SOFTWARE FOR ASSESSMENT OF ECONOMIC, ENVIRONMENTAL AND SOCIAL IMPACTS OF ROAD PROJECTS

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ABSTRACT

Feasibility studies are prepared during the planning phase of road projects in order to evaluate the viability of projects. This is further simplified to economic appraisal and calculation of Economic Internal Rate of Return (EIRR). When EIRR is greater than the current discount rate the project is economically viable. Current EIRR calculations in road projects are basically including the following components : i) Vehicle Operating Costs (VOCs), ii) Travel Time Costs, and iii) Costs for Accidents. There have been discussions of adding environmental factors to these calculations but it has been proved to be difficult.

Hence EESAR (Environmental, Economic and Social Assessment of Road Projects) Project was started in year 2007. Main goal of the Project is to incorporate socioeconomic dimensions to project planning and post evaluation. Post evaluation is often totally neglected after the project implementation. In phase I EESAR model is developed mainly for rural roads.

This Study uses the Sustainable Livelihoods Approach (SLA) as a theoretical approach to assess the impacts of roads and improved access to markets and services in people's livelihoods and in reducing their vulnerability and poverty. EESAR Model will prepare assessment of rural road project. Main focus in pre-evaluation is to see is the Project viable or not. Main focus in post evaluation is to account the impacts of the project implementation and prepare comprehensive assessment of the positive and negative impacts.

1 BACKGROUND

Feasibility studies are prepared during the planning phase of road projects in order to evaluate the viability of projects. This is further simplified to economic appraisal and calculation of Economic Internal Rate of Return (EIRR). When EIRR is greater than the current discount rate the project is economically viable. Current EIRR calculations in road projects are basically including the following components : i) Vehicle Operating Costs (VOCs), ii) Travel Time Costs, and iii) Costs for Accidents. There have been discussions of adding environmental factors to these calculations but it has been proved to be difficult.

Hence EESAR (Environmental, Economic and Social Assessment of Road Projects) Project was started in year 2007. Main goal of the Project is to incorporate socioeconomic dimensions to project planning and post evaluation. Post evaluation is often totally neglected after the project implementation. In phase I EESAR model is developed mainly for rural roads. EESAR Model will prepare assessment of rural road project. Main focus in pre-evaluation is to see is the Project viable or not. Main focus in post assessment is to evaluate the impacts of the project implementation and prepare comprehensive assessment of the positive and negative impacts. EESAR follows the multi-criteria analysis principles in combining economic, environmental and social factors in calculations.

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2 FRAMEWORK: UNDERSTANDING THE SOCIO-ECONOMIC IMPACTS OF ROAD PROJECTS

Infrastructure investments contribute to economic growth and to raising the quality of life. They contribute to economic growth by reducing the cost of production, by making possible the diversification of the economy, and by making other factors of production more productive. There is significant empirical evidence at the macroeconomic level of a positive correlation between infrastructure networks, including roads and GDP per capita or growth rates. Quality of life is improved by creating amenities in the physical environment and by providing outputs, such as transportation and communication, which are valued in their own right.

Transport reduces poverty by supporting economic growth, complementing most poverty-targeted interventions, and encouraging the poor to participate in social and political processes. Primary benefits to the poor depend quite heavily on the contextual situation, and their ability to overcome structural restraints. The major social and economical impacts on local populations occur when roads are first constructed. It must be noted that potential benefits from better road access and transportation increase directly with the degree to which households are non-poor .

At the household level, rural road improvements can lead to increases in agricultural production and open up alternative non-farm employment, resulting in both higher overall earnings and more diversified sources of income. Road reduce the transaction costs of looking for employment and thus contribute to making labor markets more efficient. Roads may also contribute directly to household wealth by having a positive impact on real estate values.

Transportation has the potential to bestow important consumption benefits by virtue of the increased personal mobility and communication it makes possible. It can also be a means to acquiring other goods and services, by improving access to education and health facilities and to markets. The absence of roads in rural areas frequently necessitates the practice of "head-loading" of firewood, water and crops. The establishment of roads can reduce this burden and free up time to engage in more productive income-earning activities. To the extent that women are often responsible for these duties, rural roads can be expected to free up their time for employment opportunities and improved childcare.

The short and long term distributive impacts of transport projects, particularly on low income groups, are not well understood. In poor rural areas, lack of adequate and reliable transport can penalize households pursuing cash crop farming and reduce non-farm employment opportunities and access to social services. It is thus argued that rural roads can contribute to poverty reduction by removing major constraints faced by the poor in accessing markets, services and jobs.

Transport is an intermediate good. It makes possible other activities that increase the productivity and enhance the welfare of poor people, and it contribute to economic growth that may provide resources to reduce poverty. Road improvement has the potential to enhance household welfare not through increased consumption of transport services per se, but through improving the quality and security of access to markets, work and services and through release of scarce household resources for consumption and production.

Tracing the welfare impact of the road construction is difficult because transport access is complementary service to the availability of other basic services, such as health care and education. Thus, while the construction of a road can make it possible that the poor travel easier to a health clinic, national health policy will be responsible for ensuring that the facility is adequately staffed and provided with medicines.

More transport does not necessarily lead to less poverty and simply improving a road is not enough; the poor also require support in being able to make use of it. More effective support mechanisms through projects are needed for more equitable distribution of impacts. Transport interventions can have impact on the poor only if other sectoral interventions are also adequate in place. Alternatively, the effectiveness of direct targeted interventions in the education, health, and agricultural sectors depends on the adequacy of transport infrastructure and services. The process through which the benefits of road investments lead to improvements in the standard of living of households involves many links.

Integrated rural infrastructure development programs can build synergies across sectors. Because they are more comprehensive, these programs can have greater impact on the incomes and quality of life of poor villages. Multi-sector approaches, combined with stakeholder participation, can let rural communities set priorities according their own needs.

The structural conditions and the institutional conditions govern how people use assets including roads in their livelihood strategies. Livelihood outcomes feed into livelihood assets as they enable poor people to build up their assets. Alternatively livelihood outcomes may run down the assets base (e.g. through unsustainable use of natural resources). Figure 1 shows how assets, including transport infrastructure and services lie at the heart of the sustainable livelihoods framework.

Structural conditions are fixed in the medium to long term and delineate the physical,

economic, and political environment in which poor people live and work. Institutions and processes includes government (national, regional, and local), private sector firms, NGOs, and the processes and social norms, legal, judicial, customary and gender relations, that provide opportunities and constraints for poor people to use and build assets. Capital assets consist of common property including roads, and individually owned resources poor people can draw on for their livelihoods.

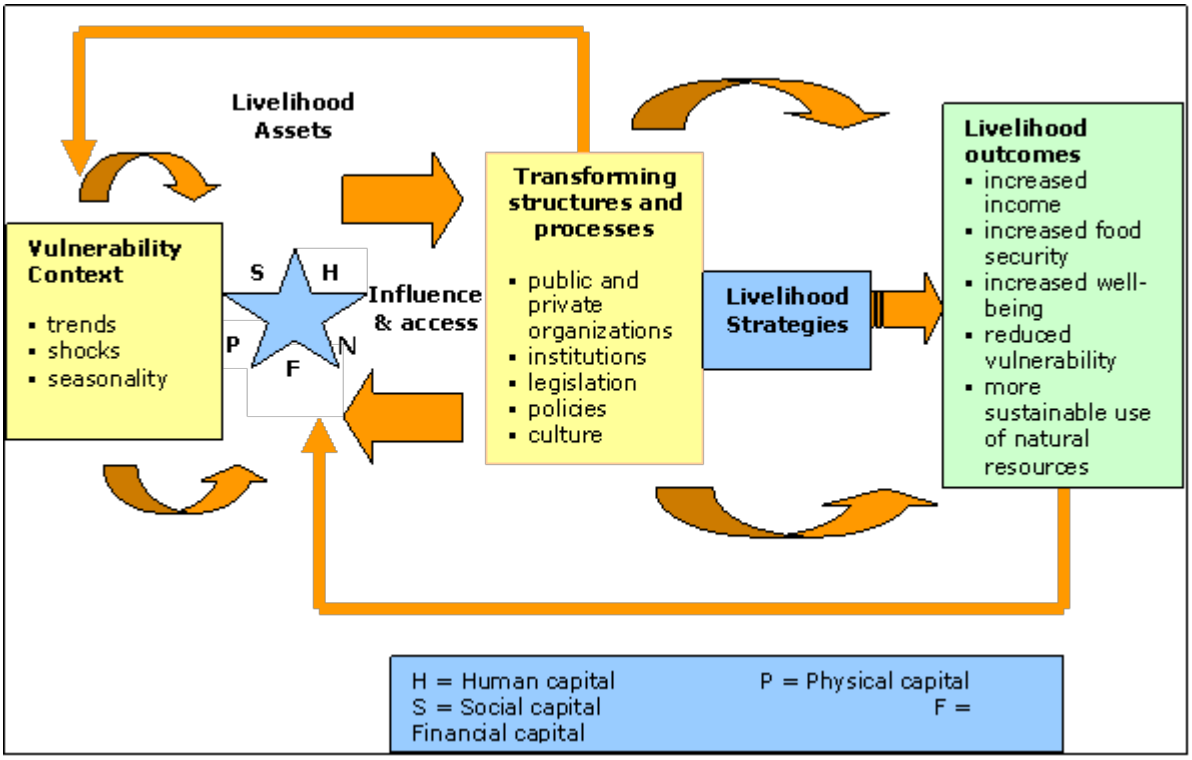

Figure 1. Sustainable Livelihoods Approach (SLA)

3 ECONOMIC, ENVIRONMENTAL AND SOCIAL IMPACTS

In evaluation terms, impact indicates the effects seen across a wider perspective than achieving the immediate objectives only, the concept of impact is a far broader one, as it includes both positive and negative consequences, whether these are foreseen and expected, or not. In principle it includes economic, social, political, technical, and environmental effects on a local, regional, or national level. This study on impact concentrates on the effects of the road development project on wider economic benefits, poverty alleviation and negative impacts.

3.1 Economic Impacts

These are traditional impacts which are basically used in all economic appraisals conducted. These are:

- Impacts for Vehicle Operating Costs (VOC)
- Impacts for Travel Time Costs
- Impacts for Accident Costs

Main focus of EESAR in pre-evaluation model is to include these traditional impacts and incorporate the social and environmental dimensions and have comprehensive

assessment of the road project available.

3.2 Social Impacts

The problem with assessing impact is that the relationship between road activities and poverty alleviation is not a direct one. The relationship is in general indirect through variables such as (i) reduced vehicle operating costs, (ii) improved agricultural product marketing, (iii) increase in social mobility and (iv) access to water, energy, telecommunications, hospitals and schools. Assessing the impact on gender aspects, is even more difficult. Poverty alleviation will in principle also benefit women, however, family structures and traditional cultural factors play a role in gender impact. Because gender aspects need a much more in-depth study, not possible within this brief assessment, the impact on gender aspects have been combined together with impacts on poverty alleviation.

The following chapter describes socioeconomic impacts of road improvement projects, The discussion of economic benefits and dis-benefits (as these are clear) is not included in this paper, the paper is focusing on social- and environmental impacts. The impacts have been divided to five categories: (i) direct impacts, (ii) impacts on the agricultural economy, (iii) impacts on education and health, (iv) impacts on poverty alleviation and gender aspects, and lastly (v) environmental and negative effects.

3.2.1 Direct Impacts

Direct effects of a road development project are accessibility, reduced travel time and savings in fuel and other direct transport costs. Investment in road project can improve access to economic opportunities. Economic impacts are a result of removing missing links, reductions in travel time and travel cost, improvements in safety, and other benefits of the road project that affect the cost of doing business. Economic impacts can result from two sources: (1) cost savings to existing businesses through reductions in travel time and cost; and (2) business expansion through the growth of existing businesses or the attraction of new businesses to an area.

The impact of these cost savings on the poor will depend on the extent to which the poor are users of the service provided. If markets are reasonably competitive, this can result in lower prices for freight and passenger services. However, previous studies have indicated that passengers do not benefit with lower public transportation costs in rural areas. The lowered costs of public transportation do not reach to level of ticket prizes and thus the economical benefit to garden producers for example will remain low due to low competition.

Lowered freight and passenger prices in turn can lead to lower prices for product and consumer goods, a spatial extension of the market for production and consumption goods, higher personal mobility, and a general higher level of socioeconomic activities.

Secondary benefit of an economic nature is the income generated by direct employment in the construction, operations, and maintenance in rural transport sector. The use of labor is a direct approach to poverty alleviation in by income generation. This will promote the use of domestic resources including materials, tools, and locally assembled small and intermediate equipment. The use of labor intensive methods in road works, where relatively low wages make it cost effective, can provide a sustainable source of supplementary employment for the poor, especially in rural communities. Procurement of works should include sufficient incentives for contractors to use labor for appropriate

works. Furthermore, labor-based methods contribute to local empowerment through skills-transfer and creation of ownership. Also, if correctly designed, labor-based methods can have a substantial gender-specific impact.

3.2.2 Impacts on the Agricultural Economy

Investments in road development projects have also been known to greatly stimulate the general enabling environment' and potential for economic development and agricultural including aquaculture production by providing access to markets, helping also in the transition from pure subsistence to market-oriented production. More recent evaluations have also shown the importance of roads in stimulating and expanding non-farm activities.

Local farmers can benefit from roads because the cost of transportation agricultural products to markets is reduced and the access to markets improved. This might lead to expanding the area of land under cultivation and increasing the production of cash crops. Road development projects can further reduce production costs by lowering the delivered price of inputs, including equipment and information (for example, through better agricultural extension service, creation of co-operatives and micro-financing opportunities). The year-round and all-weather passability of the roads mean that farmers are able to not only increase income from farming activities, but also make it more stable and thus enables them to improve their management of risk.

3.2.3 Impact on Education and Health

Social effects can include enrollment of children in schools, due to better access and improved school quality. Quality of education can improve as it become easier to recruit teachers, and absenteeism rates of both teachers and students drop. It has been argued that better qualified teachers are willing to work in areas served by roads.

Improved road network can enhance more rational distribution of schools and health centers Access to other social services often improves as well, particularly health services. The quality of health services can improve as the supply of medicines increases and health staff could easier reach the facilities, and additionally immunization and other health prevention programs could became easier to implement.

3.2.4 Poverty Alleviation and Gender Aspects

The general objective of rural road transport, although not seen directly, is to alleviate rural poverty and raise living standard of rural communities through increased access to basic social needs, economic empowerment and income generating activities. Socio-economic studies have indicated that road improvements have a positive impact on rural poverty. Investment in road projects may filter economic growth, or target the road transport needs of the poor, or directly generate employment opportunities for the poor. The road sector can contribute significantly on poverty reduction strategies through employment of labor during construction and maintenance of roads. Reliable and adequate road network benefits the poor in many ways. It links village to village, village to district centers, and to the rest of the country. It can also increase the income from agricultural produce and improve farmers' access to market information and new ideas.

Though, linking welfare outcomes such as improved health or education status to investments in road development can be problematic. Even if infrastructure investments provide access to services and help to improve the quality of services, many other factors

the propensity of the poor to use such services and the outcomes, which they experience. It is perhaps safest to stay in “realm” of “opportunity” and note that transport investments will remove barriers to the provision of services and facilitate their use by the poor . Rural areas often need other collateral investments to make the transportation investment useful.

Road improvement in itself is, therefore, not sufficient to maximize socioeconomic impacts. Complementary factors include agricultural credits and micro-financing, finance for transport investments, improved farm technology, processing and storage facilities, as well as the long-term systematic maintenance of feeder roads (and not irregular maintenance).

The impact of transport infrastructure on women can be profound. Transport interventions that respond more to women's transport needs reducing the transport burden on them can help women expand their income-earning activities, increase their productivity, promote gender equality, and improve their quality of life. Additionally, where rural roads improve access to schools, often the enrollment rate for girls, which is typically lower than that for boys before the project, increases more than boys. Also, the construction of roads generates employment. Women are eager to participate in roadwork opportunities. To achieve such changes, it is essential to identify the specific transport needs of women and devise cost-effective interventions.

3.2.5 Negative Effects

It needs to be pointed out that rural road projects do not solely have positive effects. Inappropriately designed projects can harm residents, especially the poor. The negative impacts can include involuntary resettlement and difficulties in land compensation issues, increased traffic accidents, environmental effects such as deforestation and erosion, and the spread of diseases such as HIV/AIDS.

3.3 Environmental impacts

Environmental impacts include effects on air and water quality, noise, habitat destruction and fragmentation, and greenhouse gas emissions. The impacts of a road or highway project on water quality and habitat are frequently negative but can be mitigated to some extent through appropriate design and construction techniques.

Air quality, greenhouse gas, and noise impacts, which result from vehicle operations, also may be negative as a result of increased traffic on the roadway. These can be mitigated most effectively through regulation of vehicle technology, including emissions controls, fuel efficiency standards, and noise standards. They can also be mitigated through provision of high-quality service by alternative, less environmentally damaging modes of transport such as public transportation, sea transport, and non-motorized transport.

Additionally, erosion of bare soil or reworked soil at construction sites is a common problem that is encountered in road construction projects . In road improvement section contamination of waterways by storm-water containing sediment produced by erosion of bare ground surfaces and stockpiles in the construction zone (road works and quarrying operations) is a potential environmental problem. There is also the possibility of alteration of natural drainage, which could result in erosion as well as flooding, and absorption of pollutants from areas, which have not previously been subject to flooding.

In some cases re-graveling of previously degraded, poorly trafficable roads have lead to considerable increases in dust levels with consequent deleterious health and lifestyle

effects to people living immediately adjacent to the road improvement project area. To prevent the gradual deterioration of the environment or to improve existing conditions, it is important therefore to include environmental considerations in the preparation and implementation of road maintenance programs.

4 EESAR SYSTEM DESIGN

4.1 Basic principles

All the relevant information is stored in EESAR database that can also take data from other road administration databases such as road condition or traffic databases. In the initial stage the database contains questionnaire questions and tables to store the answers. Figure 2 provides classification of the database data. Questionnaire and indicator data contain economic, environmental and social questionnaires.

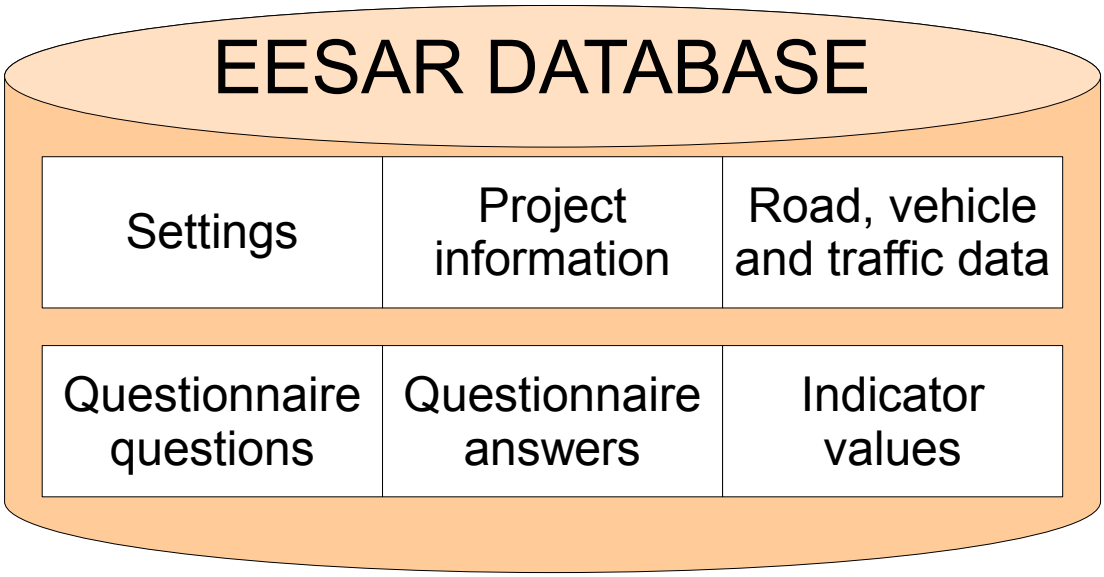

Figure 2. Contents of EESAR database.

The database feeds the map-based graphical user interface, where the projects are presented on the map with their status (planned, on-going, completed). Figure 3 depicts a screen-shot of one project and actions user can perform regarding to data entry. When an impact study is done the data will be entered in the EESAR database before indicators related to decision-making can be calculated.

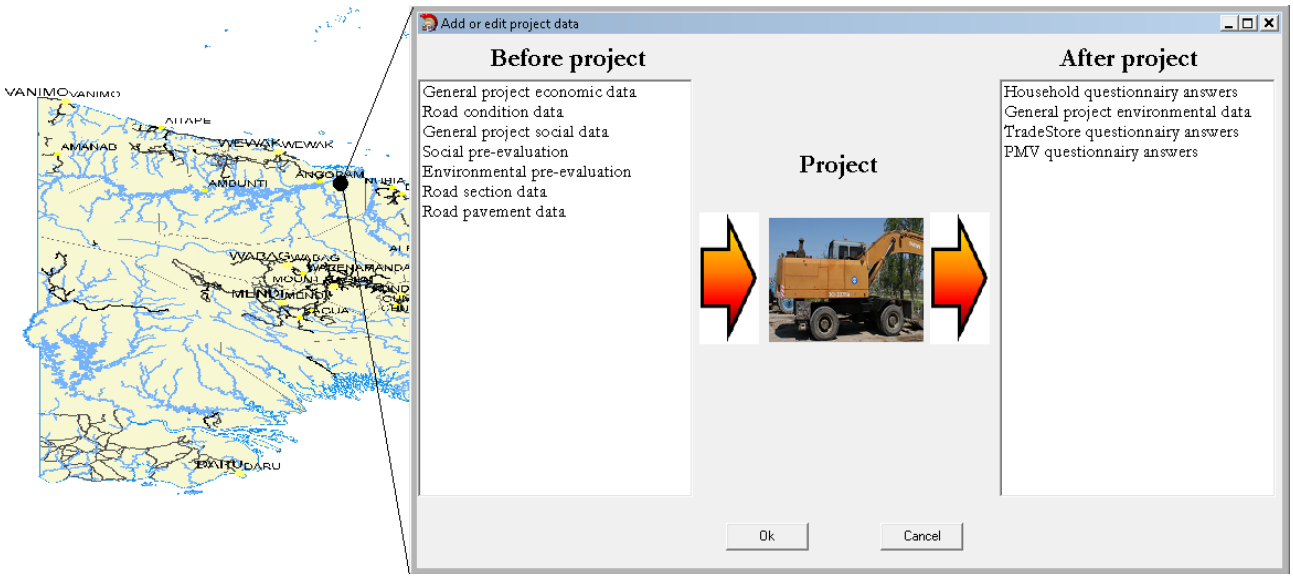

Figure 3. A screen-shot of a single project data entry.

4.2 Analysis stages of road projects

Evaluation of road projects can be divided into pre-evaluation (planning) and post-evaluation (monitoring) as shown in Figure 4. In the pre-evaluation phase the impacts are assessed before investment decisions are made. In post-evaluation the impacts are assessed after the investment decision has been done and the project has been completed. Post-evaluation is typically carried out in several stages in order to see the long-term impacts.

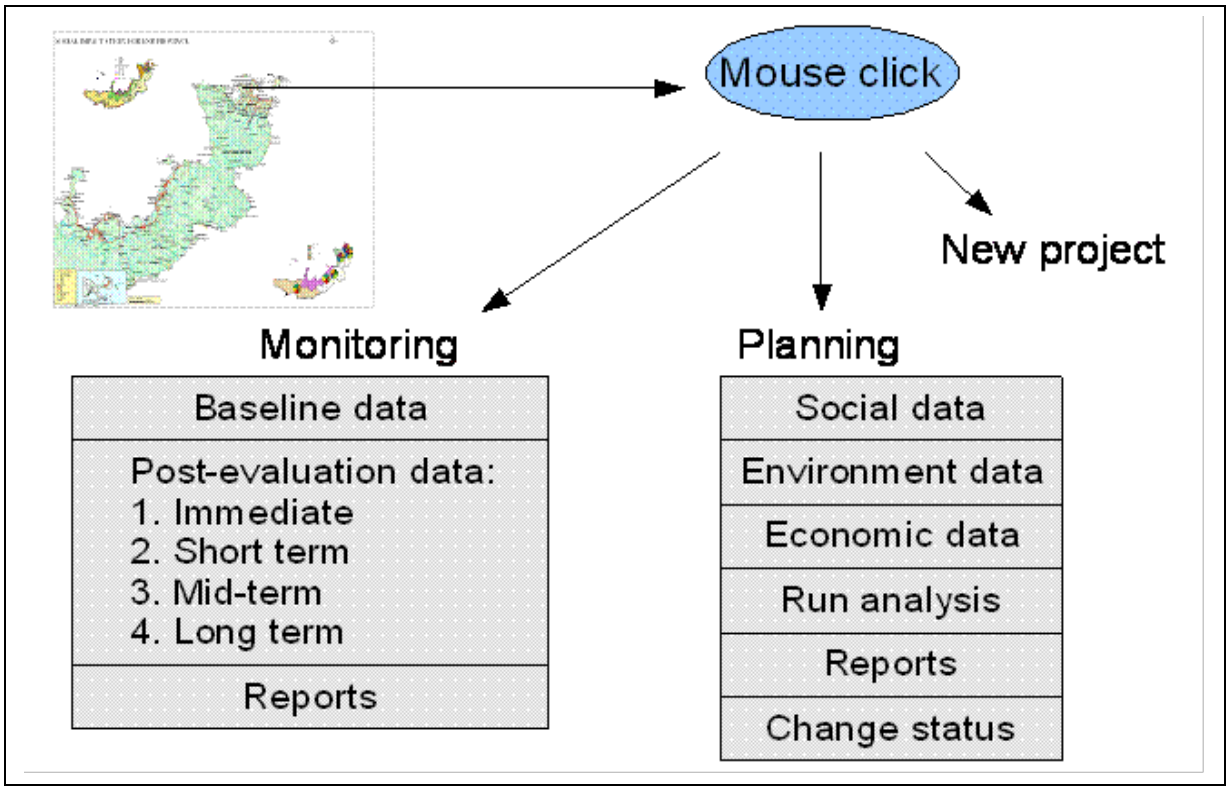

Figure 4. Social, environment and economic dimensions are incorporated in EESAR model.

4.2.1 Pre-evaluation analysis

Cost-benefit analysis seeks to value the expected impacts of an option in monetary terms. The valuations are based on the willingness to pay of the potential gainers for the benefits they will receive as a result of the option, and the willingness of potential losers to accept compensation for the losses they will incur. CBA is a comprehensive accounting of all the real costs and benefits associated with a project. In the case of road projects, this includes users and non-users, as well as road agency costs. Where the impact on non-users is negligible, a CBA of road alternatives centers around the trade-offs between total life-cycle costs of infrastructure (capital and maintenance) and user costs and benefits (operating cost of the primarily vehicle and time savings).

The outcome of CBA permits ranking of alternative interventions on a particular link based on the net present value (NPV). Where a number of different but independent links are being considered (and there is a fixed capital budget) ranking can be based on the net present value per financial investment outlay ratio (NPV/INV), or net present value per kilometer (NPV/KM) if road infrastructure costs (capital and maintenance) are the same for all links. The benefit from cost savings for transport users can be considered an increase in “consumer surplus”, if such savings accrue to the users as reduction in transport costs or charges. Alternatively, if transport cost reductions lower producers’ input and output costs, and result in higher net income, then the benefits can be considered as an increase in “producers’ surplus.”

4.2.2 Post-evaluation analysis

Post-evaluation for the projects is realized by conducting several types of surveys in order to cover the three dimensions for sustainable development. Traffic counts are used for estimate the overall cost-benefit ratio in monetary terms as increased traffic and decreased traveling times increase the economic benefits of a project. Transportation cost survey also incorporate economic issues at micro level as well as social aspects.

Households and village surveys reveal more social impacts of road projects as they often have impacts on traveling frequency, general access and therefore more sustainable livelihood.

Environmental data is collected related to the areas affected by a road project. Environmentally vulnerable areas affected by projects is estimated area-wise and other environmental impacts such as noise and other roadside impacts are evaluated by questionnaire answers from people living in the proximity of the roadside.

4.3 Vehicle emission modeling

EESAR software contains also a vehicle emission modeling tool that estimates carbon monoxide, particle, hydrocarbon, nitrogen oxygen and carbon dioxide emission of the traffic. The model takes into consideration annual average daily traffic of selected roads in each vehicle category. More importantly, it can be then estimated how different road projects affect the amount of traffic emissions.

4.4 Indicators

During the post evaluation extensive amount of indicators are collected and compared to the baseline data (before project implementation). The indicators can be categorized to four main groups as presented in Figure 5.

Category	Indicators
Livelihood patterns and income generation	economically active household members, types of markets visited and frequencies, market income, sold and purchased goods, household income and expenditure, financial needs, product prices, earnings from business
Access to social services and infrastructure	distance to nearest schools, cost of school trips, reasons for not attending school, distance to health centre, reasons for and frequency of visiting health centres, awareness of HIV/AIDS and risky behaviour, distance to nearest road, modes of transport, perceived road benefits, factors improving the quality of life
Poverty and vulnerability	households living below poverty lines, food security, household asset status
Environmental issues	noise, dust, water contamination, loss of animals/vegetation, clearing of the bush

Figure 5. Indicators used in EESAR post evaluation

The list is an example that was used in Papua New Guinea, but the EESAR software model can incorporate any other indicators as well. As there are hundreds of respondents the indicator values are calculated average values from the basic questions.

As impacts of the dimensions are not commensurable is the decision-making based on considering the dimensions separately. In the planning phase it is clear that Pareto-optimal solutions should be selected under budget constraints. In the monitoring phase however, it is important that the same indicators are used with the same calculation formulas for reliable comparison. EESAR software con be used to combine indicators of the same category in order to see an overall picture and change over years after a road project.

REFERENCES

1. Finnroad Ltd. Approach towards Multi-Criteria Analysis in Assessment Process of Road Projects in RAMS, 2003

2. Papua New Guinea. Human Development Report. 1998. Prepared by the Office of National Planning, Port Moresby, Papua New Guinea with funding from the United Nations Development Programmd.

3. Hettige, M. & Chaundhry, P. Asian Development Bank. Operations of Evaluation Department. Impacts of Rural Roads on Poverty Reduction.

4. Transport Technical Notes and Case Studies, Draft for Comments, April 2001 by Gannon, C., Gwilliam, K. Liu, Z. and Malmberg, C.

5. ADB and Government of Papua New Guinea, Department of Works and Transportation. August 2000. TA No. 3037-PNG: Road Upgrading and Maintaining Project, Simbu and Enga Provinces. Initial Social Assessment. Prepared by Hughes, P. & York, D.

6. ADB and Government of Papua New Guinea, Department of Transport, Works and Civil Aviation. June 1999. TA No. 3037-PNG: Road Upgrading and Maintaining Project. Initial Social Assessment. Prepared by Egis Consulting