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SUMMARY OF BACKGROUND PAPER 14

AFRICA INFRASTRUCTURE COUNTRY DIAGNOSTIC

Roads in Sub-Saharan Africa

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June 2008

This report was produced by the World Bank and the SSATP with funding and other support from (in alphabetical order): the African Union, the Agence Française de Développement, the European Union, the New Economic Partnership for Africa's Development, the Public-Private Infrastructure Advisory Facility, and the
U.K. Department for International Development.

About AICD

This study is part of the Africa Infrastructure Country Diagnostic (AICD), a project designed to expand the world's knowledge of physical infrastructure in Africa. AICD will provide a baseline against which future improvements in infrastructure services can be measured, making it possible to monitor the results achieved from donor support. It should also provide a more solid empirical foundation for prioritizing investments and designing policy reforms in the infrastructure sectors in Africa.

AICD will produce a series of reports (such as this one) that provide an overview of the status of public expenditure, investment needs, and sector performance in each of the main infrastructure sectors, including energy, information and communication technologies, irrigation, transport, and water and sanitation. The World Bank will publish a summary of AICD's findings in spring 2008. The underlying data will be made available to the public through an interactive Web site allowing users to download customized data reports and perform simple simulation exercises.

The first phase of AICD focuses on 24 countries that together account for 85 percent of the gross domestic product, population, and infrastructure aid flows of Sub-Saharan Africa. The countries are: Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Congo (Democratic Republic of Congo), Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia. Under a second phase of the project, coverage will be expanded to include additional countries.

AICD is being implemented by the World Bank on behalf of a steering committee that represents the African Union, the New Partnership for Africa's Development (NEPAD), Africa's regional economic communities, the African Development Bank, and major infrastructure donors. Financing for AICD is provided by a multi-donor trust fund to which the main contributors are the Department for International Development (United Kingdom), the Public Private Infrastructure Advisory Facility, Agence Française de Développement, and the European Commission. A group of distinguished peer reviewers from policy making and academic circles in Africa and beyond reviews all of the major outputs of the study, with a view to assuring the technical quality of the work.

This and other papers analyzing key infrastructure topics, as well as the underlying data sources described above, will be available for download from www.infrastructureafrica.org. Freestanding summaries are available in English and French.

Inquiries concerning the availability of datasets should be directed to vfoster@worldbank.org.

Contents

Summary

Viewed against the vastness of the subcontinent, the road network of Sub-Saharan Africa is sparse. Certainly, it is much less dense than the networks of other developing regions. But viewed against the region's population and income—and hence its ability to pay for maintenance—road density begins to look rather high. In several countries (Madagascar, Malawi, Mozambique, Niger), the asset value of the road network exceeds 30 percent of gross domestic product (GDP), an indication of the magnitude of the maintenance problem. Overall, road conditions already lag behind those found in other developing regions, although the network of main trunk roads has been maintained in reasonably good condition.[1]

The region's trunk network comprises a series of strategic trading corridors linking deep sea ports to the hinterlands of Africa. These corridors, which carry some US$200 billion in annual trade, are no more than 10,000 kilometers in length. The roads are generally in good condition, good enough to sustain speeds well in excess of the effective velocity of transit along these routes, which is rendered pitifully low (typically less than 10 kilometers per hour) by administrative bottlenecks at borders and ports.

The concept of an intraregional trunk network—the Trans-African Highway—has existed for some time, but owing to missing links and poor maintenance on key segments, its potential to connect the continent remains unrealized. To provide a meaningful level of continental connectivity, between 60,000 to 100,000 kilometers of regional roads are required.

The density of national primary and secondary road networks varies substantially across countries, but in many cases it already exceeds the length required to provide basic connectivity between primary and secondary cities and key ports and land border crossings.

Beyond the classified network of primary and secondary, there is a vast unclassified network of tracks providing varying degrees of service to rural areas. Fewer than 40 percent of rural Africans live within two kilometers of an all-season road—by far the lowest level of rural accessibility in the developing world. There is also evidence that physical isolation is preventing large areas of the continent from reaching their true agricultural potential. However, owing to low levels of population density, reaching a 100 percent target for rural accessibility would imply doubling or tripling the length of the existing classified network in most countries—a Herculean task.

With accelerating urbanization, Africa is also developing a substantial network of intra-urban roads. However, urban road density lags far behind what is found in other developing cities, particularly with respect to paved roads.

[1] This note summarizes recent and ongoing research on transport investment in 24 African countries performed at the World Bank under the aegis of the Africa Infrastructure Country Diagnostic. The full report, with detailed country annexes and technical notes, is available at http://www.infrastructureafrica.org.

New institutions: road funds, road agencies, and toll-road concessions

The African roads sector has passed through a wide ranging and consistent set of policy reforms, with strong donor support. There is a relatively high degree of consensus about the direction of reform, with most countries embarked on very similar paths.

The initial thrust of the reform has been to create an *independent source of funding for road maintenance* based on road-user charges. The funds are fenced off from the general government budget and administered by an autonomous board. The great majority of countries surveyed already have established second-generation road funds, and most of the others are following suit. Only Nigeria and South Africa neither have a fund or a plan to create one.

Close scrutiny of the new generation of road funds reveals that not all of them correspond fully to the conceptual blueprint. Only 20 percent of the road funds studied in the sample (notably those in Kenya, Namibia and Tanzania) meet all seven criteria of good design specified by the 35-member Sub-Saharan Africa Transport Policy Program (figure A1). The criteria are a clear legal foundation, separation of functions, application of road-user charges, direct transfer of funds, representation of road users on the board, clear revenue allocation rules, and independent auditing of accounts.

Moreover, despite widespread application of fuel levies to fund road maintenance, the level of the fuel levy—and hence its utility—varies enormously across countries. The range extends from symbolic levels of around US$0.03 per liter, which are nowhere near high enough to make a material contribution to road maintenance, to around US$0.16 per liter, adequate to cover most maintenance needs. In addition, some countries have trouble collecting fuel levies owing to evasion (Tanzania) or delayed transfer of revenues (Rwanda). As a result they may capture as little as 50 percent of the anticipated resources. Because of lower-than-expected fuel levies, road funds in Benin, Côte d'Ivoire, Ethiopia, Gabon, and Zambia are dependent on budget allocations for more than 75 of their resources.

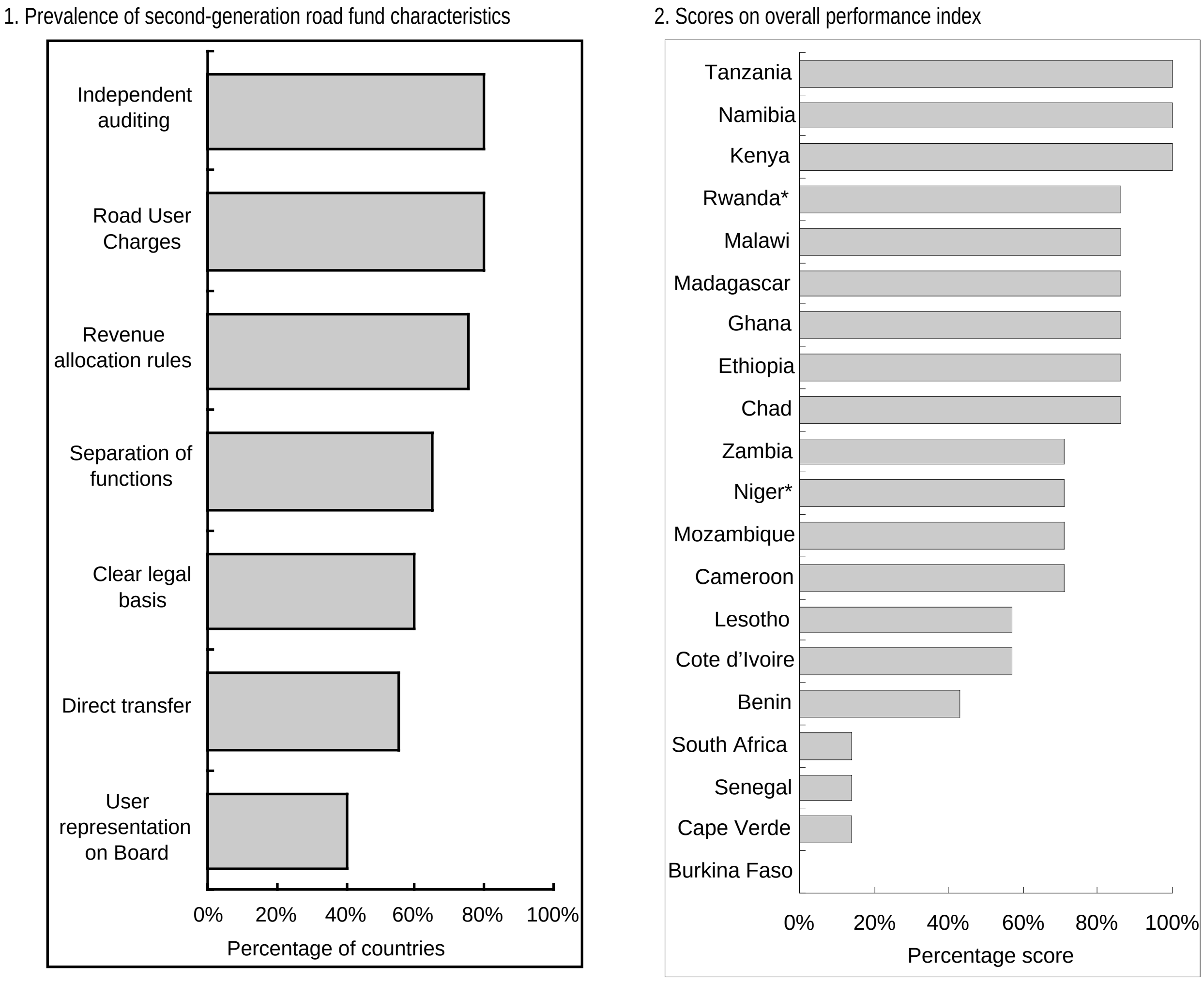
While 60 percent of road fund revenues are typically allocated to the main interurban road network, some countries have to varying degrees attempted to channel portions of the road fund toward the maintenance of rural and, to a lesser extent, urban road networks.

The second stage of the reform process has involved the creation of *road agencies*, independent from line ministries, with responsibility for contracting out public works. About two-thirds of the sample countries have already established a road agency, and others are in the process of doing so. Levels of autonomy vary from full responsibility for road network management to limited responsibility for the execution of road maintenance programs assigned by the roads department or ministry of roads. Only a third of these have private sector representation on their boards. Nigeria, Senegal, and South Africa have a road agency but not a road fund.

Road agencies have moved toward contracting out performance-based maintenance contracts—an important trend. The potential advantage of such contracts is that they provide a strong incentive for maintenance contractors to perform well, while reducing expenditure uncertainties for the road fund. In about half of the sample countries, more than 80 percent of maintenance work was contracted out. Use of this approach has been strongly, though not exclusively, associated with the presence of a road agency.

Improved contract management and disbursement arrangements of this kind have reduced the unit cost of road maintenance by 10 to 20 percent in Ethiopia, Ghana, and Zambia.

Figure A Evaluation of road fund reforms



Source: SSATP RMI Matrix, 2007.

Toll-road concessions are rare, affecting barely 0.1 percent of the region's classified road network, almost all in South Africa. Concessions have captured no more than US$1.6 billion in investment commitments, paltry when compared to the region's overall needs. The limited prevalence of toll-road concessions reflects the fact that less than 10 percent of the region's road network attracts traffic volumes in excess of 10,000 vehicles per day, the minimum required to make concessions economically viable. Toll-road concessions hold additional potential in South Africa—and, to a lesser extent, in Nigeria—but the potential elsewhere in the region is extremely limited.

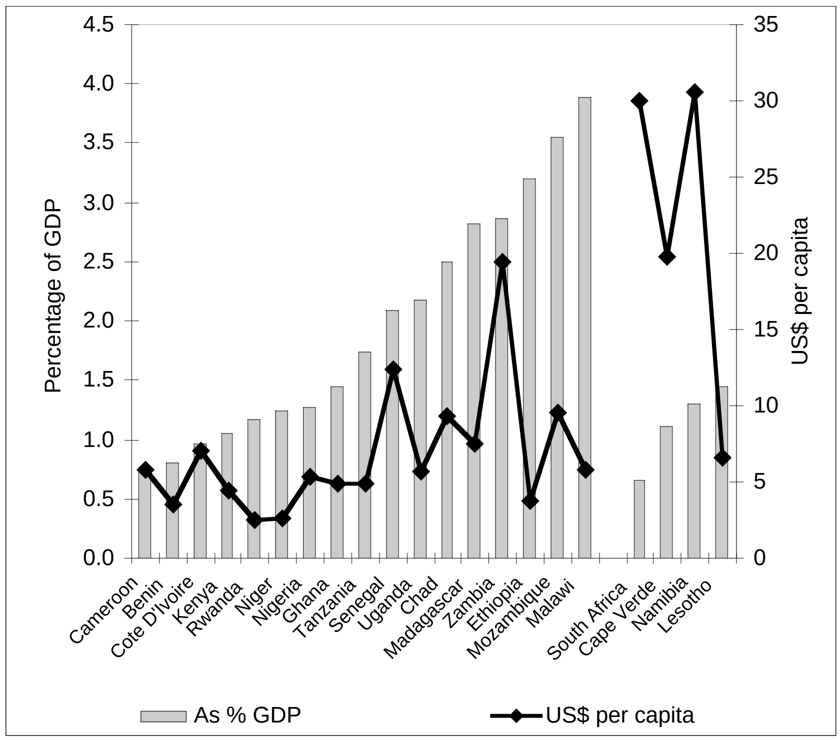
Spending: maintenance, rehabilitation, and new construction

Spending on roads in Sub-Saharan Africa averages just below 2 percent of GDP, with substantial variance across countries (figure B). This compares with the 1 percent of GDP that is typical in industrialized countries, and the 2–3 percent of GDP found in fast-growing emerging economies.

Although the level of effort is high relative to the size of Africa's economies, it remains little in absolute terms, with low-income countries spending an average of about US$7 per capita per year.

On average, countries spend US$9,000 per kilometer of the main road network. However, low-income countries spend 50 percent more per kilometer than do middle-income countries. Curiously, countries with road agencies and high fuel levies seem to spend somewhat less than those without.

Figure B Average annual expenditures on road transport by country, 2001–05



Source: AICD, 2008

While road sector reforms have focused on maintenance, there is evidence of a persistent capital bias in spending. Investment accounts for two-thirds of total spending, leaving only one-third for maintenance. Based on practice elsewhere in the world, the balance between investment and maintenance should be closer to half and half.

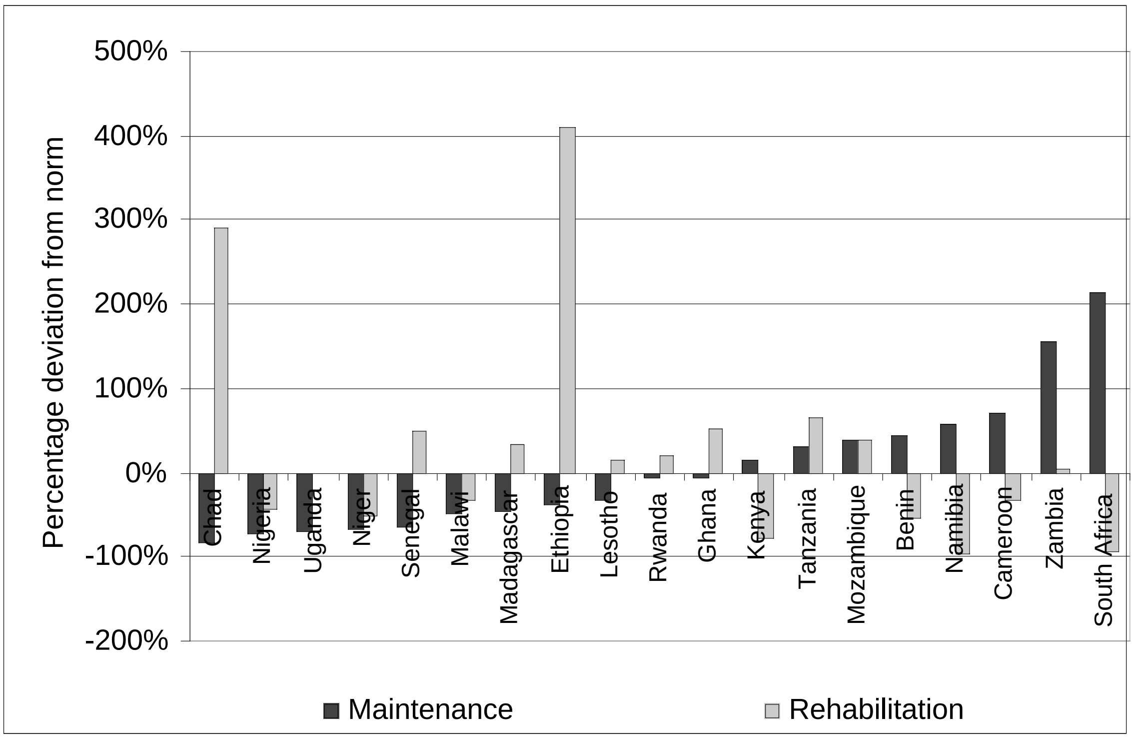
The capital bias is most pronounced in low-income countries, those with difficult geographical environments, and those without road funds or fuel levies, which may in part explain the higher levels of spending observed in these countries.

The bias would be even more pronounced if capital budgets were fully executed. On average, however, countries have budgeted 50 percent more on road investment than they actually succeed in spending during a given budget cycle. This represents an execution ratio of around 70 percent on average. Middle-income countries and those with established road funds and fuel levies fare substantially better than others in this respect. Deficiencies in planning and delays in procurement are the chief causes of this major problem.

High capital expenditure may be justified in some cases by large backlogs in rehabilitation projects in many sample countries. In fact, except in Chad and Ethiopia, current levels of capital spending either fall well below what is needed to clear rehabilitation backlogs within a reasonable five-year period, or lie very close to that level (figure C).

The source of the funds spent on roads may also perpetuate the capital bias we have discerned. The limited evidence available indicates heavy dependence of road investment on official development assistance, ranging from just over 50 percent in Senegal to almost 90 percent in Rwanda. Donors have tended to favor dramatic new construction over mundane maintenance. Moreover, development assistance has proven to be quite volatile, contributing to the erratic pattern of public investment in the sector.

Figure C Rehabilitation and maintenance spending relative to norms



Source: AICD Fiscal Costs Study, 2008; AICD RONET Analysis, 2008.

Fully half of the countries surveyed are not devoting adequate resources to maintenance of the main road network, and about half of these are not even spending enough to meet routine maintenance requirements. In Chad, Niger, Nigeria, Senegal, and Uganda, maintenance spending is less than half the normative requirements.

There is great variation in spending for maintenance across countries, but underspending is conspicuous in low-income countries (particularly the resource-rich), whereas the few middle-income countries tend to spend substantially above the maintenance norm.

For the main road network, the maintenance range extends from barely US$200 per kilometer in Chad to more than US$6,000 per kilometer in Zambia. Maintenance spending per kilometer of the main network tends to be about double that of the rural networks, which consistently get short shrift, even where maintenance is adequate on the main roads. On the whole, there is an inverse relationship between the level of maintenance expenditure in a country and the level of capital expenditure in the same country.

Countries with a road fund and higher fuel levies devote a greater share of their spending to maintenance and fall closer to normative levels of spending. **[[can this be easily illustrated?]]** Among countries with fuel levies, those with high levies do substantially better than those with low fuel levies. Notwithstanding the shortfalls in road fund resources noted above, there is evidence that road funds have reduced the volatility of sector spending relative to traditional budget allocations.

The results presented here are premised on unit costs that have been observed in the recent past, which are fairly consistent between Sub-Saharan Africa and other developing regions. However, it is known that unit costs for roads have recently undergone a significant escalation, which threatens to further dilute the adequacy of current budget allocations. The escalation can be attributed to a lack of competition and to increases in the prices of road-construction inputs, most traceable to the recent escalation in the oil price.

With road costs rising, it is more important than ever that engineering standards should be cost-effective. Network analysis reveals that on average around 30 percent of main road networks are overengineered relative to observed traffic volumes, while only 10 percent of main road projects (and 15 percent of rural projects) are underengineered. The failure to follow appropriate engineering standards suggests that resources have been wasted, but it also points to the way to cost savings in the future.

Greater efforts are also needed to adapt road design standards to local conditions and materials so as to avoid excessive costs in road construction. Particularly urgent is the development of an appropriate standard for low-volume sealed roads.

Road quality: surface and condition

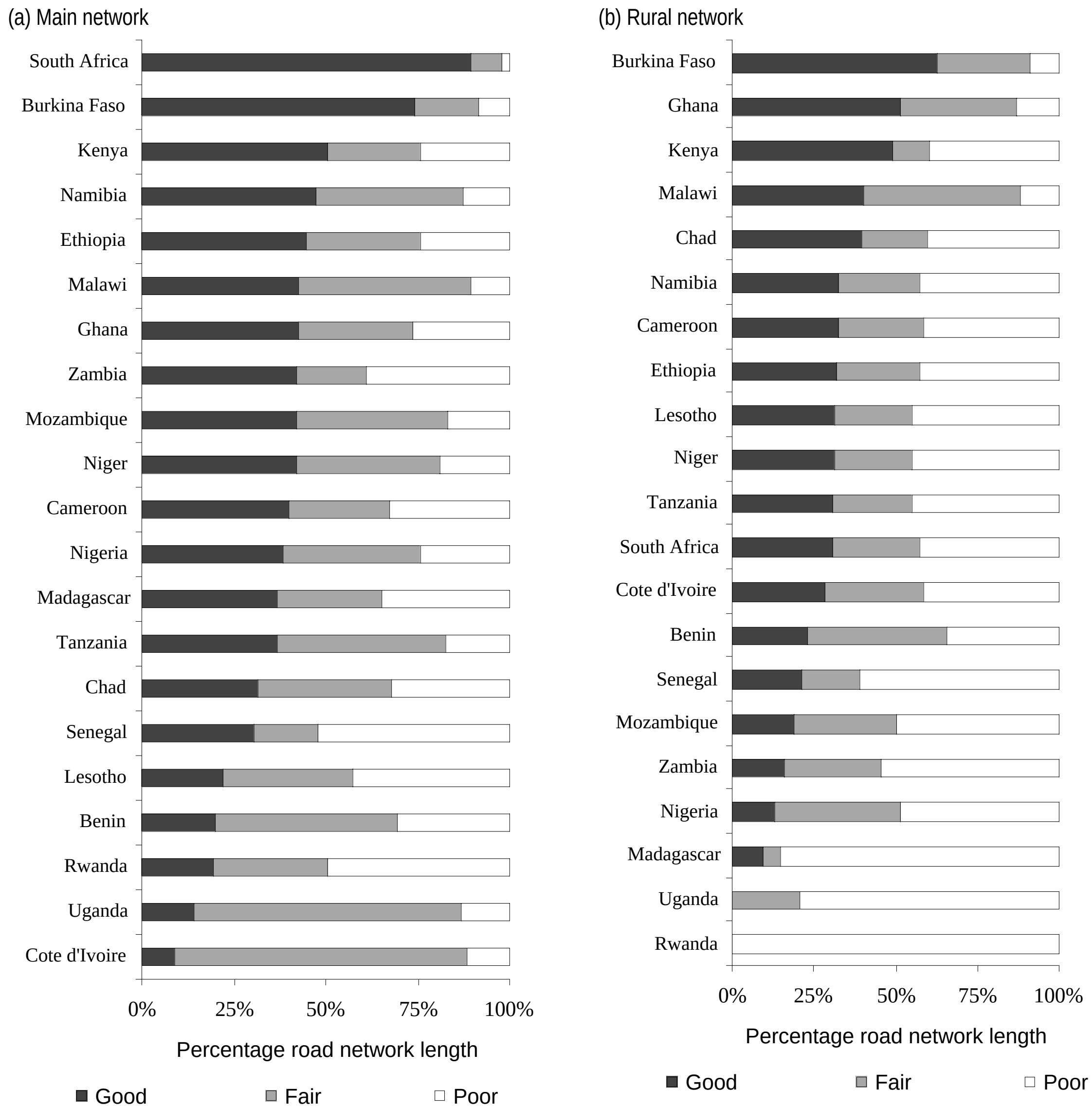
The countries surveyed vary widely in the share of main roads in good condition, but less so in the share in good or fair condition (figure D). On average, about half of the main network is in good condition and a further third in fair condition. The same cannot be said for the rural network. In the countryside, only about a quarter of the road network is in good condition and a further quarter in fair condition. Things may be improving, however. The limited time series evidence available suggests that most countries have achieved improvements in road quality in recent years.

Notwithstanding substantial variation in the percentage of roads in good condition, there is surprisingly little variation in the asset value of road networks as a percentage of its *potential maximum* were it all to be in good condition. All countries realize at least 70 percent of this potential asset value, suggesting they have concentrated their efforts on preserving the high-value paved road network.

Policy variables also turn out to have a material effect on road network performance. Countries with *both* road funds and road agencies show substantially higher levels of road quality than those that lack either one of these institutions. Furthermore, both the design of the road fund (whether it meets the SSATP criteria) and the amount of the fuel levy reliably predict the quality of the main road network but not of the rural network.

Countries that devote a larger share of their road funds to maintenance (and that also have road agencies) show significantly better quality indicators for their main road network; though, once again, no such clear relationship is found for rural roads.

Figure D Good, fair, poor: road network length by country, class, and condition



Source: SSATP RMI Matrix, 2007; AICD RONET Database, 2008

Putting it all together: institutions, expenditures, and quality

According to their performance on the three variables—institutions, expenditures, and network quality—the countries can be divided into four groups. South Africa and Namibia stand out as being the strongest performers overall. Prominent in the second tier are Ethiopia, Ghana, Kenya, Mozambique, Nigeria, and Tanzania. The third tier includes Benin, Cameroon, Chad, Madagascar, and Zambia. The final tier comprises countries such as Lesotho, Rwanda, and Senegal. In each tier, it is possible to observe countries that are further ahead in institutional development or maintenance expenditure.

Variations in road quality across countries reflect both fundamental economic and geographic conditions, as well as the influence of institutional design and financing flows. GDP per capita is the factor most strongly correlated with the percentage of the main road network in good condition, reflecting effort devoted to the paved roads in the network. Climate and terrain, on the other hand, are the factors that best predict the percentage of the main and rural network in poor condition, because difficult climate and terrain speed the rate of deterioration. But economic and geographic idiosyncrasies do not explain all of the variation in road quality across countries. Even controlling for income and climate, substantial variation can be seen in road quality across countries.

Important lessons emerge from this analysis. Notwithstanding their limitations, institutional reforms have had a discernible impact on outcomes. Countries with well-financed road funds do significantly better at capturing resources for maintenance. Countries with road funds *and* road agencies do significantly better at converting resources into road quality.

But the advance of institutional reforms—though impressive—is incomplete in many cases. To be effective, the establishment of a road fund must be accompanied by a fuel levy set at a realistic level and adequately collected.

Finally, the choice of road surface type needs to be more carefully informed by analysis of traffic volumes. Funds wasted on overengineered roads could be better used for other purposes, notably maintenance and the extension and improvement of rural road networks.

1 Introduction

A road network providing adequate connectivity across national territory is typically one of the most costly items of infrastructure that any country requires. It is also the one that has typically weighed most heavily on the national budget—with a strong character for public good—that has traditionally limited the scope for cost recovery.

This review of the state of road networks in Sub-Saharan Africa provides a snapshot of the current state of evolution of the sector. The snapshot encompasses the maturity of the institutional framework, the adequacy of public finance, and the performance of networks. It focuses on exploring the interconnections between these three aspects, and in particular the extent to which institutional reform has contributed to improving sectoral finances and ultimately network condition.

The review triangulates between three important sources of primary data.

The first is an institutional database maintained by SSATP. The Sub-Saharan African Transport Policy program (SSATP) has for some time been tracking the development of institutional reforms in the African road sector in recent year, and to this end regularly updates a descriptive policy matrix. The matrix places particular emphasis on documenting the adoption road funds and road agencies, and the specific characteristics of their design. On this basis, it is possible to classify countries quite precisely according to the maturity of their institutional framework for the sector.

The second is the AICD Fiscal Cost Study. This study collects detailed data on road expenditures during the last five years and (typically) in the 24 Phase I AICD countries. The data is sufficiently detailed to allow for disaggregation of road Fund and non-road fund expenditures, as well as a breakdown between capital and operating expenditure. In some cases—particularly countries with road funds—it is possible to provide some breakdown between expenditure on the main network and on the rural network. However, it is not possible to capture budget allocations of local jurisdictions to the rural network, and as a result rural network spending is almost certainly underrecorded to a varying degree.

The third is the AICD road network survey analysis based on the RONET model. As part of this study, a detailed survey of road networks was performed in 21 of the 24 Phase I AICD countries.[2] The survey entailed consultant visits to the central road entity in each country to collect link-by-link information on the primary, secondary, and (as far as possible) tertiary network. For each network link, the survey ascertained the class (primary, secondary, tertiary), the surface type (concrete, asphalt, gravel or earth), the condition (good, fair or poor), and the traffic volumes (across a series of five bands corresponding to typical values for each tier of the network). The link-by-link data was also geo-referenced to allow physical representation on a map and thereby support spatial analysis of road network characteristics. This parsimonious representation of the network in each country was analyzed making use of a new tool recently developed by SSATP: the Road Network Evaluation Tool (RONET) model. The details of the model are introduced in Box 1 below and more extensively described in Annex 1. However, in brief, the model calculates refined network specific estimates of asset value, as well as required

[2] It did not prove possible to do this work for Cape Verde, DRC, and Sudan.

maintenance and rehabilitation expenditures, and allows simulation of the interaction between network quality and the road maintenance regime over time.

A parallel analysis is conducted throughout between the situation on the main road network and that on the rural network. The main network is defined as being that which is under the jurisdiction of the central road entity. In most countries, this corresponds to the primary plus secondary network, but in a handful of cases (including larger countries such as Nigeria and South Africa) it comprises the primary network only. The rural network comprises the remainder of the classified network, which in most cases corresponds to tertiary roads, but in a few others comprises secondary plus tertiary roads. The reason for adopting this categorization is so that data on historic road expenditure (which can only be split this way and not between primary, secondary, tertiary networks) can be dovetailed with data on road network condition and future expenditure needs. The analysis of the rural network is necessarily more speculative than that of the main network, due to the lower quality of the available data both on network condition and (particularly) on network expenditure.

A number of country typologies are used throughout the study to facilitate the presentation of results. While the range of results across individual countries is typically described, in order to make sense of cross-country variations it is useful to work with a limited number of country typologies. Two kinds of typologies are used. The first relates to fundamentals, which are completely exogenous to the roads sector, but which could nonetheless be expected to influence it significantly. These include macro-economic circumstances (where a three-way distinction is made between middle-income countries, low-income resource-rich countries and low-income aid-dependent countries), geography (where the distinction is between coastal, landlocked, and island nations) and terrain (distinguishing between flat and arid versus rolling and humid terrain). The second relates to policy variables, which are completely endogenous to the road sector, and whose influence it is relevant to isolate as far as possible. These include institutions (namely whether the country has a road fund, or a road agency, or both), as well as funding mechanisms (namely the existence of a fuel levy and the level at which it is set).

Unfortunately, the small size of the sample precludes the use of multi-variate regression techniques. When all of these factors are taken into account, there are only about 19 countries for which the fully triangulated set of data is available. As a result, it is not statistically feasible to conduct multi-variate regression analysis that would allow the isolation of influences due to specific factors while controlling for all of the others. Instead, comparisons of averages across country typologies are used and bivariate regressions are conducted to ascertain the statistical significance of particular influences. However, it is not possible to say whether these influences would remain in a more sophisticated framework of analysis, which must await the accumulation of a larger sample.

The study is organized as follows. Chapter 2 presents the overall anatomy of the Sub-Saharan African road network, comparing its basic attributes to road networks found in other developing regions. Chapter 3 describes the evolution of institutional reform in the sector and classifies countries according to the quality of these frameworks. Chapter 4 analyzes road sector expenditure trends relative to theoretical norms, and tries to explain differences in expenditure across countries using the typology described above. Chapter 5 focuses on road network condition, and uses the same typology to understand differences in country performance. Chapter 6 concludes.

Box 1.1 A brief introduction to the Road Network Evaluation Tools (RONET) Model

The Road Network Evaluation Tools (RONET) model is being developed by the Sub-Saharan Africa Transport Policy Program (SSATP) to assist decision makers to monitor the current condition of the road network, plan allocation of resources, and assess the consequences of macro-policies on the road network.

RONET is a tool for assessing the performance of road maintenance and rehabilitation policies and the importance of the road sector for the economy, to demonstrate to stakeholders the importance of continued support for road maintenance initiatives. It assesses the current network condition and traffic, computing the asset value of the network and road network monitoring indicators. It uses country-specific relationships between maintenance spending and road condition, and between road condition and road user costs, to assess the performance over time of the network under different road works standards, determining, for example, the minimum cost for sustaining the network in its current condition. It also shows the savings or the costs to the economy to be obtained from maintaining the network at different levels of road condition. It further determines the proper allocation of expenditures among recurrent maintenance, periodic maintenance, and rehabilitation road works. Finally it determines the “funding gap,” defined as the difference between current maintenance spending and required maintenance spending (to maintain the network at a given level of road condition), and the effect of under spending on increased transport costs. RONET is being developed for use in the Africa region, but there are no impediments to its application in any other country worldwide. The primary audience for RONET is decision makers in the road sector, for whom it is designed as a tool for advocacy of specific revenue enhancing or cost recovery measures.

2 Sub-Saharan Africa's roads in international context

Figure 2.1 Spatial density of road networks in world regions

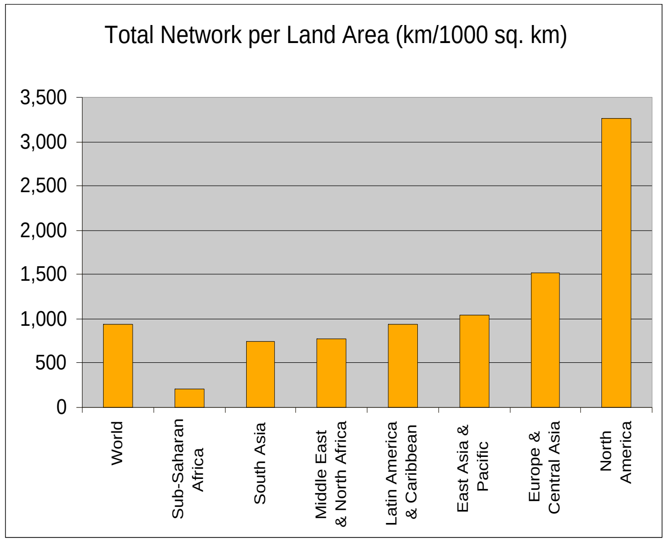
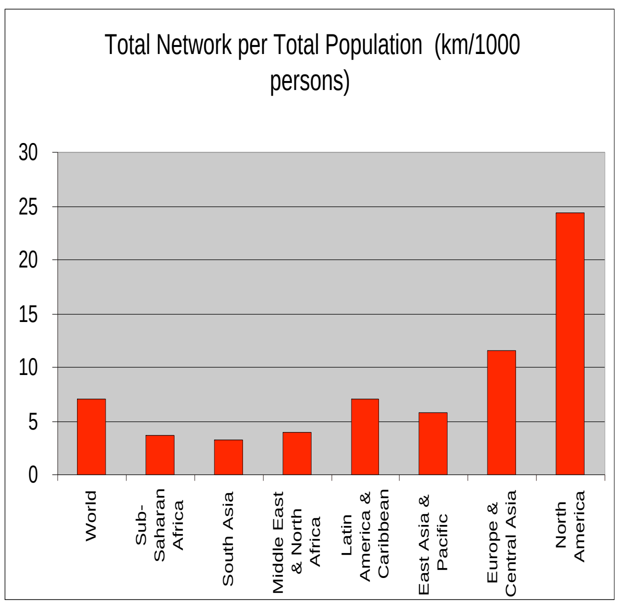


Figure 2.2 Total road network per capita in world regions



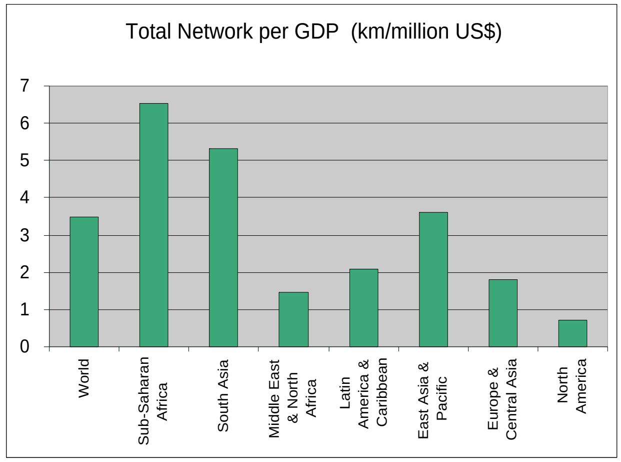
Sub-Saharan Africa has a much lower density of paved roads than any other region of the world. (figure 2.1) It has only 204 kilometers of road per thousand square kilometers of land area, with only one quarter are paved. This compares with a world average of 944 kilometers per thousand square kilometers, with over half paved. Its spatial density of roads is less than 30 percent of the next worst provided region, South Asia, with half being paved, and only 6 percent of North America, with two thirds paved.

To some extent this reflects the low population densities of the SSA region. Because of vastly different population densities road networks per capita are much less disparate than those per square kilometer. Sub-Saharan Africa has a total road network of 3.6 kilometers per thousand persons, compared with a world average of 7.07 kilometers (figure 2.2).

The density with respect to population in Sub-Saharan Africa is actually slightly higher than that of South Asia, with 3.19 kilometers per thousand and only slightly lower than that of Middle East and North Africa, with 3.88 per thousand. But the paved road length in Sub-Saharan Africa of 0.79 kilometers per thousand population, still remains less than half of that of South Asia, and only about one fifth of the world average.

Moreover, given low gross domestic product, the fiscal burden of maintaining this limited road network is significantly higher than elsewhere (figure 2.3). Although its paved road network of 1.12 kilometers per million dollars of gross domestic product is only slightly higher than the world average of 0.98, and less than South Asia's average of 2.67, it has a total road network of 6.55 kilometers per million $, compared with South Asia's 5.32 and a world average of 3.47. The North American equivalent value, at 0.79 is only a little 10 percent of that of Sub-Saharan Africa.

Figure 2.3 Total road network as share of GDP in world regions



The same order of under provision is exhibited in comparisons specifically of countries with comparable incomes. Table 2.1 compares the paved road networks of the AICD countries with those of other lower income and lower middle-income countries of the world. It shows that lower income countries in Africa have lower levels of paved road per capita, per km^2 and per $ GDP per capita than other low-income countries in the world. While African low-income countries have lower average population densities than other world low-income countries (70 compared with 125 per km^2), the relative disparity in provision of paved roads is substantial greater than this (10.7 to 37.3 kms per 1000 km^2).

Table 2.1 Cross region comparison of paved road infrastructure

Paved roads	Units	SSA LICs	Other LICs
Density by area	Km/1000 km^2	10.7	37.3
Density by population	Km/000 pop	269.1	700.7
Density by GDP per capita	Km/ US$ billion	663.1	1,210.0

Source: AICD Transport Investment Needs Study, 2008.

Making inter-regional comparisons of road condition is difficult because of potential differences in road classification, condition measurement procedures and date of measurement. The data summarized in table 2.2 comes from several different sources.

Table 2.2 Cross-region comparison of % of roads in good or fair condition

Region	Data source	No. of data points	Minimum value	Median value	Maximum value
			%	%	%
Africa	ARM	26	23	64	95
	AICD (classified network)	19	29	66	91
	AICD (primary network)	19	45	86	98
LAC	WRS/WB	11	65	77	100
Asia	WRS/WB	11	4	88	100
Europe	WRS/WB	12	72	100	100

Sources: SSATP Africa results Monitoring (ARM); special studies undertaken for AICD (RONET data); International Road Federation World Road Statistics (WRS); country reports of the World Bank.

The data show that, whether you consider all classified roads or just the primary roads (which in Africa are in rather better condition) the median condition in Africa is inferior to that in Europe or Asia. Conditions in the Latin American countries covered showed a median value lower than that for the African primary roads surveyed for RONET, but higher than that for all classified roads in Africa. The minimum values found in the LAC sample were substantially better than those for any of the African data sets. Given the limitations of the data it can be weakly concluded that road conditions in Africa are generally worse than those in Europe and Asia, and probably worse than those in Latin America and the Caribbean.

Sub-Saharan Africa's road infrastructure

The strategic international road network

Africa's international road network can be viewed through two different lenses. The first is the lens of international trade, and the second is the lens of intra-regional trade and cohesion.

A relatively small number of international road transport corridors play a crucial role in maintaining the economies of the landlocked countries of Africa. On an immediate level, much attention has focused on the main international trade corridors that connect the landlocked countries of each sub-region to their respective ports. Some US$200 billion worth of imports and exports per year move along these key corridors that in total amount to little more than 10,000 kilometers in length.

For Central Africa, regional transport is dominated by two road and rail corridors which link the port of Douala in Cameroon with Chad and the Central African Republic, serving the cotton and oil exports of Chad and the logging exports of the CAR.

For West Africa, there are several potential gateways (in Ghana, Benin, Cote d'Ivoire, Senegal, Guinea and Togo) serving the landlocked countries Burkino Faso, Mali and Niger. However, the closing of the international routes from Abidjan as a consequence of the crisis in Cote d'Ivoire has meant that most of the traffic now goes through ports in Togo, Benin, and Ghana, with Burkino Faso also becoming a transit country for Mali. Some 50 percent of the import traffic to Burkino Faso is now routed through Lome and 36 percent through Tema in Ghana.

In East Africa, 80 percent of the trade flows are still going to/from outside the region, despite the creation of the East African Community. Mombassa is the dominant port for the region, handling more than 13 million tons of freight per annum, serving not only Kenya and Uganda but also DRC, Burundi and Rwanda.

In Southern Africa, there are four main trade routes. The main route, the North-South corridor from Durban, serves as an intra-regional trade route linking Zambia, South-eastern DRC and western Malawi with Botswana, Zimbabwe and South Africa. The alternative routes through Beira, Walvis Bay, and Dar es Salaam, although closer to some parts of the region, suffer relative to Durban both because of the superior road infrastructure to Durban and its better port equipment and lower maritime rates

Currently around 70 percent of these corridors are in good condition, and efforts are focusing on non-physical barriers to trade. Donors are increasingly channeling resources to infrastructure improvements along these strategic routes. But there is also recognition that it will take more than good infrastructure to make these corridors function effectively. Member countries have increasingly organized themselves in corridor associations that aim to address the non-physical barriers to transit, with a particular focus on cutting lengthy delays of between 10-30 hours each at border crossings and ports by the creation of one-stop integrated frontier posts and improvements to ports and custom administration.

The Southern corridors perform significantly better than those in Central and West Africa. The Southern corridor approaches broader developing country norms in terms of freight tariffs, but even there the duration of transit leaves much to be desired (see table). Notwithstanding, the emphasis on trade facilitation, AICD analysis indicates that the high cost and low quality of road freight service in Central and Western Africa is primarily attributed to a highly regulated and cartelized trucking industry, making liberalization the number one priority measure to improve road transport in that region.

Table 1.3 Overview of Africa's key transport corridors for international trade

Corridor	Length (kms)	Road in good condition (%)	Trade density (US$m per km)	Implicit velocity* (km per hour)	Freight tariff (US$ per ton-km)
Western	2,050	72	8.2	6.0	0.08
Central	3,280	49	4.2	6.1	0.13
Eastern	2,845	82	5.7	8.1	0.07
Southern	5,000	100	27.9	11.6	0.05

*Implicit velocity includes time spent stationary at ports, border crossings and other stops.

Source: Adapted from AICD Road Transport Costs Study, 2008

The official Trans African Highway Network is far from complete. On a more visionary level, there has also been much discussion regarding the possibility of creating a comprehensive continental road network. The concept of such a network was formulated in 1970 as part of a political vision for pan-African integration and co-operation. It consisted of nine main corridors with a total length of 59,100 kilometers. Although the concept of the Trans-African Highway system has been around for almost 40 years, it has proved elusive to get national governments to prioritize the investments needed to make this network a reality. Of course, many of the links in the network already exist, and form important elements in the national highway networks of their countries. As of today, almost half of the official 50,000 kilometer network is in poor condition. About 70 percent is currently paved, but 25 percent has either an earth surface or no formed road at all. Most of these missing links are concentrated in Central Africa. In 2002, the African Development Bank reviewed the status of the concept.[3] Of the nine links, only one, Cairo-Dakar, was complete. For the rest it was estimated that the costs of completion would be over 4 billion US dollars.

A more extensive intra-regional network could contribute substantially to intra-African trade. Extending the network further to inter-connect all cities in Sub-Sahara Africa exceeding 500,000

[3] African Development Bank. *Review of the Implementation Status of the Trans-African Highways and the Missing Links.* 2002

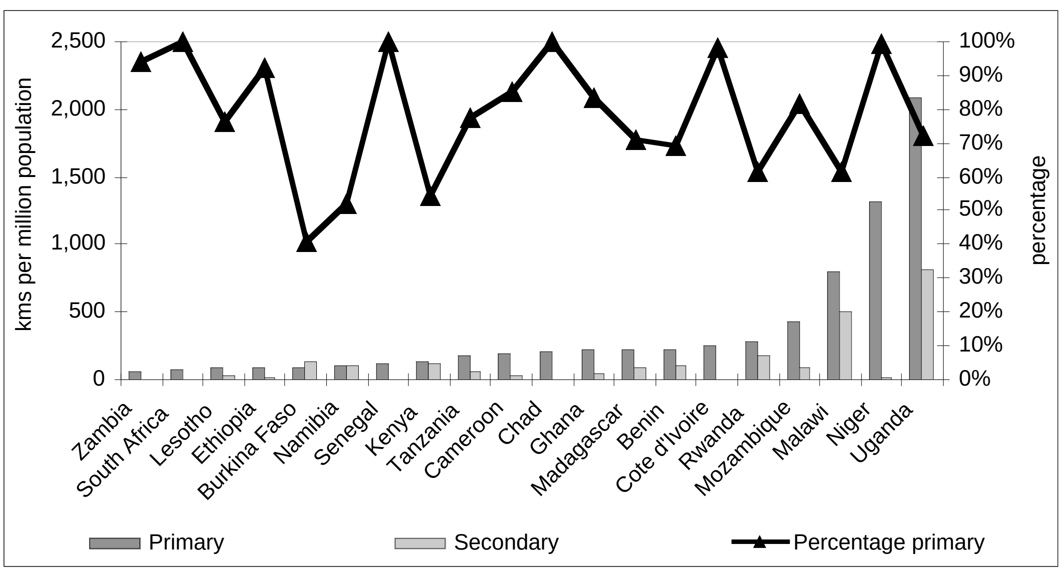
populations would add an additional 50,000 kilometers to its length. It is estimated that this extended intra-regional network carries the order of US$10 billion of intra-African trade each year, a tiny fraction of the intercontinental trade volumes moving along the four major sea corridors (Buys and others, 2006). The costs of the one-time upgrades needed to achieve this network have been estimated at US$20 billion, plus an annual bill of US$1 billion for ongoing maintenance (Buys and others, 2006). The associated benefits are necessarily somewhat more speculative. However, Buys and others (2006) estimate that based on well-established relationships between trade volumes and transport costs, an operative intra-regional network could conservatively be expected to triple current volumes of intra-African trade from US$10 billion to almost US$30 billion per year. Even assuming rehabilitation costs as high as US$20 billion, the benefit-cost ratios over a 15-year period would be as high as five.

The national classified road networks

There is huge variation in primary road densities across countries. Most countries present primary network densities of between 100 to 300 kilometers per million of population (figure 2.4). However, there are important outliers. At one extreme, countries such as South Africa, Lesotho, and Namibia have around 50 kilometers of primary road per million of population. At the other extreme, countries like Uganda and Niger have more than a thousand kilometers of primary road per million of population.

In most countries, primary road densities are substantially higher than secondary road densities. The degree of variation in secondary road densities is much lower, with most countries presenting secondary network densities of between 10 to 100 kilometers per million of population (figure 2.5). With few exceptions most countries have more extensive primary networks than secondary networks. The differences are very large in some cases.

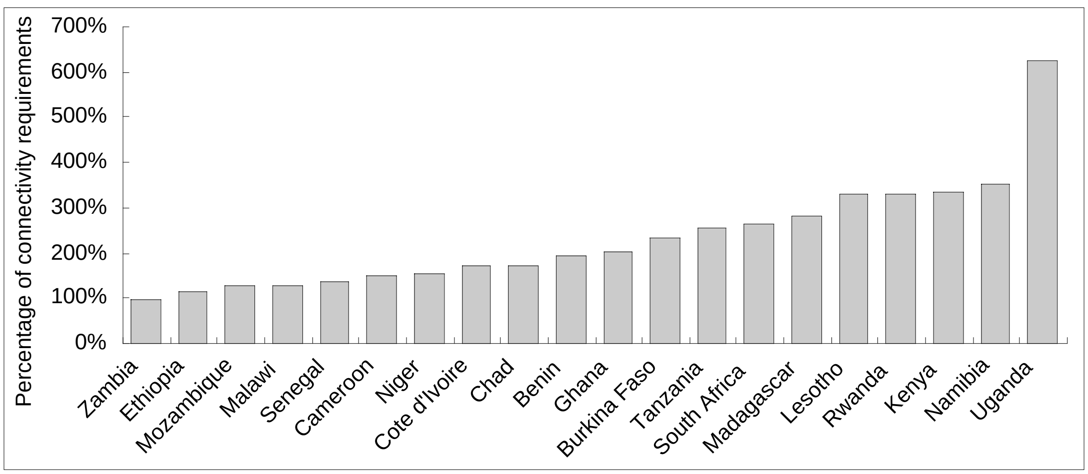
Figure 1.4 Range of primary and secondary road densities



Source: AICD RONET Analysis, 2008.

Primary and secondary road networks appear to be long relative to what is needed to meet regional and national connectivity requirements. The definition of primary and secondary road networks, as well as their (normalized) length, varies substantially across countries. In order to benchmark these against a standardized notion of functionality, a GIS model of the road network as well as key demographic and geographic features is used to determine the network length required for each country to achieve a common definition of regional and national connectivity. Regional connectivity is defined as the network needed to link national capitals and any other cities with more than 250,000 of population to international frontiers and deep sea ports. National connectivity is defined as the network needed to link all provincial capitals and any other cities with more than 25,000 of population to the regional network. On the assumption, that the main goal of the primary and secondary network should be to achieve regional and national connectivity, the ratio of the actual primary and secondary network length to the network required to reach these connectivity standards can be calculated to assess the extent to which these networks may potentially be over- or underextended.

Figure 2.5 Length of primary and secondary network as percentage of length required to meet basic regional and national connectivity

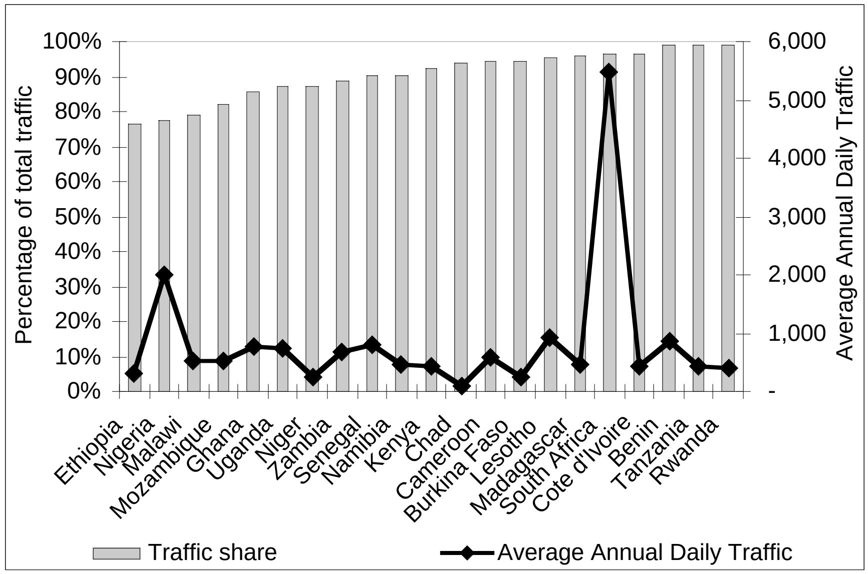


Source: AICD RONET Analysis, 2008.

Network traffic is heavily concentrated on the main road network, but remains low in absolute terms (figure 2.6). In most countries, at least 90 percent of reported traffic on the classified network is carried on the main networks. These typically comprise centrally administered primary plus secondary networks. However, in a handful of countries (Malawi, Nigeria, South Africa, and Uganda) only the primary network is centrally administered and hence included here. With the exception of Nigeria and South Africa, the absolute volumes of traffic on the main road network are low, averaging about 500 vehicles per day.

Rural roads

Figure 2.6 Volume of traffic carried on main network

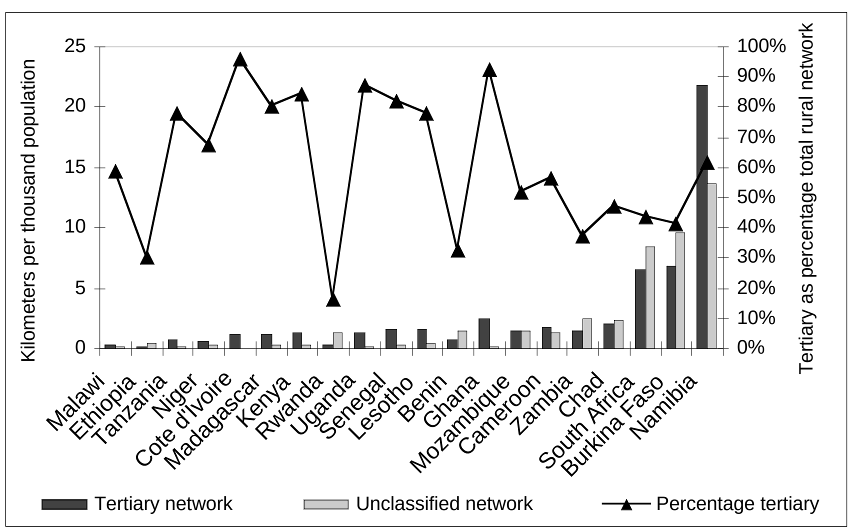


Source: AICD RONET Analysis, 2008.

Rural transport infrastructure is more than designated and mapped roads. In rural areas people and vehicles move not only on the classified tertiary road network but also on a myriad of unclassified paths and tracks, which may be the only means of access to villages. To understand the rural situation, it is therefore crucial to take a holistic view of rural road infrastructure, even if the unclassified part is typically poorly documented.

The size of the rural network is difficult to state precisely because it contains many roads and paths which are unrecorded or unmeasured. Sub-Saharan Africa has about 940,000 kilometers of designated rural roads, whose replacement value is estimated at US$48 billion. In addition, Africa has a vast network of undesignated rural roads, tracks, paths, and footbridges. It has been estimated that this may be one and a half or two times as extensive as the local government road network. Along this rural network is generated a third of the region's gross domestic product from agriculture and 40 percent of its export revenues.

Figure 2.7 Range of tertiary and unclassified road densities per thousand population

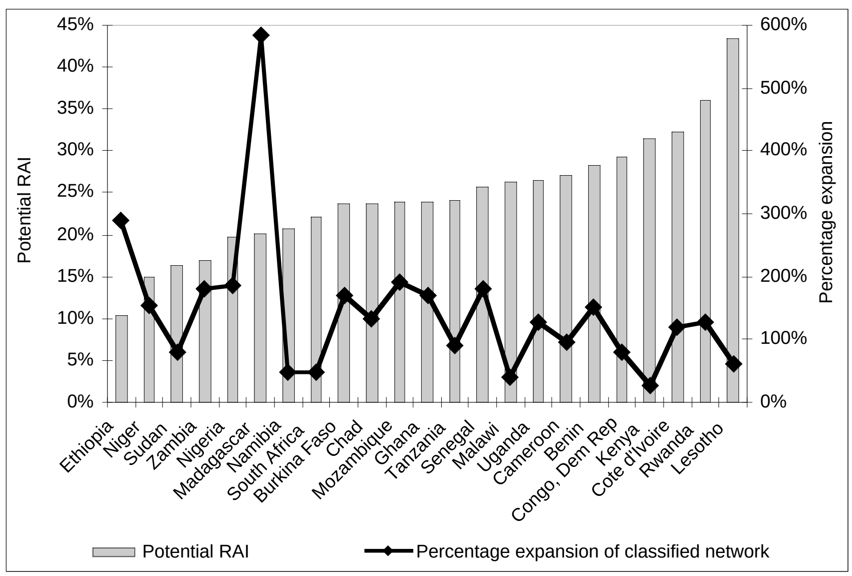


Source: AICD RONET Analysis.

There is huge variation across countries in the density of this (broadly defined) rural road network, and on the relative weight of classified tertiary roads (figure 2.7). The availability of rural roads ranges from 0.5 kilometers per thousand of population in Malawi to 35.5 in Namibia. The inter-quartile range lies between one and three kilometers per thousand of population. South Africa, Burkina Faso, and particularly Namibia stand out as having relatively extensive rural networks relative to their respective populations. In most countries, the majority of rural network kilometers are captured by the official tertiary network. However, in a number of cases—including Benin, Ethiopia, and Rwanda—less than one third of the rural network is classified.

The network is nevertheless inadequate as reflected in the low value of the Rural Accessibility Index. The adequacy of the rural network may be indicated by the proportion of rural population within a two kilometer walking distance of an all-weather road.[4] Based on household survey evidence analyzed for 20 countries in Africa, this Rural Accessibility Index (RAI) takes an average value of less than 40 percent.[6] This is compared to an average of 94 percent for the richer countries that borrow from the International Bank for Reconstruction and Development. However, the availability of household surveys asking the question required to compute the RAI is currently limited, and there are also issues regarding whether datasets designed to be representative of the whole rural space can accurately reflect more spatially disaggregated issues such as accessibility.

Figure 2.8 Potential Rural Accessibility Index from current network and percentage expansion needed to reach 100% Rural Accessibility Index



Source: AICD RONET Analysis, 2008.

Meeting a 100 percent rural accessibility target would for most countries imply doubling or tripling their current classified road network. Using a GIS model of Africa's road network and the geographical distribution of population, it is possible to estimate the potential RAI, which is to say the percentage of rural population that live with two kilometers of the current road network and who would therefore be connected were that network adequately maintained to provide all-season access (figure 2.8). The average value of this potential RAI is only 22 percent for the 24 countries in the sample. Countries such as Ethiopia, Niger, Sudan and Zambia report particularly low values of under 20 percent for the potential RAI. Even Namibia, with its extensive rural network reaches a potential RAI of just over 20 percent. Using the same GIS model, it is possible to calculate the kilometers of additional tertiary network that would need to be build to reach a 100 percent target for the RAI. When

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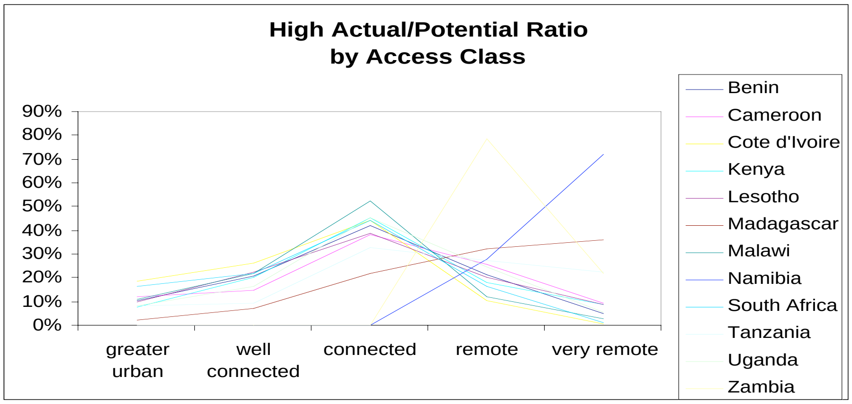
[4] *Rural Accessibility Index: A Key development Indicator.* Transport Paper 10. World Bank. 2006

[6] Rural *Accessibility Index for countries eligible for World Bank loans and IDA credits*. Internal Memo. World Bank. 2007

these additional kilometers are expressed as a percentage of the current classified network, the results are quite sobering (figure 2.9). Even in the best cases, the classified road network would need to grow in length by around 50 percent, and in most cases it would need to double or even triple in length. Madagascar is evidently an outlier: It would need to increase the length of its current classified road network six fold in order to attain 100 percent rural accessibility.

Isolated rural areas are able to realize only a small percentage of their full agricultural potential. Another way of measuring rural connectivity is to look at the extent to which the rural network provides adequate access to high value agricultural land. FAO estimates of actual and potential crop production were compared area-wise, using GIS maps. The ratio indicating extent of realization of agricultural potential was then correlated with the degree of remoteness of these areas. For most countries, exploitation of potential (for many crops such as cotton, maize, and coffee) was highest in zones which are between two to five hours travel time from the nearest large town. Beyond this time zone, the ratio of actual production to potential drops off very sharply (see figure 2.9). The reason for the peak not being in closer proximity to the towns is that in such areas agricultural production is either limited or concentrated on food crops not covered by the survey. Lack of accessibility is thus limiting the exploitation of agricultural potential in poorer and less densely covered countries.

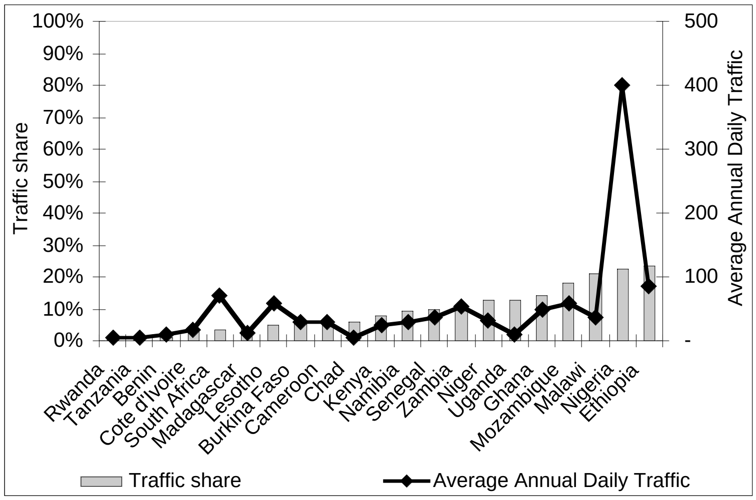
Figure 2.9 Accessibility and agricultural production



Source. Murray [[date?]].

Rural networks typically carry very low levels of traffic amounting to no more than 10 percent of overall traffic on the classified network (figure 2.10). There are a handful of countries where the rural network plays a more prominent role capturing more than 20 percent of traffic, namely Ethiopia, Malawi, and Nigeria. With the exception of Nigeria, the absolute volumes of traffic on the rural network are very low averaging around 30 vehicles per day.

Figure 2.10 Volume of traffic carried on rural network



Source: AICD RONET Analysis, 2008.

Urban roads

It is estimated that Africa has a total urban road network of about 220,000 kilometers.[7] However, because these roads are not separately classified in many countries there is relatively little firm information about them as a class. Urban roads thus overlap the standard roads classification, and their length should not be added to the total lengths of the classified network categories. Most roads were laid when the cities were monocentric and before the growth of private vehicular transport. The capacity of the main highways is thus typically limited.

Overall, the road network constitutes less than 7 percent of the land area in most of our cities, compared with 25–30 percent in developed cities and only a third of the roads are paved. Paved road density is typically on the order of 300 meters per thousand inhabitants (or close to two kilometers per square kilometer). According to the U.N. Millennium Cities Database, these values are at the extreme lower end of developing cities worldwide, for which the average is close to 1,000 meters per thousand inhabitants. Again, the range is Dakar has more than 1,500 meters per thousand inhabitants, about four times higher than the next best case (Lagos). At the other extreme, Kinshasa has just 63 meters of paved road per thousand inhabitants, barely half that of the next worst city (Dar es Salaam).

The road network in all cities is substandard. The proportion of paved road ranges widely (table 2.3) from barely 10 percent in Kinshasa and 12 percent in Kigali to 74 percent in Kampala. The limited evidence available suggests that approximately 80 percent of paved urban roads, and 60 percent of unpaved urban roads, are in good or fair condition. Kumar and Barrett report, in their study of 14 cities that capacity is generally limited, service lanes are absent, pavement is deteriorating, and street lighting is minimal. Because traffic management is limited in scope and extent, accidents are frequent. Pedestrians account for two-thirds of fatalities. The majority of the roads have one lane in each direction, and where

[7] This estimate is based on extrapolation of the data on roads in the 14 cities covered in Table 4. The sample cities have a total population of 52 million out of an estimated total African population of 770, million, of which about 240 million are estimated to live in urban areas.

roads are wider, one lane is often taken up by pedestrians and parked vehicles. Intersections are spaced closely together and are ill designed for turning.[8]

Table 2.3 Characteristics of the road network in 14 African cities

City	Length of road network (kms)	Length of paved road network (kms)	Paved roads as share of all roads (percent)	Paved road density	
				m per 1,000 pop.	kms per km^2
Abidjan	2,042	1,205	59	346	2.1
Accra	1,899	950	50	339	2.8
Addis Ababa	—	400	—	129	0.7
Bamako	836	201	24	167	0.8
Conakry	815	261	32	174	2.3
Dakar	14,756	4,427	30	1,581	8.0
Dar es Salaam	1,140	445	39	122	0.2
Douala	1,800	450	25	237	2.4
Kampala	610	451	74	225	0.5
Kigali	984	118	12	170	0.2
Kinshasa	5,000	500	10	63	0.1
Lagos	—	6,000	—	400	1.7
Nairobi	—	—	—	—	—
Ouagadougou	1,827	201	11	185	0.4
Average	—	—	33	318	1.7

Sources: AICD Urban Transport Review, 2008

Note:—= not available.

[8] Kumar, A.J. and F. Barrett. *Stuck in Traffic:Urban Transport in Africa.* AICD Background Paper. World Bank. October, 2007.

3 Institutions

During the last decade most countries in Africa have followed a consistent path of institutional reform in the roads sector. The central focus of road sector reforms over the last decade has been improving the availability of funds for road maintenance and the capacity to execute public works. Through initiatives such as the Sub-Saharan African Transport Policy Program (SSATPP), a relatively high degree of consensus has been achieved between country governments and development partners regarding the desirable institutional structure for the sector. The central emphasis has been on the establishment, or further improvement of road funds, which provide ring-fenced revenues for road maintenance based on a user charge concept expressed through fuel levies. A secondary area of action has been in the establishment of independent Road Agencies with strong capabilities for the execution of public works.

Most of the countries have a formal transport policy statement, and many have a long term investment program. More than 80 percent of the countries studied have adopted formal sector policies, although the majority of these are more than five years old. Just over 60 percent have a long term road investment program, and these tend to be more recent than the respective policy documents. In most cases, however, these programs depend heavily on foreign aid and cheaply borrowed finance.

Experience with second-generation road funds

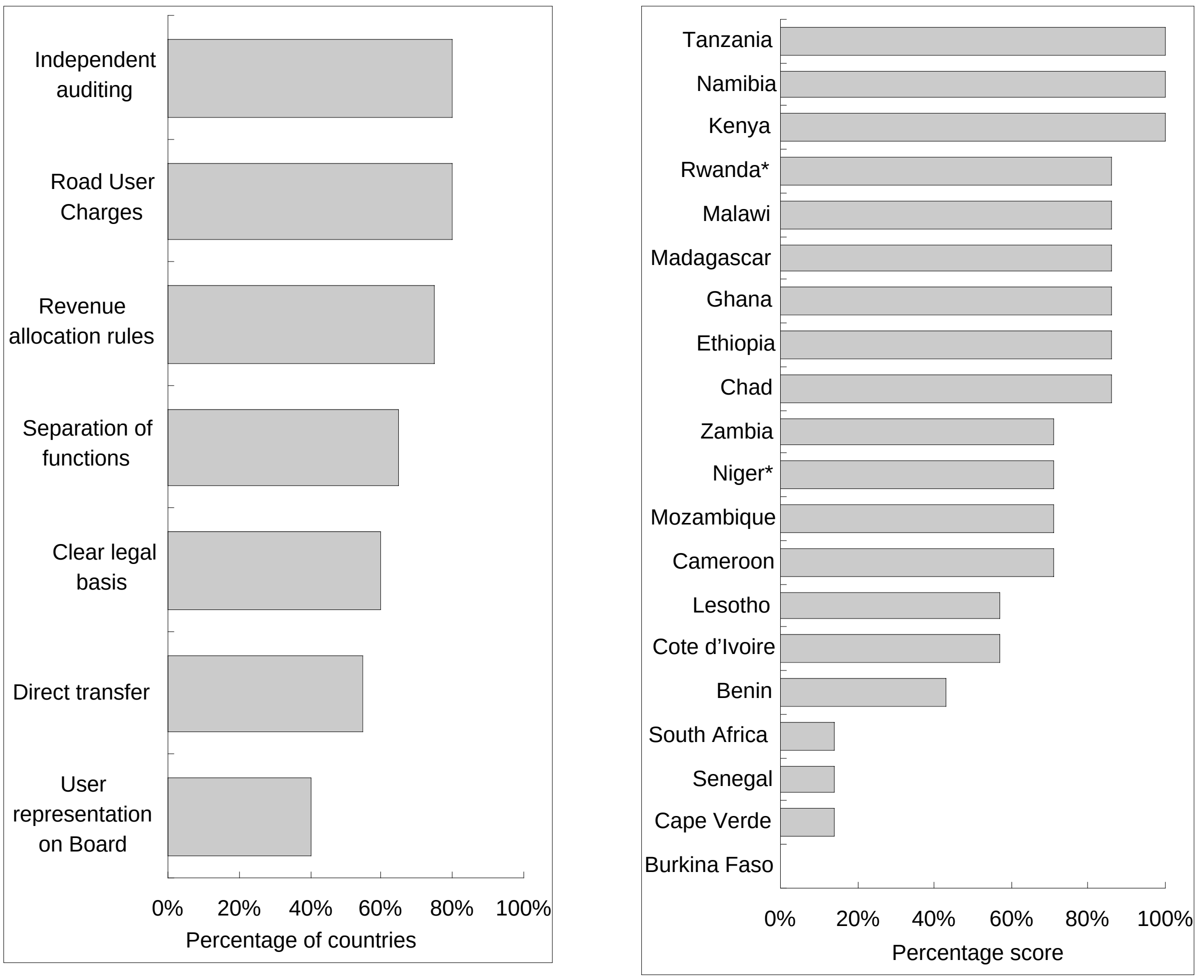
With respect to road funds, the emphasis has been on reaching second-generation standards for design. The aim of establishing road funds is to improve the condition of the road stock by better funding and more businesslike management of road maintenance. The philosophy is that road users would be willing to pay increased charges for road use if they were assured that the funds generated would be used for improved maintenance. More than 80 percent of the sample countries have already introduced road funds, and others are in the process of doing so. Nevertheless, not all of these institutional frameworks are of equal quality. In order to meet second generation standards road funds need to embody the following seven good design features, which will be discussed in greater detail below: a clear legal basis, separation of functions, establishment of road user charges, direct transfer of revenues to the fund, user representation on road fund board, clear revenue allocation rules, independent auditing, and public reporting of road fund activities. Using these seven criteria for good design, it is possible to create an index and score each of the road funds according to how fully they accord with these. The results show that prevalence of each of these criteria differs significantly across countries and that the overall score for road fund design also varies widely (figure 3.1b).

First, it is important to establish a strong legal basis for Road Fund operations as a protection against ad hoc political interference. This ideally entails a short enabling law supported by published regulations specifying how the fund is to be managed. Around 60 percent of the sample countries with Road Funds have an associated piece of founding legislation. In the remaining cases, the Road Fund is established merely by Decree. Nevertheless, the quality of the legislation is not uniformly high. A review of road fund legislation in 2004 concluded that many of the funds were poorly designed with limited administrative or financial autonomy and inadequate auditing provisions.[9]

Figure 3.1 Evaluation of road fund reforms

(a) Prevalence of second-generation characteristics

(b) Scores on overall performance index

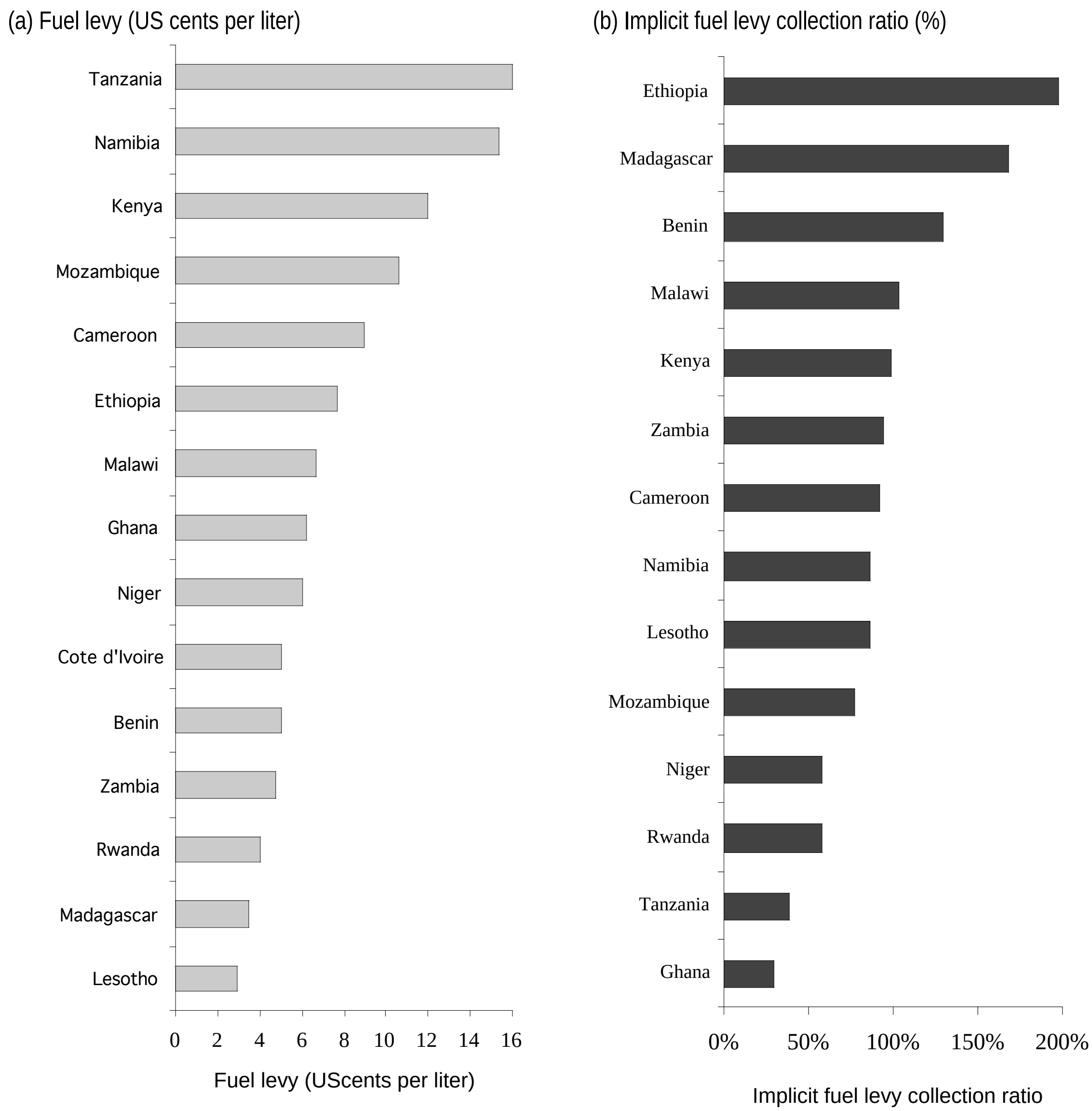


Source: SSATP RMI Matrix, 2007

Second, the second-generation model calls for separation of the functions of road funding and road service provision, with both undertaken by autonomous agencies. The creation of autonomous road agencies for public works execution has generally lagged behind that creation of road funds. At present, about 65 percent of the countries with quasi-independent road funds also have an independent implementation agency, with implementation undertaken in other countries by departments of the relevant central ministry.

[9] *Road Fund Legislation Database.*SSATP, 2004.

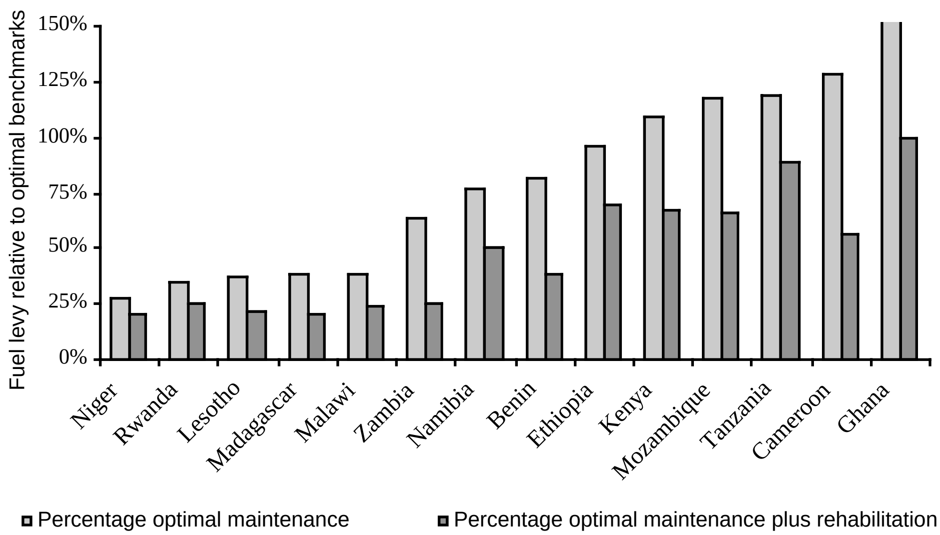
Figure 3.2 Average fuel levy across countries with second generation road funds



Source: SSATP RMI Matrix, 2007; AICD RONET Analysis, 2008.

Third, the fund should be financed by cost recovery user charges entirely independent of any fuel taxes that may apply for general revenue purposes. About 80 percent of the sample countries have established road user charges, typically in the form of fuel levies, to provide revenues to the road fund. However, the level of the fuel levy varies enormously across countries from US 3 cents per liter in Lesotho to US 16 cents per liter in Tanzania (figure 3.2a). Moreover, the fuel levy collection rate also varies substantially. An important subset of countries (including Ghana, Niger, Rwanda, and Tanzania) are barely managing to collect half of the fuel levy revenue that should be captured by the road fund. The underlying problems range from widespread tax evasion in Tanzania to administrative problems associated with transfer of revenues from the collection agency to the road fund in Rwanda (figure 3.2b). In a number of other cases (notably Ethiopia and Madagascar), the implicit fuel levy collection ratio is well above 100 percent, which is simply an indication of substantial central government transfers to the road fund. Indeed, in several cases (Ethiopia, Benin, Gabon, Cote d'Ivoire, and Zambia) the fund is dependent on budget allocations for more than 75 percent of its resources. Finally, few road boards really have effective power to adjust fuel levies over time in line with changing road maintenance requirements, due to residual controls by the Ministry of Finance over the level of fuel levies. As a result, in many cases, the fuel levy is set well below the level needed to cover the maintenance costs arising from wear and tear of the network by road users, let alone contribute to funding the rehabilitation backlog (figure 3.3).

Figure 3.3 Fuel levy relative to optimal requirements for maintenance and rehabilitation



Source: SSATP RMI Matrix, 2007; AICD RONET Analysis, 2008.

Fourth, the effective ring fencing of road user charges entails that the revenues be transferred directly to the road fund without passing through the budget. Channeling of fuel levy revenues through the government budget increases the risk that the revenues may be diverted to finance other aspects of public expenditure. Just over 50 percent of the sample countries with road funds succeed in channeling a high percentage (i.e. at least 75 percent) of their fuel levy revenues directly to the road fund. In other cases, direct channeling covers a very low proportion of fuel levy revenues (i.e. less than 25 percent) or none at all, making the resource base for the road funds much more vulnerable to being diverted to finance other aspects of the public budget.

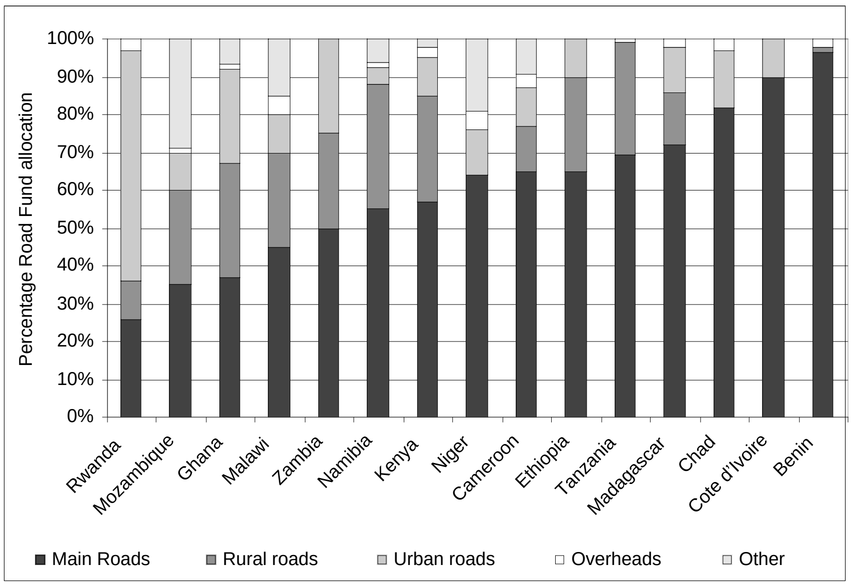
Fifth, user representation on the road fund board helps to strengthen accountability. It also allows users to directly make trade-offs between the level of user charges and the quality of the road network. With the exception of Malawi, all the countries with road funds have established independent road fund boards. However, only half have private sector majorities on the board, and very few have a chairman from the private sector. In fact, half of the boards still have a majority of government representation, with the chairman and executive secretaries usually being political appointees.

Sixth, in order to reduce discretion in funds allocation, it is desirable to have clear rules for the allocation of funds to different types of expenditures. About 60 percent of the road funds surveyed have established clear percentage allocations for dividing funds between different portions of the road network, although the chosen allocations differ substantially across countries (figure 3.4). On average, about 60 percent of the resources go to the main road network. Around half of the countries are allocating at least

20 percent of the Road Fund resources to the rural road network. Typically, around 10 percent of resources are allocated to the urban road network. Rwanda stands out as allocating 60 percent of Road Fund revenues to the urban road network. Given the high volumes of traffic in urban areas, the urban road network typically receives a much smaller proportion of the total Road Fund revenues than urban road users likely contribute in the form of fuel levies. Overheads typically account for no more than six percent of Road Fund revenues even though professional staff employed vary widely from only six in Niger to 48 in Kenya.[10]

Seventh, independent technical and financial auditing and public reporting of the road fund activities also helps to strengthen accountability (Heggie and Vickers 1998). About 80 percent of the countries with road funds report that auditing procedures are in place. In most cases these cover both technical and financial auditing and take place on an annual basis. However, the quality of these audit process is dubious in some countries. The prevalence of financial auditing is somewhat higher than prevalence of technical auditing.

Figure 3.4 Overview of road fund allocation rules



Source: SSATP RMI Matrix, 2007.

On average, the road funds in the sample countries meet 65 percent of the defining criteria for second-generation road funds. There is a broad range of performance, from countries such as Tanzania, Namibia, and Kenya that embody 100 percent of the criteria, to countries such as Benin and Burkina Faso that capture well below 50 percent of them.

Experience with road agencies

Restructuring of road departments has not had the expected beneficial impact on road project implementation. It was initially thought that the problems associated with timely and cost-effective implementation of public works contracts could be solved by reform and restructuring of the road Departments housed in the line ministries for the sector. However, this approach has not proved to be very effective, in part because too many constraints remained preventing the full use of existing technical capacity. One important constraint has been staff skills and leadership. The economic growth in the

[10] The large size of the staff in Djibouti is accounted for by the fact that fund staff are involved in collecting transit fees.

region over the last decade has increased the demand for engineers in the private sector, which has attracted better qualified staff with higher salaries. Road authorities therefore lack the skills needed to review the design, costs, and work under various contracts. This prolongs the contracting process and may be a reason for the recent escalation in the unit costs of road construction.

Current thinking therefore focuses on the creation of an autonomous road agency to be responsible for project implementation. When combined with an autonomous road fund, such an arrangement ensures the effective separation of funding and implementation arrangements. Under this approach, the road agency replaces (or sometimes simply commercializes) the former Roads Department of the Ministry of Transport. Responsibilities of the road agency include strategic management and planning of the development, maintenance, and rehabilitation of the national road network. The roads agency is ideally overseen by a majority private sector board and managed on a day-to-day basis by a chief executive officer (CEO).

A considerable number of such agencies are already in existence, though with a widely varying set of mandates. About two thirds of the sample countries have already established a roads agency, and a number of others are in the process of doing so. However, only a third of these have private sector representation on their boards. Levels of autonomy vary from full responsibility for road network management to limited responsibility for the execution of road maintenance programs defined by the roads department or Ministry of Roads. Even the creation of a supposedly autonomous road agency does not necessarily solve the leadership problem, as the post of chief executive is frequently given to a technically senior, but politically connected candidate, rather than being chosen competitively on an open international market.

Another important development has been the growing use of multi-annual performance-based contracts for road maintenance, particularly by road agencies. The greater security of road maintenance revenues resulting from the establishment of second-generation road funds has made possible the increasing adoption of multi-annual performance-based road maintenance contracts with the private sector. The potential advantage of such contracts is that they provide a strong incentive for contractors to undertake effective maintenance activities and reduce expenditure uncertainties for the road fund. In about half of the sample countries, more than 80 percent of maintenance work was contracted out. Use of this approach was strongly, though not exclusively associated with the presence of a road agency in the country. Contractors are typically paid directly by the road fund, with an average time for paying undisputed contractors bills of less than 30 days in most cases.[11] Improved contract management and disbursement arrangements of this kind have resulted in a reduction in road maintenance cost per kilometer by 10–20 percent in Zambia, Ethiopia, and Ghana.

The road construction industry in Sub-Saharan African countries is presently dominated by large foreign-based firms, some of which operate in joint venture or association with local firms and a few medium size firms from the region. In recent years availability of staff from downsized force account units[12] has generated a large number of small domestic firms, but there is a low survival rate for such

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[11] The exceptions in 2006 were Kenya, Ghana, and Burundi, in all of which the average payment time was 90 days.

[12] Brushett, S., and S. Seth. *Construction Industry Development and the Road Sector Effectiveness of National Construction Councils* SSATP Technical Note 38, March 2005.

firms. Few contractors have been able to make the transition to medium scale due to: (a) limited access to construction equipment; (b) limited access to capital and credit facilities; and (c) lack of business training and shortage of technical and management skills.

Concerted effort is still needed to develop an indigenous contracting industry. In 1993 a meeting of the Southern African Construction Industry Initiative (SACII) reached a broad consensus on the need to provide a clear focal point for implementing national construction policy, to expand the role of domestic contractors and consultants through public/private partnerships, to study constraints on development of the local road construction industry, and to develop specific programs and measures to address those constraints. Subsequent regional initiatives through the Southern African Regional Construction Industry Council (SARCIC) have proved relatively ineffective. Country level initiatives have proven to be more robust. For example, Zambia and Malawi established National Construction Councils in the mid-1990s. However, the usefulness of the councils depends on the existence of a suitable policy framework and a clear strategic vision and business plan. South Africa has the strongest program in the region, as construction industry development has become a critical element of the government's strategy for majority economic empowerment.

Training in road management and finance is an urgent need for both public and private sectors. With the assistance of SSATP many senior executives have already received overseas training. But this effort needs deepening through involvement of regional associations in strengthening program design, sharpening the definition of the specific sub-markets within the overall demand and developing relevant offerings, promoting the wider involvement of training institutions including those in Africa, and developing and disseminating materials for communicating innovations and advice.[13]

Urban and rural roads

The institutional arrangements for urban roads are frequently complex. Legislation pertaining to roads is usually separate from that governing transport services, and several national and local bodies often share jurisdiction. In Conakry, for example, several institutions have responsibility for segments of the road network. In Accra, responsibility for urban transport has been devolved from central to local government—at least in principle. However, local governments have neither the resources nor the technical know-how to carry out the functions assigned to them. This means that the Ministry of Transportation (through the Department of Urban Roads) is effectively responsible for road maintenance and development.

In many countries the responsibility for part of the network is devolved to local authorities or communities. These roads are often called local roads, but frequently include secondary as well as tertiary classified roads, as well as unclassified roads and tracks.

There are two distinct administrative categories within the total set of rural transport infrastructure, local government roads and community roads and tracks. The former have been designated as the responsibility of the appropriate local government unit. The latter are orphans, having no formal owner.

[13] Stephen Brushett, Les Sampson, and Solomon Waithaka *Building Capacity in Management and Financing in the Road Sector Meeting the Challenge* SSATP Technical Note 37. August 2004

While they may have been built by NGOs or even by foreign aid agencies, they have never been formally assigned to any agency for their subsequent maintenance. Consequently they tend to be neglected.[14] To overcome this it is necessary, first to establish a comprehensive, categorized inventory of facilities and then, second, to establish legal ownership and responsibility for each facility either to a local government organization or to a community.[15]

Sources for financing local government roads are usually very limited. Local governments mobilize only modest revenues of their own, the main sources of which often being market and business taxes. Inter-governmental transfers are therefore the main source of domestic funding for local government road expenditures in many countries. Three main problems result from relying on the central budget for maintenance funding. First, throughout most of Sub-Saharan Africa, less than 5 percent of aggregate public sector revenue is generally made available to rural governments. Second, general budgets rarely allocate adequate funds for maintaining main roads, much less rural roads. Third, capital and recurrent allocations to local governments are usually not fungible, and the allocation for recurrent expenditures may barely cover the salary expenditures of the local rural road unit. Moreover, such transfers are dictated by the budget cycle so that central-local government fiscal transfers are unlikely to provide an adequate and timely source of funding for maintaining local government roads. Adequate and steady funding for local government road maintenance is more likely to be forthcoming from a dedicated road fund, so long as there is some formal commitment in the road fund law to ensure that the road fund accepts responsibility and makes provision for local roads.

Box 3.1 Road concessions in Sub-Saharan Africa

The World Bank's Private Participation in Infrastructure (PPI) database records only 10 toll road projects in Africa since 1990. These include eight projects took place in South Africa alone, one an international road corridor connecting Mozambique. The other two projects involve the construction of bridges over the Abidjan Lagoon in Cote d'Ivoire and the Limpopo River in Zimbabwe. These deals are quite evenly divided between Greenfield projects, concession contracts, and lease contracts.

Thus, overall, only 1,600 kilometers out of Africa's total classified road network of 1.2 million kilometer have been contracted out to the private sector under a medium or long-term management arrangement. The total cumulative private sector investment committed under these projects amounts to US$1.6 billion, which is barely 20 percent of the estimated annual investment need in Africa's road sector of US$7.6 billion.

The potential for toll road concessions in Africa remains limited due to the relatively low traffic flows in the region. Based on the AICD sample of countries, only 8 percent of the region's road network (i.e. less than 9,000 kilometers) has traffic levels in excess of 10,000 vehicles per day, which is the lower bound to make toll road concessions economically viable. Some 86 percent of those viable kilometers are concentrated in South Africa and a further 8 percent in Nigeria. A number of other countries have up to 100 kilometers of paved road in this traffic band, but many others do not reach this level of traffic in any segment of their paved road network.

Source: World Bank PPI Database, 2007 and AICD RONET Analysis, 2008.

[14] For example a Zambian nongovernmental organization (NGO) built thousand of kilometers of roads during the early 1990s as part of a food drought relief effort, but as no institution was legally responsible for them they have subsequently deteriorated badly.

[15] Functional definition does not always define administrative responsibility. Tertiary roads, which provide links between sub-district headquarters, or between the main network and key facilities, are usually a local government responsibility. Paths and tracks which serve purely local functions or connect villages with tertiary roads, are usually left to the communities. But some paths and tracks are the responsibility of local government, and some tertiary roads, particularly where built by NGOs or donors, may not have been adopted by the local authority.

It is unrealistic and inefficient to build full capacity for all management functions in each local government and community. Individual local government networks are small, and the management contract for an individual local government may be too modest to attract the interest of competent consulting firms. In Madagascar the average network size for a local government is 140 kilometers; in Cameroon and Nigeria, 180 kilometers; and in Tanzania and Zambia, 280 kilometers while the network should preferably be 500 to 2,000 kilometers to justify employing an engineer in a local unit economically. Joint services committees of local authorities may achieve economies of scale in procurement for the group of authorities that they represent, but usually require substantial technical assistance from central ministries or from the regional offices of a main roads authority. In countries with an autonomous road authority responsible for main roads, local governments may contract the roads authority to manage the roads on their behalf or to assist with planning and procurement

Private sector capacity and capabilities can also be mobilized by contracting out physical works or even key management functions to local consultants. Specialized contract management agencies (AGETIPs) are common in Francophone Africa**,** for example in Madagascar, Mali, Niger, and Senegal. They manage and use private consultants and contractors on behalf of the public authority and perform all the necessary functions for contract preparation, implementation and supervision.

Some countries centralize the technical responsibility for rural roads. Relying on a main roads ministry or another central sector ministry to manage rural roads has the advantage that there is a formal channel for technical support, but the disadvantage that it often operates completely independently of the local government structure and is thus poor connected to local needs and developments. In principle, a central coordinating unit for local government roads should be able to perform as well as a central government rural roads department. In practice, however, coordinating units for local government roads in Tanzania and Zambia in the late 1990s were weak.

The options are not mutually exclusive. For example, a joint-services committee may use private consultants, hired through a contract management agency. Choice of the best option for managing local government roads depends on many local factors including the size of the authorities, the nature of the network for which they are responsible and the competence of the private sector or higher level public authority units.

Community infrastructure faces particular problems. Community contributions in cash and in-kind are suitable primarily for community roads and paths, but contributions in kind may produce relatively inefficient labor and other sources of money income are necessary. Strategically designed cost-sharing arrangements for both local government roads and community roads and paths stimulate resource mobilization at all levels and increase the proportion of the network receiving regular maintenance. Well structured donor financing through rural road projects or through social and community or rural infrastructure funds can also assist investment in community level infrastructure. Cost sharing arrangements may also be effective in maintaining community roads. Many local authorities in Africa have more roads to maintain than they can afford. In these circumstances cost sharing with communities has merit.

Lack of technical know-how is often an impediment to achieving effective community management. Communities in Sub-Saharan Africa therefore need technical advice (for instance on road design and standards, appropriate materials, and work planning) and managerial advice (such as on financial accounting, contract management, procurement) so that they can effectively perform the responsibilities that come with ownership of roads and paths.

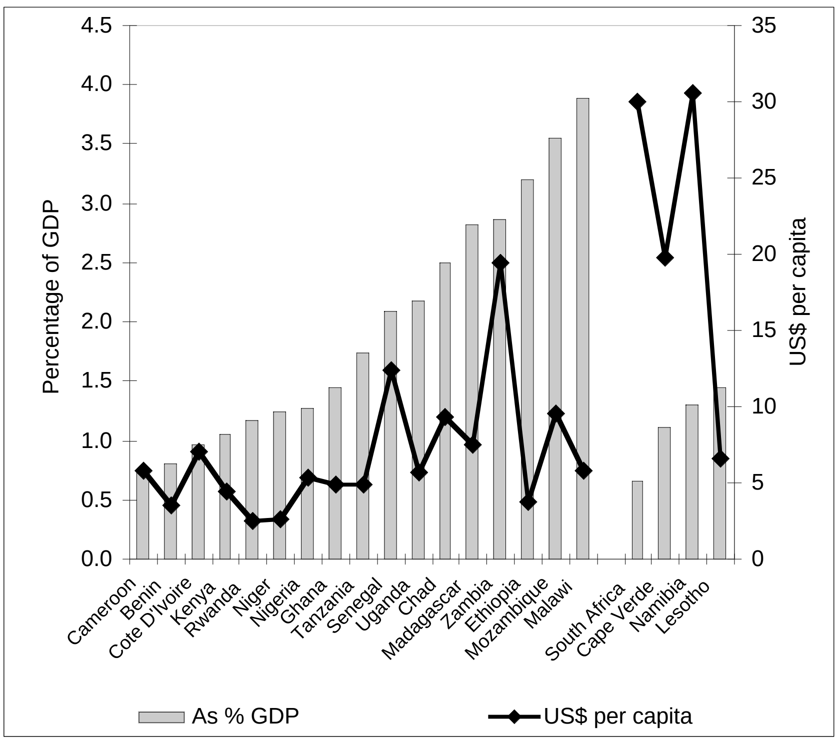
4 Road funding, road spending

Roads expenditure in Sub-Saharan Africa is relatively high, averaging 1.8 percent of country's GDP. Based on the AICD Fiscal Costs Survey, it is possible to estimate the percentage of national income allocated to the roads sector, when all budget and extra-budgetary channels (such as Road Funds) are taken into account. On average, the sample countries devote 1.8 percent of gross domestic product (GDP) to the roads sector. This is within the range of expenditure found in other countries around the world, although below the levels found in a number of fast growing countries that made intensive efforts to upgrade transport infrastructure.

Industrialized countries invest around 1 percent of GDP annually on their road systems. The US has been investing about 1 percent of GDP on roads over the last 25 years. Most European national governments invest no more than 2 percent of GDP on all transport infrastructures, though in some countries there is additional expenditure by regional and urban authorities from their own resources. These are countries with already well-developed infrastructure and GDP growth rates of 2-3 percent.

Developing countries which have had periods of rapid growth have invested 23 percent of GDP. For example, South Korea, India, Brazil, and the former Soviet Union all invested between 2 and 3 percent of their GDP in transport infrastructure during the eighties, while between 1964 and 1973 Japan invested between 3.5 and 3.8 percent.[17] In more recent years, between 2000 and 2002, Malaysia, Korea, and Thailand were investing 1.7 percent to 1.9 percent of GDP and achieving GDP growth rates between 4 and 6 percent.

Figure 4.1 Average annual expenditures on road transport by country 2001–05



Source: AICD Fiscal Costs Study, 2008.

Although spending is relatively high as a share of national income, it remains low in absolute terms, and cross-country variation is high. Roads expenditure as a percentage of GDP varies from less than 1 percent of GDP in South Africa to almost 4 percent in

[17] China Railway Strategy. World Bank. 1994.

Malawi. The highest income shares are found in the poorest countries. For the middle-income countries in the sample, spending tends to be clustered around 1 percent of GDP. Although the level of effort is considerable relative to the scale of the country's economies, the absolute values remain small at around US$7 per capita per year for the low-income countries and US$22 per capita per year for the middle-income countries.

A lot of this variation can be explained in terms of underlying economic, geographic, and institutional influences. The same aggregate information about road expenditure can also be normalized per kilometer of the main road network. The main network is defined as those roads managed by the central government, which in most countries comprises the primary plus secondary network, but in a few cases is limited to the primary network only. On average, sample countries spend just over US$9,000 per kilometer of the main road network. However, spending levels in low-income countries (LICs) are more than 50 percent higher per kilometer than spending levels in the middle-income countries (MICs), with resource-rich LICs spending slightly more than aid-dependent ones. Landlocked countries and islands spend substantially more per kilometer than what is spent by coastal nations, which may be attributable to higher costs of importing materials and services. Countries with rolling and humid terrains that tend to accelerate road deterioration show somewhat higher levels of spending than countries with flat and arid terrains. The institutional framework also seems to matter. Countries with road agencies seem to spend substantially less than those without, irrespective of whether or not they have road funds. Perhaps surprisingly those with low fuel levies actually spend substantially more than those with no fuel levies or high fuel levies.

Table 4.1 Average annual expenditures per kilometer of main road network by country groupings, 2001–05

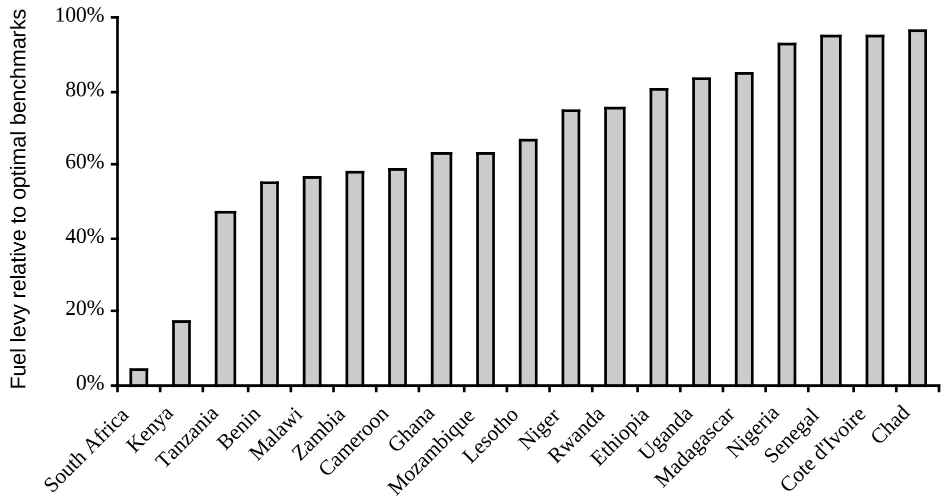
	US$ per km		US$ per km
Macro-economy		Institutions	
MIC	6,050	Road Fund and Road Agency	7,112
LIC aid dependent	8,823	Road Fund only	9,793
LIC resource rich	9,551	Road Agency only*	6,053
Geography		Financing	
Coastal	7,014	Low fuel levy	9,458
Island	13,302	High fuel levy	8,117
Landlocked	9,984	No fuel levy*	7,153
Topography			
Flat and arid	7,977		
Rolling and humid	9,518		

*South Africa is excluded from this group
Source: AICD Fiscal Costs Study, 2008

Capital expenditures

A strong capital bias is evident in road sector spending. Estimates of road sector spending needs in Africa suggest that about half of roads spending should go on capital projects and the other half on maintenance of existing assets. However, in reality, the share of spending allocated to capital projects is much higher, about two thirds (figure 4.2).

Figure 4.2 Percentage of roads spending allocated to capital projects



Source: AICD Fiscal Costs Study, 2008.

The bias is most pronounced in low-income countries, those with difficult geographical environments, and those without road funds or fuel levies. There is a very striking difference between MICs, which devote only 25 percent of road spending to capital projects, and LICs, which devote around 70 percent to capital. To some extent, this may reflect the fact that LICs are still developing transport networks, whereas MICs have typically established their basic transport platform and can devote themselves predominantly to maintenance. Countries facing difficult geographic and topographic conditions also show evidence of a stronger bias toward capital expenditure than countries that do not. In terms of institutions, countries with road funds show a somewhat lower degree of capital bias than those without road funds, irrespective of whether they have road agencies. Countries with high fuel levies show no evidence of capital bias, in contrast to countries with low fuel levies or none at all.

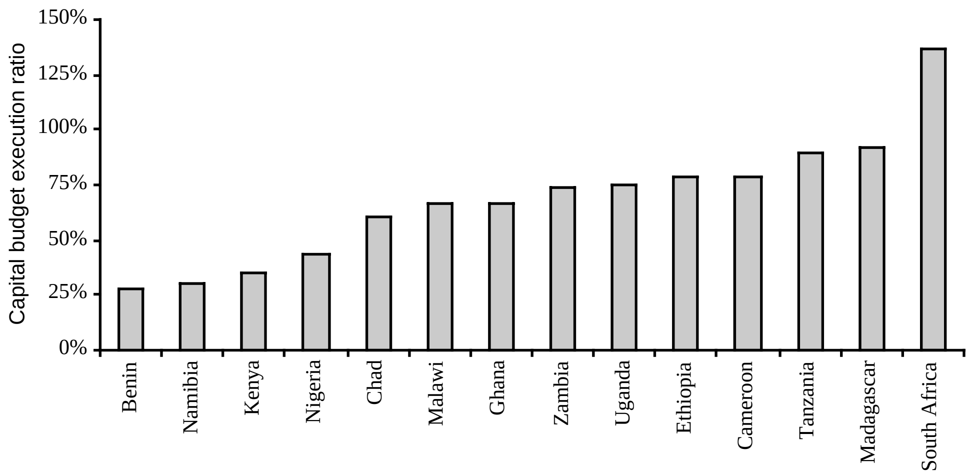
Table 4.2 Percentage of road spending allocated to capital projects by country groupings

	Percentage		Percentage
Macro-economy		Institutions	
MIC	25%	Road Fund and Road Agency	58%
LIC aid dependent	68%	Road Fund only	64%
LIC resource rich	77%	Road Agency only*	86%
Geography		Financing	
Coastal	53%	Low fuel levy	72%
Island	85%	High fuel levy	45%
Landlocked	74%	No fuel levy*	85%
Topography			
Flat and arid	58%		
Rolling and humid	72%		

Source: AICD Fiscal Costs Study, 2008.
*South Africa is excluded from this group.

Moreover, actual capital expenditures fall substantially below the amounts programmed in the budget (figure 4.3). Even these relatively high levels of capital expenditure understate the true extent of capital bias in road spending. The reason is that on average only around 70 percent of budgeted capital spending is actually executed within the corresponding budgetary cycle. This means that countries are trying to reach levels of public investment in roads that are 40 percent higher than those they actually achieve. The main cause of low budget execution is weaknesses and delays in the public procurement process that prevents contracts from being awarded and completed within the 12-month budget cycle.

Figure 4.3 Capital budget execution ratios



Source: AICD Fiscal Costs Study, 2008.

There are substantial and systematic variations in budget execution across countries and country groupings. The level of budget execution varies substantially across countries ranging from 25 percent in Benin to over 100 percent in South Africa. There are also systematic differences by country grouping. MICs perform substantially better than LICs. Countries with a road funds and fuel levies perform substantially better than those without. There is also a striking difference in favor of countries with rolling humid terrains relative to those facing flat and arid conditions, perhaps indicating the greater urgency of road works in the former setting.

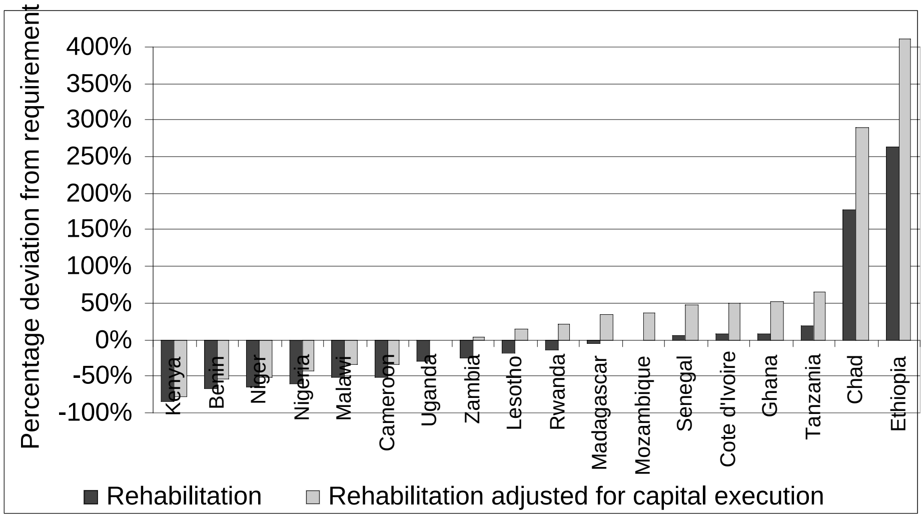
Table 4.3 Capital budget execution ratios by country groupings

	Percentage		Percentage
Macro-economy		Institutions	
MIC	83%	Road Fund and Road Agency	66%
LIC aid dependent	67%	Road Fund only	64%
LIC resource rich	61%	Road Agency only*	43%
Geography		Financing	
Coastal	64%	Low fuel levy	65%
Island	92%	High fuel levy	62%
Landlocked	71%	No fuel levy*	59%
Topography			
Flat and arid	63%		
Rolling and humid	78%		

Source: AICD Fiscal Costs Study, 2008.
*South Africa is excluded from this group.

High capital expenditure on roads may be justified by large rehabilitation backlogs. Using the RONET model, it is possible to produce detailed estimates of the rehabilitation requirements for each country's road network taking into account the current distribution of network condition and working toward a target of clearing the current rehabilitation backlog within a five-year period. On that basis, the rehabilitation requirements can be compared with the current levels of capital expenditure to determine whether these are high enough to eliminate the rehabilitation backlog within a reasonable period of time (figure 4.4). It is important to note that this calculation is only illustrative and is based on the assumption that the entire capital budget is devoted to network rehabilitation. While rehabilitation does tend to dominate capital spending, other types of investment do take place including upgrading road categories or adding new roads, and the available data do not make it possible to know the exact split. However, the calculation is helpful in illustrating whether current levels of capital expenditure would be high enough to address the rehabilitation problem if they were fully allocated to rehabilitation works.

Figure 4.4 Capital expenditure as a percentage of rehabilitation requirements



Source: AICD Fiscal Costs Study, 2008.

Table 4.4 Capital expenditure as percentage rehabilitation needs by country groupings

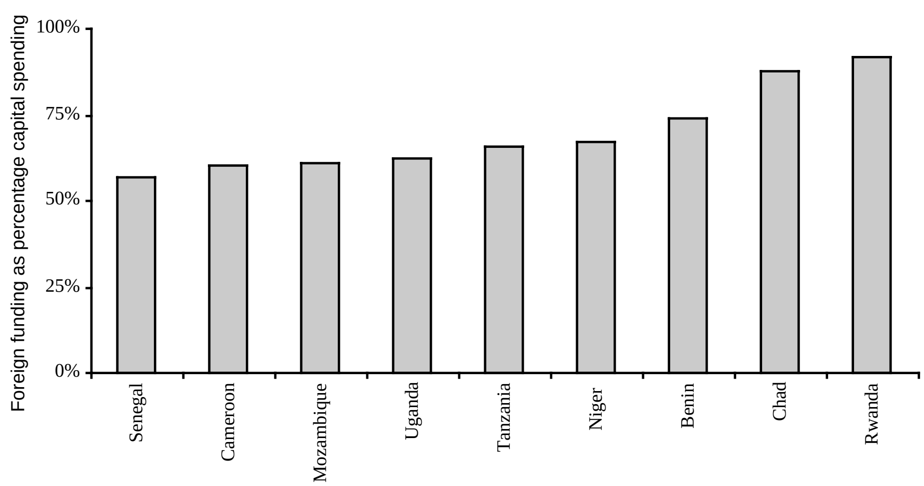
	Percentage		Percentage
Macro-economy		Institutions	
MIC	-6%	Road Fund and Road Agency	60%
LIC aid dependent	-3%	Road Fund only	-19%
LIC resource rich	22%	Road Agency only*	-27%
Geography		Financing	
Coastal	-21%	Low fuel levy	-5%
Island	-4%	High fuel levy	24%
Landlocked	30%	No fuel levy*	-28%
Topography			
Flat and arid	-7%		
Rolling and humid	13%		

Source: AICD Fiscal Costs Study, 2008.
South Africa is excluded from this group.

In fact, only half of the countries have capital spending high enough to reasonably address rehabilitation backlogs. In about half of the sample countries current capital spending falls well below what is needed to clear rehabilitation backlogs, while most of the remaining countries are within 10 to 20 percent of the requisite spending level. Chad and Ethiopia stand out from the rest as being countries undergoing very large road investment programs that are two to three times the levels needed to clear rehabilitation backlogs, and include major works to upgrade road category and extend the reach of the network. Countries with both a road fund and a road agency seem to show the highest increment of capital spending over rehabilitation requirements, as do countries with high fuel levies. Resource rich LICs, landlocked countries and countries with high fuel levies, also all tend to show capital spending that is somewhat higher than rehabilitation needs.

If low capital budget execution is taken into account, two thirds of countries have budgeted capital spending high enough to reasonably address rehabilitation backlogs. As noted above, budgeted capital spending is typically 40 percent higher than what countries actually succeed in spending. If rehabilitation requirements are compared to an estimate of budgeted (versus actual) capital spending, then the funding situation looks somewhat more positive. The percentage of countries able to meet their rehabilitation requirements within a reasonable time period increases from one half to two thirds. Thus improving capital budget execution is an important first step in clearing rehabilitation backlogs.

Figure 4.5 Foreign funding as percentage capital spending



Source: AICD Fiscal Costs Study, 2008.

Public investment on roads is highly dependent on flows of aid, which can be volatile. It is not always possible to trace with precision the items on the public investment budget that are financed by official development assistance (ODA). The limited evidence available indicates the heavy dependence of roads investment on foreign funding, which ranges from just over 50 percent in Senegal to almost 90 percent in Rwanda (figure 4.5). The volatility of ODA flows contributes to the volatility of public investment in the sector. Thus, the very high ratio of road investment to gross domestic product (GDP) in Chad in 2003-2005, in Tanzania in 2000, and in Madagascar in 2004-05 are all associated with short-lived surges in aid.

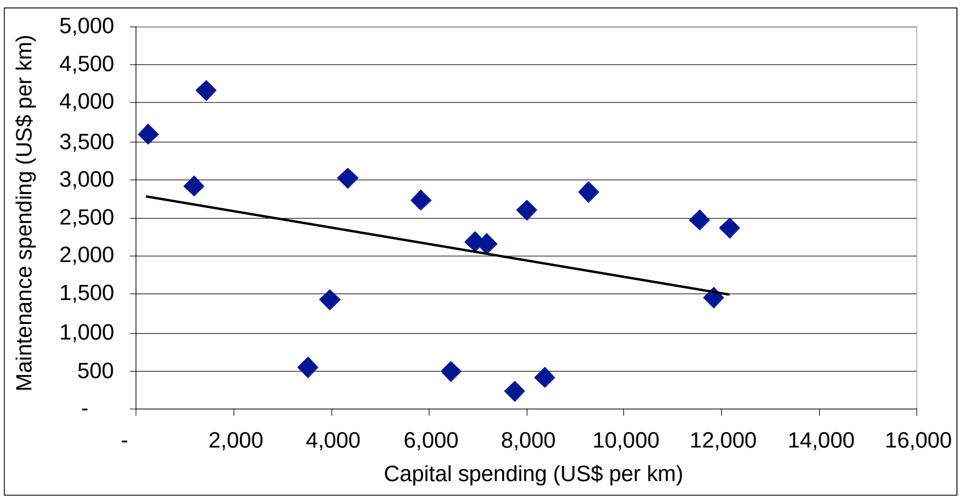
Higher construction standards may compensate for the chronic shortage of maintenance funds. As noted above, the AICD data shows a negative correlation between capital and maintenance expenditures;

it also shows under funding of maintenance expenditures. It is expected that the persistent shortage of maintenance funds is compensated by road authorities and design consultants through provision of stronger, and thus more costly, initial designs. These structures have slower deterioration rates and lower annual maintenance costs. The relationship between surface type and maintenance standards is complex. Construction standards vary not only with traffic but are also influenced by assumed maintenance standards. Roads constructed to higher standards than warranted by traffic levels subsequently require lower maintenance and may be reflected in the capital bias seen in the expenditure figures.

Maintenance expenditures

There appears to be a trade-off between levels of capital expenditure and levels of maintenance expenditure. On the one hand, countries that spend too little on maintenance will end up with larger rehabilitation liabilities, often resulting in the need for emergency works to restore the functionality of critical infrastructure. On the other hand, countries with large investment programs may have fewer resources left over to address road maintenance needs. By doing a cross-plot of the level of maintenance expenditure per kilometer of the main network against the level of capital expenditure per kilometer, it is possible to see whether such a trade-off exists (figure 4.6). The results show a large negative correlation (–0.33) between these two variables. This is a worrisome finding because if high capital spending comes at the expense of lower maintenance expenditure, then the condition of the network will only deteriorate further over time.

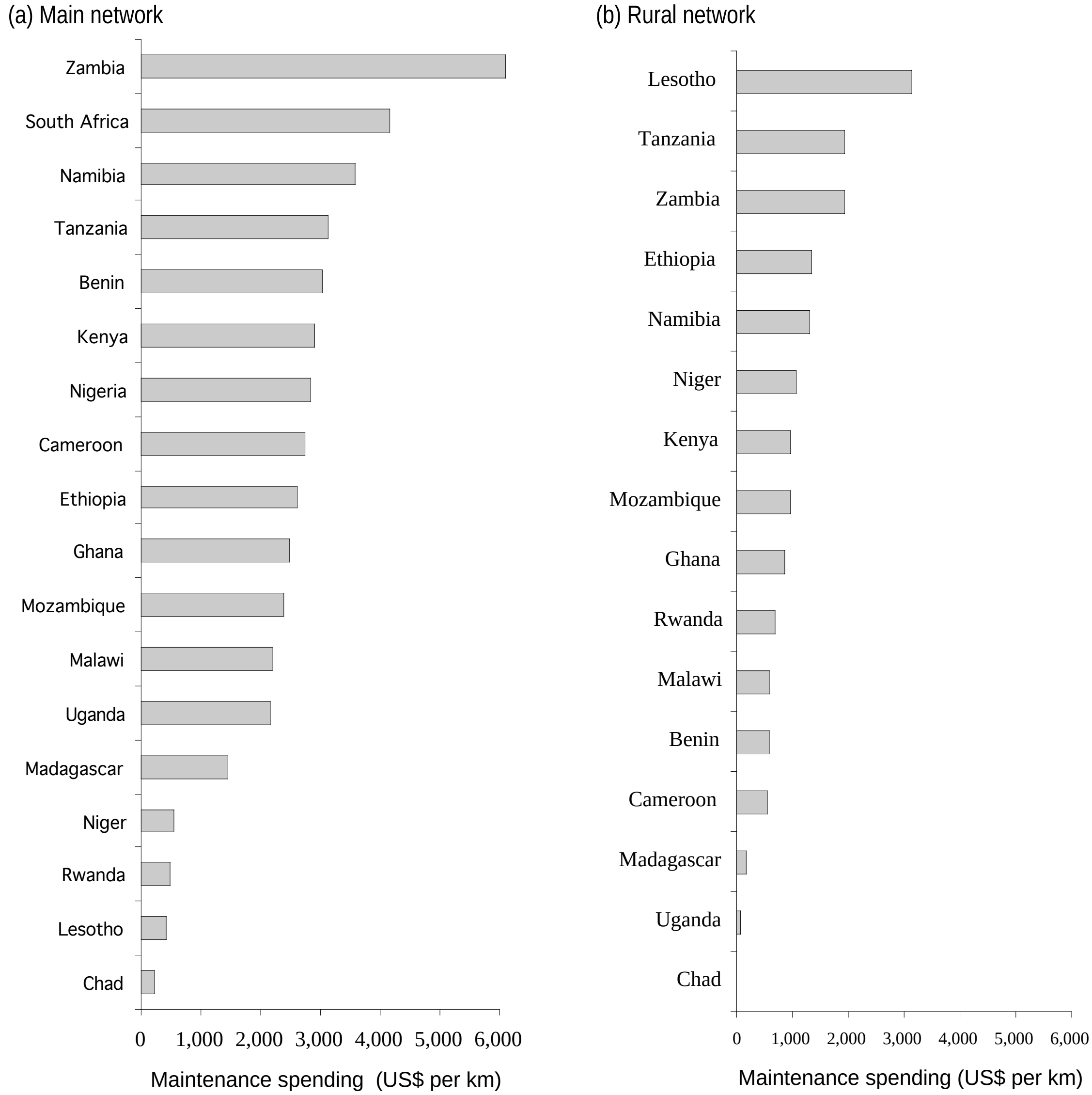
Figure 4.6 Cross-plot of capital spending against maintenance spending per kilometer of main network



Source: AICD Fiscal Costs Study, 2008.

There is huge variation in maintenance expenditure effort across countries and consistency in the level of effort expended across rural and main road networks. For the main road network, the range extends from barely US$200 per kilometer in Chad to over US$6,000 per kilometer in Zambia. For the rural road network, the range extends from barely US$20 per kilometer in Chad to more than US$3,000 per kilometer in Lesotho (figure 4.7). On average, countries are spending US$1,100 per kilometer of the rural network and about double that US$2,200 per kilometer of the main network. Indeed, some countries are spending more on maintenance per kilometer of their rural networks than other countries are spending on maintenance per kilometer of their main road networks; compare, for example, Tanzania and Madagascar. Overall, the correlation between maintenance effort on main networks and rural networks is positive and high (0.36) across countries, which is to say that countries that tend to spend larger amounts on main network maintenance also tend to spend larger amounts on rural network maintenance and vice versa.

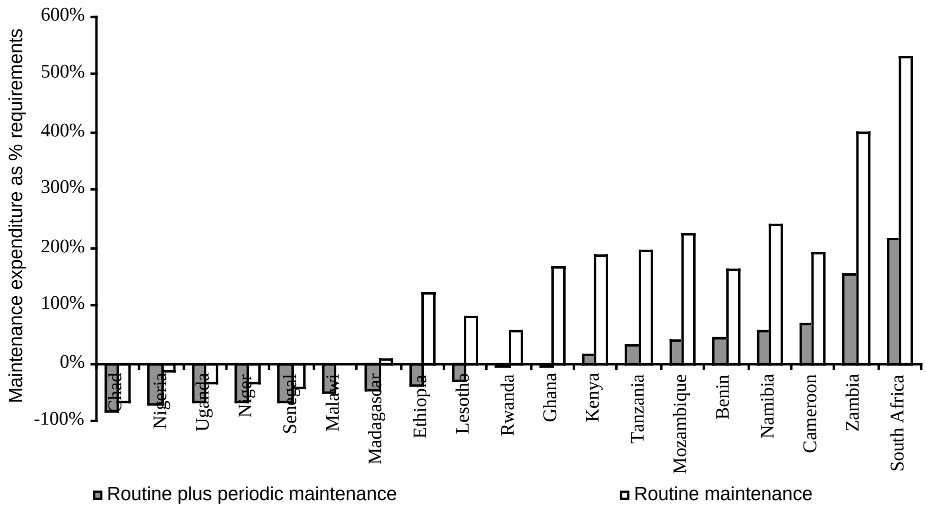
Figure 4.7 Average maintenance spending across different parts of the network (US$ per km)



Source: AICD Fiscal Costs Study, 2008.

It is relevant to compare current maintenance expenditures with the norm for Africa. Using the RONET model, it is possible to produce detailed estimates of the routine and periodic maintenance requirements for each country's road network taking into account the current distribution of network condition. On that basis, the maintenance requirements can be compared with the current levels of maintenance expenditure to determine whether these are high enough to preserve the network in good condition (figure 4.8). It is important to note that this calculation is only illustrative, and is based on the assumption that the entire maintenance budget is spent on maintenance works at efficient unit costs. However, the calculation is helpful in illustrating whether current levels of maintenance would be high enough to preserve the network if they were efficiently spent.

Figure 4.8 Maintenance expenditure as a percentage of requirements



Source: AICD Fiscal Costs Study, 2008.

Table 4.5 Maintenance expenditure as a percentage of requirements by country groupings

	Percentage		Percentage
Macro-economy		Institutions	
MIC	80%	Road Fund and Road Agency	-11%
LIC aid dependent	-12%	Road Fund only	-3%
LIC resource rich	-28%	Road Agency only*	-69%
Geography		Financing	
Coastal	20%	Low fuel levy	-19%
Island	-45%	High fuel levy	28%
Landlocked	-24%	No fuel levy*	-69%
Topography			
Flat and arid	12%		
Rolling and humid	-24%		

Source: AICD Fiscal Costs Study, 2008.
South Africa is excluded from this group.

Half of the countries are not devoting adequate resources to maintenance of the main road network, particularly those without road funds and fuel levies. In cases such as Chad, Nigeria, Uganda, Niger, and Senegal, maintenance spending is less than half the normative requirements. Under spending on maintenance is evident in LICs (particularly the resource-rich) and in countries with difficult geographical environments and terrain. MICs tend to spend substantially above the maintenance norm. However, the problem of under spending on maintenance is by far the most pronounced in countries that lack a road fund and hence, a fuel levy. Among countries with fuel levies, those with high levies do substantially better than those with low fuel levies.

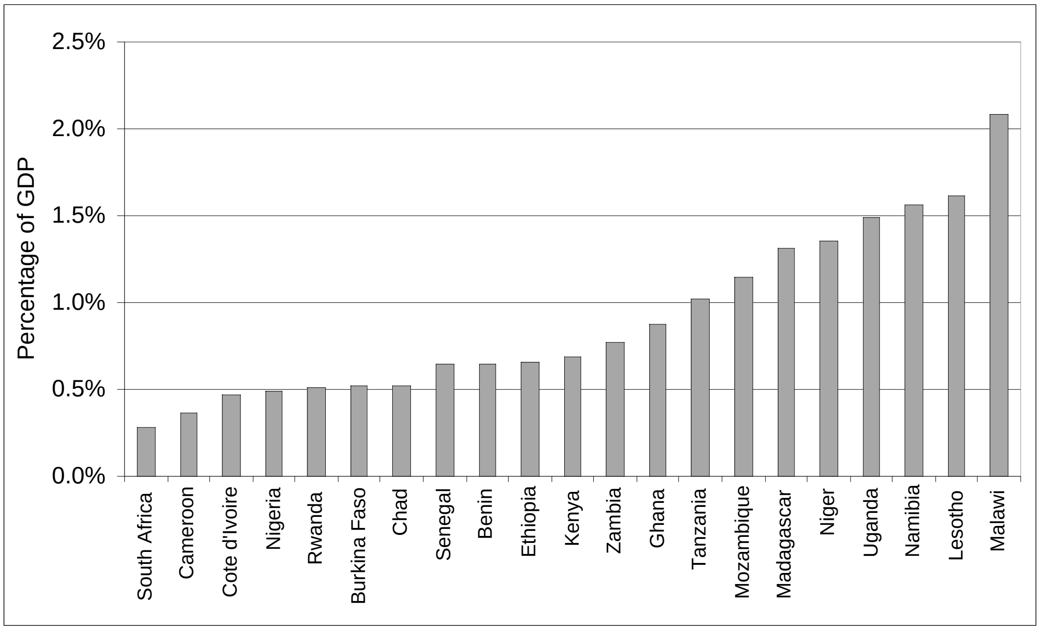
Around a quarter of the countries in the sample are not even devoting adequate resources to cover just routine maintenance activity. If the definition of maintenance is narrowed to consider only the routine aspects of maintenance, the costs are reduced by about one half. However, still around a quarter of the sample falls short of the spending levels needed to cover routine maintenance requirements. Though limited, available data indicates that, on average, maintenance costs in Africa at US$ 2,160 per kilometer are higher than the world wide average of US$ 2,024 per kilometer and twice the costs of maintenance in South and East Asia. This suggests that routine maintenance is less effectively performed in Africa than other regions. In the present inflationary environment beyond the control of local road agencies, seeking implementation efficiencies becomes key to preventing further decline in the share of network maintained roads.

Undermaintenance will lead to further network deterioration over time, increasing the size of the rehabilitation backlog and increasing social costs. A low-volume sealed road in good condition, carrying about 200 vehicles per day, requires resealing, costing about $10,000 per km, every seven years to keep it in good condition. This has a net present value (NPV) discounted at 12 per cent over twenty years, of $7,000 per km. Without maintenance, the road will deteriorate from good to poor condition. This will increase vehicle operating costs by about $2,000 per km which has an NPV when discounted over 20 years of $18,000 per km, making the benefit cost ratio of a fully funded road maintenance program almost 3. Poor road maintenance also increases the long-term costs of maintaining the road network. Keeping up such a maintenance regime for a low-volume sealed road for 15 years costs about $60,000 per km. If the road is not maintained and allowed to deteriorate over the 15 year period, it will then cost about $200,000 per km to rehabilitate it so rehabilitating paved roads every ten to twenty years is more than three times as expensive in cash terms, as maintaining them on a regular basis, and 35 per cent more expensive in terms of net present value discounted at 12 percent per year.

Another important achievement of road funds has been to avoid the volatility of maintenance expenditures. In addition to supporting higher levels of road maintenance expenditure, there is some evidence that road funds have also helped to improve the predictability of road maintenance expenditure. Expenditure data for 2001-05 show that volatility of road fund expenditures (measured by calculating the standard deviation around the trend line) was only half that of expenditures arising from external funding and one third that of central government allocations. Moreover, the volatility of road fund expenditures appears to be lower in countries that have made efforts to ensure the independence of their road funds and increased the proportion of revenues channeled directly into the road funds.

Finally, the estimated cost of preserving the classified road network lies in the range 0.5 to 1.0 percent of GDP for most countries (figure 4.9). The network preservation costs estimated by RONET, including both maintenance and rehabilitation for the entire classified network, can be compared to GDP to gauge their overall affordability at the country level. The RONET calculations are based on efficient unit costs and hence likely represent an underestimate. The results range from 0.3 percent in South Africa to 2.1 percent in Malawi, with most countries falling in the 0.5 to 1.0 percent of GDP range. These numbers do not look very high compared to data on real historic expenditure reported above.

Figure 4.9 Requirements for preserving classified road network as a percentage of GDP



Source: AICD RONET Analysis, 2008.

Road unit costs

Based on the World Bank's global database, road unit costs in Africa are within 10-20 percent of those found elsewhere in the developing road. The maintenance and rehabilitation norms used above to benchmark the adequacy of current road spending patterns were derived from the World Bank's ROCKS Database, which extracts unit costs from World Bank roads projects around the world. The ROCKS data for Africa indicates that unit costs in the region are within 10–20 percent of those found in the rest of the developing world, with no systematic upward or downward bias (table 4.6). Nevertheless, the spread of unit costs is very wide both for Africa and the other developing regions.

However, there has been a marked increase in unit costs in recent years, large enough to undermine the adequacy of road funding. A more recent unit cost study, undertaken as part of the AICD, analyzed data from bills of quantities for 115 recently completed donor-funded road contracts in SSA. The focus is primarily on the World Bank and the African Development Bank. The unit costs from this study are two to three times higher than those found in the ROCKS database. While this is partly explained by differences in the methodology between both databases, it also reflects a marked upward trend in the unit costs of road contracts. The associated cost increases are large enough to seriously affect the adequacy of road sector maintenance and rehabilitation expenditure. As a result, a number of donors are finding that their roads projects experience substantial cost overruns that range from 20 to 120 percent relative to expectations based on initial engineering designs.

Table 4.6 Recent estimates of unit costs of road maintenance and rehabilitation

US$ per km	World Bank ROCKS Database		AICD Unit Cost Study
	Other developing regions	SSA	SSA
Routine maintenance	2,000	2,200	-
Periodic maintenance	43,000	54,000	158,000
Rehabilitation	191,000	162,000	300,000

Source: World Bank ROCKS Database, 2007 and AICD Unit Cost Study, 2008

A more detailed investigation of cost overruns identifies three explanatory factors: lack of tender competition, the upward trend in oil prices, and delays in project implementation. In decreasing order of importance, they can be explained as follows. First, the lack of effective competition—defined as having a price spread of no more than 10 percent among the three lowest price bidders—is strongly associated with the presence of cost overruns in road maintenance and rehabilitation contracts. Second, since 2002 and more particularly from 2005 on, there have been price increases of the order of 60-100 percent in the basket of items that are key inputs into road construction (such as bitumen, cement, steel, aggregates, and so on). Third, significant delays (which are not uncommon) in project implementation are also associated with greater cost overruns, in part because they lead to greater exposure to other inflationary influences. The study concluded that cost overruns were the result of increased input costs against a growing demand for contracting in an environment of generally low competition for contracts. Hence action is required to achieve development of more competitive domestic markets for engineering contracting services.

In view of the mounting upward pressure on road costs, it is relevant to ask whether any economies can be made from more appropriate choice of road technology at design stage. Key questions are whether road surface type and condition is well aligned with the traffic volumes carried by each road, and more fundamentally whether the technologies used are the most cost-effective for delivering a particular type of surface. In general, the correlation between traffic levels and road surface type (i.e. paved or unpaved) is strong, standing at close to 0.7 although the correlation between traffic levels and road condition is much weaker, ranging from 0.2 to 0.4.

There is evidence of substantial over-engineering in the main road network and a much more limited problem of underengineering. Using the widely accepted minimum traffic threshold of 300 vehicles per day to make paving of roads economically viable, it is possible to compare actual traffic levels against this benchmark. Paved roads with traffic volumes below the threshold can be considered to have been potentially over-engineered (unless steep traffic growth is anticipated), and vice versa. Applying this criterion reveals that on average across countries about 30 percent of the main network is over-engineered and about 10 percent is underengineered suggesting a scope for significant cost savings by better aligning surface types with traffic volumes (figure 4.10). Nevertheless, the variation across countries is huge. At one extreme, in Nigeria, almost 30 percent of the main road network appears to be underengineered and only a minimal share is over-engineered. At the other extreme, in Zambia, more than 60 percent of the main network looks to be over-engineered and only a minimal share is underengineered.

On the rural network, one finds substantial underengineering (figure 4.11). In this case, the key traffic threshold is 30 vehicles per day widely considered to be the minimum required to justify gravelling of roads. The results indicate no particular evidence of overengineering on the rural network, implying no real scope for cost savings on this part of the network. However, on the contrary, across countries about 15 percent of the rural network length appears to be underengineered, meaning that a gravel surface could be warranted. At one extreme, lie countries—such as Burkina Faso, Ethiopia, Ghana, Lesotho, Mozambique and Niger—where as much as 30 to 50 percent of the rural network may be underengineered. At the other extreme, lie countries—such as Chad, Rwanda, Tanzania, South Africa, and Uganda—where there is no evidence of underengineering.

Figure 4.10 Extent of over- and underengineering on main road network

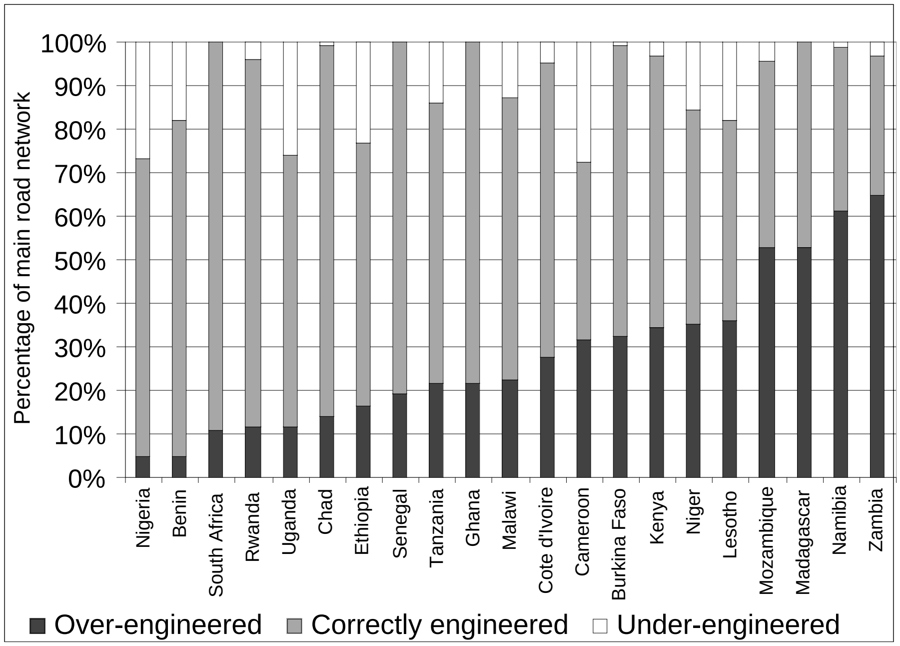
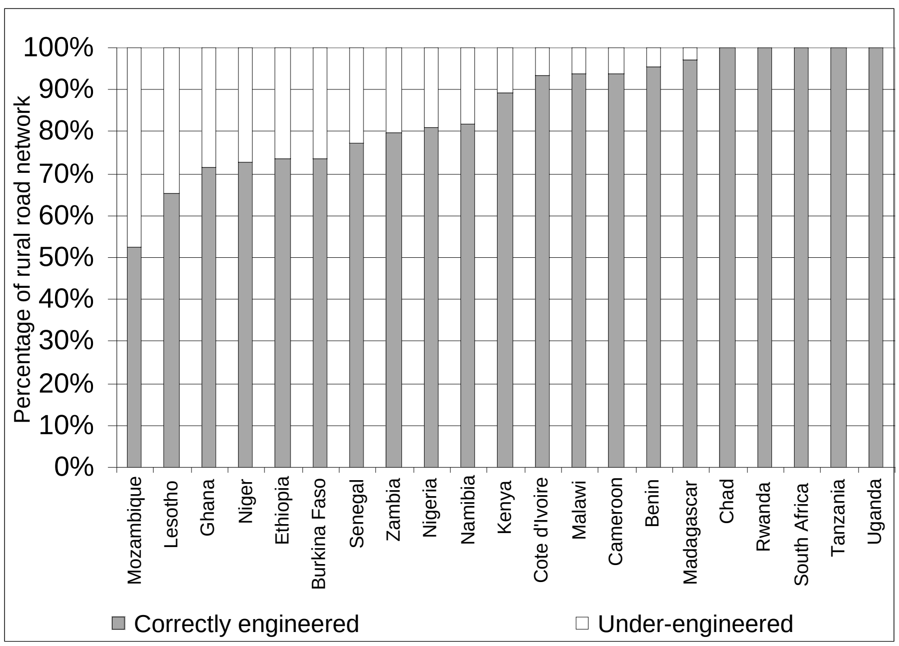


Figure 4.11 Extent of over- and underengineering on rural road network



Source: AICD RONET Analysis, 2008.

Further economies in road network costs could be made by adapting design standards to local conditions. Standards and warrants need continuous adjustment in the light of materials availability and development. An approach of fitting the specifications to the materials applies a more customized and tailored design corresponding to the local climate, natural materials available in the area, and traffic load and volume. In many cases, this will economically justify sealing gravel at traffic thresholds of less than 100 vehicles per day as opposed to the conventional approaches that require levels in excess of 200 vehicles per day.[18] Such roads also have a black surface like any bitumen surfaced road. Typically, life-cycle cost savings would be in the order of 30-50 percent over 20 years compared with traditional surface treatments. The reduced cost of construction is achieved through reduced earthworks, reduced haulage distances for construction materials, reduced need for material processing and reduced surfacing costs due to use of locally available materials. Pavement life is also increased due to reduced pavement deflection as pavement layers are compacted to refusal.

Geometrical standards also need review in the light of improvement of road materials. Prior to 2001, the 1965 American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Rural Highways -- which did not cater specifically for low-volume roads -- was the de facto standard adopted in most Southern African Development Community (SADC) countries. The new guidelines recognize that to select design standards that minimize total transport costs road improvements should be planned at the lowest practicable standards (without unduly impairing safety requirements).

Unfortunately, there are still no comprehensive standards in any African country that are based on in-country research into economic and safety factors. In recognition of the shortcomings of the use of guides from developed countries, attempts have been made to develop more appropriate guides for developing countries[19] Guidelines have also been developed in Africa for use either nationally (for example South Africa[20] and Ghana[21]) or regionally[22]. However, none of these guidelines apply to Low Volume Sealed Roads (LSVRs). Until such standards for LVSRs are developed, the challenge is to apply existing designs and standards in a flexible manner to fit the parameters pertaining to the local environment and to achieve safe economic design. The SADC guidelines offer a systematic approach to doing that.[23]

Use of labor-based methods for rural road construction show promise but have not yet been widely applied. Labor-based methods have been an important part of the strategy to improve rural transport infrastructure in Africa over the past thirty-five years. These methods not only produce gravel roads of equal quality to those produced using equipment-based methods, but also generate rural employment in a cost-effective manner. Nevertheless, these methods have not been applied on large scale often due to contractors' reluctance to adopt them.[24] First, contractors believe the cost of learning this new technology is high. Second, it has been argued that the cost of managing large labor forces makes labor-based methods less competitive than equipment-based methods. Unit-rate cost comparisons of labor-based and equipment-based methods, therefore, cannot predict firm behavior. However, labor-based methods

[18] SADC *Guidelines on Low Volume Sealed Roads*. op.cit.

[19] TRL Overseas Road Note 69 Also note the Australia Manuals produced by NAASRA, Austroads and ARRB.

[20] CSIR Transpotek. *G2 Geometric Design Manual.* CSIR. Pretoria. 2001

[21] Government of Ghana. *Manual on Feeder Road Design*

[22] SATCC *Geometric Design of Rural Roads*

[23] SADC. 2001. op.cit.

[24] Stock, E.A. *Problems facing Labor-based Road programs and What to Do About them- Evidence from Ghana* . SSATP Working Paper No. 24. March, 1996

appeared to be more attractive to small firms than to large firms, because, being small, they can supervise their sites better and find it easier to increase worker productivity and control truancy. Moreover, unlike large firms, small firms that wish to use equipment-based methods face high variable costs: they either own older, less-efficient equipment-with high maintenance costs or must rent equipment at a high cost.

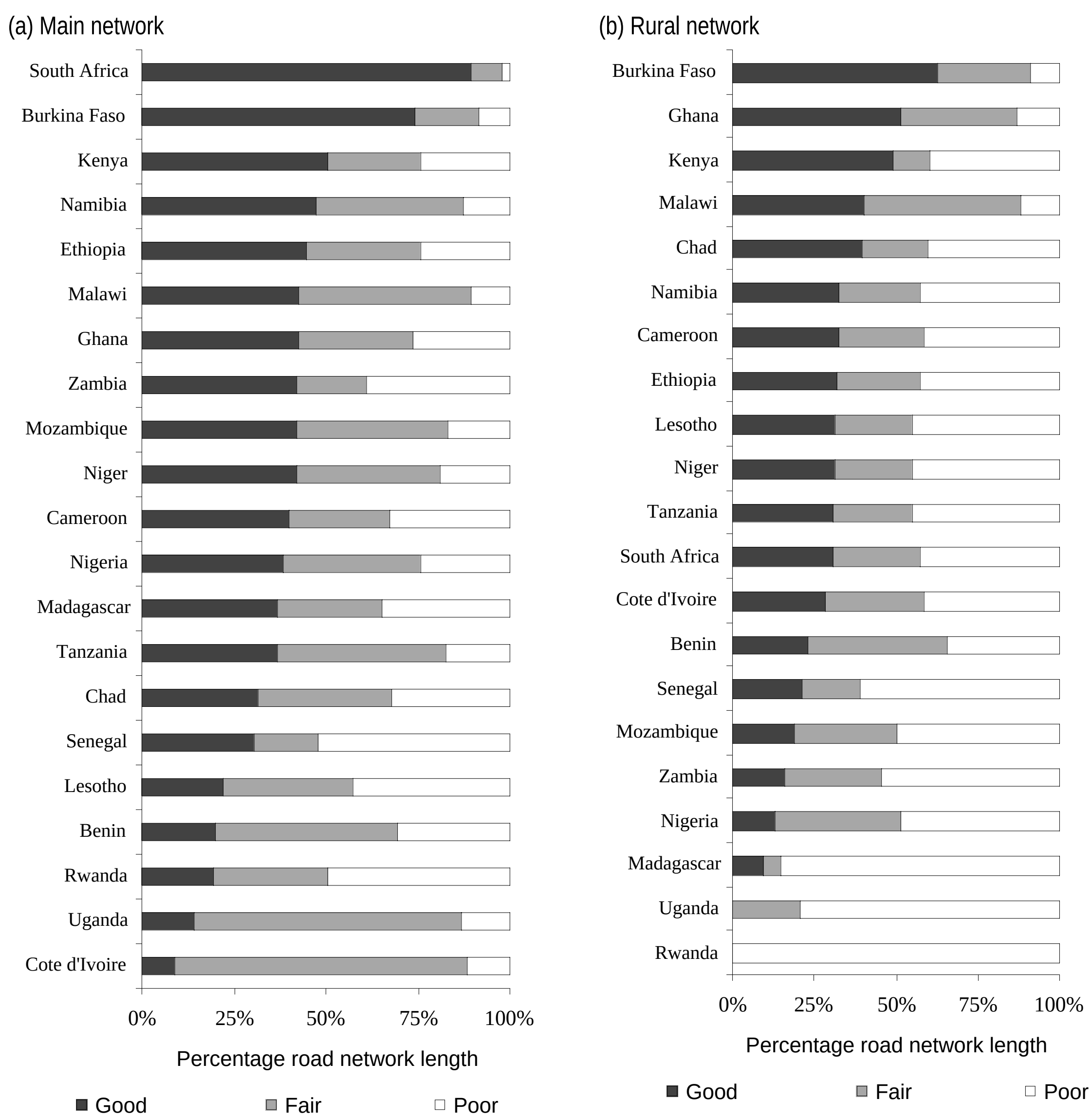
Decentralization of responsibilities and improved financial management are essential for labor based maintenance to work effectively. A review of experience gained under the Rural Travel and Transport Program in 1996 identified these as the two key reforms necessary to mainstream labor-based programs, but which had not received the attention they required.[25] Improved financial management was needed to ensure that funds flow adequately and laborers are paid on time, and decentralization was needed to streamline payment procedures and strengthen stakeholders' support of the programs. They would need to be accompanied by strong government commitment, effective labor laws, appropriate design standards, and training, as well as a suitable delivery mechanism.

[25] Stock, E.A. and J de Veen *Expanding Labor-Based Methods for Road Works in Africa.* SSATP Working Paper No. 22. October, 1996

5 Road network performance

Road quality is the primary indicator of the performance of the road management system in any country. Link-by-link data was collected on the quality of the road network in the sample countries distinguishing between the main network (managed by the central government or affiliated agency) and the rural network (managed by the local government). A three-way quality classification is used: good, fair, and poor. The classification of poor is used to designate roads that are in need of rehabilitation. The data on the rural network is at a lower level of accuracy than data for the main road network, owing to the fact that sub-national field visits were beyond the budgetary scope of the exercise.

Figure 5.1 Distribution of road network length across condition classes



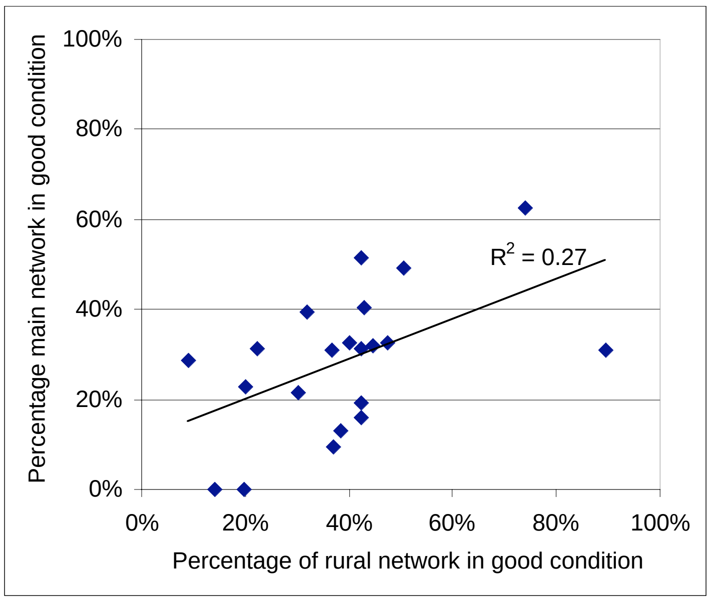
Source: SSATP RMI Matrix, 2007; AICD RONET Database, 2008.

There is huge variation in the percentage of main roads in good condition, but less so in the percentage of main roads in good or fair condition (figure 5.1a). On average, about 46 percent of the main network is in good condition, a further 34 percent in fair condition and the remaining 20 percent in poor condition. The percentage in good condition ranges from 9 percent in Cote d'Ivoire to 90 percent in South Africa. However, the percentage in good or fair condition covers a narrower range, from 48 percent in Senegal to 98 percent in South Africa. Overall, the majority of countries have 60-90 percent of their main network in good or fair condition.

As might be expected, the condition of the rural networks is substantially lower than that of the main road networks (figure 5.1b). On average, about 25 percent of the rural network is in good condition and a further 28 percent in fair condition and the remaining 47 percent in poor condition. The percentage in good condition ranges from zero in Rwanda to 63 percent in Burkina Faso. Only a handful of countries succeed in maintaining more than 60 percent of their rural networks in good or fair condition.

Overall, there is a reasonably strong correlation between the quality of the main and rural road networks in a given country (figure 5.2). The quality of the main road network is a statistically significant predictor of the quality of the rural road network. This suggests that there is a country effect, with competence in main network management carrying over into the rural network.

Figure 5.2 Cross-plot of percentage of main and rural roads in good condition



Of particular interest are the trends in road quality over time. Ultimately, the impact of road sector reforms on road condition can best be understood by examining changes in trends over time. Unfortunately, the availability of time series data on road condition is extremely limited. An early detailed review of new "second generation" road funds by Gwilliam and Kumar showed improvements in outcomes for all five of the countries studied for which road condition data was available (Benin, Ethiopia, Ghana, Malawi and Zambia).[26]

More recent trends in road condition have been broadly positive. There is only very limited data available on road quality trends, based on data collected by SSATP for 2004 and 2007. Some of the figures for 2004 depend heavily on local engineers impressionistic assessments, and there have also been some changes of classification that reduce the reliability and comparability of the statistics. Overall, many countries appear to have made substantial progress in improving the quality of their main road networks. Even with these caveats, half of the sample increased the percentage of their main road networks in good

[26] Gwilliam, K.M. and A.Kumar. (op.cit).

or fair condition by more than 10 percentage points, and more than 30 percentage points in a number of cases (table 5.1). A further group has seen quality remain fairly static, while in a handful of cases there has been a significant deterioration in quality (Cote d'Ivoire, Ghana, Guinea, and Lesotho). In the case of Cote d'Ivoire this can be attributed to the general collapse of services associated with political unrest. Overall, the gap between the best and worst performers has been closing over time, from 90 percentage points in 2004 to around 50 percentage points in 2007.

Road asset value as a percentage of potential maximum asset value provides a more synthetic measure of road quality. Using the RONET model, it is possible to calculate the asset value of the classified road network in its current condition and to express this as a percentage of the asset value of the same network were it to be entirely in good condition. This provides a synthetic indicator of road network quality, and since the close this ratio to 100 percent the closer the network to perfect quality. The value of this indicator is strongly influenced by the condition of the paved road network, since this has a much higher replacement cost per kilometer than the unpaved network.

Table 5.1 Trends in road condition, 2004–07

	% of roads in good or fair condition		
	August. 2004	September 2007	Change to good or fair
Madagascar	30	75	+45
Mali	44	80	+36
Burundi	5	40	+35
Tanzania	50	69	+19
Benin	75	93	+18
Chad	30	48	+18
Niger	57	72	+15
Kenya	57	77	+10
Cameroon	60	65	+5
Ethiopia	62	65	+3
Malawi	63	65	+2
Mozambique	70	72	+2
Guinea	66	62	-4
Ghana	65	60	-5
Cote d'Ivoire	60	50	-10
Lesotho	96	80	-16

Source: RMI Matrix for August 2004 and September 2007.

There is strikingly little variation in the road asset value as a percentage of potential maximum asset value across countries (figure 5.3). The range runs from a minimum of 70 percent in the case of Uganda, to a maximum of 92 percent in the case of Burkina Faso. Moreover, the vast majority of countries have scores in the 80-90 percent range. This essentially indicates that countries are focusing their efforts on maintaining their high value paved network in good or fair condition, and hence easily preserving 70 percent of their potential asset value.

Figure 5.3 Road asset value as percentage of the potential maximum

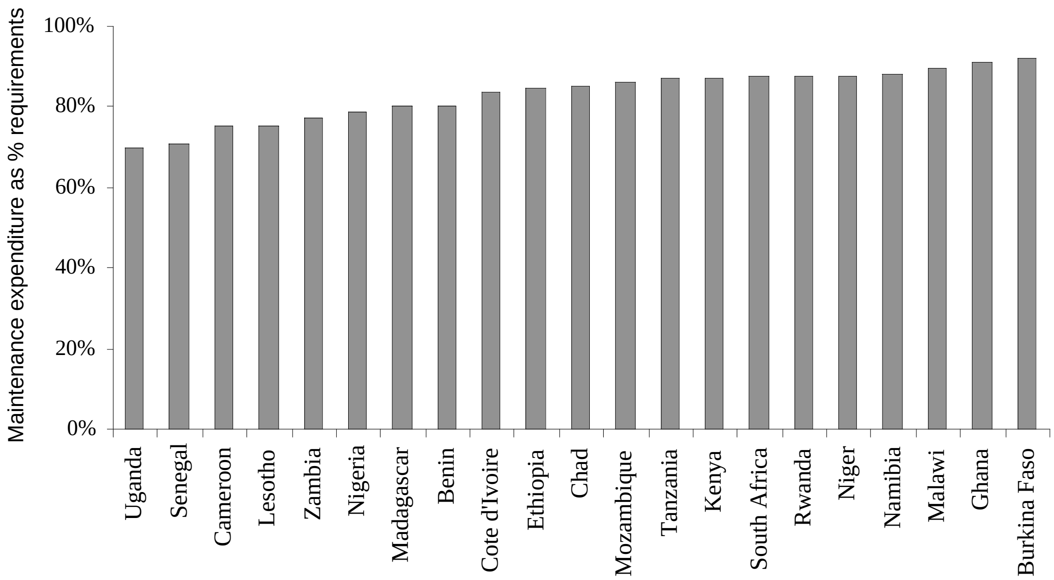
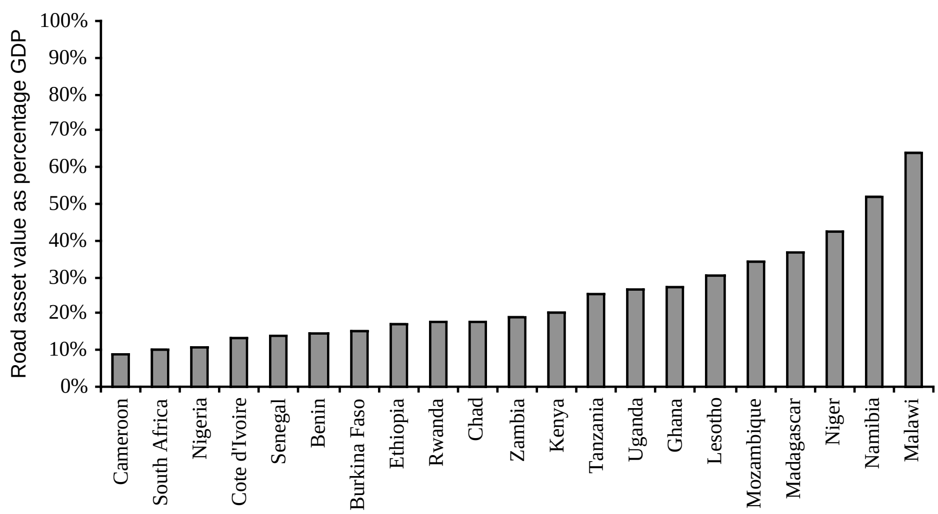


Figure 5.4 Road asset value as percentage of GDP



One way of capturing the affordability of road network maintenance at the country level is to express the associated asset value as a percentage of GDP (figure 5.4). The vast majority of countries have road networks that are worth less than 30 percent of their GDP. However, an important subset of countries has networks worth significantly more than that. Most are very poor countries (Malawi, Niger, Madagascar, Mozambique). A rather different case is Namibia, which though a middle-income country, has a large geographic extension and exceptionally low population density.

A key question is the extent to which road network quality is determined by economic and geographic fundamentals or can be influenced by policy variables. Factors such as geography, climate, terrain, and macro-economic conditions could all be expected to have a major influence on road quality. However, the issue is whether—within these overall constraints—policy variables such as the design of road sector institutions, the road financing framework, and associated budget allocations can make a significant difference to observed road network performance. Attention now turns to each of these two sets of variables in turn.

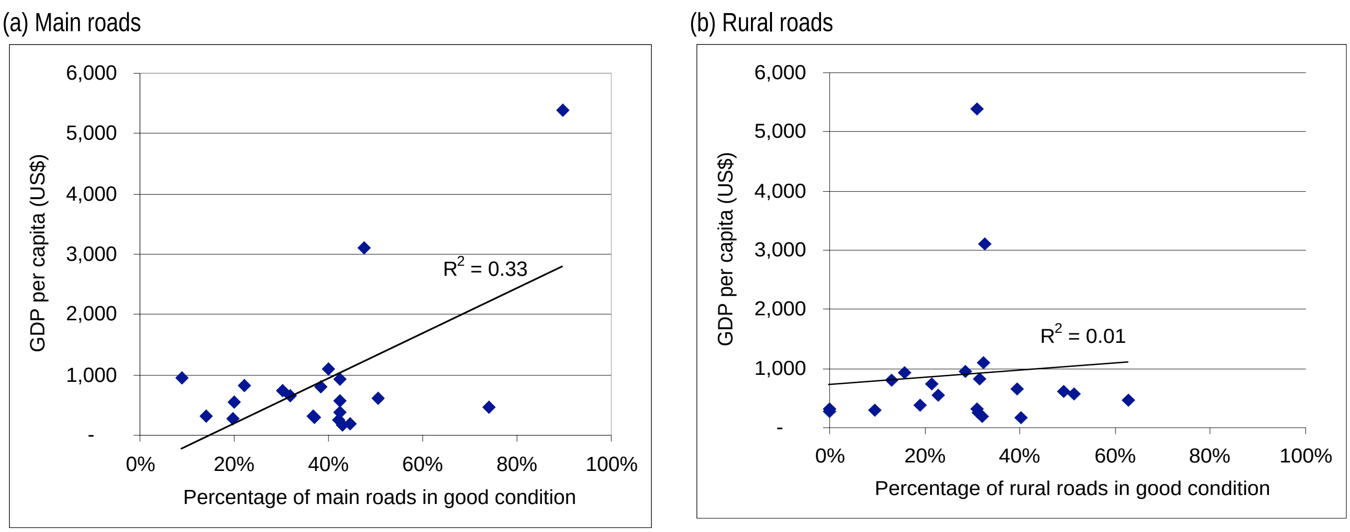
How do economic fundamentals influence road quality?

The broader economic and geographic context of the country is well captured by GDP per capita on the one hand and climate and terrain on the other. The correlation between these two fundamental variables and road quality is explored below.

GDP per capita has a significant impact on the condition of main roads, but none whatsoever on the condition of rural networks. A reasonably strong and statistically significant correlation is found between GDP per capita and the percentage of the main road network in good condition (figure 5.5a). Overall, variations in GDP alone explain 33 percent of the variation in road quality observed across countries. The same cannot be said for rural roads, where no such relationship is found, and where variations in GDP explain barely 1 percent of the variation in road quality observed across countries (figure 5.5b).

Nevertheless, both for main and rural roads, there is a very wide variation in network condition across countries in the low-income bracket (with GDP per capita of less than US$1,000 per year). Within the low-income class, the percentage of main roads in good condition ranges from 9 percent in Cote d’Ivoire to 74 percent in Burkina Faso. Similarly, the percentage of rural roads in good condition ranges from 0 percent in Uganda to 63 percent in Burkina Faso, for low-income countries. This suggests that national income is by no means the determining factor for explaining network condition.

Figure 5.5 Cross-plot of road network in ***good*** condition against GDP per capita

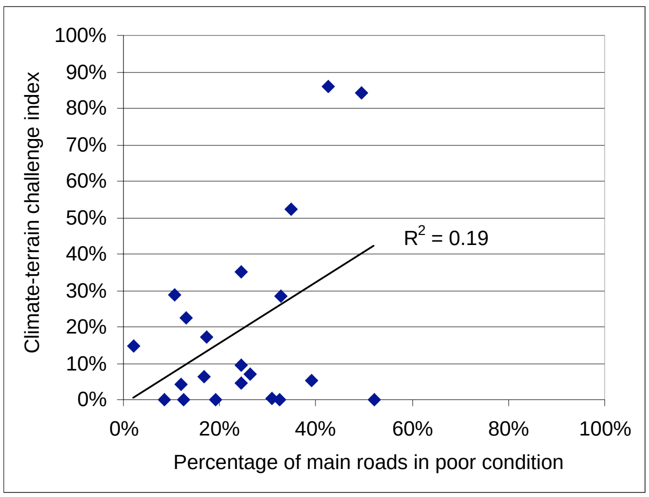


Geographical conditions in the country can also have a major impact on road condition. In particular, countries with wetter and more mountainous terrains face substantially higher costs of road construction and maintenance than do those in flat and arid terrains. High rainfall greatly accelerates the process of road deterioration, requiring frequent and more intensive maintenance interventions, and thus stretching limited road sector budgets. Extreme weather events such as floods and landslides, associated with high precipitation, also increase the need for emergency rehabilitation works. In order to analyze the impact of geographical conditions in greater depth, a composite index is created that indicates the percentage of a country's national territory that is steep, moderately steep or rolling *and* has rainfall in excess of 600 mm per year.

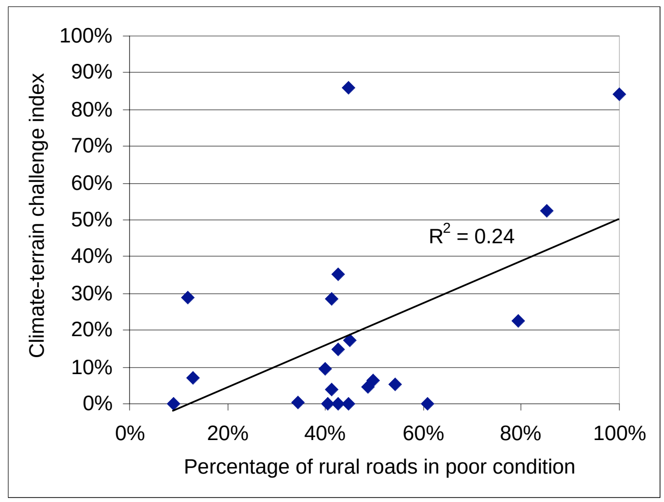
Difficult climate and terrain has a significant impact on road network condition, particularly on the percentage of the network in poor condition. The climate-terrain index shows a significant correlation with the quality of both main networks and rural networks, though the effect is stronger in the case of rural roads. The index is most strongly correlated with the percentage of road networks in poor condition and explains about 20 percent of the variation in this indicator across countries (figure 5.6).

Figure 5.6 Cross-plot of road network in ***poor*** condition against climate-terrain index

(a) Main roads



(b) Rural roads



In summary, both economic and geographic conditions explain part but by no means all of the variation in road quality across countries. GDP per capita is most strongly correlated with the percentage of the main road network in good condition, reflecting efforts in the most costly paved road segment of the network. Climate and terrain on the other hand are most strongly correlated with the percentage of the main and rural network in poor condition, contributing to the rate of deterioration. Nevertheless, even controlling for income and climate there is still substantial variation in observed road quality across countries. Some part of this may be attributable to policy variables.

How does policy affect road quality?

Looking at the percentage of the road networks in good or fair condition across country groupings confirms the findings above. Middle income countries as well as flat and arid countries present a noticeable advantage with respect to the condition of the main road network (table 5.2), while flat and arid countries present a noticeable advantage with respect to the condition of the rural road network (table 5.3).

There is also evidence that countries with both road funds and road agencies perform substantially better than those with either one of these institutions alone. For both the main and rural road networks, countries with *both* a road fund and a road agency have an additional 20 percentage points of their road networks in good or fair condition relative to the other cases. Although countries with only a road fund seem to perform somewhat better than those with only a road agency, the difference is not very pronounced. Regression analysis confirms that these differences are statistically significant in the case of the main road network, but not in the case of the rural network.

Table 5.2 Percentage of main road network in ***good or fair*** condition by country groupings

	Percentage		Percentage
Macro-economy		Institutions	
MIC	81%	Road Fund and Road Agency	82%
LIC aid dependent	75%	Road Fund only	70%
LIC resource rich	70%	Road Agency only*	62%
Geography		Financing	
Coastal	77%	Low fuel levy	70%
Island	65%	High fuel levy	79%
Landlocked	73%	No fuel levy*	75%
Topography			
Flat and arid	77%		
Rolling and humid	70%		

Source: AICD RONET Analysis, 2008.
South Africa is excluded from this group.

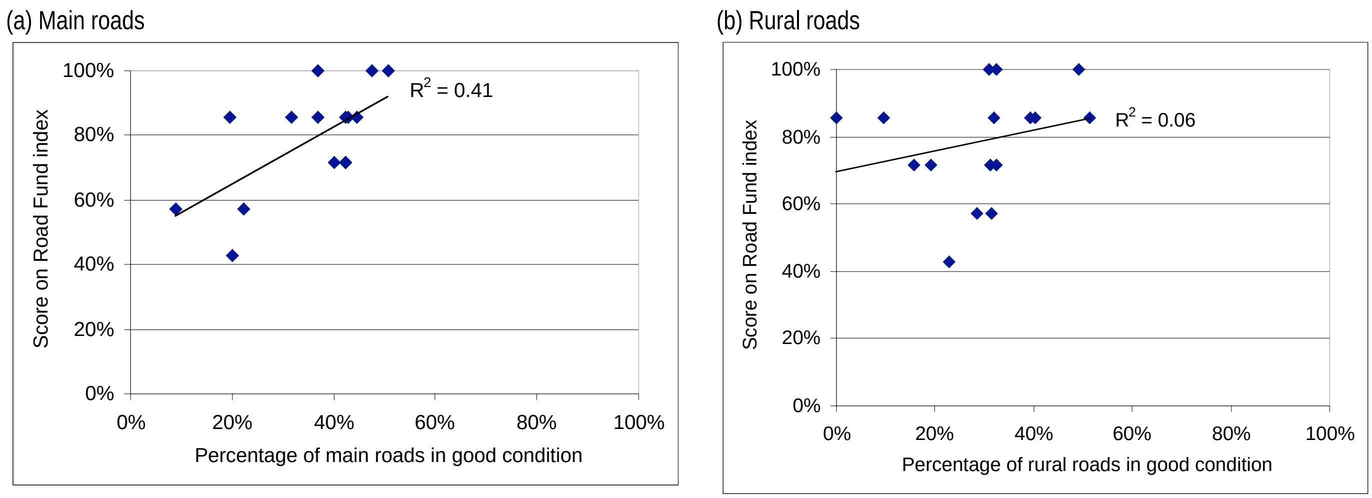
Table 5.3 Percentage of rural road network in ***good or fair*** condition by country groupings

	Percentage		Percentage
Macro-economy		Institutions	
MIC	57%	Road Fund and Road Agency	63%
LIC aid dependent	53%	Road Fund only	50%
LIC resource rich	57%	Road Agency only	49% (45%)
Geography		Financing	
Coastal	58%	Low fuel levy	53%
Island	15%	High fuel levy	56%
Landlocked	53%	No fuel levy	52% (51%)
Topography			
Flat and arid	60%		
Rolling and humid	42%		

Source: AICD RONET Analysis, 2008.
South Africa is excluded from this group.

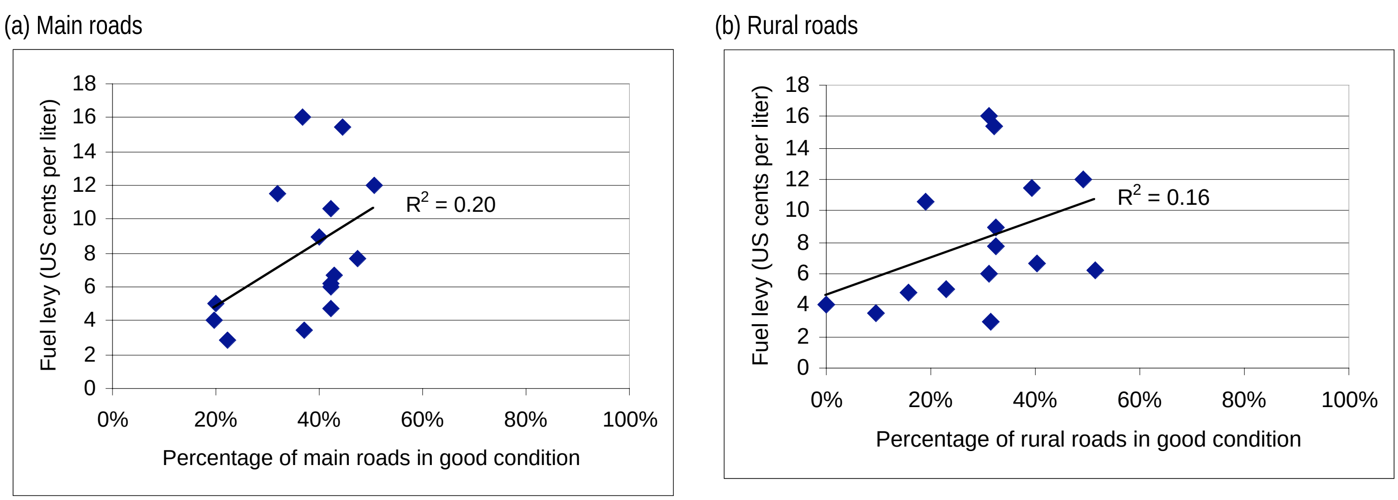
The quality of the road fund institutions also seems to affect the condition of the main road network. Beyond the presence or absence of a road fund, it is interesting to examine whether the quality of the road fund has a material effect on the network condition. In an early section, a road fund scoring system was established to see how many out of seven key road Fund design criteria each country currently meets. A substantial and significant correlation is found between the score on the road fund index and the percentage of the main road network in good condition (figure 5.7a). However, the score on the road fund index does not appear to have a material impact on the quality of the rural road network.

Figure 5.7 Cross-plot of road network in ***good*** condition against score on Road Fund index



While countries with high fuel levies seem to do a little better than those without, the difference is not so pronounced. Countries with high fuel levies have an additional 10 percentage points of their main road networks in good or fair condition, and an additional 5 percentage points of their rural road networks (table 5.4). There is no clear ranking between countries with low fuel levies versus no fuel levies at all. In order to shed further light on this issue a cross-plot is undertaken showing the percentage of the road networks in good condition only against the level of the fuel levy (figure 5.8). A reasonably strong correlation is found between the two variables. This correlation proves to be marginally statistically significant in the case of main roads, but not so in the case of rural roads.

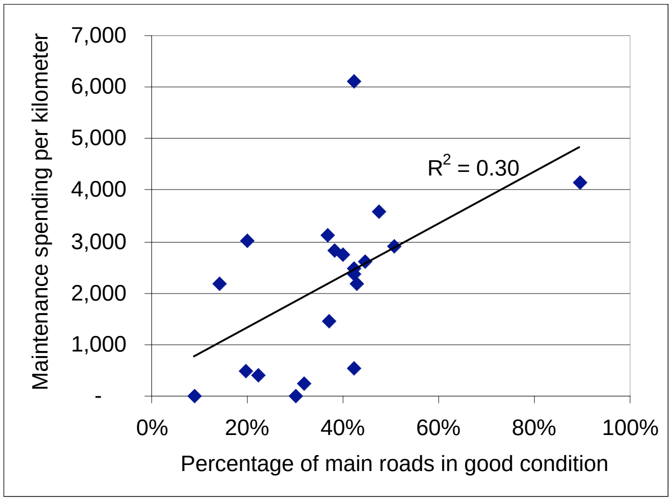
Figure 5.8 Cross-plot of road network in ***good*** condition against fuel levy



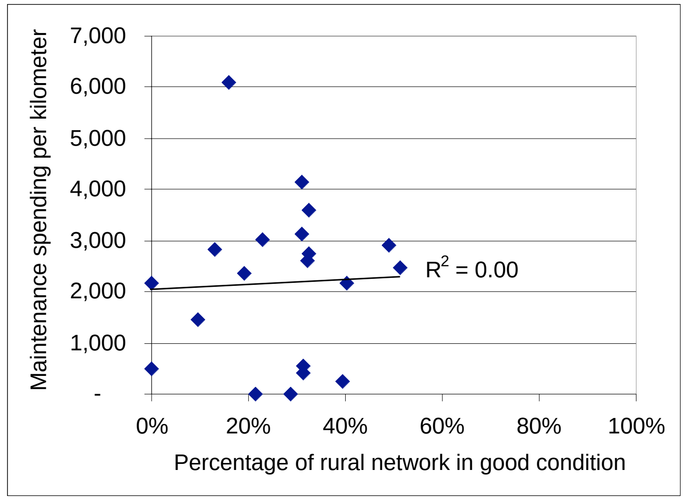
The level of maintenance expenditure shows strong correlation with the quality of the main network, but not the rural network. Another key question is whether countries devoting higher levels of expenditure to road maintenance see a clear dividend in terms of resulting road quality. To investigate this issue maintenance expenditure per kilometer is plotted against the percentage of roads in good condition. A strong and statistically significant correlation is found between maintenance spending on the main network and the percentage of that network in good condition (figure 5.9a). However, in the case of the rural network, no such relationship could be found, and countries with a wide range of maintenance expenditure on the rural network are reporting similar outcomes in terms of quality.

Figure 5.9 Cross-plot of road network in ***good*** condition against maintenance expenditure

(a) Main roads



(b) Rural roads



In summary, policy choices on road institutions and funding levels have a material impact on the quality of the main road network. Countries with both road funds and road agencies, as well as those with high fuel levies and relatively high maintenance expenditure seem to reap the benefits in terms of having a substantially higher proportion of their main road networks in good or fair condition. However, these policy variables have much weaker, if any, impact on the quality of the rural road network. This may reflect deficiencies in the accuracy of the data on spending and road quality for the rural network, due to challenges gathering data for these more decentralized assets. Alternatively, it may reflect the fact that rural network management is driven more by institutions and resource allocations at the local level, which are not adequately captured by national policy variables. Either way, more investigation will be needed to understand the huge differences in performance across rural roads.

Summarizing country performance

The ultimate goal of the road sector is to provide fluid connectivity across the geographical extension of any particular country. Road quality is the most concrete measure available for measuring this degree of connectivity. The road sector essentially captures fiscal resources and channels them through institutions charged with safeguarding and enhancing the quality of the network.

A useful way of summarizing the road sector situation at the country level is therefore to plot a triangle that scores performance on expenditure, institutions and quality. The higher the level of quality attainable for any given level of effort on expenditure and institutions, the better off the situation of the road sector in that country.

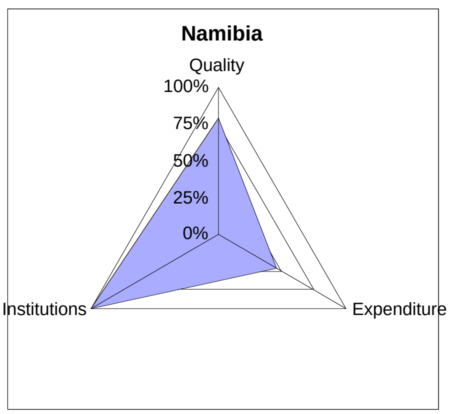
The triangles are based on normalizing three key indices discussed during this report so that all countries fall within an interval of 0 to 100 percent. Quality is defined as the percentage of the main network in good *or* fair condition. Institutions is defined as a composite index that attaches a weight of 50 percent to the existence of a road agency and a weight of 50 percent to the score obtained on the design features of any second-generation road fund. Finally, expenditure is defined as actual maintenance spending relative to the estimated requirement.

The higher the score on the quality indicator the better is the performance of the country. Countries that show triangles skewed towards the left or the right shows some kind of imbalance in policy measures. They may be spending relatively high levels relative to the quality of their institutions, or may have relatively high quality institutions but with limited levels of finance.

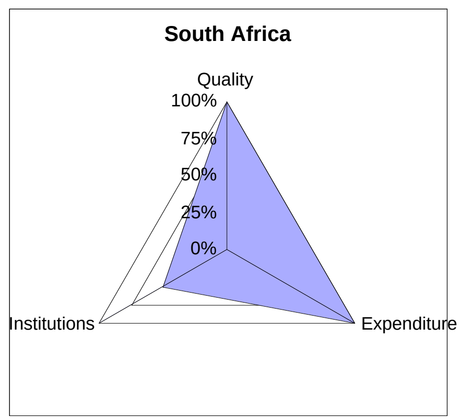
The two strongest performers are Namibia and South Africa (figure 5.10). Both achieve very high levels of quality, which in the case of Namibia seem to reflect particularly high quality institutions, while in the case of South Africa seem to reflect relatively high levels of spending.

Figure 5.10 Top performers

(a) Namibia



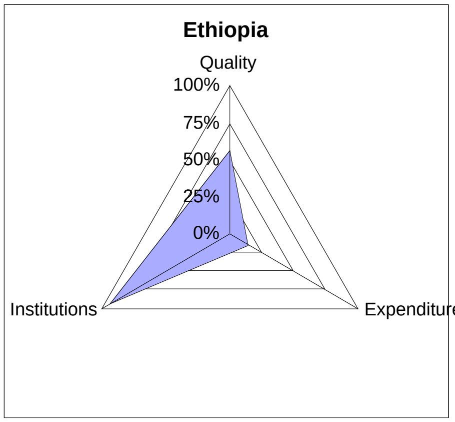
(b) South Africa



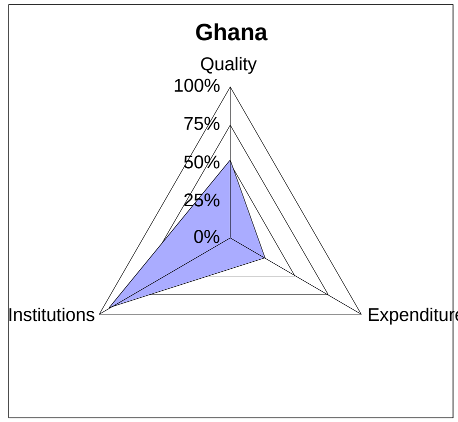
In the second tier of good performers come countries such as Ethiopia, Ghana, Tanzania, Kenya, Nigeria, and Mozambique (figure 5.11). Ethiopia, Ghana, Nigeria, and Tanzania seem to do well primarily on the basis of their institutions rather than by channeling large volumes of resources. On the other hand, Kenya and Mozambique have more of a balanced contribution between expenditure and institutions.

Figure 5.11 Good performers

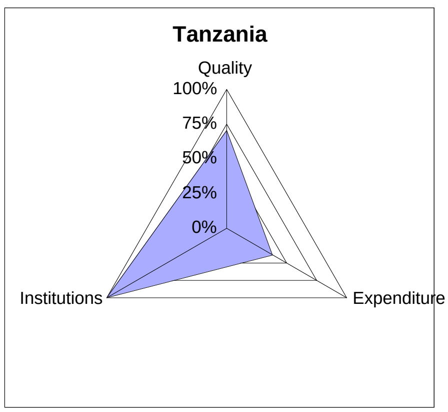
(a) Ethiopia



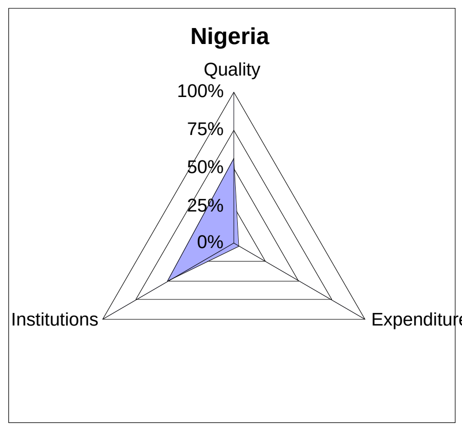
(b) Ghana



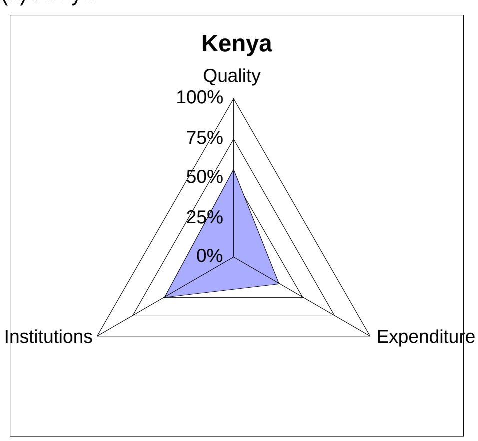
(c) Tanzania



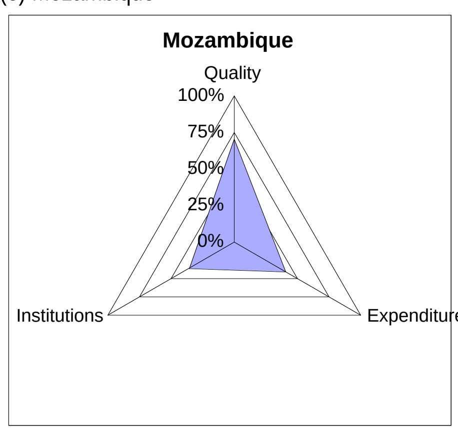
(d) Nigeria



(d) Kenya

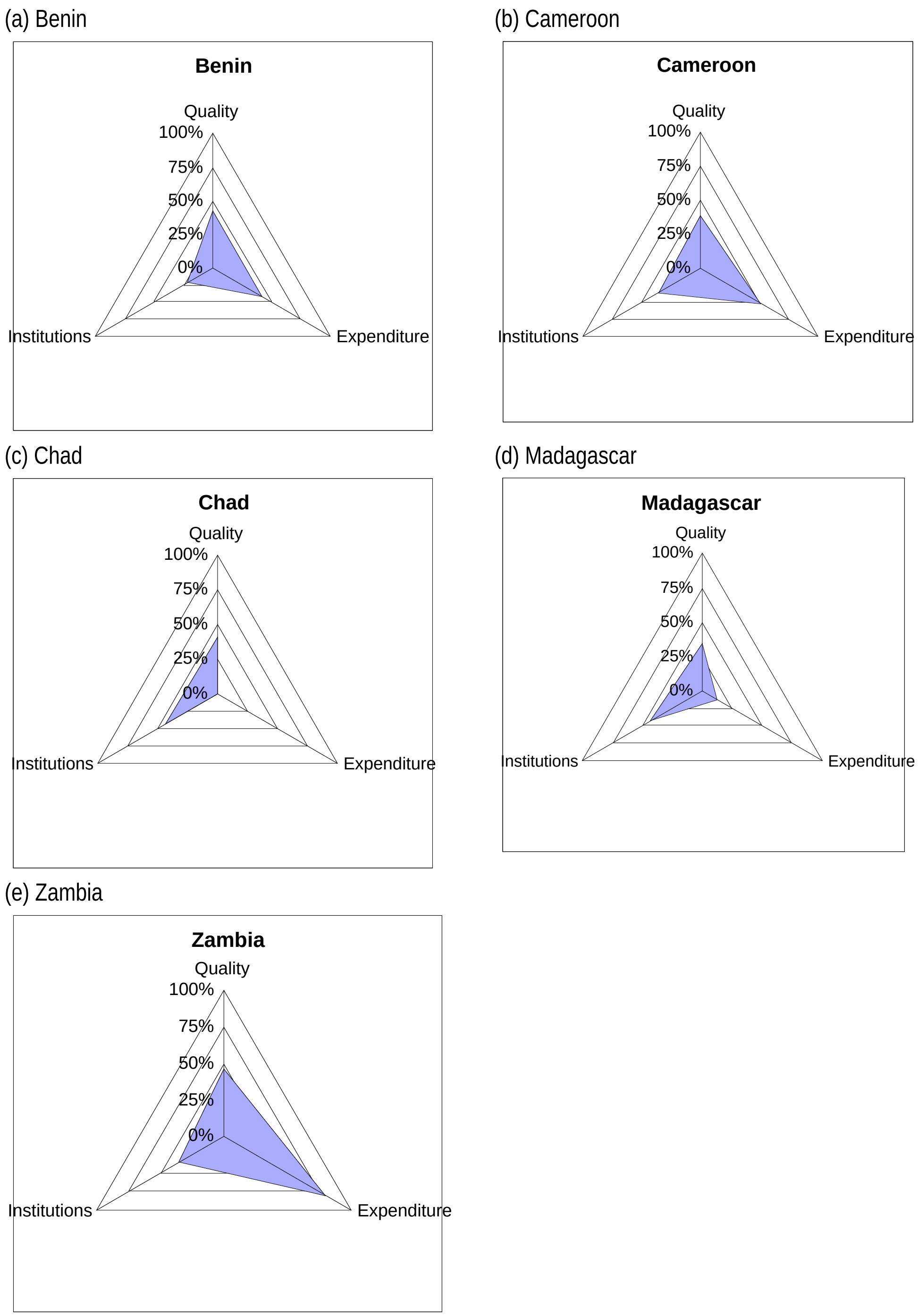


(e) Mozambique



In the third tier of weaker performers come countries such as Benin, Cameroon, Chad, Madagascar, and Zambia (figure 5.12). Benin, Cameroon and Zambia seem to show relatively high levels of spending relative to the quality of their institutions. Chad and Madagascar, on the other hand, show relatively high levels of institutional development relative to their levels of spending.

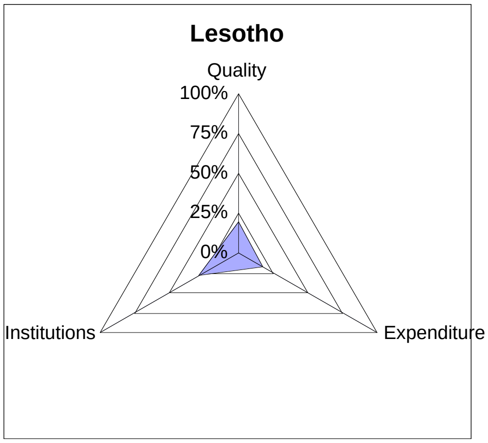
Figure 5.12 Weaker performers



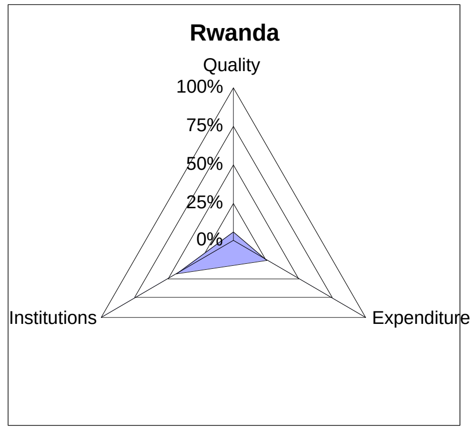
Lesotho, Rwanda, and Senegal have low scores on all three dimensions (figure 5.13). Although in the case of Senegal, institutional development seems to be further ahead of resource capture and road quality.

Figure 5.13 The worst performers

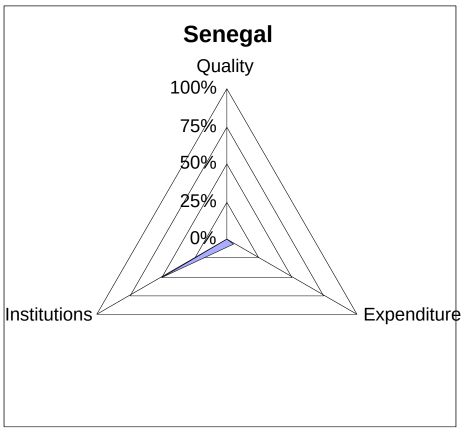
(a) Lesotho



(b) Rwanda



(c) Senegal



6 Conclusions and implications

Africa's road network though physically sparse is relatively large compared to the size of its population, and even larger when seen in the context of national incomes. Considerable efforts are being made to preserve quality and ease mobility along key land-sea trading corridors. However, intra-regional connectivity remains deficient. There has also been a tendency to overlook the considerable needs of both rural and rapidly growing urban populations.

There has been a remarkable degree of consensus as to the direction of institutional reform in the road sector. Second-generation road funds have been very widely adopted, although the quality of these reforms varies substantially across countries. Though lagging somewhat behind, the adoption of road agencies is also spreading.

A key deficiency is the level of the fuel levy, which in many countries is set too low to provide an adequate revenue base for maintenance. In other countries, the level is adequately set but revenue collection remains a serious problem. Another issue is the allocation of road fund resources, which does not always give adequate attention to the special needs of the rural and urban networks noted above.

Countries, on average, spend around 2 percent of GDP on roads. Within this envelope, there is a significant bias towards capital expenditure. This bias is further exacerbated when one considers that countries are typically only able to execute around 60 percent of budgeted capital spending. As a result, countries are only budgeting on average 30 percent of road expenditure to maintenance versus a norm of over 50 percent. Nevertheless, even with this degree of capital bias, only about half of the countries surveyed have capital expenditure large enough to clear current network rehabilitation backlogs within a reasonable time period. At the same time, fewer than half of the countries are allocating enough resources to cover routine and periodic maintenance requirements. As a result, a significant number of countries are in a vicious cycle of low maintenance budgets leading to network deterioration, but without adequate capital resources to clear their escalating rehabilitation backlog.

Within this overall picture, there is evidence that countries with road funds and in particular those that also set fuel levies at a reasonably high level perform systematically better in terms of road financing. In particular, they exhibit a lower degree of capital bias and are significantly closer to covering road maintenance requirements.

Recent escalations of unit costs for road maintenance and reconstruction are likely to further dilute the adequacy of road budget allocations over time. There is thus a need to spend as cost-effectively as possible, in particular by exploring the potential for cost savings through the adoption of more appropriate technological standards. Even within the current technology, there is evidence of substantial over-engineering of the main road network relative to traffic volumes. The rural network on the other hand shows a tendency to be somewhat underengineered.

Overall, countries have done a reasonably good job of keeping the bulk of their main networks in good or fair condition and hence of preserving the asset value of the national road network, which in no case falls below 70 percent of its maximum potential value. Lack of funding and institutional capacity shows up most strongly in the condition of the unpaved and lower tiers of the network; compromising territorial connectivity.

Geographical factors, in particular climate and terrain, seem to have a material impact on road network condition. However, the impact of GDP per capita is surprisingly weak, such that there is a very wide variation in the quality of the main road network observed among countries with GDP per capital under US$1,000. The condition of the rural road network is much harder to make sense of, perhaps owing to deficiencies in the primary data, although the strongest correlation is with climate and terrain.

As far as policy variables are concerned, there is some evidence that countries with both road funds and road agencies tend to perform better with regard to the condition of their road networks. Countries with higher levels of maintenance spending also have better quality networks.

A number of important lessons emerge from this analysis. First, the adoption of institutional reforms (though impressive) is far from complete in many cases, and the creation of a road fund needs to be accompanied by a fuel levy that is set at a realistic level and can be adequately collected. Second, despite the emphasis of the institutional reform process in safeguarding resources for road maintenance, this goal has not yet been fully achieved. Third, notwithstanding their limitations, institutional reforms have had a discernible impact on outcomes. Countries with (well-financed) road funds do significantly better at capturing resources for maintenance. Countries with road funds and road agencies do significantly better at converting resources into road quality outcomes. Fourth, choice of road surface type needs to be more carefully informed by analysis of traffic volumes.

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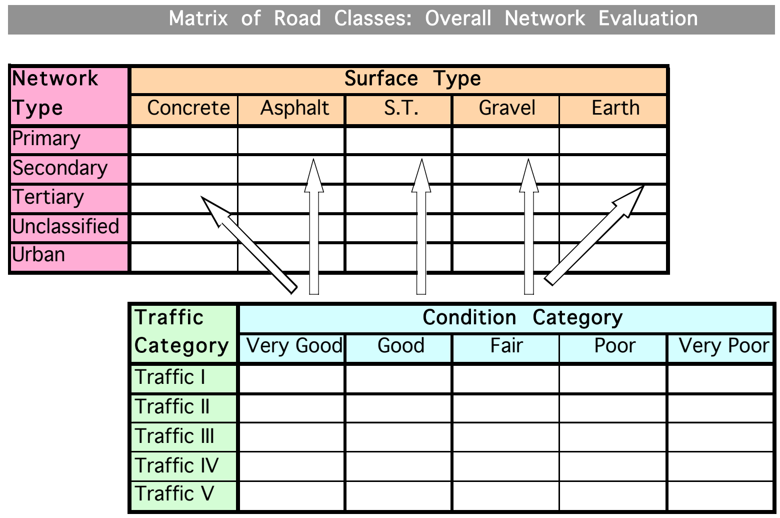
Annex 1 Methodology underlying RONET model



The Road Network Evaluation Tools (RONET) model is a tool for assessing the performance of road maintenance and rehabilitation policies and the importance of the road sector for the economy to demonstrate to stakeholders the importance of continued support for road maintenance initiatives. The RONET road network length can cover the entire road network system of the country (roads, highways, expressways, streets, avenues, and so forth), or a partial road network, for example, the road network of a state or province of the country, or the road network managed by the main road agency. The road network is represented by road classes that are a function of (i) five network types, (ii) five surface types, (iii) five traffic categories, and (iv) five condition categories, which total a maximum of 625 road classes. The figure below illustrates the representative road classes.

Each surface type is subdivided into five possible traffic categories (Traffic I, Traffic II, Traffic III, Traffic IV, Traffic V). The table below presents the RONET default assignment of traffic levels to each traffic category per surface type.

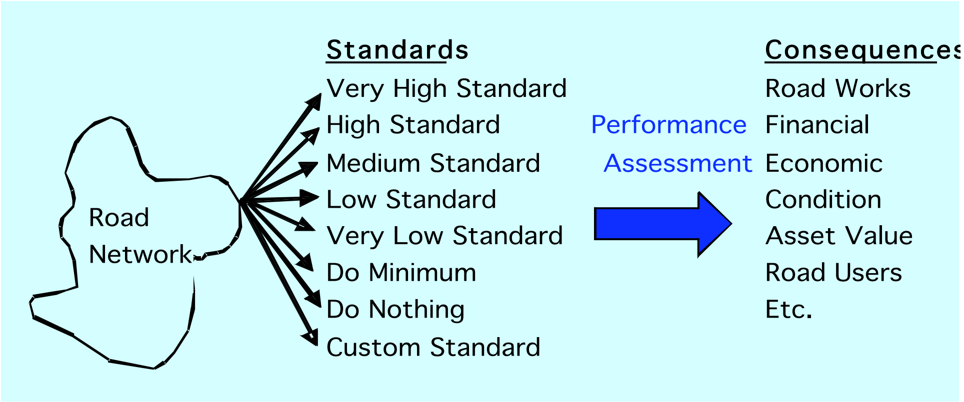
Each network type, road type, and traffic category is subdivided into five possible road condition categories defined as a function of the engineering assessment of the capital road works (periodic maintenance or rehabilitation works) needed to bring a road to very good condition. Routine maintenance road works are needed by all roads every year; therefore, they are not considered on the definition of the road condition classes. The road condition classes are defined as follows:

- *Very Good:* Roads in very good condition require no capital road works.
- *Good:* Roads in good condition are largely free of defects, requiring some minor maintenance works, such as preventive treatment, crack sealing or grading.
- *Fair:* Roads in fair condition are roads with defects and weakened structural resistance, requiring resurfacing of the pavement (periodic maintenance), but without the need to demolish the existing pavement.
- *Poor:* Roads in poor condition require rehabilitation (strengthening or partial reconstruction).
- *Very Poor:* Roads in very poor condition require full reconstruction, almost equivalent to new construction.

RONET default assignment of traffic levels							
			Average Annual Daily Traffic (AADT)			Illustrative Standards	
Surface Type	Traffic Category	Traffic Level	Minimum (veh/day)	Maximum (veh/day)	Average (veh/day)	Geometry Standard	Pavement Standard
Earth	Traffic I	T1	0	10	5	1-lane warranted	Formation not warranted
	Traffic II	T2	10	30	20	1-lane warranted	Formation warranted
	Traffic III	T3	30	100	65	2-lane warranted	Gravel warranted
	Traffic IV	T4	100	300	200	2-lane warranted	Gravel warranted
	Traffic V	T5	300	1,000	650	2-lane warranted	Paved Surface warranted
Gravel	Traffic I	T2	10	30	20	1-lane warranted	Formation warranted
	Traffic II	T3	30	100	65	2-lane warranted	Gravel warranted
	Traffic III	T4	100	300	200	2-lane warranted	Gravel warranted
	Traffic IV	T5	300	1,000	650	2-lane warranted	Paved Surface warranted
	Traffic V	T6	1,000	3,000	2,000	2-lane warranted	Paved Surface warranted
Paved	Traffic I	T4	100	300	200	2-lane warranted	Gravel warranted
	Traffic II	T5	300	1,000	650	2-lane warranted	Paved Surface warranted
	Traffic III	T6	1,000	3,000	2,000	2-lane warranted	Paved Surface warranted
	Traffic IV	T7	3,000	10,000	6,500	2-lane warranted	Paved Surface warranted
	Traffic V	T8	10,000	30,000	20,000	4-lane warranted	Paved Surface warranted

Standard given for illustration purposes. Proper standards are country specific. AADT of motorized 4-tires or more 2-way traffic.

RONET has a module that computes the network monitoring indicators based on the current condition of the network and a module that does a performance assessment of the network under different road agency standards. The objective of this module is to assess the consequences of applying different road works standards that represent different levels of road works expenditures over time. The consequences are presented on the road works requirements, financial cost, road condition, asset value, and so on. The figure below illustrates the process.



This module evaluates the performance of the network under different road works standards over a 20-year evaluation period. The user defined road works standards are the following:

- Very high standard
- High standard

- Medium standard
- Low standard
- Very low standard
- Do minimum
- Do nothing
- Custom standard
- Optimal standard

The very high standard represents a scenario without budget constraints but with a high level of periodic maintenance and rehabilitation works. The high, medium, low, and very low standards represent scenarios of decreasing levels of road works expenditures. The “do minimum” standard represents a scenario where the only capital road work applied over the evaluation period is reconstruction, at a very high roughness. The “do nothing” standard represents a scenario where no capital road works are applied over the evaluation period. On all these cases, the defined standard is applied to all road networks types. On the custom standard, one defines the standard (Very High, High, Medium, Low, Very Low, Do Minimum or Do Nothing) to apply to each road network type. On the optimal standard, RONET evaluates each road class and identifies for each road class the standard that maximizes the society benefits Net Present Value, at a given discount rate.

RONET was used to evaluate the preservation needs of the main roads of nineteen African countries, defined as the primary and secondary roads of each country. The total network length of the nineteen countries is 991,567 km, of which 293,039 km are main roads (30 percent). The total network utilization of the nineteen countries is 123,755 million vehicle-km, of which 117,905 million vehicle-km circulate on main roads (95 percent). The median traffic of the main roads is 456 vehicles per day. RONET evaluated the current condition and traffic of the main roads and computed current monitoring indicators for each country. The median percentage of roads in good and fair condition is 75.6 percent and the median average network roughness weighted per vehicle-km is 4.69 IRI, m/km. The median current asset value as a share the maximum asset value is 85 percent and the median current asset value as a share of GDP is 17 percent.

RONET evaluated the performance of the main roads under different preservation standards in order to determine the optimal needs for recurrent maintenance, periodic maintenance, and rehabilitation road works. RONET identified for each road class, characterized by functional classification, surface type, traffic, and condition, the preservation standard that yields the highest Net Present Value (NPV), at 12 percent discount rate, thus maximizing society net benefits. The RONET evaluation adopted the following assumptions that were considered the same for all countries: (i) a traffic growth rate of 3 percent per year; (ii) discount rate of 12 percent; (iii) evaluation period of 20 years; (iv) average unit costs of road works based on the World Bank Road Works Costs Knowledge System (ROCKS) system; and (v) average unit road user costs based on the World Bank Road User Costs Knowledge System (RUCKS) system. The following table presents the adopted unit costs of road works.