- Development of the concept and work style for mobilizing local resources, means and skills for local infrastructure development through people's participation
- Harmonization with donor agencies
- Coordination and integration of other thematic concerns such as gender, poverty, environment, etc.

General assessment of technologies

While detailed assessment of the selected rural roads is found in Chapter 6, a general review of literature provides a number of positive and negative features of LB and EB technologies (Table 1).

Genesis of unsustainable roads

Unsustainable roads are those that have: (i) no drainage arrangements; (ii) high gradient; (iii) no protection structures in critical places; (iv) no biological protection; (v) no operation and maintenance arrangements or fund; etc. Standards should be designed and effectively enforced to avoid situations leading to unsustainable roads. In Nepal, unsustainable conditions

Table 1 Positive and negative features of different road construction methods

Particulars	Positive features	Negative features
LB roads	➤ All road functions can be done ➤ Resources retained in village for future investments/development ➤ Potentially environment-friendly ➤ Road can be built from multiple points to expedite construction ➤ Poor can benefit from local employment (poverty alleviation effect)	➤ Financially costly ➤ Generally takes longer time to build
EB roads	➤ Financially cheap ➤ Quicker construction	➤ Not all road functions can be done ➤ Foreign-currency-based imports of equipment and fuel drain the country's foreign currency ➤ Potentially less environment-friendly ➤ Road construction cannot be done from multiple points ➤ Less benefits to the poor

have strong correlation with unplanned and non-engineered roads, which have been built without prior feasibility and environmental studies and which generally use EB technologies. Typical rural roads being constructed by VDCs within the last decade share some common characteristics: (i) they are unplanned and often conceived by local influential person/s; (ii) heavy equipment such as excavators are rented to do the road work as quickly as possible; (iii) alignment choice is largely left to the driver of the equipment; (iv) road gradient is above the technically acceptable threshold in several road sections; (v) excavated soil and boulders are disposed of indiscriminately down the roadside, often causing heavy loss of vegetation, trees, farmland, other infrastructure and even human lives; (vi) side drains to dispose of water safely are not constructed so that roads are seriously damaged during the rainy season, often requiring considerable work to restore the road before the next season. Some serious accidents have also taken place during the construction of EB roads in Nepal (see Box 4).

Box 4 Accidents related to use of heavy equipment in Dolakha district

There have been three accidents related to heavy equipment in Dolakha district. A DDC-owned piece of equipment was pushed down from the road by Maoists during the conflict, resulting in its complete loss. Another piece of heavy equipment, owned by Bhimeswar Construction Company, was partially submerged under landslide debris during road construction and was heavily damaged but not written-off totally. The diesel tank on a third piece of equipment was crushed by falling rock.

An excavator working on an unplanned rural road in Sindhupalchok district about six years ago constructed a long spell of high gradient road. When the day's work was over and the driver turned the excavator around to drive down to its night destination, the gradient of the road was so steep that the driver was unable to control the heavy equipment and the vehicle tumbled down the road killing both the driver and the helper.

Although the policy for development of rural roads seems reasonable, other related policies and practices have rendered several rural roads in Nepal unsustainable with ruthless stripping of the natural environment, indiscriminate disposal of debris, and the use of wild alignments and gradients as shown in the photos below. No study is required to formulate and strictly implement policies that discourage the construction of such roads.

Quick road connection

Road connection has become a matter of pride for VDCs: if a neighbouring VDC has a road and you don't, it is considered humiliating and disgraceful. People perceive that construction time is much longer for green roads than for EB roads. So, in the quest for quick road connection, economic, social and environmental considerations are often relegated to the background. Another important justification for road connection emerged during the conflict: insurgents preferred to live in remote areas not connected to the road network in order to operate outside the influence of state forces. Therefore, local communities felt that quick road connection would keep the insurgents out of their area.

Technical manpower deficits at local body levels

At present, VDCs have no technical unit of their own and, therefore, they have to depend on technical resources available within the DDC and its District Technical Office. With an ever-increasing amount of development resources being channelled through local bodies, there are now on average about 15 projects per year per VDC. Each sub-overseer is currently looking after one *ilaka* (of 4–5 VDCs), which means that each sub-overseer has to provide technical inputs for about 75 projects. Each project requires technical inputs at several steps: pre-feasibility study, feasibility study, initial environmental examination, detailed design, work start, work supervision, work completion check, etc. A project will thus require a minimum of 10 days of technical inputs from a sub-overseer, i.e., 750 days of technical staff involvement in one *ilaka*. If a minimum standard of technical inputs is to be provided to VDC projects, at least three sub-overseers are needed per *ilaka*. There is an acute shortage in the districts of technical manpower for infrastructure work: overseers and sub-overseers are rare commodities across the country. In Dolakha District Technical Office, only three of six overseer positions are filled.

Typical debris disposal on EB roads

Road construction causing landslides in Kavre district

One of the reasons for unsustainable infrastructure at the local level is this shortage of technical manpower. Resource availability in VDCs has increased by up to 10 times but availability of technical manpower remains the same. The only solution to this problem is to set aside a portion of increased resources for hiring needed technical manpower. Grants for rural roads, therefore, have to be provided with a separate budget head for hiring technical persons.

It is also recommended that, in the state-restructuring, the current *ilaka* are defined as the new local body equivalent to the current VDC. If the *ilaka* is taken as the lowest local body structure, then it will have adequate resources and capacity to have its own technical unit.

Practices and trends that favour wrong road construction methods

There are several situations in Nepal that have tilted the choice of technology for road construction in favour of heavy equipment. These include the following.

- Late disbursement of budgetary grant funds to local bodies (usually in May–June) when local people are busy with agricultural operations, and there is limited time (less than two months) to complete the work before the end of the fiscal year after which the budget is frozen.
- Price trends for heavy equipment have fallen over the last 15 years. Heavy equipment rental costs (excluding fuel, transportation and operator allowances) have decreased from about NRs 3,500 per hour to less than NRs 1,800 per hour in contrast to labour wage rates (unskilled) which have increased by almost three times. The cost of heavy equipment in real terms is also decreasing over time, which together with the increased supply (competition), has resulted in a reduction in rental costs of equipment.
- Local people want roads built quickly. Road opening is generally faster with EB construction than LB construction.
- Opportunities for rent-seeking are greater for unplanned EB roads. A common financial abuse is to use heavy equipment, which costs around NRs 5,000 per hour (rent, diesel, driver), but prepare a fake muster roll for human labour, which is about 2.5–3 times higher than the cost of equipment. An effective system of public auditing would discourage this practice, but there appears to be a conspiracy between political party committees, user committees, VDC secretaries and DDC staff responsible for technical auditing to prevent public audits from happening. This practice is also bolstered by the current budgetary process and the severe lack of technical persons within the local body structure.

EB road at Bhainse, Makwanpur, showing ruthless stripping of the natural environment

Typical alignment and debris disposal of EB road, Lalitpur district

High gradient and huge mass wasting on road built in Dolakha district

Lack of operation and maintenance funds

Many rural roads have no operation and maintenance fund and, therefore, even small maintenance needs have to wait for funding from external sources. Although there are provisions in policies for regular, periodic and emergency maintenance, the institutional and resource set-up does not exist in many cases.

Losers and gainers

The benefits to the poor from road connection are mainly from employment during construction, operation and maintenance. If equipment is used for these purposes, benefits to the poor are limited in the construction phase. Although road access does also benefit poorer sections of society to a certain extent through lower transaction costs and better access to markets, education and health services, this is not systematically nor automatically the case. Often road access benefits the rich more than the poor because of their greater power and resources to make use of the road. Elites can therefore expand their wealth and power over the poor, which can lead to segments of the poor being worse off than before the road was constructed. This is especially the case if the poor depend on the rich for land use or financial loans.

The issue of (social) benefits and costs is closely linked to existing livelihood strategies and access to new opportunities. This is complex and should be studied carefully before the road is constructed. Efforts are needed to support the poor in optimally benefitting from road access, e.g., access to finance or agricultural support. Efforts are also needed to ensure the empowerment of the poor for long-term benefits from road access.

In addition, communities and households are not homogeneous. Inter- and intra-household benefit-sharing can show substantial disparities. Therefore, it is of utmost importance to analyse and deal with issues such as caste and gender in order to ensure equity in development benefits.

Opinions of various stakeholders on technologies

Different stakeholders of rural roads were interviewed to solicit their opinion on the two rural road construction technologies. Their views and perceptions are as follows.

DDC/VDC officials

DDC officials, including the Local Development Officer (LDO), in both study districts said that they were aware of the advantages and relative sustainability of LB technology over EB technology, but expressed the need to select EB technology due to various processes and practices. They first mentioned the pressure associated with the budgetary process. Another factor was the urgency felt by local people to have a road connection quickly. They also said

that growing labour constraints, mainly owing to current migration patterns particularly for remittance jobs, was another factor that led to the choice of EB technology.

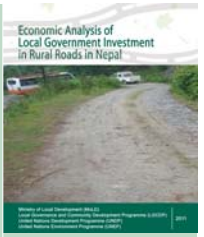
Owners of heavy equipment

Owners of heavy equipment tended to demonstrate the advantages of EB technology on the grounds of being relatively more time efficient and inexpensive compared to LB technology. They also claimed that the stock of over 2,000 pieces of heavy equipments currently used in rural road construction would remain idle and be a sunk cost to the country if EB technology was strictly discouraged by policy. They were in favour of combining the two technologies to harness the positive features of both.

Local community stakeholders

Local community stakeholders had mixed opinions about the two technologies. They wanted roads quickly, which they thought was possible only with EB technology, but they were also concerned about the negative environmental consequences of EB roads. They said that roads built with EB technology caused damage to pasture and vegetation up to 300 m above the road level and more below the road level. A few locals went as far as saying that, with EB technology, "we are not building roads, we are excavating them". Poorer households seemed to desire local employment opportunities from road construction to improve their livelihoods.

5 CHAPTER



GENERAL DESCRIPTION OF SELECTED ROADS

Selected roads

The roads selected in the two study districts—Makwanpur and Dolakha—are detailed in Table 2.

Table 2 Rural roads selected for detailed study in Dolakha and Makwanpur districts

	Road	Total length (km)	Length considered (km)	Technology
Dolakha				
Road 1	Mude–Melung	44	21	Mixed
	Mude–Deurali (2.5–14 km)	11.5	11.5	District EB
	Deurali–Bhainse (14–28 km)	14	14	LB (RCIW)
Road 2	Bhirkot–Chhaunde		14	LB (DRSP)
Road 3	Barabise–Bigu	63	15	EB
Makwanpur				
Road 4	Dandabas–Pakani	15	15	LB (GTZ)
Road 5	Pakani Kharka–Baikuntha	13	13	EB
Road 6	Sitalchowk–Jatiya Pokhari	6	2.5	EB

These roads are described in the following paragraphs. It should be noted that the entire section of each selected road is not taken for analysis because regular vehicle movement was limited to some sections only. For example, only 21 km of Road 1 has been analysed because there is regular movement of vehicles on the Mude to Bhainse section only. In some sections, construction is still ongoing. Road 6 has no public vehicle movement as yet, and so this road is described only as an EB process.

Dolakha district

Mude–Melung mixed road (Road 1)

The Mude–Melung road in Dolakha district was constructed using various modalities, as follows.

- 0–2.5 km EB technology (DoR)
- 2.5–14 km EB technology (DDC)
- 14–28 km LB technology (RCIW)
- 28–30 km EB technology (DDC)
- 30–36 km LB technology (DRSP)
- 36–44 km EB technology (VDC)

Stone soling, using LB methods, was added to the road section using EB technology because the LB section was beyond the EB section and the LB road would not function if vehicles were blocked on the EB road.

The road passes through the part of the district with most potential in terms of production of high-quality and high-value agricultural products such as potatoes, off-season vegetables and non-timber forest products. Potatoes from this area are renowned in Kathmandu and fetch higher prices than potatoes from other places.

Landslides begin as soon as the EB road section is entered, Mude–Melung road, Dolakha district

The initial 25-km spell is almost all-weather (except for some blockage during the monsoon). The remaining 15 km is seasonal and operates for about seven months a year. When the DTMP was first prepared, this road was the second priority among district roads, after the Dolakha–Singati road. However, when the Singati road was taken up as the access road for the Upper Tamakoshi hydro project, this road became the district's number one priority. Since the road has used both LB and EB technologies on different road sections, the features of both technologies can be easily observed. The photo shows that, after the first section of DoR road, landslides are observed when EB technology starts.

In order to reduce the cost of transportation, large trucks are being used to haul products and inputs. For example, trucks of up to 21-t capacity are sometimes used (see photo below), while the capacity of district roads are rated at only 5 t. As a result, the stone pitching on the road is disoriented and the road becomes muddied, making it impassable for smaller vehicles. This situation is also created by human neglect such as dumping waste soil on to the road, draining excess water on to the road alignment, and dumping soil on the road for timber storage (see photos below).

Roads are public assets, and are cared for and well maintained in areas where there is high social capital—i.e., where there is a high degree of trust and reciprocity among members of the community. Therefore, where there are low levels of social capital, as evidenced by fouling of the road (channelling water on to the road alignment, dumping soil and waste in the road, plying over-capacity vehicles, etc.), the situation can be improved though social mobilization. Effective mobilization also helps local people to assume local ownership of public assets such as roads, which also reduces the incidence of soil-dumping, etc.

In Nepal, social mobilization is often conducted with a 'one size fits all' mentality. However, the messages to be delivered and their method of delivery should differ across communities, depending upon local levels of education, cultures and beliefs, patterns of interaction when people meet each other, patterns of local consumption, etc. Hence, the social mobilization methodology must be tailored for each community, depending upon the level of social capital in that community. A simple 15-variable model of social capital estimation, developed by the author in a Microsoft Excel template, is presented in Annex 2.

Reduction in transaction costs

A typical case of reduction in transaction costs associated with roads was observed on the Mude–Deurali section of the road, where the cost of transporting goods by vehicle from Banepa is NRs 1.10 per kg: NRs 0.80 per kg up to Mude plus NRs 0.30 (or NRs 0.0375 per kg per km) from Mude to Deurali bazaar (8 km). Without the road, a porter would take four hours to reach Deurali from Mude. At the existing wage rate of NRs 215 per eight-hour day, the portering cost from Mude to Deurali with 50 kg load, will be NRs 2.15 per kg or NRs 0.27 per kg per km. So, with the availability of vehicle transportation, the transportation cost is reduced by seven times. The importance of the road in this context is that it significantly

21-t capacity truck plying 5-t capacity Mude–Melung road

Soil dumped into road to create timber storage space

Road damaged by local neglect

reduces transaction costs in input acquisition and output sales, making local economic activities more competitive. Such competitiveness can be achieved, if there are bulk volumes of exportable products. In areas where such export is not feasible, roads will only reduce costs of some consumption items imported from outside such as rice, sugar, etc. The savings in such petty costs cannot finance the maintenance of the road, and these roads will 'die a natural death'. This is what is happening to many rural roads financed with VDC resources.

Change in gender roles: man does household chores, while his wife studies in college

Youth from Bhirkot VDC, Dolakha, heading for a job in the Gulf

Bhirkot–Chhaunde LB road (Road 2)

The Bhirkot–Chhaunde road was constructed solely using LB technology (DRSP model) with a sidewall in critical slopes, stone soling, and tree planting for biological protection. The DRSP model for road construction is livelihood-based, with improving livelihoods as its primary objective and connectivity as a secondary one. Started in 1999, the road took a long time to complete and some resoling work is still not finished. The first vehicles plied in 2006. The road is easily passable up to Dhule all year round. DRSP also supported local households through social mobilization, distribution of goats, training programmes for income-generating activities, toilet construction, and drinking water taps for Dalit households (see Box 5). As a result of social mobilization, there have been some notable changes in gender roles. For example, Mr Raj Kumar Shrestha of Gairimudi, a medicine shop owner, has taken on his household's chores so that his wife can go to Kathmandu to study in college (see photo).

Five buses used to ply this road, but two buses have recently been withdrawn owing to a conflict between the drivers and local people. In addition, trucks and vans regularly come to sell products in the villages. A private school run by villagers has been opened: this would not have been possible without the road, as students from further away can now feasibly come to the school.

Box 5 Traditional exploitative *'bataye'* system

Dolakha is a poor and food-insecure district. Many households have barely six months of food supply from their own production and that bought from regular sources of income. In the recent past, a local system called *bataye* existed under which food-insecure households borrowed food grains from food-surplus households in the village; food grains were repaid in kind with one-third interest at the next harvest. Poor households fell into a trap of spiralling poverty and debt, until the Lamosangu–Jiri road began construction. The road was purposively built with intensive labour use and no application of heavy equipment. Local labourers were paid with rice, oil, pulses and some cash, and all poor households found employment. This road construction abolished the exploitative *bataye* system, as there was no need for the poor to approach richer households to borrow food. Although the road took a long time to complete, it provided sustenance to the local poor and, at the same time, avoided the heavy environmental costs that are generally associated with conventional road construction methods.

When the road was being constructed, workers were abundantly available. However, recently, adult youths from this area are leaving for jobs in India and the Gulf countries (see photo). From a single settlement in Gairamudi VDC, 10 adult males have left. The lower availability of labourers and the rising cost of labour are also evident in the change in stone-soling practices on this road over time. The original stone soling was a very fine work and the road surface looked like it was paved; however, as time went by and labour became more expensive, there was a gradual trade-off in soling application (see photos below).

Agriculture as a source of livelihood has declined in recent years because of the diminishing productivity of traditional cereal crops. Irrigation is a major constraint for crop production. High-value crops and off-season vegetables are faring well and the road is important for dispersing these more perishable crops. Important high-value crops include potato, cauliflower, garlic and *lapsi,* and the road has helped to export these products to the district headquarters. These products are sold and rice for consumption is purchased from district headquarters. Previously, rice brought from outside cost at least NRs 5 per kg because of transport costs, but it is now only NRs 1 per kg brought from a 30-km distance.

The road is technically much superior to EB technology roads, but some elite-influencing practices have been observed (see Box 6). For rural roads, there is provision for compensation to losers of land for road alignment or of crops destroyed during construction. However, compensation is so low compared to that for national roads that local people do not accept it and prefer to wait until the road is taken up by the DoR to claim the higher compensation. When people lose a farming or housing plot to the road alignment, there is a need to provide adequate compensation; this is particularly important for the poor.

Barabise–Bigu EB road (Road 3)

The Barabise–Bigu road is an inter-district road connecting the two districts of Sindhupalchok and Dolakha. The road was built first from Barabise to Thingsang in Sindhupalchok and later extended into Dolakha district up to Bigu. It was first conceived in 2000 and construction started with EB technology. The total length of the road up to Bigu is 63 km. Before starting construction, there was no feasibility or environmental study. A total of 7,500 hours of heavy

Gradual change in stone-soling practices because of labour shortage in DRSP road (Bhirkot–Chhaunde)

Box 6 Elite influences

Near Bohora Gaon of Gairamudi VDC on the DRSP-supported Bhirkot–Chhaunde road, there are a few influential families and one poor Dalit family. When the road alignment was being planned, the elite families were able to save their land at the cost of the Dalit household, who had only little land. The alignment was fixed in such a way that the road covered nearly the entire land of the Dalit family within only a small strip remaining (see photo below). Furthermore, one of the elite families successfully claimed in court that the small strip of land legally belonged to it rather than the Dalit family, resulting in the Dalit family losing everything while the elite family's land more than doubled in price as it was next to the road.

equipment were used for construction within a period of three years. Equipment was rented at NRs 2,100 per hour and total cost for equipment use was NRs 5,000 per hour. About 65 percent of the cost of road construction was borne by local beneficiaries (including donations provided by people of the area who currently live in Kathmandu). The remaining 35 percent was mobilized from government and local body sources. The first vehicle reached Bigu in 2006.

Former house of Sitaram Bishwakarma along Bhirkot–Chhaunde road

Typical new alignment feature of an unplanned VDC road in Sindhupalchok

Common landslide events in EB VDC roads

One major problem for lengthy EB roads is that they always have some kind of blockage. Local people say that the chances of landslides are about five times higher in EB roads than in LB roads. On this road, it means that vehicles reach Dolakha for only about 5–6 months a year in the dry season, with virtually none in the monsoon. Six workers have been deployed for regular road maintenance with support from DDC resources. Workers are paid NRs 203 per day by the DDC. However, they are not provided with any work or security tools.

Because of the choice of technology, it is difficult to achieve the full potential of the road corridor, as the road is not gravelled and there are no protection structures in place.

Although the area has great potential and several vehicles ply the road, there is no certainty as to how far the vehicles will be able to reach because of the poor road condition. Three buses operate regularly and, in the potato season, 8–10 trucks haul products daily. Other major exports from the road corridor are *lapsi*, *churpi* and vegetables. With vehicular movement, the number of shops along the road alignment has increased threefold.

The photo here shows a typical EB road alignment, although this represents a new situation, with locals not trying to avoid agricultural land. Many landslides are found within about 5 km of Barabise (see photos), blocking the road to vehicular movement. Landslides threaten nearby houses and community buildings, putting households and local assets at great risk. In the urgency to open up the road for vehicle movement quickly after a landslide, impending threats are not dealt with properly. Since the road was not planned, the alignment is found to have favoured richer households.


Landslides do not even spare electrical poles


Road benefitting well-off household


Community building endangered by landslide


Road passing alongside well-off households


Temporary passage for vehicles opened up without attending to the threat


This large stone threatens 36 houses below on the Barabise–Thingsang road

Makwanpur district

Two roads were selected in Makwanpur district. The larger Manahari–Dandabas road, which started construction in 2001, used different technologies on different sections of the road, so separate sections were compared with each other. The Manahari–Dandabas road corridor covers 12 VDCs of north-western Makwanpur. It is the highest priority road in the Makwanpur DTMP. The DDC implements the programme through user committees. The WFP provides food support and Manahari Development Institute (MDI) has provided technical assistance and social mobilization services since 2002 with financial support from the Danish International Development Agency (DANIDA) (2002–08) and WFP (2008–09). It links to the Tribhuvan Rajpath in Palung to the north and the East–West Highway in Manahari to the south. Its estimated length is around 48 km, of which about 30 km is already in operation.

Dandabas village in Agra VDC has long been relatively isolated, even after the opening of the Tribhuvan Rajpath in 1956. Located at some 2,000 m, it lies over 10 km from Palung. Local residents are mostly Tamang (90 percent). Owing to its high altitude and cold climate, Dandabas has high potential for off-season cultivation of potato, green leafy vegetables, cauliflower and cabbage, which can fetch high prices in the market. Before construction of the road, locals had to hire porters to carry produce for nearly 12 km to reach the nearest market at Ghartikhola;

this cost about half the value of the produce. Therefore, there was little incentive to grow crops for market, and most farmers adopted traditional subsistence livelihoods, growing maize or marijuana (a drug plant, the growing of which is illegal in Nepal).

According to Mr Buddhi Lal Ghalan, resident of Dandabas, commercial vegetable production started only after initiation of the road in 2002. The area under vegetable cultivation has gradually increased with the extension of road each year. Now the road has reached Kagatikhola of Gogane VDC (24 km) and vegetable farming is increasing in Gogane as it did in Agra VDC. It is estimated that almost 90 percent of households in Agra and Gogane VDCs are involved in commercial vegetable farming, almost 2,130 households. The cash return from land has increased dramatically from NRs 3,000–5,000 per *ropani* per year for maize growing to around NRs 30,000–40,000 per *ropani* per year for vegetable growing.

Potato is planted during February/March and harvested in June; it receives NRs 10–15 per kg in the market. Cauliflower is planted immediately after the potato harvest and is cropped during the Dashain festival from August to September. It receives NRs 15–25 per kg. Peas are sown in July/August and harvested in November/December. The net return after deducting costs is about 30 percent. This is the equivalent of NRs 9,600 per *ropani* per year or NRs 192,000 per ha per year in financial prices and NRs 182,400 in economic prices (after multiplying by the SCF value of 0.95). Typical vegetable production, sales and income profile of the area is presented in Table 3.

The road has had a significant impact on the local area. Local people use their increased income to buy food, pay school fees for their children, buy stationery, and pay off debts. A number of *pukka* houses have also been built and improved toilets have been constructed. About a quarter of households have installed solar-heated water systems. Children are going to boarding school in Palung, Hetauda and Kathmandu to attain a good education. Youths have stopped going to foreign countries in search of jobs.

Table 3 Annual vegetable sales and return in Dandabas area

	Potato	Cauliflower	Pea	Total
No. of collection centres	13	13	13	13
Vegetable collection in centres (kg/day)	24,000	6,000	300	30,300
Operational days in centres (days/season)	50	40	30	120
Total weight (kg)	1,200,000	240,000	9,000	1,449,000
Price (NRs/kg)	12	20	20	52
Total value (NRs)	14,400,000	4,800,000	180,000	19,380,000
No. of farmers using centres	565	565	565	565
Average gross earnings (NRs per household)	25,487	8,496	319	34,301
Average net earnings (NRs per household)	**7,646**	**2,549**	**96**	**10,290**

Source: *Mr Bel Bahadur Muktan, Bhakundebas Collection Centre, 2010.*

Dandabas–Pakani LB road (Road 4)

From Dandabas to Pakani, the road is 4–5 m wide and was built using LB technology, following the RCIW modality. Because of the high level of management and supervision, the cost of the road was high (about NRs 18.2 million per km). However, since construction involved extensive environmental protection measures, the maintenance costs are expected to be low. Local people were happy to work on the road for food, as it ensured an additional three months of food security.

Pakani–Baikuntha EB road (Road 5)

From Pakani onwards, the road alignment passes through a long stretch of forest area (about 15 km) and hence it was difficult to find local labourers. The use of labour would have required camping arrangements, which would have been expensive. Therefore, EB technology was deployed for this section of the road. The use of EB technology reduced cost of the 5-m wide road to about NRs 619,000 per km. Since no protection structures and bioengineering work were built, the road is expected to function only about seven months of the year compared to about 11 months of operation for fully LB roads. Furthermore, a considerable sum has to be invested each year to make the road pliable again after the monsoon season.

Sitalchowk–Jatiya Pokhari EB road (Road 6)

The Sitalchowk–Jatiya Pokhari road originates from the Kathmandu–Hetauda road at a point near Sitalchowk. It was originally conceived as a connection to the historic tourist site of Chaukat Devi Temple in Chhaimale VDC (6 km from Sitalchowk). On a clear day, it is possible to see trains running in India from the temple area. However, the road was built only as far as Jatiya Pokhari (2.5 km from Sitalchowk), where some influential people had bought a large piece of commercial land. In fact, the road was deceptively planned as being meant for tourist purposes in order to mobilize resources from the DDC and VDC. This is a glaring example of how elites and rich institutions capture state resources for their personal benefits. Although they did contribute towards the cost of the road, the benefits to them in terms of an increase in land prices has been enormous.

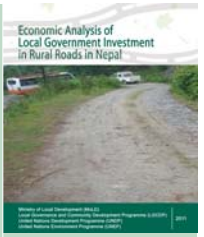
Started in 2007/08, the road was built using rented heavy equipment (excavator) for a total of 226 hours. The equipment was used up to 14 hours per day. The rental rate was NRs 2,300 per hour without fuel. Fuel consumption was 15 litres per hour at a cost of NRs 65 per litre plus NRs 3 per litre for transportation. In addition, another NRs 1,500 per day was spent on topping up the driver's and helper's salaries and food. About 250 workdays of labour were also required during construction at a rate of NRs 350 per day including tiffin. The actual cost of construction was low at NRs 355,128 per km (Table 4) because no protection structures or side drains were constructed.

Table 4 **Estimate of construction cost of Sitalchowk–Jatiya Pokhari road**

	Cost (NRs)
Transport of equipment to site	20,000
Driver/helper (food and salary top up for 20 days)	30,000
Fuel (226 hours, 15 l/hr, NRs 68/l)	230,520
Rent (NRs 2,300/hr)	519,800
Labour (250 workdays, NRs 350/day)	87,500
Total cost	887,820
Cost per km (2.5 km)	355,128

During road construction, every effort was made to save farmland but about 0.5 ha belonging to five households could not be saved. The affected households were extremely resentful but were eventually persuaded to accept the situation by user committee members. Since the road did not reach its originally planned destination, no vehicle services have started along the road. Most traffic is private 4WD vehicles belonging to persons and organizations who have bought land at Jatiya Pokhari. Hence, no benefits have been derived by local people along the road alignment except for some rise in the price of land. Benefits from this road can only be generated when the road is extended up to the originally planned destination; however, there are no resources left to do this. Furthermore, the gradient at many places is prohibitively steep for the movement of normal vehicles.

6 CHAPTER



FINANCIAL, ECONOMIC AND ENVIRONMENTAL ANALYSIS

Analysis concept and methodology

Economic analysis is used to assess the economic performance of an investment project or scheme; it examines the stream of costs and benefits related to the project or scheme. Analysis can be ex-post, i.e., after the scheme/project has been implemented and all benefits have been realised; ex-ante, i.e., when an investment is only conceptualized and has not yet been initiated; or in between, when implementation has begun or been completed but the full benefit streams are yet to be realized and some costs may yet be borne. The economic analysis for this rural roads study falls into the latter category: investments in construction have been made and vehicles have begun to ply the roads, but investment returns are yet to be fully realized and streams of future costs and benefits remain to be estimated.

The cost and benefit streams are taken as net incremental net income (net profit from activities minus the baseline net income before the road), such that the streams are assumed to represent the sole share of the given roads.

There are basically two types of economic analyses. The first one is financial analysis, which shows the return on investment to an entrepreneur calculated on the basis of actual costs and actual prices (market prices) paid or received by the entrepreneur. The second one is economic analysis, which shows the return on investment to a society or nation based on costs or prices borne or received by the society/country. These costs or prices are known as the opportunity costs or shadow prices. The second is the special case of human labour, whose financial price is the prevailing wage rate while the economic price (shadow wage) is the average annual rate that the labourer would have obtained if there was no new investment. The average annual rate means that, if the labourer is employed only six months a year, then his average wage rate will be half of what he receives on a working day. Thus, there are basically four adjustments needed for converting financial prices into economic ones:

- adjustments for taxes and subsidies;
- adjustments for import or export parity;
- adjustments for opportunity cost; and
- adjustments for exchange rate risks and other market distortions (SCF).

Equipment importers are liable to pay four percent tax to the Government of Nepal on the value of equipment and hence this taxed amount has to be deducted in the process of economic price calculation. Except for equipment and fuel, other export and import costs are not involved.

Labourers used in road construction are skilled and unskilled. The demand for skilled labour is high and competitive; hence, no shadow pricing is involved. For unskilled labour, the economic or shadow price has been corrected by the observed rate of combined unemployment and underemployment. During FGDs, labour group members were asked how many days a year (by month) they found work outside that for the road.

Prices are subject to foreign exchange risks and market distortions, which are represented by the SCF. In fully liberalized economies where even exchange rates are determined by market forces, the SCF correction is not required. In Nepal, the current value of SCF is taken as 0.95 (five percent exchange rate and other risks) after semi-liberalization of the economy since 1990. Before this, an SCF value of 0.9 was used.

Results for five of the selected roads are presented in Table 5.

Broadly, there are two tools to evaluate returns from economic analysis, namely, benefit/cost ratio (BCR) and internal rate of return (IRR). Both of these tools have been used to compute financial and economic returns. For BCR analysis, the discount rate is taken as eight percent, which is the standard interest rate offered by banks on time deposits. For IRR, the process itself finds the discount rate at which benefits and costs are the same. The IRR becomes the financial internal rate of return (FIRR) if financial costs/prices are used and the economic internal rate of return (EIRR) if economic costs/prices are used.

Table 5 **Average days of work engagement in road corridors**

	Mude–Melung (Road 1)	Bhirkot–Chhaunde (Road 2)	Barabise–Bigu (Road 3)	Dandabas–Pakani (Road 4)	Pakani–Baikuntha (Road 5)
January	12	10	10	8	8
February	12	10	10	10	10
March	15	12	15	15	15
April	10	10	10	12	12
May	15	15	12	12	12
June	25	25	20	20	20
July	28	25	25	20	20
August	15	10	12	12	12
September	10	8	5	6	6
October	16	15	12	12	12
November	12	12	12	12	12
December	12	10	10	10	10
Total	**182**	**162**	**153**	**149**	**149**
% workdays per year	**49.9**	**44.4**	**41.9**	**40.8**	**40.8**
Shadow price	**0.50**	**0.44**	**0.42**	**0.41**	**0.41**
Wage rate/day (NRs)	**250**	**215**	**215**	**175**	**175**
SCF	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**
Shadow wage rate (NRs)	**118**	**91**	**86**	**68**	**68**

Methodological issues for mixed roads

In a small sample study such as this, it is useful for comparability to take a single road that uses each technology separately on different sections of the road. The benefits for both sections of the road are shared, but the EB section of the road requires higher maintenance and experiences more frequent blockages than the LB section. In the case of Road 1, the potential benefit for the LB road may not have been fully realized because the EB road precedes it, and the EB road's limitations may have affected the LB road's performance. For Roads 4 and 5, the case is reversed: the LB road precedes the EB road. So for comparison, analysis of this situation might be more appropriate. This is a methodological question, and the methodology for comparative studies of these types of roads should be refined in the future. Because of such situations, it was found that districts are now trying to follow a network approach in road construction, so that roads do not have a beginning and an end (but are a ring or circle).

Economics of equipment renting

Renting out heavy equipment for road construction is a lucrative business and the number of suppliers is increasing, making the business highly competitive. Given the data and assumptions presented in Table 6, the annual variable cost to equipment owners is about NRs 380,000 and the gross annual earnings is about NRs 2.16 million. This gives a BCR to the owner of 1.69 and an IRR of 18 percent in financial prices; these can be considered to be very high (see Annex 2 for financial returns and Annex 3 for economic returns). The owner recovers the full cost of equipment in just five years. The return to investment must have been even higher a few years ago when competition was lower and hourly rental rates were nearly double the present levels.

This financial analysis suggests that heavy equipment businesses may also have been lobbying in favour of EB local road construction.

An excavator can open a 5-m road track at the rate of 150 m per hour, if the soil is soft. At this rate, 1.5 km of road is opened in 10 hours. However, the speed of construction in rocky portions is slower and is governed by the type of rock. For breaking hard rocks, a breaker bucket can be attached to the equipment. For an excavator with breaker attachment, there is an additional NRs 10,000 per day for breaker use and an extra NRs 1,000 per hour for rent of the excavator. The extra charge for the excavator is because it requires more power to operate the breaker.

Lubricant is changed during servicing, which is generally done after 500 hours of operation. Basic driver and helper salary is borne by the owner and they receive extra payment from the user when equipment is in operation. Diesel consumption of the equipment is 12–18 litres per hour, depending upon the size and capacity of the equipment. While renting the equipment, the renting party has to pay the diesel cost. The renter also bears the cost of transportation up to the site and back, which averages NRs 192 per km for a 200-km round trip.

The hourly cost of equipment is NRs 4,181 at financial prices and NRs 3,260 in economic prices. For this cost, 150 m of 5-m wide road can be opened on a soft-soil section. For LB technology, the same distance will require 50 labourers for one day involving, costing a minimum of NRs 15,000. Hence, earth work is around four times cheaper and eight times quicker when done with heavy equipment. However, average hourly calculations can be somewhat misleading, as it is not possible to rent heavy equipment for just one hour because the cost of transporting equipment to the site would be prohibitive. If equipment is rented for multiple hours or days, then it cannot be kept idle.

Table 6 **Financial and economic cost of equipment use (12-t excavator)**

	Parameter data	Financial cost per hr	Parameter data	Economic cost per hr
Hours of use per year	1,200		1,200	
Life of machine (years)	25		25	
Cost of machine (NRs)	9,200,000	307	8,390,400	280
Annual insurance cost (NRs)	50,000	42	47,500	40
Diesel consumption (l/hr at NRs 70 per l)	12	840	12	840
Lubricant, repair and maintenance (NRs/yr)	150,000	125	142,500	118.75
Driver and helper salary (NRs/yr)	180,000	150	180,000	150
Driver and helper cost during operation including food (NRs/day in use)	1,500	150	1,425	142.5
Equipment rental charge (NRs/hr)		1,800	–	1,800
Average use per transaction (hr)	50		50	
Two-way transport cost (NRs)	38,400	768	36,480	730
Total per hour cost		**4,181**		**3,260**

In any case, the problem is not heavy equipment *per se*, it is rather the other practices such as lack of proper water drainage, unacceptably high gradients, indiscriminate disposal of debris, lack of soling in critical soft spots, etc. that are closely linked with the use of heavy equipment.

Equipment owners sometimes have problems obtaining payments and have, on occasion, had to file writs against user committees to collect their money.

Economic analysis of selected roads

Cost of roads

Direct costs

The costs entailed in road construction include survey and design, social mobilization, construction (track opening, widening, cross-drainage (CD) structures and bioengineering), and supervision. The per km construction costs for selected roads is presented in Tables 7 and 8. For Dolakha district, the mixed Road 1 cost NRs 3.3 million per km, the LB Road 2 cost NRs 3.7 million per km, and the EB Road 3 cost NRs 639,000 per km. For Makwanpur district, the LB Road 4 cost NRs 1.8 million per km and the EB Road 5 cost NRs 619,600 per km. It should be noted that precise data on all cost heads were not available and some figures had to be based on experience from elsewhere and estimates provided by stakeholders during FGDs.

Table 7 **Direct financial costs of selected roads in Dolakha district and share of labour cost**

	Mude–Melung (Road 1)			Bhirkot–Chhaunde (Road 2)			Barabise–Bigu (Road 3)		
	Cost ('000 NRs /km)	Share of labour (%)	Labour wages ('000 NRs)	Cost ('000 NRs /km)	Share of labour (%)	Labour wages ('000 NRs)	Cost ('000 NRs /km)	Share of labour (%)	Labour wages ('000 NRs)
Survey and design	18.3	18	3.30	14.1	20	2.82	26.1	15	3.92
Social mobilization	80.4	65	52.28	80.4	80	64.34	15.7	80	12.53
Track opening	633.9	70	443.71	690.0	90	621.00	0.0	0	0.00
3-m widening	788.8	65	512.73	861.0	80	688.80	0.0	0	0.00
5-m widening	1,408.6	65	915.59	1,530.6	80	1,224.49	522.0	20	104.40
CD structures	283.1	30	84.94	308.2	30	92.45	41.8	30	12.53
Bioengineering	39.7	50	19.84	79.4	50	39.68	23.8	50	11.90
Supervision	75.0			125.0			10.0		
Total direct cost	**3,327.9**		**2,032.39**	**3,688.7**		**2,733.58**	**639.3**		**145.28**
Routine maintenance	10.0	95	9.50	14.3	95	13.57	19.6	95	18.62
Periodic maintenance	53.6	65	34.82	28.6	95	27.14	142.9	20	28.57

Table 8 Direct financial costs of selected roads in Makwanpur district and share of labour cost

	Dandabas–Pakani (Road 4)			Pakani–Baikuntha (Road 5)		
	Cost ('000 NRs /km)	Share of labour (%)	Labour wages ('000 NRs)	Cost ('000 NRs /km)	Share of labour (%)	Labour wages ('000 NRs)
Survey and design	15.0	25	3.75	25.6	20	5.12
Social mobilization	74.0	80	59.20	30.7	80	24.59
Track opening	311.0	90	279.94	0	0	0.00
3-m widening	389.1	80	311.32	0	0	0.00
5-m widening	693.2	80	554.56	512.3	10	51.23
CD structures	139.3	25	34.84	41.0	20	8.20
Bioengineering	75.0	50	37.50	0	50	0.00
Supervision	125.0			10		
Total direct cost	**1,821.7**		**1,281.02**	**619.6**		**89.14**
Routine maintenance	16.0	95	15.20	22.7	95	21.57
Periodic maintenance	33.5	95	31.83	166.2	25	41.55

The time taken for selected roads construction was five years for Roads 1 and 2, two years for Road 3, four years for Road 4, and two years for Road 5. Summary of total costs and annual distribution of costs is presented in Table 9.

Table 9 Total cost of selected roads and the annual distribution

	Road length (km)	Total cost (NRs '000)	Annual investment cost distribution (NRs '000)				
			Year 1	Year 2	Year 3	Year 4	Year 5
Dolakha							
Mude–Melung (Road 1)	25.5	84,861	8,746	8,442	20,478	11,799	35,406
Bhirkot–Chhaunde (Road 2)	14	51,641	5,603	5,405	12,629	11,289	16,715
Barabise–Bigu (Road 3)	15	9,590	4,499	5,091	–	–	–
Makwanpur							
Dandabas–Pakani (Road 4)	15	27,326	3,304	3,079	6,583	14,360	
Pakani–Baikuntha (Road 5)	13	8,055	3,728	4,327	–	–	–

The percentage share of different cost heads for each road is presented in Table 10.

Table 10 Percentage share of different cost heads in the selected roads

Road	Skilled labour	Unskilled labour	Material and other costs	Equipment
Dolakha				
Mude–Melung (Road 1)	2	50	13	35
Bhirkot–Chhaunde (Road 2)	3	77.4	19.6	0
Barabise–Bigu (Road 3)	0.1	10	9.9	80
Makwanpur				
Dandabas–Pakani (Road 4)	3	77.4	19.6	0
Pakani–Baikuntha (Road 5)	0.1	10	9.9	80

Indirect costs including environmental costs

Construction of the selected roads also incurred some indirect costs that would have been saved if these roads had not been constructed. Two major cost heads were the loss of farmland—that directly on the road alignment and that destroyed by debris disposal—and the loss of forest (trees and shrubs) and pasture land. While farmland was lost forever, forests are assumed to regenerate after about one decade. Human loss during construction and loss of infrastructure due to roads are found elsewhere in Nepal, but such losses were not reported on selected roads. Assessment of these costs has been presented separately for farmland (Table 11) and forest losses (Table 12).

Road maintenance costs

In road maintenance, two cost heads are involved: regular maintenance and periodic maintenance. Under regular maintenance, local workers are assigned at the rate of about one person per 3–4 km. They are provided with basic training on minor road maintenance work and given the appropriate small tools. Their function is to clean the roads and drains on a regular basis, and to fill small potholes. Periodic maintenance is carried out at least once a year and during emergencies when the road is blocked owing to landslides. Its function is to clear landslides, fill larger potholes and improve damaged structures. The annual cost of maintenance per km of selected roads is presented in Tables 7 and 8. It should be noted that while routine maintenance are more or less similar in LB and EB roads, periodic maintenance is much higher in EB roads, as roads are heavily damaged after the monsoon season. It should also be noted that, when the road alignment has to be changed or improved, which is more likely for unplanned EB roads, the cost could be huge with possibly negative returns.

Unaccounted costs

Besides the reported direct and indirect costs incurred during road construction, there are other costs that have not been accounted for. These include eco-costs such as reduced carbon sequestration and loss of habitat of birds and animals; debris flow to water systems affecting water quality and aquatic animals; etc. In road environs, people also change their consumption

Table 11 Farmland losses during construction of selected roads

	Road length traversed (km)	Total farmland under road (ha)	Annual production value foregone (NRs/ha)	Total value foregone ('000 NRs)
Dolakha				
Mude–Melung (Road 1)	25.5	10	70,000	700
Bhirkot–Chhaunde (Road 2)	14	12	50,000	600
Barabise–Bigu (Road 3)	15	13	40,000	520
Makwanpur				
Dandabas–Pakani (Road 4)	15	5	40,000	200
Pakani–Baikuntha (Road 5)	13	2	30,000	60

Table 12 **Loss of forest and pasture resources during construction of selected roads**

	Road length traversed (km)	Total forest/ pasture destroyed (ha)	Forest/pasture loss value (NRs/ha)	Total value foregone ('000 NRs)
Dolakha				
Mude–Melung (Road 1)	25.5	13	200,000	2,550
Bhirkot–Chhaunde (Road 2)	14	5.6	200,000	1,120
Barabise–Bigu (Road 3)	15	25	150,000	3,750
Makwanpur				
Dandabas–Pakani (Road 4)	15	9	180,000	1,620
Pakani–Baikuntha (Road 5)	13	18	200,000	3,600

and recreation patterns towards imported products such as alcohol, noodles, games and, sometimes, even narcotics.

Benefits from the roads

Roads are made for development and prosperity mainly through increased economic activities because of enhanced competitiveness and cost savings in travel and on imports and exports. In the selected roads, the benefit heads were (i) benefit from cheaper travel for productive work; (ii) incremental production of agricultural products; (iii) savings in food import; (iv) incremental benefit from merchandise trade; and (v) safe return on 50 percent of wage earned in road works.

To maximize the benefits of rural road construction to local people, it is necessary to promote the local peoples' access to governmental inputs and services. Although service expansion has been an integral part of some donor-funded roads (ADB, World Bank, DRSP), this was not found to be the case for roads constructed by local bodies. Hence, emphasis should be placed on enhancing and promoting social services to the community such as by promoting access to education, health and livelihood improvement services.

Travel and migration benefits

Roads accommodate public transport vehicles which allow local people to conduct productive movement for work. Estimates of such benefits based on locally provided information are presented in Table 13. Obviously, not all travel is productive and some incurs costs. About 15 percent of travel is productive in Dolakha and 20 percent in Makwanpur. Benefits are estimated at one day's wage minus travel costs—NRs 165 for Dolakha and NRs 200 for Makwanpur.

Table 13 People's movement and associated benefits

	No. of buses	No. of days per year	No. of passengers per bus	Total no. of passengers	% of value-added passengers	Average benefit per value-added passenger (NRs)	Total added return ('000 NRs)
Dolakha							
Mude–Melung (Road 1)	9	300	25	67,500	15	165	1,671
Bhirkot–Chhaunde (Road 2)	5	320	20	32,000	15	165	792
Barabise–Bigu (Road 3)	4	200	15	12,000	15	165	297
Makwanpur							
Dandabas–Pakani (Road 4)	9	320	20	57,600	20	200	2,304
Pakani–Baikuntha (Road 5)	5	200	15	15,000	20	200	600

Production and export of agricultural products

Off-season potato and other vegetables produced in the mountain environment fetch higher prices if they can reach the market. Before the construction of roads, such opportunities were not feasible because transportation costs were prohibitively high. Now that roads are in place, there has been a positive response from both demand and supply sides. In the selected road corridors, the principal products are potato and off-season vegetables. In addition, some specialized products such as medicinal herbs and *lokta* for hand-made paper are grown in Dolakha, and *ghee* is produced in Bigu; however, these products have not been included separately. The incremental income from agricultural products made possible by the roads is presented in Table 14.

Table 14 Incremental production and export of vegetables from selected roads

	Total potato exported per year (t)	Value of potato (NRs '000)	Vegetables and other products (t)	Value (NRs '000)	Total value (NRs '000)	Incremental benefit (NRs '000)
Dolakha						
Mude–Melung (Road 1)	3,500	63,000	120	2,400	65,400	19,620
Bhirkot–Chhaunde (Road 2)	1,600	28,800	90	1,800	30,600	9,180
Barabise–Bigu (Road 3)	750	11,250	60	1,200	12,450	3,735
Makwanpur						
Dandabas–Pakani (Road 4)	800	9,600	150	3,000	12,600	3,780
Pakani–Baikuntha (Road 5)	600	7,200	120	2,400	9,600	2,880

Food security

Almost all households along the selected road corridors were food insecure for between three and 12 months a year before the road was built. Although food imports from outside were expensive, a limited amount was bought in. Now, households are able to import food at a lower cost (at least NRs 8 per kg lower) due to improved access as well as increase the amount they buy as a result of their increased income. Improvement in food security and savings on food imports are presented in Table 15.

Incremental business benefits from other merchandise movements

Local traders and local residents have privately enlarged their hitherto petty shops and businesses to earn additional income. The estimated amount of such benefits is presented in Table 16.

Table 15 Savings in rice imports along selected roads

	Estimated no. of households along road	% of households importing rice	Import after road (t)	Import before road (t)	Cost savings (NRs '000)
Dolakha					
Mude–Melung (Road 1)	2,200	80	605	151	1,210
Bhirkot–Chhaunde (Road 2)	850	60	234	58	468
Barabise–Bigu (Road 3)	550	80	151	38	303
Makwanpur					
Dandabas–Pakani (Road 4)	565	27	155	39	311
Pakani–Baikuntha (Road 5)	150	50	41	10	83

Table 16 Incremental income from other business and merchandising transactions

	Estimated no. of households	Value of merchandise per households (NRs)	Total value of merchandise (NRs '000)	10% profit on merchandise (NRs '000)
Dolakha				
Mude–Melung (Road 1)	2,000	5,000	10,000	1,000
Bhirkot–Chhaunde (Road 2)	850	3,500	2,975	298
Barabise–Bigu (Road 3)	600	3,000	1,800	180
Makwanpur				
Dandabas–Pakani (Road 4)	565	2,500	1,413	141
Pakani–Baikuntha (Road 5)	150	1,500	225	23

Total annual benefit at full development

The total annual benefits at full development, based on values from tables above, are presented in Table 17.

Unaccounted benefits

Besides the above-categorized benefits, there are a few other benefits that have not been built into the analysis. Such benefits include access to inputs, services and technologies, opportunities outside the village for access to education for children, extension of health facilities, awareness through social mobilization, etc. Health benefits could reduce the number of sick-days in a family thus improving labour efficiency.

Financial and economic returns from selected roads

The accounted costs in road construction and benefits from activities in each road influence area have been used to construct an annual stream of costs and benefits for a 30-year period from the beginning of road construction in order to compute NPV, BCR and IRR for each road. Although the roads will be permanent infrastructure for many more years to come, a 30-year life is assumed because the NPV of returns accruing after 30 years at normal interest rates are virtually zero.

Build-up period

The incremental benefits discussed above will not accrue all at once when the road starts operating. Some period of learning, adaptation and adoption is required to build these potential benefits to a useful level. In the selected road corridors, this period is assumed to be three years from the start of vehicle operation on the road. Full development is generally reached within three years. During the first two years, activity levels are generally at the level of 50 percent for in the first year and 75 percent for the second year.

Table 17 Total annual benefit at full development (NRs '000)

	Travel and migration	Potato and vegetables	Cost saving in food import	Business merchandise income	Total incremental income
Dolakha					
Mude–Melung (Road 1)	1,671	19,620	1,210	1,000	23,501
Bhirkot–Chhaunde (Road 2)	792	9,180	468	298	10,737
Barabise–Bigu (Road 3)	297	3,735	303	180	4,515
Makwanpur					
Dandabas–Pakani (Road 4)	2,304	3,780	311	141	6,536
Pakani–Baikuntha (Road 5)	600	2,880	83	23	3,585

Table 18 Estimated NPV, BCR and IRR from selected roads at financial and economic prices

		Financial			Economic		
		NPV (NRs)	BCR	IRR (%)	NPV (NRs)	BCR	IRR (%)
Dolakha							
Mude–Melung (Road 1)	LB+EB	73,183	1.83	15.9	85,712	2.27	18.9
Bhirkot–Chhaunde (Road 2)	LB	24,707	1.47	12.7	41,915	2.34	19.7
Barabise–Bigu (Road 3)	EB	1,880	1.05	9.5	7,328	1.24	14.3
Makwanpur							
Dandabas–Pakani (Road 4)	LB	18,644	1.60	14.6	29,764	2.71	24.6
Pakani–Baikuntha (Road 5)	EB	499	1.01	8.4	6,915	1.25	14.7

For economic returns, streams have been adjusted by the economic prices discussed at the beginning of the chapter. Computations have been done separately for each road for comparison purposes. Computations from the streams of costs and benefits are presented in Annexes 3 and 4 (financial returns and economic returns) for the five roads. The summary of the financial and economic returns for each road are presented in Table 18.

Sensitivity analysis

Sensitivity analysis shows the changes in outcomes when a process or parameter is changed. The sensitivity analysis has been done for the LB Bhirkot–Chhaude road (Road 2) to see (i) how outcomes change when vehicle operation is increased by one month per year; and (ii) how the same will change when the benefit stream is pulled ahead by one year. The result shows the following.

- When vehicle operation on the road is increased by one month per year, the FIRR is increased by 1.3 percentage points (10.2 percent increase) while the EIRR is increased by 1.6 percentage points (8.1 percent increase). This explains the higher returns from the LB road because vehicles operate for more months a year on LB roads compared to EB roads (an average of 10 as opposed to an average of seven months).
- When the benefit stream is pulled ahead by one year, the FIRR is increased by 1.9 percentage points (15 percent increase) while the EIRR is increased by 3.6 percentage points (18.3 percent increase). This explains why local people want roads to be built quickly. Here lies the utility of environment-smart EB technology.

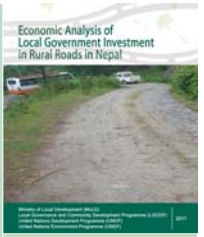
Summary findings from the economic analysis

Findings from financial and economic return computations using the data, parameters and assumptions have been summarized as follows.

- All roads have a positive return on both financial and economic investments, and returns to the country/society are more than returns to households in all cases. This justifies state investment in and support for development of rural roads.

- LB roads had higher returns (about 30 percent more) compared to EB roads. This is owing to the higher number of vehicle and days of movement per year on LB roads (3–7 months for EB roads and 7–12 months for LB roads).
- LB and EB combination provided the highest return (Road 1). This is because the EB road was improved considerably to reach the quality of the LB road. If the EB road precedes the LB road, the LB party is compelled to improve the EB road to reach the former's performance (Mude–Melung, Dolakha). This also shows the utility of a blend of LB and EB technology in a single road.
- LB roads have a pro-poor effect because the resources retained as labour wages, which are much higher in LB roads, can have a multiplier effect.

7 CHAPTER



CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The following conclusions have emerged from the study.

- Roads are the number one priority for local communities and, rightly so, considering the spatial nature of poverty in rural areas. However, if roads cannot be plied or the poor do not adequately benefit from them (because the roads are not developed properly), the present high priority allocated to them can itself become a source of problems. LB roads are more pro-poor than EB roads and can provide employment to the poor. Hence, rural road construction can be made into a pro-poor initiative with the use of LB technology.
- Existing government processes, particularly budgetary processes, result in long delays in fund release, which limits the working season for road projects. This is not favourable for construction, especially with LB technology, and instead encourages or compels the choice of EB technology for 'last-minute' work.
- Current price trends (threefold increase in wages over the last 10 years and more than 50 percent reduction in heavy equipment rental rates in the same period) have increased the economic feasibility of EB technology.

- The use of EB technology has a strong correlation with the unsustainability of roads. This is caused by, amongst other things, higher risk of too-steep gradients; lack of adequate water-draining structures; an absence generally of road stabilizing and protection structures; significantly higher environmental damage which causes high environmental costs; and a high risk/occurrence (about five times higher) of landslides compared to LB roads.
- There are certain situations when EB technology can be efficient and less damaging. These situations are in (i) road widening; (ii) ridge alignments; and (iii) long alignments through unpopulated areas that require the establishment of labour camps under LB methodology. Similarly, EB technology allows for breaker attachments on excavators, which can be more efficient for breaking very hard rock than LB technology that often uses skilled labourers for tedious chisel-cutting.
- EB technology can be economical and is faster, but is still not necessarily associated with high rates of return. In contrast to this, the returns from LB methods are about 30 percent higher than for EB methods. In Nepal, most non-functioning and seasonal roads have been constructed using EB technologies.
- There are several known instances of corruption and other financial abuses, but none have been formally investigated or penalized. This indicates a clear state of impunity and lack of financial discipline. The risk of corruption is significantly higher with EB methods, since beneficiaries and communities in general have far less involvement in decision-making and in monitoring of alignment selection, tendering for work, and actual construction.
- Whenever and wherever possible, a blend of LB and EB technologies should be used for rural road construction to harness the positive features of each technology—cheaper and faster from EB technology, and sustainable and poverty-reducing from LB technology.

Policy recommendations

Road planning

- The road to be built must be planned in a participatory way and should be a part of the DTMP. No road should be financed by local bodies, unless it is included in the DTMP. Special care should be taken that decision-making processes on road prioritization, the DTMP and road alignments are participatory and transparent. Community auditing needs to be included and an appeals process should be established.
- Feasibility and environmental assessments should be mandatory, and problems highlighted in environmental reports must be resolved within the road design.

Fund management

- No roads should be started without sufficient funds at hand or without assured funding sources.
- Fund support from local bodies and the centre should be disbursed at the beginning of the lean season (November). For this, the following changes should be made.

- Change the fiscal calendar in a way that allows development funds to be available for use at the local level by about the middle of November.
- Expedite the budget release process.
- Abolish the budget-freezing process at the financial year-end for development work.

➤ For road projects, an ensured multi-year budget should be allocated, so that the financial grant system does not negatively impact the capacity of local government bodies to construct roads.

Preparing the community

➤ Social mobilization of communities in the influence area of roads should be mandatory for road building. This is important for developing local ownership and mitigating intentional tampering. Social mobilization messages and modes of delivery should be tailored to each community, depending on its level of social capital (see Annex 2).

Road construction

➤ The use of bulldozers and rock-blasting materials should be discouraged, as the tremor effect they produce impacts on surrounding geological formations and significantly increases the probability of landslides. Controlled blasting techniques, which have a higher efficiency and lower cost because of substantial savings on blasting materials, can be considered. The force of the blast should be directed outward so that remaining rock faces are stable. These techniques can also be used in combination with LB methods, if compressors and jack hammers are made available.

➤ LB technology should be encouraged and particularly emphasized in poverty-ridden areas. However, to harness some of the positive features of EB technology, the use of excavators should be allowed for (i) road widening; (ii) ridge alignments (see photo below); and (iii) long alignments that require labour camps under LB methodology. Similarly, breaker attachments can be time- and cost-efficient for breaking rocks over long spells of very hard rock that require tedious chisel-cutting under LB methodology. However, equipment use should be duly complemented by water management structures (side and cross drains), other protection structures and bioengineering works in critical areas.

➤ The Department of Local Infrastructure Development and Agricultural Roads and local bodies should jointly institute a system of annual policy auditing for rural road construction by local bodies to assess policy compliance. Any failure to comply with policy should entail appropriate sanctions such as budget cuts.

A ridge alignment in Dolakha that may be ideal for EB technology to expedite road construction

Road operation and maintenance

➤ Operational guidelines need to be developed to ensure that transport does not damage roads and the maximum weight limit is enforced. This is especially relevant in relation to criteria for road closure, e.g., during the monsoon, when road surfaces are easily damaged.

- A concerted effort is needed to secure the participation of beneficiaries in all steps of the road project cycle in order to ensure ownership of the road and contributions for road maintenance. Different road maintenance models will need to be developed for different road standards and conditions to allow for communities to contribute within their capacity.
- All rural roads should have adequate operation and maintenance funds for timely maintenance. Such funds must be complemented by beneficiary contributions raised from the increased income resulting from the road. A system of reasonable taxing of vehicles and goods movement can also be developed for this purpose. The tariff fixed for such purposes should not be specified as an absolute amount in the Local Self-Governance Rules but should be left for local bodies to decide for themselves.
- Local road maintenance skills should be developed through training and work during road construction.

Enhancing benefits from the road

- Public service packages in agriculture and the social sectors (health, education, etc.) should be part of road design, so that benefits from the road are enhanced to their full potential. This is built into some projects funded by donors such the ADB and World Bank, but not for roads built by local bodies themselves.
- Public forest and land needs to be protected from exploitation by (often) outsiders, who have easy access to natural resources through the expanding road network.

Other issues

- Rent-seeking practices are anti-poor and should be strictly controlled. For this, public auditing should be mandatory.
- One of the reasons for unsustainable infrastructure at the local level is the shortage of technical manpower. Although resource availability within VDCs has increased by up to 10 times, the availability of technical manpower has remained the same. Therefore, a separate budget head for the outsourcing of technical manpower, e.g., for survey, design, construction and/or supervision, should be provided in grant funds. In addition, the possibility of using public–private partnerships for road development should be explored and tested.
- It is recommended that, in the new state structure for Nepal, the current *ilaka* are defined as the local body equivalent to the current VDC. If the *ilaka* is taken as the smallest local administrative body, then it will have adequate resources and capacity to have its own technical unit. There are currently about 700 *ilaka* compared to 3,915 VDCs.
- The foreseen transformation of democratic and public institutions in Nepal provides a good opportunity for developing clear roles and responsibilities and institutional arrangements conducive for rural road development. New guidelines for planning, design and construction as well as for operation and maintenance are needed, and beneficiary participation and monitoring and evaluation should be reinforced.
- Adequate compensation arrangements should be made for the losers of land to road alignments or of crops destroyed during construction, particularly since the losers are more often than not the poor.

BIBLIOGRAPHY

Deoja, B.B., 1994. *Sustainable Approaches to the Construction of Roads and Other Infrastructure in the Hindu Kush-Himalayas*, ICIMOD Occasional Paper No. 24, Kathmandu: International Centre for Integrated Mountain Development.

Dolakha DDC, 2001. *Periodic District Development Plan 2001/02–2007/08*.

DOLIDAR, 1999. *Approach for the Development of Agricultural and Rural Roads: A Manual for the Preparation of District Transport Master Plan and for the Implementation of Rural Road Sub-projects*. Kathmandu: Department of Local Infrastructure Development and Agricultural Roads.

Makwanpur DDC, 2001. *Periodic District Development Plan 2002–2006*.

Meyer, W.P., Acharya, B.N., Aryal, R. and Karmacharya, B.B., 1999. *Greens Roads in Nepal: Best Practices Report*. Kathmandu: GTZ and SDC.

MoLD, 2004. *Local Infrastructure Development Policy 2061 (Revised 2004)*. Kathmandu: Ministry of Local Development.

Sharma, C.K., 1988. *Natural Hazards and Man-Made Impacts in the Nepal Himalaya*. Kathmandu.

Shrestha, H.R. and Mallik, G.N., 1994. Eco-design Approach to Hill Road: An Appropriate Strategy to Preserve Mountain Environment. In *Proceeding of the Regional Conference on Environment and Biodiversity in the Context of South Asia, 7–9 March 1994, Kathmandu*. Kathmandu: Ecological Society (ECOS).

Shrestha, H.R., 1998. *Resource Management for Rural Road Construction in the Context of Nepal*, Proceeding of Sixth National Convention of Engineers on Resource Management for Infrastructure Development, 3–4 December 1997. Kathmandu: NEA.

Stern, N., 2006. *The Economics of Climate Change. The Stern Review*. Cambridge: Cambridge University Press.

Transport Research Laboratory, 1997. *Principles of Low-Cost Road Engineering in Mountainous Regions*. Overseas Road Note 16. London: Overseas Development Administration.

ANNEXES

ANNEX 1 CHECKLIST FOR ROAD INFORMATION

District: _____

Name of road: _____

Work type: Rehabilitation/upgrading/new construction _____

If rehabilitation or upgrading, what was the road like previously? _____

Road status: Completed/under construction/abandoned/in use _____

Survey period: _____

Date of construction start: _____

Date of construction completion: _____

Starting point: _____

End point: _____

Road connecting to: Highway/district road/settlement (name) _____

Length (km): _____

Settlements/VDCs connected: _____

When and how was road planned? _____

Who made the decision to construct the road? Party/alliance/LDO/VDC secretary/others (specify) _____

Is the road included in District Transport Master Plan (DTMP)? _____

Survey period: _____

Was any environmental study (IEE/EIA) done? Yes/no _____

If yes, study findings: _____

If no, why was it not done? _____

Original estimated cost of road: NRs _____

Financing parties (specify amount contributed): _____

Contractor's name (if any): _____

Contract date: _____

Contract termination date: _____

Type of technology used: LB/EB/mixed _____

During construction/rehabilitation: _____

During regular maintenance: _____

During periodic maintenance: _____

Overhead cost of the road: (planning, operation, maintenance) _____

Is periodic maintenance done in contract? Yes/no _____

If yes, details of contract: _____

Is regular maintenance done in contract? Yes/no _____

If yes, details of contract: _____

Prevailing interest rate for borrowing: _____

Equipment/machine used (construction, periodic maintenance, emergency maintenance)

Equipment/ machine used	Make/ model	Date acquired	Normal life	Value when acquired	Value when used	Fuel use/ hour (l)	Price of fuel (NRs/l)	Lubricant used	Price of lubricant (NRs/l)	Annual maintenance cost	Driver salary (NRs/hr)	Normal rental rate (NRs/hr)	Hours used on road

Use of human labour (construction, periodic maintenance, emergency maintenance)

	Unskilled	Semi-skilled	Skilled	Supervisory
Days used Male Female				
Poor (%) Dalit (%) Janajati (%)				
Voluntary Male Female				
Wage rate (NRs/day) Male Female				
Was wage fully paid?				
Wage rate outside Male Female				
Wage in agricultural work Male Female				

QUESTIONS FOR FGDS IN SETTLEMENTS ALONG ROAD CORRIDOR

Settlement seasonality of employment

Months	No. of fulltime days in agriculture	No. of fulltime days off-farm	No. of days migrated	Common migration destination	Male wage rate in agriculture	Female wage rate in agriculture
Ashad Shrawan Bhadra						
Ashwin Kartik Mangsir						
Poush Magh Falgun						
Chaitra Baisakh Jestha						

No. of households in the settlement: _____

No. of Dalit households: _____

No. of Janajati households: _____

No. of female-headed households: _____

No. of households by food security situation: _____

All year _____

Up to 9 months _____

Up to 6 months _____

Up to 3 months _____

No. of landless households _____

No. of homeless households _____

Total land _____

Khet land _____

Bari land _____

Approximate poverty (%) _____

Average education level: _____

Vehicle, people and goods movement

Months	No. of vehicles plying	Types of vehicle plying	No. of people moving by vehicle	Approximate value of goods imported	Common goods imported	Approximate value of goods exported	Common goods exported
Ashad Shrawan Bhadra							
Ashwin Kartik Mangsir							
Poush Magh Falgun							
Chaitra Baisakh Jestha							

Was the community involved somehow in decision-making? _____

Who was instrumental in deciding to construct the road? _____

What are your perceptions about the road? _____

Alignment _____

Length _____

Good features _____

Bad features _____

Infrastructure and assets affected by the road

Affected item	Unit	Quantity	Value
Human lives (deaths/disability) Forest land Trees			
Shrubs *Khet* land *Bari* land Pasture land			
Animal/bird habitat Infrastructure Irrigation Drinking water Others			

ANNEX 2 TAILORING SOCIAL MOBILIZATION PACKAGE FOR EACH COMMUNITY

The purpose of social mobilization is to enhance the social capital (trust and reciprocity) of a community so that it is capable of establishing and managing public and community goods. Hence, social mobilization should not begin without first estimating the community's social capital. The social mobilization package should be tailored to the needs and baseline social capital of the community rather than being a 'one size fits all' package. A social mobilizer, trained on how to tailor a social mobilization package for a community, will assess the level of social capital in a community, using the method proposed below, and design a social mobilization package with appropriate processes and message contents. For example, if the average level of education is low, the message is more effectively delivered in pictorial form. The language to be used must be simple and deliberations on the message must be slow and take time. However, using this same process in a community with a higher level of education would be a waste of time. Similarly, if the score for voluntary participation in public work is low, there should be a clear message on the importance of group work, or if the score on diversity of participants is low, there will be a need for messages related to gender and ethnic sensitization. If the use of alcohol/narcotics is found to be high, the consequences of this should be highlighted. If household expenditures are wastefully high, income/expenditure arithmetic can be demonstrated to indicate how to control wasteful expenses. Thus, the score obtained on each indicator can guide the content or process of social mobilization. The aggregate social capital value will be used for measuring change in the social capital level of communities.

A 15-variable model for estimating social capital is presented in the following table. For simplification, three categorization levels have been proposed for each indicator. The assessment may be fine-tuned by increasing categorization levels to more than three. The higher the num-

ber, the more precise the assessment will be. In addition, one or more indicators may be added or deleted. Equal weights have been proposed for all 15 indicators. However, depending on the level of importance of the indicator in influencing/contributing to the level of social capital, it might be better to select unequal weights for different indicators. A participatory exercise can be done with the community to determine the weights for each indicator. If this is done in each community, the basis for comparing social capital across communities will not be uniform. However, if the same weight is given to each indicator for every geographical unit whose social capital is being assessed, then there will be sufficient uniformity to allow for comparison.

The maximum score for a village (or any geographical unit whose social capital level is being assessed) is 45—three for each of 15 indicators (assuming equal weighting for each indicator). The following five social capital range values are proposed: very low for <20; low for 20–<25; medium for 25–<30; high for 30–<35; and very high for 35 or more.

Estimating social capital

S. No.	Variable	Answer codes	Received value	Weight	Weighted received value
1	House density	3-Dense, 2-Medium, 1-Sparse	—	1	0
2	Average years of schooling	3-High (>5) 2-Medium (2–6) 1-Low (<2)	—	1	0
3	Quarrel frequency	1-High, 2-Medium, 3-Low	—	1	0
4	Level of alcohol use	1-High, 2-Medium, 3-Low	—	1	0
5	Level of court cases	1-High, 2-Medium, 3-Low	—	1	0
6	Level of security expenses	1-High, 2-Medium, 3-Low	—	1	0
7	Number of social institutions	3-High, 2-Medium, 1-Low	—	1	0
8	Service nature of social institutions	3-Good, 2-Medium, 1-Not good	—	1	0
9	Help level from neighbours	3-High, 2-Medium, 1-Low	—	1	0
10	Existence of labour exchange system	3-High, 2-Medium, 1-Low	—	1	0
11	Level and composition of participation in social gatherings	3-High, 2-Medium, 1-Low	—	1	0
12	Previous level of social mobilization	1-High, 2-Medium, 3-Low	—	1	0
13	State of local public goods	3-Good, 2-Medium, 1-Not good	—	1	0
14	Participation and quality in village infrastructure	3-High, 2-Medium, 1-Low	—	1	0
15	Rating of the village for matrimonial purposes	1-High, 2-Medium, 3-Low	—	1	0
	Total				**0**

ANNEX 3

FINANCIAL STREAM OF COSTS AND BENEFITS AND FINANCIAL RETURNS FROM EQUIPMENT RENTING

Year	Capital cost	Insurance	Driver cost	Repair and maintenance	Total cost	Rental charge	Net benefit
1	9,200,000	50,000	90,000	75,000	9,415,000	540,000	-8,875,000
2	—	50,000	180,000	75,000	305,000	1,080,000	775,000
3	—	50,000	180,000	75,000	305,000	2,160,000	1,855,000
4	—	50,000	180,000	75,000	305,000	2,160,000	1,855,000
5	—	50,000	180,000	75,000	305,000	2,160,000	1,855,000
6	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
7	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
8	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
9	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
10	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
11	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
12	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
13	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
14	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
15	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
16	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
17	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
18	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
19	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
20	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
21	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
22	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
23	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
24	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
25	—	50,000	180,000	150,000	380,000	2,160,000	1,780,000
NPV	**$8,518,519**	**$533,739**	**$1,838,126**	**$1,301,763**	**$12,192,147**	**$20,631,591**	**$8,439,444**
BCR							**1.69**
IRR							**18%**

ANNEX 4

ECONOMIC STREAM OF COSTS AND BENEFITS AND ECONOMIC RETURNS FROM EQUIPMENT RENTING

Year	Capital cost	Insurance	Driver cost	Repair and maintenance	Total cost	Rental charge	Net benefit
1	8,390,400	47,500	90,000	71,250	8,599,150	513,000	-8,086,150
2	—	47,500	180,000	71,250	298,750	1,026,000	727,250
3	—	47,500	180,000	71,250	298,750	2,052,000	1,753,250
4	—	47,500	180,000	71,250	298,750	2,052,000	1,753,250
5	—	47,500	180,000	71,250	298,750	2,052,000	1,753,250
6	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
7	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
8	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
9	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
10	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
11	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
12	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
13	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
14	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
15	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
16	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
17	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
18	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
19	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
20	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
21	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
22	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
23	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
24	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
25	—	47,500	180,000	142,500	370,000	2,052,000	1,682,000
NPV	**$7,768,889**	**$507,052**	**$1,838,126**	**$1,236,675**	**$11,350,742**	**$19,600,011**	**$8,249,269**
BCR							**1.73**
IRR							**19%**

ANNEX 5 FINANCIAL STREAM OF COSTS AND BENEFITS

Road 1 (Mude–Melung, Dolakha)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	8,795	—	—	1,019	9,814	—	—	—	—	—	—	-9,814
2	8,492	—	—	1,019	9,511	—	—	—	—	16	16	-9,495
3	20,525	64	342	955	21,885	—	—	—	—	41	41	-21,845
4	11,847	128	683	955	13,613	—	—	—	—	81	81	-13,531
5	35,456	191	1,025	955	37,627	—	—	—	—	122	122	-37,505
6	—	255	1,366	955	2,576	9,810	835	605	500	163	11,913	9,337
7	—	255	1,366	955	2,576	14,715	1,253	908	750	163	17,788	15,212
8	—	255	1,366	955	2,576	19,620	1,671	1,210	1,000	163	23,663	21,087
9	—	255	1,366	955	2,576	19,620	1,671	1,210	1,000	163	23,663	21,087
10	—	255	1,366	955	2,576	19,620	1,671	1,210	1,000	163	23,663	21,087
11	—	255	1,366	955	2,576	19,620	1,671	1,210	1,000	163	23,663	21,087
12	—	255	1,366	955	2,576	19,620	1,671	1,210	1,000	163	23,663	21,087
13	—	255	1,366	955	2,576	19,620	1,671	1,210	1,000	163	23,663	21,087
14	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
15	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
16	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
17	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
18	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
19	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
20	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
21	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
22	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
23	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
24	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
25	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
26	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
27	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
28	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
29	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
30	—	255	1,366	700	2,321	19,620	1,671	1,210	1,000	163	23,663	21,342
NPV (8% DR)				**$88,088**						**$161,271**	**$73,183**	
BCR												**1.83**
IRR												**15.9%**

Road 2 (Bhirkot–Chhaude, Dolakha)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	5,603	—	—	740	6,343	—	—	—	—	—	—	-6,343
2	5,405	20	—	740	6,165	—	—	—	—	22	22	-6,143
3	12,629	50	100	712	13,491	—	—	—	—	55	55	-13,437
4	11,289	100	200	712	12,301	—	—	—	—	109	109	-12,192
5	16,715	150	300	712	17,877	—	—	—	—	164	164	-17,713
6	—	200	400	712	1,312	4,740	396	234	149	219	5,737	4,425
7	—	200	400	712	1,312	7,110	594	351	223	219	8,496	7,184
8	—	200	400	712	1,312	9,480	792	468	298	219	11,256	9,944
9	—	200	400	712	1,312	9,480	792	468	298	219	11,256	9,944
10	—	200	400	712	1,312	9,480	792	468	298	219	11,256	9,944
11	—	200	400	712	1,312	9,480	792	468	298	219	11,256	9,944
12	—	200	400	712	1,312	9,480	792	468	298	219	11,256	9,944
13	—	200	400	712	1,312	9,480	792	468	298	219	11,256	9,944
14	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
15	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
16	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
17	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
18	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
19	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
20	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
21	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
22	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
23	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
24	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
25	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
26	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
27	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
28	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
29	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
30	—	200	400	600	1,200	9,480	792	468	298	219	11,256	10,056
NPV (8% DR)					**$52,233**						**$76,940**	**$24,707**
BCR												**1.47**
IRR												**12.7%**

Road 3 (Barabise–Bigu, Dolakha)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	4,499	—	—	729	5,228	—	—	—	—	—	—	-5,228
2	5,091	147	1,071	729	7,038	—	—	—	—	12	12	-7,027
3	—	294	2,143	427	2,864	1,868	149	151	90	12	2,269	-595
4	—	294	2,143	427	2,864	2,801	223	227	135	12	3,397	534
5	—	294	2,143	427	2,864	3,735	297	303	180	12	4,526	1,662
6	—	294	2,143	427	2,864	3,735	297	303	180	12	4,526	1,662
7	—	294	2,143	427	2,864	3,735	297	303	180	12	4,526	1,662
8	—	294	2,143	427	2,864	3,735	297	303	180	12	4,526	1,662
9	—	294	2,143	427	2,864	3,735	297	303	180	12	4,526	1,662
10	—	294	2,143	427	2,864	3,735	297	303	180	12	4,526	1,662
11	—	294	2,143	427	2,864	3,735	297	303	180	12	4,526	1,662
12	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
13	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
14	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
15	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
16	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
17	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
18	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
19	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
20	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
21	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
22	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
23	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
24	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
25	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
26	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
27	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
28	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
29	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
30	—	294	2,143	520	2,957	3,735	297	303	180	12	4,526	1,569
NPV (8% DR)					**$38,391**						**$40,271**	**$1,880**
BCR												**1.05**
IRR												**9.5%**

Road 4 (Dandabas–Pakani, Makwanpur)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	3,304	—	—	303	3,607	—	—	—	—	—	—	-3,607
2	3,079	60	109	303	3,550	—	—	—	—	99	99	-3,451
3	6,583	120	218	362	7,283	—	—	—	—	99	99	-7,184
4	14,360	180	327	362	15,228	—	—	—	—	99	99	-15,129
5	—	240	436	362	1,038	1,890	1,152	155	71	99	3,367	2,330
6	—	240	436	362	1,038	2,835	1,728	233	106	99	5,001	3,964
7	—	240	436	362	1,038	3,780	2,304	311	141	99	6,635	5,598
8	—	240	436	362	1,038	3,780	2,304	311	141	99	6,635	5,598
9	—	240	436	362	1,038	3,780	2,304	311	141	99	6,635	5,598
10	—	240	436	362	1,038	3,780	2,304	311	141	99	6,635	5,598
11	—	240	436	362	1,038	3,780	2,304	311	141	99	6,635	5,598
12	—	240	436	362	1,038	3,780	2,304	311	141	99	6,635	5,598
13	—	240	436	362	1,038	3,780	2,304	311	141	99	6,635	5,598
14	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
15	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
16	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
17	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
18	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
19	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
20	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
21	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
22	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
23	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
24	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
25	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
26	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
27	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
28	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
29	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
30	—	240	436	200	876	3,780	2,304	311	141	99	6,635	5,760
NPV (8% DR)					**$31,058**						**$49,703**	**$18,644**
BCR												**1.60**
IRR												**14.6%**

Road 5 (Pakani–Baikuntha, Makwanpur)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	3,728	—	—	480	4,208	—	—	—	—	—	—	-4,208
2	4,327	148	2,161	48	6,683	—	—	—	—	43	43	-6,640
3	—	295	2,161	420	2,876	1,640	300	41	11	43	2,036	-840
4	—	295	2,161	420	2,876	2,460	450	62	17	43	3,032	156
5	—	295	2,161	420	2,876	3,280	600	83	23	43	4,028	1,153
6	—	295	2,161	420	2,876	3,280	600	83	23	43	4,028	1,153
7	—	295	2,161	420	2,876	3,280	600	83	23	43	4,028	1,153
8	—	295	2,161	420	2,876	3,280	600	83	23	43	4,028	1,153
9	—	295	2,161	420	2,876	3,280	600	83	23	43	4,028	1,153
10	—	295	2,161	420	2,876	3,280	600	83	23	43	4,028	1,153
11	—	295	2,161	420	2,876	3,280	600	83	23	43	4,028	1,153
12	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
13	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
14	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
15	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
16	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
17	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
18	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
19	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
20	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
21	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
22	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
23	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
24	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
25	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
26	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
27	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
28	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
29	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
30	—	295	2,161	60	2,516	3,280	600	83	23	43	4,028	1,513
NPV (8% DR)					**$35,389**						**$35,888**	**$499**
BCR												**1.01**
IRR												**8.4%**

ANNEX 6 ECONOMIC STREAM OF COSTS AND BENEFITS

Road: Road 1 (Mude–Melung, Dolakha)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	6,984	—	—	968	7,952	—	—	—	—	—	—	-7,952
2	6,743	—	—	968	7,711	—	—	—	—	15	15	-7,695
3	16,297	32	170	907	17,406	—	—	—	—	39	39	-17,368
4	9,407	63	340	907	10,717	—	—	—	—	77	77	-10,640
5	28,153	95	510	907	29,665	—	—	—	—	116	116	-29,549
6	—	127	680	907	1,714	9,320	794	575	475	154	11,317	9,604
7	—	127	680	907	1,714	13,979	1,190	862	713	154	16,899	15,185
8	—	127	680	907	1,714	18,639	1,587	1,150	950	154	22,480	20,766
9	—	127	680	907	1,714	18,639	1,587	1,150	950	154	22,480	20,766
10	—	127	680	907	1,714	18,639	1,587	1,150	950	154	22,480	20,766
11	—	127	680	907	1,714	18,639	1,587	1,150	950	154	22,480	20,766
12	—	127	680	907	1,714	18,639	1,587	1,150	950	154	22,480	20,766
13	—	127	680	907	1,714	18,639	1,587	1,150	950	154	22,480	20,766
14	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
15	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
16	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
17	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
18	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
19	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
20	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
21	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
22	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
23	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
24	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
25	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
26	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
27	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
28	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
29	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
30	—	127	680	665	1,472	18,639	1,587	1,150	950	154	22,480	21,009
NPV (8% DR)					**$67,496**						**$153,208**	**$85,712**
BCR												**2.27**
IRR												**18.9%**

Road 2 (Bhirkot–Chhaude, Dolakha)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	3,031	—	—	703	3,734	—	—	—	—	—	—	-3,734
2	2,924	—	—	703	3,627	—	—	—	—	21	21	-3,607
3	6,833	25	50	676	7,584	—	—	—	—	52	52	-7,532
4	6,108	50	100	676	6,934	—	—	—	—	104	104	-6,830
5	9,044	75	149	676	9,944	—	—	—	—	156	156	-9,788
6	—	100	199	676	975	4,503	376	222	141	208	5,450	4,475
7	—	100	199	676	975	6,755	564	333	212	208	8,072	7,097
8	—	100	199	676	975	9,006	752	444	283	208	10,693	9,718
9	—	100	199	676	975	9,006	752	444	283	208	10,693	9,718
10	—	100	199	676	975	9,006	752	444	283	208	10,693	9,718
11	—	100	199	676	975	9,006	752	444	283	208	10,693	9,718
12	—	100	199	676	975	9,006	752	444	283	208	10,693	9,718
13	—	100	199	676	975	9,006	752	444	283	208	10,693	9,718
14	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
15	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
16	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
17	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
18	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
19	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
20	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
21	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
22	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
23	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
24	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
25	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
26	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
27	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
28	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
29	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
30	—	100	199	570	869	9,006	752	444	283	208	10,693	9,824
NPV (8% DR)					**$31,178**						**$73,093**	**$41,915**
BCR												**2.34**
IRR												**19.7%**

Road 3 (Barabise–Bigu, Dolakha)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	3,923	—	—	692	4,615	—	—	—	—	—	—	-4,615
2	4,439	63	849	692	6,043	—	—	—	—	11	11	-6,032
3	—	125	1,697	406	2,228	1,774	141	144	86	11	2,155	-73
4	—	125	1,697	406	2,228	2,661	212	216	128	11	3,228	999
5	—	125	1,697	406	2,228	3,548	282	287	171	11	4,300	2,072
6	—	125	1,697	406	2,228	3,548	282	287	171	11	4,300	2,072
7	—	125	1,697	406	2,228	3,548	282	287	171	11	4,300	2,072
8	—	125	1,697	406	2,228	3,548	282	287	171	11	4,300	2,072
9	—	125	1,697	406	2,228	3,548	282	287	171	11	4,300	2,072
10	—	125	1,697	406	2,228	3,548	282	287	171	11	4,300	2,072
11	—	125	1,697	406	2,228	3,548	282	287	171	11	4,300	2,072
12	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
13	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
14	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
15	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
16	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
17	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
18	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
19	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
20	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
21	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
22	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
23	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
24	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
25	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
26	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
27	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
28	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
29	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
30	—	125	1,697	494	2,317	3,548	282	287	171	11	4,300	1,983
NPV (8% DR)					**$30,930**						**$38,258**	**$7,328**
BCR												**1.24**
IRR												**14%**

Road 4 (Dandabas–Pakani, Makwanpur)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	1,701	—	—	287	1,989	—	—	—	—	—	—	-1,989
2	1,585	—	—	287	1,873	—	—	—	—	94	94	-1,779
3	3,390	86	91	344	3,910	—	—	—	—	94	94	-3,816
4	7,393	129	136	344	8,002	—	—	—	—	94	94	-7,908
5	—	172	181	344	697	1,796	1,094	148	67	94	3,199	2,502
6	—	172	181	344	697	2,693	1,642	221	101	94	4,751	4,054
7	—	172	181	344	697	3,591	2,189	295	134	94	6,303	5,606
8	—	172	181	344	697	3,591	2,189	295	134	94	6,303	5,606
9	—	172	181	344	697	3,591	2,189	295	134	94	6,303	5,606
10	—	172	181	344	697	3,591	2,189	295	134	94	6,303	5,606
11	—	172	181	344	697	3,591	2,189	295	134	94	6,303	5,606
12	—	172	181	344	697	3,591	2,189	295	134	94	6,303	5,606
13	—	172	181	344	697	3,591	2,189	295	134	94	6,303	5,606
14	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
15	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
16	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
17	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
18	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
19	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
20	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
21	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
22	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
23	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
24	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
25	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
26	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
27	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
28	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
29	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
30	—	172	181	190	543	3,591	2,189	295	134	94	6,303	5,760
NPV (8% DR)					**$17,453**						**$47,218**	**$29,764**
BCR												**2.71**
IRR												**24.6%**

Road 5 (Pakani–Baikuntha, Makwanpur)

Year	Investment stream (NRs '000)	Routine maintenance (NRs '000)	Periodic maintenance (NRs '000)	Environmental losses (NRs '000)	Total cost (NRs '000)	Benefit from export (NRs '000)	Benefit from people's movement (NRs '000)	Cost savings in rice export (NRs '000)	Benefits from merchandise import (NRs '000)	Return from income from road works (NRs '000)	Total benefits (NRs '000)	Net incremental benefit (NRs '000)
1	3,247	—	—	456	3,703	—	—	—	—	—	—	-3,703
2	3,769	61	853	46	4,729	—	—	—	—	41	41	-4,688
3	—	123	1,706	399	2,228	1,558	285	39	11	41	1,934	-294
4	—	123	1,706	399	2,228	2,337	428	59	16	41	2,880	653
5	—	123	1,706	399	2,228	3,116	570	78	21	41	3,827	1,599
6	—	123	1,706	399	2,228	3,116	570	78	21	41	3,827	1,599
7	—	123	1,706	399	2,228	3,116	570	78	21	41	3,827	1,599
8	—	123	1,706	399	2,228	3,116	570	78	21	41	3,827	1,599
9	—	123	1,706	399	2,228	3,116	570	78	21	41	3,827	1,599
10	—	123	1,706	399	2,228	3,116	570	78	21	41	3,827	1,599
11	—	123	1,706	399	2,228	3,116	570	78	21	41	3,827	1,599
12	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
13	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
14	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
15	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
16	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
17	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
18	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
19	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
20	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
21	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
22	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
23	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
24	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
25	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
26	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
27	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
28	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
29	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
30	—	123	1,706	57	1,886	3,116	570	78	21	41	3,827	1,941
NPV (8% DR)					**$27,179**						**$34,094**	**$6,915**
BCR												**1.25**
IRR												**15%**

MAP OF NEPAL SHOWING STUDY AREAS