

GOAL
9**Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation**

Photo: Jesse Montes

SDG 9 spans a wide range of aspects of infrastructure, industrialisation and innovation. It has a cross-cutting focus on assisting poorer and more vulnerable groups to better access and benefit from the economic and market opportunities associated with infrastructure and industry, stimulating innovation and growth in these sectors, and enhancing the sustainability of the facilities and enterprises that are involved.

How do ecosystems and biodiversity support this SDG?

The concepts of 'green economy' and 'green growth' are widely integrated into regional, national and local development and investment plans in the Asia-Pacific region. A green economy can be characterised as one that "results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities ... growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services". The greening of infrastructure, industrialisation and innovation—and the reorientation of the investments and economic delivery mechanisms that are associated with them—represents a substantial paradigm shift. It places the natural environment at the centre of (and as the source of) development and growth, rather than leaving it on the margins.

How does UNDP's work **support** this SDG?

Case study: Investing in “green roads” in Nepal

Lack of rural roads poses one of the greatest obstacles to socio-economic development in Nepal's countryside, including food and livelihood security. Nepal is one of the least accessible countries in the world, with 83 percent of the rural population living more than 2 km from an all-season road, and almost a third of the 3,915 Village Development Committees yet to be linked to the road network. Unsurprisingly, road construction is a major item of local government spending. Yet conventional approaches based on the use of heavy equipment and mechanized techniques have had devastating environmental impacts on Nepal's fragile mountainous environment, including loss of forest cover and other natural vegetation, increased runoff, soil erosion, pollution and landslides. These environmental threats pose a direct risk to the socio-economic security of Nepal's poor—a risk that is exacerbated by the country's rapidly-growing population. Conventional approaches to road construction have also often failed to maximise local involvement and benefit.

In response, an 'environment-friendly local governance' approach has been integrated into local development planning processes to encourage environmental sustainability, providing a steady increase in budget allocations to District and Village Development Committees to implement pro-poor green infrastructure and green job creation initiatives. The concept of 'green roads' has been given particular attention under this new approach to local governance. This approach focuses on the use of local labour



and locally-available materials in road construction, and builds roads in a way that is adapted to local environmental conditions and involves minimal disturbance to the surrounding natural environment. However, under certain circumstances, green roads could also be achieved using a mix of labour and equipment-based technologies.

The Poverty and Environment Initiative (PEI), a joint program of the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP), works with Nepal's National Planning Commission and the Ministry of Federal Affairs and Local Development to support environment-friendly local governance approaches. This includes work carried out in 2011 in Makwanpur and Dolakha Districts in the Central Development Region to assess and advise local government investments in roads, which came out with strong recommendations in favour of the green roads approach. The recommendations were reinforced by civil society organisations and media advocacy, and adopted by both local government authorities and the Ministry of Federal Affairs and Local Development when formulating subsequent public investment planning and budget allocation processes. The shift to green road construction technologies has reduced maintenance costs and created jobs for local people. It has also proved to be an effective way of climate-proofing key infrastructure, enhancing disaster risk reduction, and strengthening local resilience to climate change.

PROJECT: Poverty-Environment Initiative (PEI) support to Strengthening Planning and Monitoring Capacity of NPC (SPMC-NPC) and the Local Governance and Community Development Programme (LGCDP)

MAJOR DONORS: UNDP, UNEP, Government of Nepal, 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

LOCATION: Makwanpur and Dolakha Districts (Central Development Region), feeding into national level Nepal

DATE: 2011

WEBLINKS: <http://www.unpei.org/what-we-do/pei-countries/nepal>;
http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/projects_and_initiatives/local-governments-go-green-in-nepal.html



Nature count\$: Key impacts of the project on infrastructure

By supporting and facilitating decentralized 'environment-friendly local governance' approaches in Dolakha and Makwanpur Districts of Nepal, the project has led to increased investments in an expanded network of green roads in rural areas. This has reduced maintenance costs and created thousands of 'green jobs' for the local community, as well as diminishing the risk of natural hazards and disasters arising from environmental degradation. Green roads generate net economic benefits over their lifetime which is up to six times higher than those generated from roads constructed using conventional methods, resulting in substantially higher financial, economic and social rates of return on investment.

CONVENTIONAL ROADS



based on heavy machinery & mechanical techniques, leaving major environmental footprint in ecologically-sensitive and hazard-prone areas

GREEN ROADS



depends on locally available materials, labour & technologies, minimising disturbance to the surrounding landscapes and natural environment

net present value (US\$/km)	6,500-7,100	26,500-39,900
internal rate at return	14.3-14.6%	19.7-24.6%
undiscounted benefit:cost ratio	1.6-1.7	4.8-5.1

This project plays a key role in developing quality, reliable, sustainable and resilient infrastructure to support economic development and human wellbeing, that ensures affordable and equitable access for all (✓SDG Target 9.1), increasing the access of small-scale enterprises to financial services and their integration into value chains and markets (✓SDG Target 9.3), upgrading to make it sustainable, with increased resource use efficiency and greater adoption of clean and environmentally sound technologies (✓SDG Target 9.4) and facilitating sustainable and resilient infrastructure development in developing countries (✓SDG Target 9.a).

How the economic impacts were calculated:

The study carried out in Dolakha and Makwanpur Districts by PEI and the Ministry of Federal Affairs and Local Development presented data on the financial and economic returns to both conventional and green road building technologies (UNDP 2011). The figures below rework these raw data.

The financial analysis calculated the costs and benefits of road-building options according to their market prices at the time of the study. A comparison of unit costs and benefits show that while conventional roads imply lower construction costs their maintenance costs and environmental losses are much higher than green roads. Green roads also display much larger benefits when calculated in a per kilometre basis, including enhanced mobility, better crop sale prices, and cheaper purchase of rice and other business and merchandise transactions). Table 1 below indicates these values, expressed as US\$ per kilometre of road and rounded to the nearest hundred dollars.

Table 1: Financial costs and benefits of road-building options according to market prices

	Total investment costs during construction	Total environmental losses during construction	Annual maintenance costs once road fully operational	Annual benefits at full development
Conventional roads				
Dolakha	8,500	3,800	2,200	4,000
Makwanpur	8,300	3,800	2,500	4,100
Green roads				
Dolakha	49,200	1,600	600	10,700
Makwanpur	24,300	1,600	600	5,900

Financial costs and benefits were also calculated over a 30-year period, covering road construction and operation. The figures were discounted to give single present values using an 8 percent discount rate (the prevailing opportunity cost of capital in Nepal at the time of the study). Discounted values were calculated for construction costs, recurrent costs and losses and benefits in order to demonstrate the net present value (NPV) and internal rate of return (IRR) for different road options. An undiscounted benefit-cost ratio (BCR) compares the total benefits and costs generated over the full 30-year period. This confirms the substantially higher NPV, IRR and BCR of green road options when compared to conventional approaches. Table 2 below indicates these values, expressed as US\$ per kilometre of road and rounded to the nearest hundred dollars.

Table 2: Financial costs and benefits of road-building options based on a 30-year period, according to market prices

	Discounted construction costs	Discounted recurrent costs & losses	Discounted benefits	NPV	IRR	Undiscounted BCR
Conventional roads						
Dolakha	7,600	28,300	35,800	1,700	9.5%	1.3
Makwanpur	7,300	31,000	36,800	500	8.4%	1.3
Green roads						
Dolakha	37,600	12,800	73,300	23,500	12.7%	3.1
Makwanpur	19,100	9,000	44,200	16,600	14.6%	3.1

The economic analysis calculated costs and benefits using economic prices (i.e. using shadow wage and adjusting for taxes, subsidies, import/export parity, opportunity cost, exchange rate risks and other market

distortions). This provides similar findings to the financial analysis, but amplifies the margin of gain from green roads compared to roads built using conventional techniques. Table 3 below indicates these values, expressed as US\$ per kilometre of road and rounded to the nearest hundred dollars.

Table 3: Financial costs and benefits of road-building options based on 30-year period, according to economic prices

	Discounted construction costs	Discounted recurrent costs & losses	Discounted benefits	NPV	IRR	Undiscounted BCR
Conventional roads						
Dolakha	6,600	22,200	34,000	6,500	14.3%	1.6
Makwanpur	6,400	23,000	35,000	7,100	14.6%	1.7
Green roads						
Dolakha	20,400	9,700	69,600	39,900	19.7%	4.8
Makwanpur	9,800	6,100	42,000	26,500	24.6%	5.1

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YEARS

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