Environmental implications of the road network in South Africa

Patrick Karani
Environmental Strategist

Abstract:

This article attempts to assess the impacts of Roads—a huge physical development component on the environment in South Africa. Infrastructure of roads' classification into surface, gravel and un-surfaced establish a huge network across the country covering a total of 752,700 square kilometers (DBSA Barometer Report, 2006) out of the 1.2 million square kilometers of the country's surface area (World Bank, 2006) and mostly used by vehicles for transportation. The road network represents an environmental frontier of interests to ecologists as well as environmental economists. The impact of current roads in the country is a consequence of displaced species, deteriorating ecosystem, pollution, hydrological and erosion effects. The interruption of ecological balance resulting from road networks calls for strategic policy interventions, spatial planning and financing infrastructure that supports road-reserve networks of native vegetation in support of biodiversity conservation and restoration of ecological resources. The harmful effects are proportion to increasing density of the roads in the country due to increasing demand for road use. Recent budget allocation of 372 billion rands (National Treasury Government of South Africa, 2006) for building, upgrading and maintaining roads in the country is intended to offset traffic overload and contribute to development of the economy. Both direct and indirect effects of roads are cumulative and impact on fauna, community structures and ecological processes are long term in nature (Noss, 2004) and must be well understood and their likely effects to the environment prevented or mitigated.

I. Introduction

The contribution of roads to economic development is globally recognized and countries allocate huge budgets for construction, upgrading and maintenance of roads. Roads are effective but not efficient modes of transportation. About 75% of South Africa's freight is transported by roads (DBSA, Barometer Report, 2006). The effects include pollution from moving vehicles, chemical spills from trucks, displacement of wildlife and vegetation due to construction of new roads, disturbance of hydrology and the ecosystem among others. Despite these negative effects on the ecology, South African population estimated at 46 million people and a positive economic growth of 4% (Government of South Africa Country Report on Millennium Development Goals, 2005) put pressure on the modes of transportation. The pressure is at all levels of roads' regulatory authorities. The provincial level stands at 47% followed by rural roads at 29%, metropolitan and municipal at 23% and National at 1% (DBSA Barometer, 2006). It is at provincial and rural levels that the impact on ecological resources is highest. This is attributed to availability of indigenous vegetation, existence of biodiversity and natural resources that require protection and conservation. Globally, South Africa is recognized as rich in biodiversity and ranked 3rd with most

rare biodiversity in the world. Out of the 1,000,000 identified species some 18,000 vascular plant species of which 80% are endemic occur in the country and no where else in the world (UNDP/UNEP/GEF, 2001).

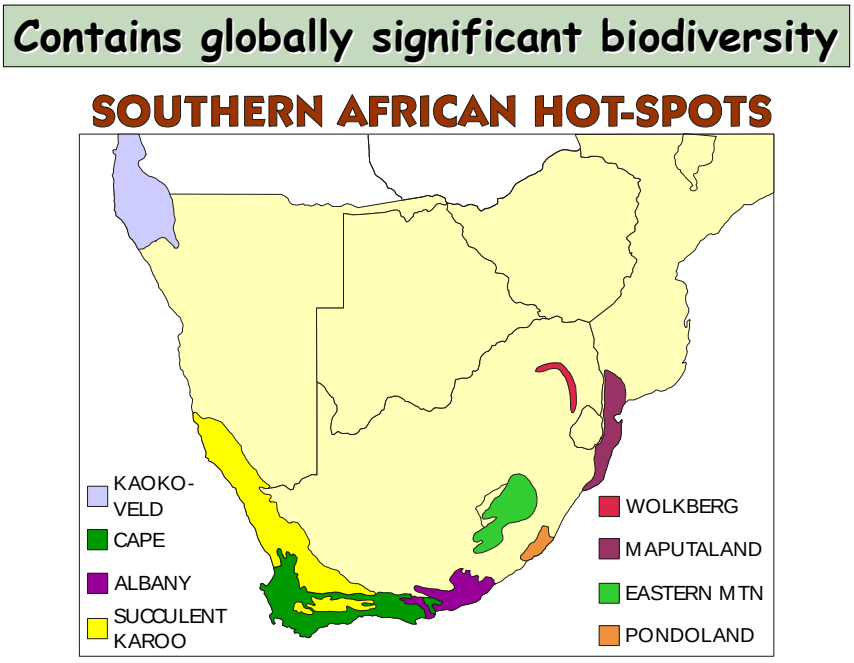
In addition to a variety of plant species, the country has a varied animal species attractive to tourism industry. The country contains about 8% of bird's species, 4.6% reptile species, 16% of marine fish species and 5.5% of the world's identified insect species (IUCN, 1992). These varied both plants and animal species that are endemic make it conditional to conserve biodiversity and construction of roads must be environmentally friendly. The recognition of the Cape Floral Kingdom (UNDP/UNEP/GEF, 2001) as the "hottest spot" in biodiversity ranks South Africa 6th in the world as a country with high levels of species richness and endemism. Other habitat types are of importance to global conservation as third of the world's succulent plant species including the succulent karoo are found in the country. In addition, the country has indigenous forest, grassland, nama karoo, savanna and thicket that require special attention during construction and upgrading of roads.

Road construction and upgrading have tremendous impact on the ecological resources since during these activities there is opening up of the earth surface as well as dust emissions and pollution from burning of the fuels. Air pollution is increasing and very much linked to health problems including cancer, bronchitis among others. Regulating pollution is not as effective as applying pollution technology (South Africa Department of Transport, 1994). Although, in developed countries such as the US, Japan and European Union, health benefits have been achieved through application of strict control of emission standards. South Africa classified as a middle-income country (South Africa, MDG Report, 2005), may not adequately afford strict emission control standards as the country has to still continue using roads as cost effective mode of transportation necessary to fuel the economy. However, the country can strategize and prioritize means of vehicle inspection and maintenance as well as road constructions with modern technologies in order to minimize impact on the ecological resources. The application of modern technology to encourage efficiency and reduce effects on the ecological resources can not happen in isolation of effective environmental legislation and policy measures as well as financial support.

II. Situational Analysis

Ecological damage occurs mainly in rural areas due to vulnerability conditions, lack of infrastructure and fragile ecosystems. Provision of support to rural areas is inevitable to

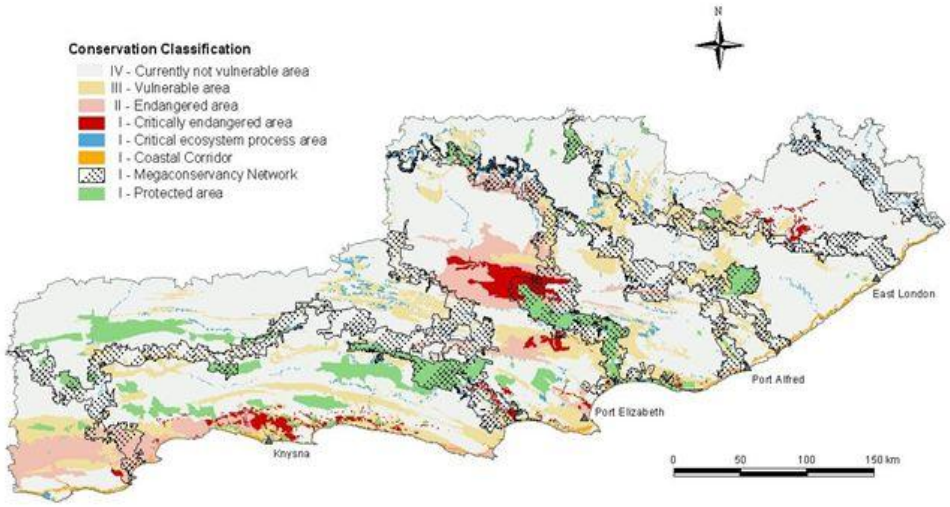
conservation. From the South African map below about seven major terrestrial biomes exist. These include forest, fynbos, grassland, Nama karoo, succulent karoo, savanna and thicket (UNDP/UNEP/GEF, 2001). These biomes have further been divided into 70 vegetation types on the basis of their population characteristics, ecological and evolutionary processes as well as their vegetation structures (UNDP/UNEP/GEF, 2001; Cowling, Pressey, Rouget and Lombard, 2003). A well developed system exists in the country in recognition of these biodiversity "hot-spots" and efforts to conserve biodiversity have been focused in these areas by the Department of Environmental Affairs and Tourism (DEAT, 2001).



Source: Clark, DBSA power point presentation, 2004

The formally protected area that constitutes about 6% of the country's land surface (UNDP/UNEP/GEF, 2001) is threatened by impacts of roads construction, upgrading and maintenance. These effects including contamination of water, oil or petrol pollution from public transportation (Department of Transport, 1994) threaten 15% of South Africa's plant species, 14% of bird species, 24% of reptile species, 18% of amphibian species, 37% of mammal species and 22% of butterfly species (UNDP/UNEP/GEF, 2001). Other related effects result from changes in the drainage patterns that lead to deterioration of water quality with resultant effects on aquatic life and on the quality of water for domestic use. In this context, the wild coast has been an area of tension between developers and conservationists. The slide below shows a classification of

conservation areas in the wild coast ranging from vulnerable to protected areas. Due to fragile ecosystem in this area, water run-offs can be increased beyond capacity levels.



Source: Clarke, DBSA power point presentation, 2004.

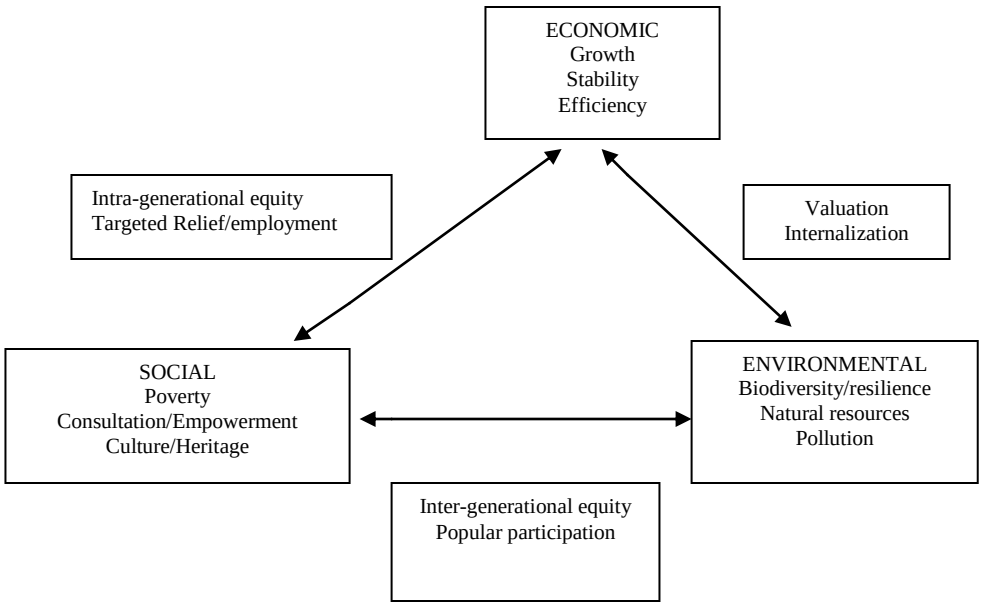
The impact of ecological imbalance resulting from run-offs is high risk to stability of roads, and may result into severe erosions (Habitat Council, 1980) that have potential for increasing costs for the maintenance of roads at the expense of biodiversity conservation. It is estimated that provinces spend about 10,000 rands per kilometer per year on maintenance of un-surfaced roads due to extensive lengths for transportation and vulnerability to erosion both by traffic and weather (Department of Transport, 2005). Out of the 750,000 km of roads in the country, about 600,000 km are un-surfaced roads and have the largest loads for public transportation (Department of Transport, 2005). The impacts of un-surfaced roads on ecological resources include direct habitat loss, facilitated invasion of weeds, pests and pathogens many of which are not indigenous as well as a variety of edge effects (Habitat Council, 1980). It is estimated that one mile of road construction consumes about 48 acres of habitat (Noss, 2004). Logging roads result into clearing about 50 acres for each square mile of commercial forests degrading about 10 acres for every mile of road and each square mile of forest averages 5 miles of road (Noss, 2004).

The impact of road construction includes displacing animals and plants that may not be recovered and the long-term consequences limit productivity of roadsides due to exposure of sub-soils,

reduction in water holding capacity by the soils, and compacting soil materials difficult for regeneration of vegetation on the roadside. In addition, the construction makes the slopes on the roadsides vulnerable to landslides and erosions. Although, some species thrive on the roadsides, most of them are weedy species and in most cases not viable. Most of these weedy species are alien and invade other areas at a fast rate as they are not affected by the disturbed ecosystem. In some cases these weedy species spread out to the communities invading farms and increasing farming costs resulting from purchase of pesticide control chemicals that also to some extent pollute underground water. In logging areas, root-rot fungus is commonly introduced and spreads to other areas affecting endemic species. The off road vehicles are becoming recognized in disturbing soil texture and encouraging perpetration of weedy species that spread rapidly to habitats constituting endemic species. As the ecological impacts of roads tend to focus on the negatives aspects there are positive effects as well. However, roads are critical to economic development and must be constructed, upgraded and maintained in conjunction with management of the ecosystems. This is possible through integrated approach that perceives management of ecological resources as part of the infrastructure development.

III. Integration of Roads and the Ecology

Integration approaches have emerged as solutions to mitigating roads impact on the ecology. The design of roads is done in such away that all ecological impacts are put into consideration and negative effects eliminated accordingly. As the ecological management is integral part of the infrastructure development, undertaking Environmental Impact Assessment (EIA) is mandatory for road constructions. The EIA makes specific recommendations that include planting vegetation and using wire mesh on the roadsides to stabilize the ecosystem through reduced soil erosion, minimized landslides and controlled sedimentations into streams. Integrated approaches promote effective management of the environment and protection of the ecosystem. For example, the model presenting relationship between economic, social and environmental aspects is so much in view of the economic aspects of roads as promoting economic growth, efficiency and stability. In view of the social aspects road construction will generate equity necessary to reduce poverty, enhance empowerment and promote cultural heritage.



Source: ECA, 2005, Africa's Sustainable Development Bulletin, pg. 2

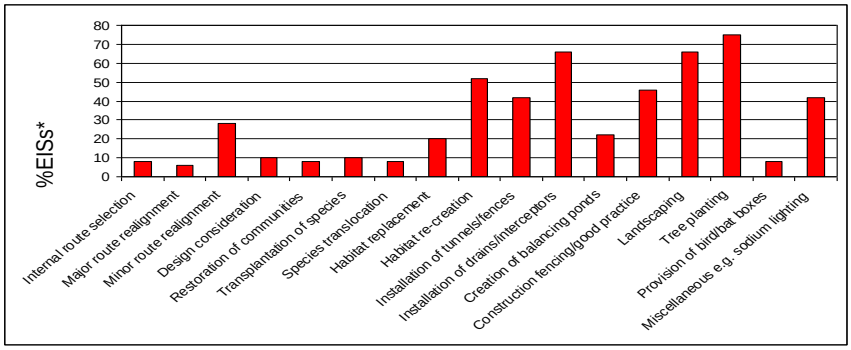
Without compromising the environment, it is necessary but not sufficient to value the environment and internalize likely impacts of road construction. The impacts are in most cases related to pollution, degradation of biodiversity and depletion of natural resources. The local communities dependent on natural resources for livelihoods perceive the environment as a source of equity and insist on popular participation that encourages stronger relationship between the social and environmental aspects. This relationship is fragile and requires regulatory measures relevant to local community needs. The Department of Environmental Affairs and the Department of Transport both recognize the need to protect the ecosystem, hence promote recognition of environmental issues pertaining to road infrastructure provision and use. Environmental issues are closely linked to the non-renewable materials used in road construction in particular scarcity and unsustainable use of road construction materials including fuel used to power engines during construction. The prevailing instruments towards enhancing integration of roads into ecology include the following:

- Environmental Impact Assessment (EIA)
- National Environmental Management Authority (NEMA)
- Air Pollution Act
- Water Pollution Act
- Noise Legislation Act

- Biodiversity Conservation Strategy
- General Environmental Legislation

Alternative approaches are promoting the use of recyclable materials and upgrading existing roads to limit construction of new roads and enhance conservation of the ecosystem. Appropriate use of public transportation is also encouraged to reduce emissions, traffic congestions and accidents. Improvement in road infrastructure is seen in a holistic manner that respects ecological resources, social and economic aspects. Therefore, integrated approaches adhere to sound environmental procedures that assess policies, environmental management plans and all aspects of the roads infrastructure projects that alternative approaches are investigated, explored and negative ecological impacts are minimized and positive ones enhanced. A review of ecological mitigation measures for impacts likely to be caused by roads suggest a number of ways in which ecological impacts can be eliminated (Byron, 2000). The chart below provides some information on environmental information systems necessary for consideration while planning road constructions. The information ranges from road site selection to miscellaneous or secondary information.

Types of ecological mitigation measures



* Percentage do not total 100 due to Environmental Information Systems (EISs) discussing multiple mitigation measures

Source: Byron (2000), Biodiversity Issues in Road Environmental Impact Assessments

Due to inadequacy of resources both technical and financial, most critical information is hardly available for public access as it is costly. For example, site selection information is available on satellite on landsat maps that are commercialized. Also some of this information including resettlement of communities, biodiversity conservation is sensitive and costly as well hence not easily accessible. The review indicates that only 20% of this information is accessible. The most

available information is on tree planting (80%), habitat recreation (50%), installation of drains and interceptors and landscaping (65%). This information is available in plenty because it is not sensitive, it is nice to have and promotes good image in public. In reviewing multiple mitigation measures it is important to access relevant and necessary information that will enhance the value of integrated approach to road construction that is ecologically sound.

IV. Conclusion

The impact of roads on ecological resources requires mitigation measures that will eliminate both direct and indirect effects. Direct effects including clearing of vegetation and displacement of wildlife during road construction can be minimized through better road design techniques based on integrated approaches. The roadsides can be replanted, new roads located and existing roads relocated outside the wildlife habitats. Indirect effects associated with pollution because of the demand for travel and mobility by people can be minimized through the use of alternative modes of travel for example increased public transportation, use of alternative routes outside the wildlife habitat, control travel to destinations subject to peak and off peak seasons of wildlife migration.

There is also need to encourage use of recycled materials for construction and upgrading of roads. This approach will ensure little negative impact on the ecological resources as possible. The reduced demand on non-renewable materials, as well as on the support for efficient public transport to reduce emissions, traffic congestions and road accidents will generate positive ecological benefits.

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Patrick Karani
Environmental Strategist

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