

State of the Road Networks in Developing Countries and a Country Typology of Response Measures

ASIF FAIZ, CLELL HARRAL, AND FRIDA JOHANSEN

An overview of the status of the road networks in 85 developing countries is presented. A broad-brush assessment of the condition of main roads in these countries is followed by an analysis of regional differences and the factors contributing to these differences. These factors have been grouped into country typology consisting of six categories. Although it is not scientifically precise, this classification is useful in explaining the regional and country differences in road condition, understanding the causes of the road deterioration problem in developing countries, and formulating appropriate responses to the problem. This paper is the first of four papers in this Record on "Road Deterioration in Developing Countries."

The road-building boom in developing countries during the 1960s and 1970s has not been matched by a comparable investment in follow-up maintenance and restoration, and the debilitation as a result of neglect has been aggravated by increasing and heavier traffic use. Much too small a share of resources available for roads has been used for maintaining existing roads, and even that small share has seldom been applied effectively. The result today in many developing countries is a network of deteriorating roads, many of them beyond the stage at which normal maintenance measures can be effective, and rehabilitation or reconstruction is required at a cost three to five times what it would have been if preventive maintenance and strengthening had been done in time. A much larger mileage will soon reach that stage if not maintained better than in the past. For many countries, it may already be well beyond their financial means to correct the deficiencies in their road infrastructure. The growing problems of road deterioration, functional obsolescence, and insufficient capacity to serve future growth have converged at a time when severe budgetary constraints are forcing governments to reassess spending priorities and make difficult investment and expenditure choices from among the many competing claims on available resources.

The increase in costs to the road authorities is only a fraction of the overall burden resulting from deteriorating roads. Vehicle operating costs on properly maintained roads account for some 80 to 90 percent of the total road transport cost except in extremely low traffic. On bad roads, vehicle operating costs (largely in foreign exchange) can easily double, imposing a heavy burden on road users. The higher road haulage costs can constrain the location of economic activities, hamper the integration of economic markets, limit the gains from special-

Consequences of Road Neglect in Ghana

Road deterioration can make an economic crisis worse. In Ghana a good road network was built before 1970, but it later suffered from serious neglect. By 1984, about 60 percent of the main paved roads were in a state of moderate to severe deterioration. Important sections have become almost impassable, and access to some interior areas has been severely curtailed. Transporters refuse to go there because they do not want their vehicles to break down.

Transport costs have increased in real terms by about 50 percent on main roads and by more than 100 percent on rural roads that have suffered even greater neglect. In many areas, the market rate for transporting fertilizer is as high as a dollar per ton-mile. These high transport costs have cut deeply into farm returns, particularly for poor farmers in areas away from main roads: some villagers can no longer move their cocoa stocks to regional depots. During the 1982-1983 famine, poor roads prevented the transport of food from surplus areas to areas facing starvation. The high transport costs have also hit the timber industry. Logs moving from the Kumasi area for export through the Takoradi port are trucked over a 500-km route because the direct road, which is about half as long, is broken down and the rail services are unreliable. The detour adds \$15 to \$20 (U.S. dollars) for each ton of logs exported.

The prospects are not encouraging. Road resurfacing and strengthening covers only about 20 percent of estimated annual needs of about \$47 million, mainly for resealing 1100 km of paved roads and regaveling 1600 km of unpaved roads. Even with a recent road maintenance project supported by the World Bank, maintenance will increase to only about 30 percent of that needed by 1989. Unless more resources can be put into road maintenance—and applied effectively—deterioration will continue. Ultimately the network will require far more costly rehabilitation, if financed, or result in an almost total collapse of road transport.

ization, and render many transport-intensive activities nonviable. Continued deterioration of road networks can lead to chronic transportation bottlenecks that inevitably erode the productive base of the economy and result in major economic dislocation (see box "Consequences of Road Neglect in Ghana").

Although neglect of maintenance may be commonplace in other sectors of the economy and in other transport modes, it is particularly acute for roads for at least three reasons:

- Because of the large magnitude of the costs and financial requirements involved, the expenditures now needed to make

up for past omissions of preventive maintenance in sub-Saharan Africa are at least 10 times as much as would be needed to provide a continuing supply of textbooks for all elementary school children in the region until year 2000.

- The nonlinear progression of deterioration on roads renders it difficult to recognize the need for preventive maintenance before it is too late to avoid more expensive corrective measures;
- The agency responsible for road maintenance is usually not directly exposed to, and hence is unlikely to be sensitive to, the economic consequences of undermaintenance of roads or organized pressure for better roads.

The purpose of this paper is to provide an overview of the status of roads in 85 developing countries that have received World Bank assistance for roads (\$9.4 billion during 1974–1985). Following a discussion of the general characteristics of the road networks, regional differences in road condition are analyzed and factors contributing to these differences are grouped into a country typology to (a) help explain the differences in road condition across countries, (b) understand the causes of the road deterioration problem, and (c) identify appropriate responses to the problem as discussed by Bhandari et al., Smith and Harral, and Harral elsewhere in this Record.

ROAD NETWORKS

The main roads in the 85 developing countries comprise the primary and secondary road systems as defined or enumerated in government road classifications. The aggregate length of the main road systems in the 85 countries is about 1.8 million km, of which slightly more than 1.0 million km are paved. The main roads carry about 70 to 80 percent of the interurban traffic.

The tertiary network and all unclassified roads are not included, because road classification practices differ considerably from country to country and data on the geographical distribution and condition of these lower-order roads are less reliable. Much of the tertiary network in developing countries consists of unpaved roads with light, low-volume traffic. The ratio of maintenance to construction costs on these roads is fairly high, and neglect of maintenance has an immediate and more severe impact on service performance (user costs) than on the physical condition of the road. Urban road systems are also excluded because their traffic and maintenance characteristics and related deterioration problems are of a different nature.

Without detailed road inventories and country-specific construction costs, it is difficult to assess the value of the road stock with precision. Value assessments of national road stocks are not commonly available. In a report prepared by the U.K. National Development Office (1), the gross replacement value of the entire U.K. road stock in 1982, including the plant and equipment owned by central and local road authorities, was estimated at about £38 billion (\$50 billion, U.S. dollars). The deficiencies in the system as compared with a brand new system were estimated at about £10 billion (\$13 billion, U.S. dollars) or 26 percent of the replacement value.

The replacement value of the main roads in the 85 developing countries is estimated at about \$300 billion, excluding the value of land, major earthworks, and bridges. (This estimate is based on generalized average costs per kilometer presented in

Table A-1 in the Appendix). This is roughly the same asset base as that for electric power generation and distribution in these countries.

In addition, there are another 5 to 6 million km of mostly unpaved, low-volume local roads and tracks (the tertiary system) with a replacement value of perhaps \$75 to \$100 billion. This overview deals primarily with main road networks, partly because they comprise the most important and valuable roads, and partly because information on other roads is too fragmentary.

There are significant differences in the coverage and quality of the road networks across the 85 countries. To illustrate, the coverage of main roads ranges from some 250 000 km in China to 760 km in Comoros, and four countries—China, India, Brazil, and Mexico—account for 51 percent of the total road kilometerage, 40 percent of main roads and 45 percent of paved roads. The differences emerging from aggregating the country data by geographic regions are equally striking as summarized in Table 1. The regional classification used in this paper reflects the geographic grouping of countries by the six operational regions of the World Bank, namely Eastern and Southern Africa (ESA); Western Africa (WA); East Asia and Pacific (EAP); South Asia (SA); Europe, Middle East, and North Africa (EMENA); and Latin America and Caribbean (LAC). See Figure 1 for a geographical demarkation of the regions. More detailed regional data are presented in Table A-1 and country-specific information is presented in Table A-2 in the Appendix.

Sub-Saharan Africa has the lowest area density $\text{km}/100 \text{ km}^2$ of roads—about one-half of the global average for developing countries—whereas road length per 1,000 persons is about twice that for Asia. The ratio of road kilometers per million dollars of gross national product (GNP) (the market value of the final output of goods and services claimed by the residents of a country in a year) is the highest of all regions. The World Bank uses estimates of GNP as the main yardstick of economic activity in a country (2, 3). These figures reflect the vast distances, the dispersed settlement patterns, and the smaller economic base of sub-Saharan Africa. Compared with other regions, a smaller proportion of main roads in sub-Saharan Africa is paved, but this is a reflection of lower traffic volumes on sub-Saharan road networks. In terms of the total road network, however, Latin America and Caribbean is observed to have a similar proportion of paved roads as Western Africa, suggesting that roads in sub-Saharan Africa may have been paved at lower traffic thresholds than in LAC. The Asian regions have the lowest road length per 1,000 population, reflecting the high population densities and spatial concentration of economic activity. These regions (except India) also have the lowest road density per million dollars of GNP, pointing to the hitherto less dominant role of modern road transport and the comparatively less developed state of roads relative to income levels. The Europe, Middle East, and North Africa region (which excludes all European countries except Hungary, Poland, Portugal, Romania, Turkey, and Yugoslavia) has the highest area density of main roads, a high ratio of road length per 1,000 population, a low road density per million dollars of GNP, and the highest percentage of paved roads, reflecting the relatively mature development of road networks relative to characteristics of the road networks in LAC are similar to their economies, in most countries of this region. The aggregate characteristics of the road networks in LAC are

TABLE 1 REGIONAL AND ROAD NETWORK CHARACTERISTICS, 1984

	Sub-Saharan Africa		Asia		Other	
	Eastern and Southern Africa	Western Africa	East Asia and Pacific	South Asia	Europe, Middle East, and North Africa	Latin America and Caribbean
Population and Economic Activity						
No. of countries	19	20	7	6	14	19
Area (million km ²)	11.1	8.9	13.2	5.1	6.5	18.9
Population (million)	201	186	1,350	1,008	232	350
Population density (persons/km ²)	18	21	102	197	36	19
GNP (1984 billion U.S. dollars)	51	105	600	258	338	583
GNP/capita (1984 U.S. dollars)	310	290	710	220	1,795	1,190
Growth in GNP/capita (1975–1985), percent	-0.1	-1.0	3.4	2.4	3.1	-0.03
Road Network (thousand km)						
All roads	588	430	1,540	1,681	1,051	2,212
Main roads	191	145	451	217	304	512
Replacement Value of Main Roads (1984 billion U.S. dollars)						
	18	17	90	33	66	76
Percent of GNP	35	16	15	13	20	13

similar to those of EMENA, except for one major difference: about 11 percent of the total road network in LAC is paved compared with 29 percent in EMENA and 31 percent in South Asia (although much of the road network in the Indian subcontinent is not suitable for modern road transport).

The regional differences in road density also reflect other factors: evidence suggests that some roads in sub-Saharan Africa have been expanded for social and political reasons beyond the levels needed to sustain economic growth. In East Asia and Pacific, motorized road transport is only now beginning to emerge as a dominant transport mode, and the extensive South Asian networks represent a legacy of road building spanning centuries.

CONDITION OF THE MAIN ROAD NETWORKS

In this study the basic information on road networks and their condition was pieced together from more than 150 internal

World Bank documents (e.g., transport sector reviews, project appraisal reports, and consultant studies), which are classified and not available for general public distribution. This information was supplemented by data from standard references on road statistics (4–6). Although the assessment of road conditions is subject to considerable error because of lack of reliable data, available evidence is good enough to gauge the broad dimensions of the problem. On the basis of information from recent surveys (7, 8), supplemented as necessary by the judgment of World Bank highway engineers, the conditions of the main road of a country have been categorized as good, fair, and poor. A road in good condition requires only normal maintenance in the short term. Fair condition connotes the need for early resurfacing or strengthening. A road in poor condition has already deteriorated to the point that reconstruction, either partial or extensive, is required.

Road conditions in different countries (Table A-2) assessed in the preceding terms were combined into regional averages, weighted by network lengths. The regional figures (Table 2) are

TABLE 2 CONDITION OF MAIN ROADS

Region	Paved			Unpaved		
	Good	Fair	Poor	Good	Fair	Poor
Eastern Africa	42	32	26	42	30	28
Western Africa	52	23	25	20	36	44
East Asia	20	59	21	41	34	25
South Asia	18	45	36	6	39	55
Europe, Middle East, and North Africa	40	35	25	30	46	24
Latin America and Caribbean	44	32	24	24	43	33
Average	32	42	26	31	36	32
United States [federal-aid network, 1981 (10, pp. 20–21)] ^a	31	57	12	—	—	—
United Kingdom (trunk road system, 1983) ^b	85	12	3	—	—	—

NOTES: As reported in an internal World Bank survey of 85 countries based as far as possible on published pavement condition information (60 countries) and supplemented where necessary by the judgment of bank highway engineers. *Paved roads* were assessed as follows: good—substantially free of defects and requiring only routine maintenance; fair—significant defects, requiring resurfacing or strengthening; and poor—extensive defects, requiring reconstruction or major rehabilitation. *Gravel roads* were assessed as follows: good—needing only routine grading or spot regraveling; fair—needing regraveling or reshaping, and spot repair of drainage; and poor—needing reconstruction and major drainage works.

^aThe condition data are based on serviceability ratings and qualitative definitions used by the Federal Highway Administration. A poor road is one that requires immediate resurfacing or complete reconstruction, a road in fair condition suggests the need for resurfacing in the near future, and a good road is one that does not require immediate resurfacing or reconstruction.

^bBased on residual life concept—15 percent with a residual life of less than 5 years (before strengthening is likely to be needed), 25 percent with a residual life of less than 10 years, and 60 percent with a residual life of more than 20 years (1, p. 9). Assuming a uniform age distribution, these data would roughly conform to 85 percent good, 12 percent fair, and, at most, 3 percent poor, using the qualitative definitions employed by the FHWA and assuming that the near future is within the next 5 years.

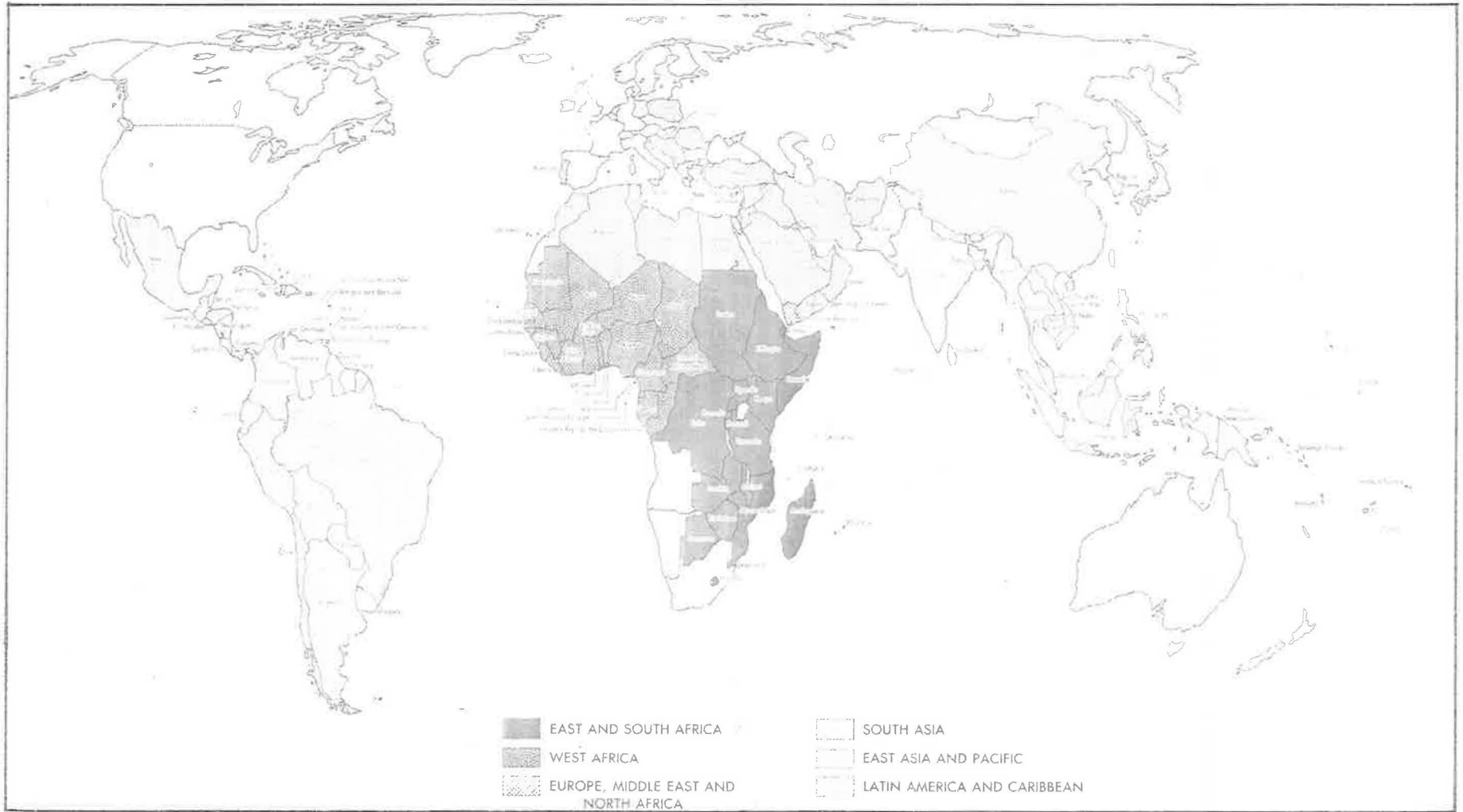


FIGURE 1 Geographical demarkation of World Bank's operational regions.

alarming on two counts. First, more than one-fourth of paved roads (some 267 000 km) are already in poor condition and a majority of these need rehabilitation or reconstruction. Second, and of even greater concern, the heavy concentration (42 percent) of paved roads in the fair category (about 430 000 km) foreshadows a crisis of major proportions, unless concerted efforts are made soon to prevent the descent of these roads into poor condition. For comparison, less serious levels of deterioration on the federal-aid highway network in the United States during the 1970s (12 percent poor as opposed to 26 percent in developing countries) prompted widespread alarm, the introduction of new legislation, new user taxes, and a large infusion of federal and state resources in the 1980s to remedy the situation (9-11). In Maryland and Virginia at that time all road funds were required to be used for maintenance to the exclusion of new construction (see box "U.S. Experience During the 1970s").

The condition of unpaved roads in the main networks in developing countries is even worse (12). In terms of road authority finances, the timing of maintenance for unpaved roads is less critical because the costs of restoration are, within rather broad limits, less sensitive to the timing of intervention. However, the aggregate effect of deterioration on vehicle operating costs can be quite large. Although unpaved roads normally carry less traffic, the riding condition of an unpaved road that is not maintained deteriorates much faster than a paved road. Deferral of simple maintenance measures (e.g., routine blading) on unpaved roads results in a rapid increase (as much as 100 percent) in vehicle operating costs.

Considerable variation exists in the conditions of roads in different regions and countries, which is explained by differences in the past maintenance needs of individual networks on the one hand and in the countries' responses to those needs on the other. A regional overview of the road conditions is presented in the following section.

U.S. Experience During the 1970s

The consequences of neglecting road maintenance are demonstrated by the U.S. experience during the 1970s. Needed maintenance on the federal-aid highway system was deferred or canceled by state agencies faced with budget constraints arising from the energy crisis and sharp recession beginning in 1974-1975. Because federal funds were not available for maintenance and rehabilitation, many states chose to let their roads, bridges, and highways deteriorate until they became eligible for capital federal aid for reconstruction. By 1982, the escalating deterioration of the federal aid highways, particularly the Interstate system, required a 44 percent increase in annual federal authorizations from \$9 billion (in 1982) to \$13 billion over the 1983-1990 period to help finance the repair and replacement of various components of the federal-aid system. The total cost of this restoration was estimated at \$104.8 billion: Interstate highways, \$19.6 billion; primary, secondary, and urban systems, \$44.7 billion; and bridges, \$40.5 billion. Although the United States may be able to mobilize such a massive level of resources to rehabilitate its road infrastructure, the less developed countries can ill afford this type of response.

Sub-Saharan Africa

At present, paved roads in Western Africa are generally found to be in better condition than in most other regions: 52 percent are considered good, 23 percent fair, and 25 percent poor. In Eastern and Southern Africa conditions are more typical: 42 percent good, 32 percent fair, and 26 percent poor. The relatively better condition of the paved roads in Western Africa is largely due to the rapid expansion of the paved networks during the last 10 years—about 50 percent of the paved road network in Western Africa was newly constructed, upgraded, or reconstructed during the last decade. Ivory Coast and Nigeria (see box "Nigeria's New Roads and the Risk of Massive Deterioration") substantially rebuilt their paved networks after 1975. Nigeria financed the effort by increased income from oil revenues. Even in less-endowed countries there has been a rapid improvement of road networks in the past decade financed by external-aid agencies. In Burundi, an Eastern African example, the length of the paved network has increased by more than 50 percent since 1979, whereas gravel roads have increased four-fold. Of 20 Western African countries for which information is available, 15 have networks with relatively new roads. The proportion at 10 out of 16 is not significantly lower for Eastern and Southern Africa. Many African countries are still enjoying an initial grace period during which maintenance requirements are minimal for much of their paved networks.

Nigeria's New Roads and the Risk of Massive Deterioration

The Nigerian Federal Trunk Road System, which has a total length of 29 000 km, has been largely rebuilt since 1975 in response to the explosive growth in road traffic following the economic expansion triggered by the increase in oil prices in 1973-1974. Traffic increases of 15 to 35 percent per annum were not uncommon on the federal network until 1978. Of the 21 000 km of paved roads, about 7600 km (36 percent) were constructed or rehabilitated during 1975-1980 and another 5000 km (24 percent) during 1981-1985. As a result, 62 percent of the paved network has been virtually abandoned because of ineffective maintenance, and an estimated 90 percent is in poor condition.

Despite the remarkable expansion and improvement of the Nigerian trunk road system during the last 10 years—at an estimated expenditure of about \$8 billion—its condition is still precarious. The design standards used in road improvement and construction works have tended to encourage the use of generous geometric features but weak pavements, which require substantial strengthening within 3 to 4 years after initial construction to ensure continued use of the roads. In addition, a substantial part of the network has been improved under short-term emergency rehabilitation programs, which consist of a minimum of works necessary to make the roads serviceable. Without an extensive pavement strengthening program covering about 2000 to 3000 km a year at an estimated annual expenditure of \$150 to \$200 million and a concerted effort to improve maintenance, the Nigerian trunk road system may deteriorate rapidly, requiring massive rehabilitation and reconstruction in the next 10 to 15 years.

The continuous expansion and upgrading of the networks has masked serious weaknesses in road maintenance in many African countries; this holds serious portent. Gravel and earth roads deteriorate more quickly from maintenance neglect than paved roads; this is already reflected in the relatively poor condition of the main unpaved networks, particularly in Western Africa, with 20 percent good, 36 percent fair, and 44 percent poor.

East Asia and Pacific

The relatively poor state of East Asian paved networks (20 percent good, 59 percent fair, and 21 percent poor) primarily reflects conditions in three large countries: Indonesia, the Philippines, and China. China has not neglected maintenance; rather the existing 173 000-km paved network is woefully inadequate for the current demands placed on it, not only in terms of low spatial road density in the country's more densely populated regions, but also in terms of the structural and traffic-handling capacity of the network. Because of the expansion of the network in the 1970s, and also because many roads were built with inferior materials as a result of earlier difficulties in obtaining good quality bitumen in China, currently 70 percent of the existing main paved network is in need of resurfacing or strengthening. A substantial portion of the network requires not only structural strengthening but also substantial geometric improvements to cope with anticipated traffic growth. Other countries in East Asia, particularly Korea, Thailand, and Malaysia, have also experienced high growth, and have invested heavily in the expansion and improvement of their road networks. They are still enjoying the initial period when paved road maintenance demands are minimal, but will require a substantial expansion of road maintenance capacity to cope with future needs. The unpaved main roads in East Asia are in relatively better condition (41 percent good, 34 percent fair, and 25 percent poor) compared with other regions, possibly because of the higher traffic on these roads and consequently more intensive levels of maintenance.

South Asia

Current road conditions are by far the worst in South Asia. Only 18 percent of the paved main network is rated in good condition whereas 36 percent is in poor condition. Unpaved roads are in worse shape: no more than 6 percent are in good condition, and fully 55 percent are in poor condition. The regional aggregates are dominated by the large Indian networks (federal and state) of some 127 000 km, but conditions are not too dissimilar in other countries in the region, except Nepal whose small network is still relatively new. The pronounced deterioration in the South Asian networks is a result of the sustained growth in road transport over the last decade (without a commensurate level of investments in road infrastructure) and a shift of passenger and goods traffic from other modes to roads. The road networks consist mainly of aging and obsolete roads that have neither the geometric capacity nor the structural strength to carry the increasing traffic and vehicle loads. Poor quality construction and outmoded maintenance methods have not helped the situation. The critical need at this time is not so much restoration and maintenance as it is replacement and upgrading of an antiquated road infrastructure. To sustain its

Pakistan's Deficient Road Infrastructure

The main road network in Pakistan comprising the national and provincial highways amounted to some 45 000 km in 1983. Nearly 30 000 km are now paved compared with 8000 km at the time of independence in 1947. The main road network, together with about 49 000 km of district roads and 11 000 km of municipal roads, provides extensive coverage, but the quality of roads is deficient and in need of substantial improvement. Most of the paved road system has inadequate geometric characteristics, particularly road width, and only 1500 km of national and provincial highways have two lanes or more. The structural condition of the roads is no better. Nearly 32 percent of the paved main roads and 70 percent of unpaved roads were estimated to be in poor condition in 1984.

The rapid growth in traffic (averaging about 11 to 13 percent per annum during the past 10 years), the high proportion of heavy-laden trucks, inadequate planning and management of highway development, insufficient road maintenance, deficient design and construction standards, and obsolete construction technology have all contributed to the poor and deteriorating condition of roads in Pakistan.

To cater to the growing demand for road transport, which has now replaced rail as the dominant transport mode and accounts for 80 to 90 percent of nonurban passenger traffic and 70 percent of freight traffic, Pakistan now needs to undertake a major program of road modernization and upgrading. This will not be an easy task, because the domestic road-building capacity using modern road construction technology amounts to about 15 to 25 km of highway per month. Bad roads are likely to impede the introduction of efficient and economical road transport technology in Pakistan. Eventually they could seriously constrain the country's development and economic growth prospects.

recent rate of economic growth, South Asia now faces the need for a large road-building program (see box "Pakistan's Deficient Road Infrastructure").

Europe, Middle East, and North Africa

In this region the main networks are well developed and, for the most part, so are maintenance institutions. However, the mature age profile of the networks implies higher maintenance requirements, which, combined with budgetary constraints in some countries (e.g., Yugoslavia and Morocco), has resulted in a road condition mix of 40 percent good, 35 percent fair, and 25 percent poor, with corresponding values for the unpaved network of 30 percent good, 46 percent fair, and 24 percent poor, respectively. Although conditions have improved for the region as a whole, the situation in some countries has deteriorated over the past 5 years. Most conspicuous is Yugoslavia, whose paved network, formerly one of the better maintained of the developing countries, has slipped because of unusually severe budgetary constraints to 30 percent good condition, 41 percent fair, and 29 percent poor. In the Republic of Croatia, for example, the periodic maintenance backlog was estimated at 40 percent of the network in 1985–1986 and was growing at the rate of about 13 percent (700 km) annually. Morocco's paved

network is in even worse condition, with a current condition distribution of 20 percent good, 44 percent fair, and 36 percent poor. The need for immediate action is particularly striking in Yemen People's Democratic Republic where fully 69 percent of the paved network is now in fair condition.

Latin America and Caribbean

On average, current road conditions in the Latin American Region are still relatively good (44 percent good, 32 percent fair, and 24 percent poor for paved roads), but striking variations across countries and across time are concealed. Latin America contains two countries in which the condition of the paved networks approaches the condition distribution of well-maintained networks: Paraguay (with an estimated 73 percent of roads in good condition, 22 percent fair and 5 percent poor), and, most important, the Mexican federal network of more than 40 000 km (85 percent good, 10 percent fair, and 5 percent poor). However, the region also has countries (Bolivia, Costa Rica, Guatemala, Haiti, Jamaica, and Peru) where only one-fourth or less of main paved roads are in good condition. The condition of main paved roads are especially bad in Guatemala (7 percent in good condition, 50 percent fair, and 43 percent poor) and Jamaica (10 percent good, 75 percent fair, and 17 percent poor). Unpaved roads, which constitute about 51 percent of the main roads in Latin America, are worse than the average in Peru, Haiti, Belize, Bolivia, Jamaica, Argentina, and Costa Rica. Traffic levels on some of these roads, however, are quite low (10 to 20 vehicles per day) and substantial improvements in road conditions may not be warranted.

Road conditions in Latin America and the Caribbean as a whole have recently worsened quite rapidly, mirroring the general economic downturn and accompanying financial stringencies over the past 5 years—this illustrates how quickly roads can deteriorate once they reach the critical stage in their life cycle. Brazil with by far the largest network in Latin America has seen serious erosion despite substantial maintenance efforts. In 1984, 28 percent of the network was reported in poor condition compared with 18 percent in 1979 (see box "A Case of Undermaintenance: Brazil's Federal Highway Network"). In Honduras, which in the past had devoted an adequate level of effort and resources to road maintenance, the deterioration has been even more dramatic, with the percentage of the paved road network in good condition dropping from 82 percent in 1981 to 50 percent in 1984, largely because of financial constraints. The large decline in road condition may partly reflect differences in condition measurement and evaluation over the 2 years.

DETERMINANTS OF ROAD CONDITIONS

The condition of road networks, at both global and regional levels, point to a serious neglect of maintenance in all but a handful of countries. Most countries that currently enjoy relatively good road conditions—particularly within the sub-Saharan Africa, Latin America, and East Asia regions—do so largely because of recent large additions to their networks and because such roads have not yet reached the end of their design lives—older roads in their networks have already deteriorated.

A Case of Undermaintenance: Brazil's Federal Highway Network

A 1979 survey of Brazil's federal highway network showed the following distribution of road conditions:

Condition	km	%
Good	10 000	24
Fair	23 000	58
Poor	7 000	18
Total	40 000	

Restoring all roads at that time would have cost \$1.8 billion (1985 prices). A repeat survey in 1984 rated the network as follows:

Condition	km	%
Good	14 000	30
Fair	19 000	42
Poor	13 000	28
Total	46 000	

The increase in the percentage of roads in good condition resulted from new construction not good maintenance: 6000 km of new paved roads were constructed, whereas 2000 km of those formerly in good condition declined to fair condition. Nor did the massive backlog of roads in fair condition receive the resurfacing and strengthening that was needed. Some 6000 km of that group deteriorated to poor condition, greatly increasing the number of kilometers and the percentage of roads needing rehabilitation rather than just maintenance. The cost of this rehabilitation is estimated at \$1.7 billion, and the cost of preventive maintenance needed to save the roads in fair condition is estimated at about \$750 million (1985 prices). Thus, the federal rehabilitation and maintenance backlog increased to \$2.4 billion, a one-third increase in 6 years.

The portent is clear, as shown by the extremely high proportion of roads in fair condition—on a regional basis ranging from 23 to 59 percent for paved and 30 to 46 percent for unpaved main networks.

A multitude of factors explain why roads have been allowed to deteriorate to such an extent. The circumstances of every country are unique in one respect or another, so that generalizations are difficult and invariably subject to many exceptions. But there are common structural and response denominators that contribute to an understanding of the road deterioration problem across countries and the policy responses needed to deal with it. The structural parameters related to physical and economic conditions help to delineate the magnitude of the problem and the room for maneuvering in dealing with it. The response parameters related to financial, management, institutional, and political conditions provide a basis for gauging the efforts made to address the problem within a country's particular circumstances.

The more important of the structural parameters relate to

- Size of the country's road network and the percentage of paved roads;

- Age distribution of the paved network (which is, of course, closely associated with the level of recent investment);
- Volume and rate of traffic growth; and
- Financial capacity.

The length of the road network and the proportion paved are major determinants of overall maintenance requirements. The age distribution of the network is important because of the particular characteristics of paved road deterioration, with typically two-thirds of pavement deterioration (and an even higher percentage of maintenance costs) being concentrated in the final one-third of the pavement design life. Where a recent boom in road construction has occurred—as in many developing countries—a grace period of several years can be expected during which roads remain in good condition and maintenance demands are minimal, followed by a period in which maintenance requirements surge dramatically. Traffic growth is also an important determinant, because sustained demand for road transport can quickly render existing road networks obsolete. The size, quality, and age of networks and the growth of traffic can thus help to explain some of the differences in the level and character of maintenance requirements.

The capacity to fund road maintenance in a given country depends on the national resources. Gross national product per capita may be a good index of the fiscal capacity of the nation, although the governments of some countries are able to capture more of it than others. Out of a given total fiscal intake, allocation of funds to highways is a political decision, reflecting a judgment about national priorities. Variations in income growth (growth rate of GNP per capita) are also important: severe setbacks in income growth clearly help explain some important instances of underfunding of maintenance and consequent road deterioration, for example, in Latin America.

A broad idea of the economic burden that road maintenance imposes on a country is to be gained from the ratio of its network length to GNP (the income-density of roads), although an allowance has to be made for aging networks and heavy traffic loading that would increase the burden, whereas lower traffic volumes in poorer countries would tend to lower the burden. Values of the ratio for main roads range from 0.3 km per million dollars of GNP for Korea and 0.4 for Nigeria to more than 8.0 for Zaire and Botswana and 14.8 for Guinea-Bissau. Of the 36 countries with the highest value of this ratio, 32 are in sub-Saharan Africa (Table A-2). Even with the best management, these countries would face the world's highest burden of road maintenance requirements relative to income.

GNP per head and its rate of change, together with network length, age distribution, and traffic do not fully explain the variations in road conditions that reflect the extent to which maintenance requirements have been met. Several higher-income developing countries have poor roads, whereas some of the lowest income countries have better ones. The capacity of a country to deal with its maintenance needs depends on how effectively and efficiently it can translate available resources into protection and rehabilitation of road infrastructure.

The response parameters are intended to gauge the size and quality of a government's efforts to address its road maintenance needs and involve a number of managerial, institutional, and political factors, collectively known as absorptive capacity.

Absorptive capacity has a number of facets. One has to do with scale—the stock of machinery and the size of the labor

force that can be applied to the activity. Another is the soundness of the maintenance strategy—type, level, and timing of intervention—and still others are the managerial and operational efficiency in executing the strategy. These depend, in turn, on such factors as the institutional structure, managerial ability, staff quality, accountability, incentives, and the extent to which objectives that conflict with efficiency (such as employment generation or other objects of political patronage) are imposed on the road authority.

All of these factors can in turn be related to the level of interest and quality of public leadership not only at the road authority level but also at the political level. Often political conviction is needed to accord priority in allocation of scarce resources (human as well as financial) to maintenance rather than to other politically more popular causes. The perceived interest of high government officials in road maintenance functions can also be an important determinant of the quality and motivation of staff attracted to the task, as demonstrated in several countries.

Experience with these aspects of absorptive capacity has often been remarkably disappointing. When limited absorptive capacity cannot readily be expanded, the prospects are poor for recovering infrastructure that has already suffered degradation or for preventing heavy losses of capital when the peak of maintenance needs is yet to come.

RESPONSE TO THE PROBLEM— A COUNTRY TYPOLOGY

The countries subject to road maintenance problems are of several types. Some have backlogs of maintenance because their financial and institutional capacities have not expanded as fast as their networks. Some have built up backlogs by deferring needed maintenance during adverse economic conditions. Some do not appear to have backlogs at present, but their networks of relatively recent construction will soon greatly increase and will require systematic maintenance to prevent rapid deterioration. The road deterioration problem pervades the developing world. At the core of the problem are mainly the countries of sub-Saharan Africa and South Asia; at the hard core of the problem are sub-Saharan countries whose financial and institutional capacities are unequal to the task at hand or to the task they will soon have to face.

To differentiate responses to the road deterioration problem at the country level, a typology of cases is proposed in Table 3, for a variety of structural and response parameters influencing road conditions. The typology consists of six representative categories in which the main road networks of the 85 countries have been grouped (Table 4). The geographical distribution of the typological groups is shown in Figure 2. The quantification of response parameters in the proposed typology has been particularly difficult. Adequate data on road maintenance expenditures are available only for 18 countries. Assessing efficiency of resource utilization at either the planning or the operation level poses an even greater challenge as few developing countries possess adequate management information systems to monitor and evaluate use of resources applied to their road networks. Although no pretense to scientific precision is made, the purpose of the classification is to identify country groupings in terms of needed actions to improve the conditions of their respective main road networks.

TABLE 3 FRAMEWORK FOR A TYPOLOGY OF ROAD CONDITION DETERMINANTS

Type	No. of Countries	Determinants of Road Condition																	
		Condition of Main Roads						Road Network Expansion, Median Values (%)			Maintenance Backlog			GNP per Capita (\$ million)		GNP per Capita Growth per Annum 1975-1985 (\$)			
		Paved Networks (%)			Unpaved Networks (%)			Paved Roads		Unpaved	Replacement Value (%)			Range	Median	Range	Median	Range	Median
		Good	Fair	Poor	Good	Fair	Poor	80-84	75-79	80-84	(\$ million)	Range	Median	Range	Median	Range	Median		
Adequately maintained networks	11	74	19	7	34	44	22	12	15	24	1,357.1	2.7-8.9	5.7	180-2,290	1,240	-1.3-5.1	0.8		
Recently expanded networks, middle and upper income	21	44	31	25	34	35	31	27	19	10.5	12,240.0	2.7-28.7	13.4	540-6,490	960	-3.3-7.9	2.2		
Recently expanded networks, lower income	20	41	37	22	34	28	38	23	15	10	594.1	2.4-27.3	10.5	110-530	290	-3.7-3.7	-0.15		
Aging networks, middle and upper income	16	32	38	30	19	50	31	8	4.5	11	10,751.9	7.6-34.4	15.6	660-4,340	1,420	-4-7	1.4		
Aging networks, low income, low growth or decline	11	23	32	45	36	32	33	6	12.5	12	1,867.0	1.8-29.6	15.9	80-540	230	-7.7-0.	-3.35		
Obsolete or inadequate networks, low income, moderate or high growth	6	14	58	28	35	30	35	8	9	NA	13,053.7	8.9-33.3	23.6	130-380	285	1.6-6.8	3.25		

TABLE 4 CLASSIFICATION OF ROAD NETWORKS BY COUNTRY TYPOLOGY

Category	Regional Distribution						Average Network Condition					
	Eastern and Southern Africa (19)	Western Africa (20)	East Asia and Pacific (7)	South Asia (6)	Europe, Middle East, and North Africa (14)	Latin American and Caribbean (19)	Paved (%)			Unpaved (%)		
							Good	Fair	Poor	Good	Fair	Poor
<i>Group 1</i> Networks in countries with an adequate record of road maintenance (11)	Malawi Rwanda Zimbabwe	Niger	—	—	Hungary Romania Tunisia	Honduras Mexico Panama Paraguay	74	19	7	34	44	22
<i>Group 2</i> Recently expanded networks in middle and upper income countries (21)	Botswana Swaziland	Cameroon Congo Ivory Coast Nigeria	Indonesia Korea Malaysia Papua New Guinea Thailand	—	Egypt Oman Syria Yemen, AR Yemen, PDR	Brazil Colombia Costa Rica Dominican Republic Ecuador	44	31	25	34	35	31
<i>Group 3</i> Recently expanded networks in low-income countries (19)	Burundi Comoros Djibouti Ethiopia Kenya Lesotho Somalia Sudan	Benin Burkina Central African Republic Gambia, The Guinea Liberia Mali Mauritania Senegal	—	Nepal	—	Haiti	41	37	22	34	28	38
<i>Group 4</i> Aging networks in middle to upper income countries (16)	Mauritius	—	Philippines	—	Algeria Cyprus Morocco Portugal Turkey Yugoslavia	Argentina Barbados Belize Chile Guatemala Jamaica Peru Uruguay	32	39	29	19	50	31
<i>Group 5</i> Aging networks in low income countries with low economic growth or decline (11)	Madagascar Tanzania Uganda Zaire Zambia	Chad Equatorial Guinea Ghana Guinea-Bissau Sierra Leone	—	—	—	Bolivia	24	22	44	36	32	32
<i>Group 6</i> Obsolete or inadequate networks in low income countries with moderate to high economic growth (6)	—	—	China	Bangladesh Burma India Pakistan Sri Lanka	—	—	14	58	28	35	30	35
Global average: (19)							32	43	26	31	36	32

NOTE: Figures in parentheses are number of countries.



FIGURE 2 Typology of road networks in developing countries.

Group 1: Networks in Countries With an Adequate Record of Road Maintenance

This group encompasses a geographically disparate set of 11 countries (4 in sub-Saharan Africa, 1 in North Africa, 2 in Europe, and 4 in Latin America) that share the common characteristic that they have done a better job in preserving their road networks (particularly paved roads and to a lesser degree unpaved roads) than their otherwise comparable counterparts. On average 74 percent of paved roads are in good condition, 19 percent are fair, and only 7 percent are poor—not much different from the status of an optimally maintained network. Unpaved roads at 34 percent good, 44 percent fair, and 22 percent poor are well short of an optimal condition distribution, but still are generally better than in most other developing countries. The countries vary widely in economic circumstance (with per capita incomes ranging from \$210 to \$2,290) and in political and economic organization (from free-market to socialist). In these cases the primary advice for the future is to continue much as before with somewhat greater attention to institutional strengthening, technological improvements, and efficient operations, particularly on unpaved roads. In the two lowest income countries, Malawi and Niger, where a high proportion of the paved network is still relatively new, a swell in maintenance requirements will occur over the next several years, which might be difficult to meet without substantial external assistance.

Group 2: Recently Expanded Networks in Middle- and Higher-Income Countries

This group of 21 countries also covers a wide range of income, political and economic organization, and geographic location, although most countries in East Asia and Middle East regions are represented in this group. What they have in common is that a substantial proportion (often more than 50 percent) of their paved network has been constructed (or reconstructed) during the past 10 years, resulting in a relatively high proportion of the network being in good condition today with low current maintenance requirements but with the expectation of a surge in maintenance requirements in the future. These countries must prepare now for a major build-up in maintenance—institutionally as well as financially—well beyond their existing capabilities. A reallocation of resources from within the road sector (or from other sectors) will be needed to meet the skyrocketing road maintenance bill. Most of these countries are well placed from an absorptive capacity standpoint to institute major policy and institutional changes in their roads sector.

Group 3: Recently Expanded Networks in Lower-Income Countries

This group of 20 countries, all except 2 (Haiti and Nepal) in sub-Saharan Africa, share the characteristics of Group 2, except for the level and rate of growth of income and road networks that consist predominantly of unpaved surface. These countries, too, must prepare for the surge in road maintenance requirements ahead, but because of their low incomes, they will find it more difficult to sustain the level of expenditures needed to maintain all of their recently expanded networks to good

standards. A selective road maintenance strategy that focuses on the economically and socially most important roads is indicated. Without a sustained level of continued external assistance—both financial and institutional—and improvements in the use of available resources, the maintenance requirements of their expanded road networks will heavily strain the limited financial and institutional capacities of these countries. A major shift in policy direction will be needed to deemphasize new construction and expansion of road networks in favor of maintaining existing roads.

Group 4: Aging Networks in Middle- to Higher-Income Countries

This group of 16 countries (all in LAC and EMENA regions, with the exception of Mauritius and the Philippines) shares the characteristic that there has been relatively little expansion to their networks recently (so that current maintenance requirements are a reasonably good indication of the future) and most have long-established maintenance capabilities. Maintenance needs have not been fully funded in the past, and the networks have been deteriorating. The primary constraint is additional finance. The institutional capabilities are reasonably well-established in most of these countries.

Group 5: Aging Networks in Low-Income, Low-Growth Countries

In this group of 10 sub-Saharan countries plus Bolivia, there has been relatively little expansion to the networks, but they are still struggling to establish effective road maintenance institutions, and the low incomes with either stagnant or declining economies make it difficult for these countries to maintain their existing networks, which consist mainly of unpaved roads. With future prospects even less encouraging for this group than for countries in Group 3, and on average 4 percent of paved roads in poor condition, a selective policy must be pursued to concentrate limited available resources on the most vital segments of the networks mainly for rehabilitation and periodic maintenance work. A massive dependence on external assistance is foreseen for these countries, and it is essential that appropriate, less capital-intensive road maintenance technologies be adopted by these countries to reduce this dependence locally and establish a sustainable level of maintenance.

Group 6: Obsolete or Inadequate Networks in Low-Income, and Moderate-to-High-Growth Countries

This group, composed of five South Asian countries plus China, shares the characteristic that existing networks are either largely outmoded or, in the case of China, simply not yet developed for current or readily foreseeable traffic demands. Roads in South Asia are mostly old and in an advanced state of disrepair. Because these roads do not have the traffic flow or structural capacity to meet the needs of growing economies in which the role of road transport is rapidly expanding, restoration and maintenance of the existing networks is not enough.

What is required is replacement and, like China, expansion to a modern network commensurate with the new role of road transport. A key requirement will be the adoption of modern road building and maintenance technologies in order to make the best use of available resources. The resistance to institutional and technological change is rather strong in South Asian countries despite the availability of abundant well-trained manpower. Finding innovative approaches of technology transfer and improving technical skills will prove to be a major challenge for the road administrations in these countries.

CONCLUSIONS

The developing countries are losing capital through massive deterioration of their roads. Large networks, built at great expense, have been undermaintained and more heavily used—and abused—than expected. If the decay is allowed to continue, it will accelerate, as old pavements crumble and younger ones outlive the period when neglect has little visible effect. The cost of restoring roads after they have disintegrated—three to five times the cost of preventive measures—is compounded by drastically increased vehicle operating costs. The cost in both forms would be a major drag on economic development. It is urgent to recognize the dimensions of the problem and to arrest the process while it can still be done at a reasonable cost.

The genesis of the problem lies in the rapid development of the road networks, which expanded much faster in the 1960s and 1970s than did maintenance budgets and institutional capacities. In many countries the need for expanding maintenance capacity has not been recognized or acted on early enough, further compounding the problem. The task now facing many developing countries is to salvage valuable infrastructure that has severely decayed while protecting newer vintages of roads from a similar fate. This task has major financial and institutional dimensions.

Arresting the deterioration process and repairing damage already suffered will require serious commitment by the countries concerned and by international development agencies. It will require improvements in institutions and management, good choices of technical options, and in some cases an increase in financial inputs to the roads sector. In others, the length of maintained networks may have to be reduced in order to concentrate available resources on road links with the highest social and economic priority.

In the 85 countries that receive World Bank assistance for roads, 26 percent of paved and 34 percent of unpaved main roads outside of urban areas have already decayed to the point of needing reconstruction. Of even greater concern is the large proportion (currently 42 percent) of paved roads that are now, or soon will be, in that critical phase when pavement strengthening is required if reconstruction is not also needed.

Although the circumstances of every country are unique in

one respect or another, an attempt has been made to identify broad parameters of policy responses needed to halt the deterioration of roads. The recommended policy actions are differentiated by six country types identified from a common set of characteristics related to the condition of the road networks in the 85 developing countries.

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APPENDIX

TABLE A-1 BASIC CHARACTERISTICS OF REGIONAL ROAD NETWORKS

REGION	NUMBER OF COUNTRIES	AREA KM ²	POP.		GNP/CAPITA		TOTAL ROAD NETWORK				MAIN ROADS				MAIN PAVED ROADS				REPLACEMENT VALUE OF MAIN NETWORK					
			1984	1984	1984	p.a. (%)	1984	75-85	LENGTH	%	DENSITY: KM PER	UNIT GNP	NETWORK	%	DENSITY: KM PER	UNIT GNP	LENGTH	DENSITY: KM PER	AVG. COST/KM	AVG. COST/KM	VALUE (US\$bn)	% OF		
		(US\$bn)	(Mn)	(US\$)			('000)				(US\$Mn.)	('000KM)	PAVED	100KM ² :1000P	(US\$Mn.)	('000)	100KM ²	(US\$)	(US\$)	UNPAVED	PAVED	UNPAVED	TOTAL	GNP
EASTERN AFRICA	19	11,051	51.2	201	310	-0.1	588.3	7.7	5.3	2.9	11.5	190.5	24.6	1.7	0.9	3.7	46.9	0.8	255,000	40,000	12.0	5.7	17.7	34.6
WESTERN AFRICA	20	8,891	104.7	186	290	-1.0	430.9	12.6	4.8	2.3	4.1	144.5	37.3	1.6	0.8	1.4	53.9	0.9	245,000	40,000	13.2	3.6	16.8	16.1
Excluding Nigeria	19	7,967	34.3	90	270	-0.9	322.9	10.3	4.1	3.6	9.4	115.4	27.8	1.4	1.3	3.4	32.1	0.5	245,000	40,000	7.9	3.3	11.2	32.6
EAST ASIA & PACIFIC	7	13,184	600.4	1350	710	3.4	1539.6	18.1	11.7	1.1	2.6	450.9	61.4	3.4	0.3	0.8	276.9	9.5	300,000	40,000	83.1	7.0	90.0	15.0
Excluding China	6	3,623	281.4	221	785	2.5	571.2	15.9	15.8	2.6	2.0	196.6	52.8	5.4	0.9	0.7	103.8	5.6	300,000	40,000	31.1	3.7	34.9	12.4
SOUTH ASIA	6	5,120	257.5	1008	220	2.4	1680.7	31.1	32.8	1.7	6.5	217.1	180.3	4.2	0.2	0.8	174.3	7.4	180,000	40,000	31.4	1.7	33.1	12.9
Excluding India	5	1,922	62.7	259	180	1.8	180.7	26.7	9.4	0.7	2.9	89.6	56.0	4.7	0.3	1.4	50.2	2.3	180,000	40,000	9.0	1.6	10.6	16.9
EUROPE, MIDDLE EAST AND NORTH AFRICA	14	6,476	338.1	232	1795	3.1	1051.0	29.3	16.2	4.5	3.1	303.7	74.5	4.7	1.3	0.9	226.3	10.6	280,000	40,000	63.4	3.1	66.4	19.7
LATIN AMERICA AND CARIBBEAN	19	18,859	583.9	350	1190	0.0	2212.1	11.0	11.7	6.3	3.8	511.7	49.2	2.7	1.5	0.9	251.8	6.8	260,000	40,000	65.5	10.4	75.9	13.0
Excluding Brazil and Mexico	17	8,374	199.1	141	1160	-0.1	874.1	11.8	10.4	6.2	4.4	193.7	44.3	2.3	1.4	1.0	85.8	2.0	260,000	40,000	22.3	4.3	26.6	13.4
TOTAL	85	63,581	1935.9	3327			7502.6	19.4	11.8	2.3	3.9	1818.4	56.8	2.9	0.5	0.9	1030.0	29.5		268.4	31.5	299.9	15.5	

TABLE A-2 ROAD NETWORKS BY GEOGRAPHIC REGION

REGION COUNTRY	POP. 1984 (M)	---GNP/CAPITA---			TOTAL GNP (\$M.)	-----TOTAL NETWORK-----						-----MAIN NETWORK-----						-----MAIN PAVED NETWORK-----						-----MAIN UNPAVED NETWORK-----					
		AREA ('000KM2)	1984	ANNUAL GROWTH 1975-85 (%)		LENGTH (KM)	DENSITY			LENGTH (KM)	DENSITY			CONDITION			CONST./IMPROVED IN			CONDITION			CONST./IMP.						
							100KM	1000 \$M/GNP	\$M/GNP		100KM2	1000P	\$M/GNP	G.	P.	P.	--80/84--	--75/79--	LENGTH (KM)	G.	P.	P.	--80/84--	LENGTH (KM)	G.	P.	P.		
BSA BOTSWANA	1.00	600	960	7.9	960	13,000	2.2	13.0	13.5	8,026	1.3	8.0	8.4	1,967	90	8	2	600	31	400	20	6,059	40	30	30	400	7		
BSA BURUNDI	4.60	28	220	0.9	1,012	5,400	19.3	1.2	5.3	2,900	10.4	0.6	2.9	744	58	37	5	390.00	52	40.00	5	2,156	60	25	15				
BSA COMOROS	0.38	2	340	(1)	129	850	42.5	2.2	6.6	762	38.1	2.0	5.9	456	60	20	20	50	11	21	5	306	20	20	60				
BSA DJIBOUTI	0.36	22	358	(1)	129	2,800	12.7	7.8	21.7	1,100	5.0	3.1		300	30	60	10	24	8	0	0	800	10	10	80				
BSA ETHIOPIA	42.20	1,222	110	-0.9	4,642	43,200	3.5	1.0	9.3	13,600	1.1	0.3	2.9	3,800	33	34	33	485.00	13			9,800	33	34	33				
BSA KENYA	19.60	583	310	0.1	6,076	55,000	9.4	2.8	9.1	25,300	4.3	1.3	4.2	6,000	32	52	16	1,400	23	1,600	27	19,300	66	17	17	358	2		
BSA LESOTHO	1.50	30	530	3.7	795	4,000	13.3	2.7	5.0	2,010	6.7	1.3	2.5	398	25	35	40					1,612	20	50	30				
BSA MADAGASCAR	9.90	587	260	-3.4	2,574	50,000	8.5	5.1	19.4	10,150	1.7	1.0	3.9	4,890	20	30	50	300	6	450	9	5,260	20	20	60				
BSA MALAWI	6.80	118	180	0.2	1,224	13,280	11.3	2.0	10.8	5,571	4.7	0.8	4.6	2,004	50	35	15	270	13	913	46	3,567	30	35	35	400	11		
BSA MAURITIUS	1.10	2	1,090	2.6	1,199	2,795	139.8	2.5	2.3	1,787	89.4	1.6	1.5	1,610								177							
BSA RWANDA	5.80	26	280	1.0	1,624	10,000	38.5	1.7	6.2	4,000	15.4	0.7	2.5	800	80	20	0	300	38	60	8	3,200	20	80	0	3000	94		
BSA SOMALIA	5.20	638	260	-0.3	1,352	21,600	3.4	4.2	16.0	9,644	1.5	1.9	7.1	2,460	60	20	20					7,184	30	30	40				
BSA SUDAN	21.30	2,506	360	-0.4	7,668	19,110	0.8	0.9	2.5	7,000	0.3	0.3	0.9	2,240	40	30	30	790.00	35			4,760	20	20	60				
BSA SWAZILAND	0.71	17	800	-0.2 (*)	568	2,821	16.6	4.0	5.0	2,724	16.0	3.8	4.8	521	50	25	25	285	55	80	15	2,203	25	25	50				
BSA TANZANIA	21.50	945	210	-1.7	4,515	53,600	5.7	2.5	11.9	17,700	1.9	0.8	3.9	3,240	38	34	28	581	18			14,460	5	47	48	1700	12		
BSA UGANDA	15.00	236	230	-3.3	3,450	27,037	11.5	1.8	7.8	5,691	2.4	0.4	1.6	1,726	10	59	31			110	6	3,965	52	26	22				
BSA ZAIR	29.70	2,345	140	-3.9	4,158	145,000	6.2	4.9	34.9	40,900	1.7	1.4	9.8	2,400	17	20	63	200	8	400	17	38,500	61	25	14				
BSA ZAMBIA	6.40	753	470	-3.7	3,008	35,000	4.6	5.5	11.6	20,653	2.7	3.2	6.9	5,502	40	30	30	150	3	1,200	22	15,151	30	35	35	250	2		
BSA ZIMBABWE	8.10	391	760	-1.3	6,156	85,000	21.7	10.5	13.8	11,003	2.8	1.4	1.8	5,595	70	25	5					5,408	50	30	20	2090	39		
COUNTRIES = 19																													
SUM	201.2	11,051			51,239	589,493	5.3	2.9	11.5	190,521				46,653								143,868							
AVRAGE			255	-0.1							1.7	0.9	3.7		42	32	26						42	30	28				
WA BENIN	3.90	113	270	0.6	1,053	7,500	6.6	1.9	7.1	4,926	4.4	1.3	4.7	986	58	36	6	230	23	100	10	3,940	15	55	30	500	13		
WA BURKINA	6.60	274	160	0.9	1,056	11,200	4.1	1.7	10.6	6,300	2.3	1.0	6.0	1,400	40	40	20	400	29	281	20	4,900	10	30	60	355	7		
WA CAMEROON	9.90	475	760	3.9	7,524	64,905	13.7	6.6	8.6	13,500	2.8	1.4	1.8	2,900	60	30	10	783	27	797	27	10,600	20	50	30				
WA CHAD	4.90	1,284	80	-7.7 (*)	392	31,300	2.4	6.4	79.8	3,800	0.3	0.8	9.7	163	4	0	96	7.00	4			3,637	8	19	73	1000	27		
WA CONGO	1.80	342	1,140	2.2	2,052	11,000	3.2	6.1	5.4	7,000	2.0	3.9	3.4	1,100	69	15	16	620	56	480	44	5,900	30	20	50	150	3		
WA C.A.R.	2.50	623	260	-1.4	650	22,600	3.6	9.0	34.8	5,250	0.8	2.1	8.1	442	36	35	29	269	61	65	15	4,808	68	16	16	955	20		
WA EQUAT. GUINEA	0.37	28	180	(1)	67	1,540	5.5	4.2	23.1	1,090	3.9	2.9		485	26	0	74			80.00	16	605	0	0	100				
WA GHANA	12.30	239	350	-1.9	4,305	28,400	11.9	2.3	6.6	14,130	5.9	1.1	3.3	5,782	12	27	61	126	2			8,348	17	48	35				
WA GUINEA	5.90	246	330	0.2 (*)	1,947	14,000	5.7	2.4	7.2	4,550	1.8	0.8	2.3	1,145	51	35	14	201	18	85	7	3,405	13	22	65	975	29		
WA GUINEA-BISSAU	0.88	36	180	-2.1 (*)	158	4,040	11.2	4.6	25.5	2,300	6.4	2.6	14.5	485	2	65	33	30.00	6	30.00	6	1,815							
WA IVORY COAST	9.90	322	610	-2.2	6,039	47,880	14.9	4.8	7.9	13,680	4.2	1.4	2.3	3,620	78	15	7	955	26	1,330	37	10,060	30	60	10	170	2		
WA LIBERIA	2.10	111	470	-3.7	987	7,560	6.8	3.6	7.7	3,945	3.6	1.9	4.0	557	85	13	2	110	20	250	45	3,388	15	75	10	176	5		
WA MALI	7.30	1,240	140	0.0	1,022	13,500	1.1	1.8	13.2	5,222	0.4	0.7	5.1	1,890	43	33	24	540	29	378	20	3,332	11	4	85	1340	40		
WA MAURITANIA	1.70	1,031	450	-0.4	765	7,500	0.7	4.4	9.8	2,480	0.2	1.5	3.2	1,640	30	30	40	1,200	73	200	12	840	0	5	95				
WA NIGER	6.20	1,267	190	-1.1	1,178	19,000	1.5	3.1	16.1	6,369	0.5	1.0	5.4	2,609	70	20	10	505	19	757	29	3,760	30	35	35	666	18		
WA NIGERIA	96.50	924	730	-3.3	70,445	108,000	11.7	1.1	1.5	29,100	3.1	0.3	0.4	21,100	62	15	23	4,980	24	7,588	36	8,000	0	10	90				
WA SENEGAL	6.40	196	480	-1.3	3,072	11,700	6.0	1.8	3.8	9,700	4.9	1.5	3.2	3,762	51	36	13	470	12	740	20	5,938	4	26	70	400	7		
WA SIERRA LEONE	3.70	72	310	-0.3	1,147	9,924	13.8	2.7	8.7	7,040	9.8	1.9	6.1	1,280	20	45	35	240	19			5,760	30	40	30				
WA THE GAMBIA	0.71	11	260	-1.7	185	2,388	21.7	3.4	12.9	1,209	11.0	1.7	6.5	447	27	50	23	210	47	30	7	762	30	42	28	310	41		
WA TOGO	2.90	57	250	-1.5	725	7,000	12.3	2.4	9.7	2,921	5.1	1.0	4.0	1,712	40	24	36	427	25	235	14	1,209	30	45	25	86	7		
COUNTRIES = 20																													
SUM	186.5	8,891			104,769	430,937	4.8	2.3	4.1	144,512				53,505								91,007							
AVRAGE			562	-1.0							1.6	0.8	1.4		52	23	25						20	36	44				

(*) 1973-83

(1) Not Available

TABLE A-2 continued

REGION	COUNTRY	POP.		---GNP/CAPITA---		TOTAL GNP 1984 (\$M.)	-----TOTAL NETWORK-----			-----MAIN NETWORK-----			-----MAIN PAVED NETWORK-----					-----MAIN UNPAVED NETWORK-----													
		1984 (M)	ABBA ('000KM2)	1984	ANNUAL GROWTH 1975-85 (%)		LENGTH (KM)	DENSITY ---KM PER--- 100KM	DENSITY ---KM PER--- 1000 \$MGNP	LENGTH (KM)	DENSITY ---KM PER--- 100KM2	DENSITY ---KM PER--- 1000P \$MGNP	LENGTH (KM)	CONDITION G. F. P.			CONST./IMPROVED IN --80/84-- --75/79--		LENGTH (KM)	CONDITION G. F. P.			CONST./IMP. --80/84--								
BAP	CHINA	1029.20	9,561	310	6.8	319,052	915,100	9.6	0.9	2.9	254,300	2.7	0.2	0.8	173,300	10	70	20	22,000	13	59,000	34	81,300	50	25	25					
BAP	INDONESIA	158.90	1,919	540	3.6	85,806	201,300	10.5	1.3	2.3	45,800	2.4	0.3	0.5	27,550	30	30	40	5,530	20	5,000	18	18,250	22	47	-31	3500	19			
BAP	KOREA	40.10	98	2,110	6.4	84,611	54,000	55.1	1.3	0.6	23,481	24.0	0.6	0.3	9,928	70	25	5	3,860	39	1,926	19	13,553	60	20	20					
BAP	MALAYSIA	15.30	330	1,980	4.1	30,294	45,000	13.6	2.9	1.5	25,324	7.7	1.7	0.8	23,479								1,845								
BAP	PAPUA N GUINEA	3.40	462	710	-0.8	2,414	18,545	4.0	5.5	7.7	3,652	0.8	1.1	1.5	726	34	45	21	110	15	109	15	2,926	23	71	6					
BAP	PHILIPPINES	53.40	300	660	0.1	35,244	155,669	51.9	2.9	4.4	53,864	18.0	1.0	1.5	14,192	31	54	15	900	6	500	4	39,672	25	50	25	1055	3			
BAP	THAILAND	50.00	514	860	3.9	43,000	150,000	29.2	3.0	3.5	44,534	8.7	0.9	1.0	28,000	50	30	20	8,600	31	5,242	19	16,534	45	30	25					
COUNTRIES = 7																															
SUM		1,350	13,184			600,421	1,539,614	11.7	1.1	2.6	450,955				276,875								174,080								
AVERAGE				445	3.4							3.4	0.3	0.8		20	59	21						41	34	25					
SA	BANGLADESH	98.10	144	130	1.7	12,753	15,000	10.4	0.2	1.2	10,900	7.6	0.1	0.9	6,210	15	40	45	1,180	19	60	1	4,690	10	40	50					
SA	BURMA	36.10	677	180	3.9	6,498	27,983	4.1	0.8	4.3	25,400	3.8	0.7	3.9	8,400	0	50	50					17,000	0	50	50					
SA	INDIA/NATIONAL	749.20	3,288	260	1.9	194,792	1,500,000	45.6	2.0	7.7	32,000	1.0	0.0	0.2	31,600	20	45	35	2,500	8	3,000	9	400	20	40	40					
SA	INDIA/STATES										95,500				91,200	20	45	35					4,300	20	40	40					
SA	NEPAL	16.10	141	160	0.7	2,576	7,150	5.1	0.4	2.8	5,546	3.9	0.3	2.2	2,500	40	35	25	584	23	376	15	3,046	15	45	40	300	10			
SA	PAKISTAN	92.40	804	380	3.3	35,112	107,673	13.4	1.2	3.1	38,830	4.8	0.4	1.1	24,142	18	50	32	1,940	8	2,500	10	14,688	5	25	70					
SA	SRILANKA	15.90	66	360	3.2	5,724	25,500	38.6	1.6	4.5	8,900	13.5	0.6	1.6	8,900	10	40	50	50	1	100	1	0	0	0	0					
COUNTRIES = 6																															
SUM		1,008	5,120			257,455	1,683,306	32.9	1.7	6.5	217,076				172,952								44,124								
AVERAGE				255	2.4							4.2	0.2	0.8		19	45	36						6	39	55					
EMENA	ALGERIA	21.20	2,382	2,410	3.2	51,092	78,190	3.3	3.7	1.5	39,347	1.7	1.9	0.9	32,480	40	32	28			1,070	3	6,867	25	50	25					
EMENA	CYPRUS	0.67	9	3,590	7.0	2,405	6,831	75.9	10.2	2.8	3,031	33.7	4.5	1.3	2,938	5	55	40	253	9	400	14	93	0	50	50					
EMENA	EGYPT	45.90	1,001	720	4.8	33,048	30,089	3.0	0.7	0.9	28,725	2.9	0.6	0.9	15,081	39	33	28					13,644								
EMENA	HUNGARY	10.70	93	2,100	5.1 (*)	22,470	138,185	148.6	12.9	6.1	24,000	25.8	2.2	1.1	24,000								0								
EMENA	MOROCCO	21.40	447	670	1.4	14,338	57,692	12.9	2.7	4.0	19,080	4.3	0.9	1.3	14,816	20	44	36	1,625	11	55	0	4,264								
EMENA	OMAN	1.10	300	6,490	4.4 (*)	7,139	18,123	6.0	16.5	2.5	8,474	2.8	7.7	1.2	3,292	66	20	14	1,950	59	900.00	27	5,182				690	13			
EMENA	PORTUGAL	10.20	92	1,970	1.6	20,094	52,031	56.6	5.1	2.6	19,031	20.7	1.9	0.9	17,900	50	30	20	1,400	8	1,000	6	1,131	40	40	20	200	18			
EMENA	ROMANIA	22.70	238	2,290	(1)	51,983	73,500	30.9	3.2	1.4	14,700	6.2	0.6	0.3	14,000	69	21	10	810	6	1,670	12	700	39	37	24					
EMENA	SYRIA	10.10	185	1,620	-0.2	16,362	26,200	14.2	2.6	1.6	15,700	8.5	1.6	1.0	11,700								4,000								
EMENA	TUNISIA	7.00	164	1,270	2.6	8,890	78,190	47.7	11.2	8.8	16,900	10.3	2.4	1.9	9,140	55	36	9	1,000	11	900	10	7,760	30	40	30	2300	30			
EMENA	TURKEY	48.40	781	1,160	1.4	56,144	329,793	42.2	6.8	5.9	60,953	7.8	1.3	1.1	38,449								22,504								
EMENA	YEMEN AR	7.80	195	550	4.0	4,290	25,028	12.8	3.2	5.8	3,028	1.6	0.4	0.7	2,048	70	20	10	450	22	300	15	980	40	30	30	210	21			
EMENA	YEMEN PDR	2.00	333	550	5.2	1,100	7,100	2.1	3.6	6.5	1,887	0.6	0.9	1.7	1,650	27	69	4	637	39	602	36	237	33	33	34					
EMENA	YUGOSLAVIA	23.00	256	2,120	2.6	48,760	130,000	50.8	5.7	2.7	48,880	19.1	2.1	1.0	36,630	30	41	29	1,358	4	441	1	12,250	30	50	20					
COUNTRIES = 14																															
SUM		232	6,476			333,115	1,050,952	16.2	4.5	3.1	303,736				224,124								79,612								
AVERAGE				1,456	3.1							4.7	1.3	0.9		40	35	25						30	46	24					
LAC	ARGENTINA	30.10	2,767	2,230	-1.9	67,123	212,305	7.7	7.1	3.2	36,505	1.3	1.2	0.5	27,056	35	21	44			2,280	8	9,449	20	40	40					
LAC	BARBADOS	0.26	0	4,340	1.6	1,128	1,670	388.4	6.4	1.5	1,367	317.9	5.3	1.2	1,367								0								
LAC	BELIZE	0.16	23	1,150	3.6 (*)	184	2,000	8.7	12.5	10.9	1,871	8.1	11.7	10.2	442	32	48	20					1,429	2	43	55					
LAC	BOLIVIA	6.20	1,099	540	-4.0	3,348	39,824	3.6	6.4	11.9	9,382	0.9	1.5	2.8	1,351	21	48	31	120	9			8,031	20	30	50					
LAC	BRAZIL/FEDERAL	132.60	8,512	1,720	1.2	228,072	1,316,343	15.5	9.9	5.8	64,642	0.8	0.5	0.3	45,291	30	42	28	6,570	15			19,351	30	42	28					
LAC	BRAZIL/STATES										162,596				55,887								8,000	14	106,709						
LAC	CHILE	11.80	757	1,700	0.9	20,060	79,000	10.4	6.7	3.9	22,831	3.0	1.9	1.1	8,964	33	56	11	630	7	750	8	13,867	7	75	18	500	4			
LAC	COLOMBIA	28.40	1,139	1,390	1.7	39,476	77,200	6.8	2.7	2.0	24,397	2.1	0.9	0.6	9,620	42	37	21	1,730	18	1,953	20	14,777	42	37	22	1150	8			

(*) 1973-83

(1) Not Available

TABLE A-2 continued

REGION	COUNTRY	---GNP/CAPITA---			TOTAL GNP 1984 (\$M.)	-----TOTAL NETWORK-----			-----MAIN NETWORK-----				-----MAIN PAVED NETWORK-----				-----MAIN UNPAVED NETWORK-----											
		POP. 1984 (M)	AREA ('000KM2)	ANNUAL GROWTH 1975-85 (%)		LENGTH (KM)	DENSITY -----KM PER----- 100KM 1000P. \$M/GNP	LENGTH (KM)	DENSITY -----KM PER----- 100KM2 1000P \$M/GNP	LENGTH (KM)	CONDITON G. F. P.	CONST./IMPROVED IN --80/84-- --75/79--	LENGTH (KM)	CONDITON G. F. P.	CONST./IMP. --80/84--													
LAC	COSTA RICA	2.50	51	1,190	-0.3	2,975	28,500	55.9	11.4	9.6	4,789	9.4	1.9	1.6	3,044	22	29	49	890	29	240	8	1,745	8	7	85		
LAC	DOMINICAN R.	6.10	49	970	0.2	5,917	17,200	35.1	2.8	2.9	3,475	7.1	0.6	0.6	2,485	52	10	38	800	32	200	8	990	0	22	78	200	20
LAC	ECUADOR	9.10	284	1,150	0.3	10,465	37,910	13.3	4.2	3.6	8,400	3.0	0.9	0.8	3,380	53	19	28	270	8	790	23	5,020	65	10	25		
LAC	GUATEMALA	7.70	109	1,160	-3.3	8,932	18,426	16.9	2.4	2.1	10,641	9.8	1.4	1.2	3,043	7	50	43	243	8	162	5	7,598	11	62	27		
LAC	HAITI	5.40	28	320	0.7	1,728	4,000	14.3	0.7	2.3	2,473	8.8	0.5	1.4	606	0	100	0	130	21	130	21	1,867	10	42	48		
LAC	HONDURAS	4.20	112	700	0.4	2,940	12,058	10.8	2.9	4.1	6,018	5.4	1.4	2.0	1,614	50	43	7			282	17	4,404	50	38	12		
LAC	JAMAICA	2.20	11	1,150	-4.0	2,530	17,700	160.9	8.0	7.0	4,750	43.2	2.2	1.9	4,365	10	73	17	222	5	64	1	385	1	56	43	254	66
LAC	MEXICO/FEDERAL	76.80	1,973	2,040	0.6	156,672	212,626	10.8	2.8	1.4	43,500	2.2	0.6	0.3	40,520	85	10	5	4,000	10	2,000	5	2,980	30	50	20		
LAC	MEXICO/STATES										47,300				24,200								23,100					
LAC	PANAMA	2.10	77	1,980	1.3	4,158	8,665	11.3	4.1	2.1	8,400	10.9	4.0	2.0	3,094	36	54	10	330	11	450	15	5,306	8	68	24		
LAC	PARAGUAY	3.30	407	1,240	3.7	4,092	24,329	6.0	7.4	5.9	11,241	2.8	3.4	2.7	1,695	73	22	5	340	20	470	28	9,546	44	38	18	780	
LAC	PBRU	18.20	1,285	1,000	-2.5	18,200	58,516	4.6	3.2	3.2	27,300	2.1	1.5	1.5	7,178	24	24	52	920	13	70	1	20,122	10	30	60		
LAC	URUGUAY	3.00	176	1,980	-1.0	5,940	49,813	28.3	16.6	8.4	9,813	5.6	3.3	1.7	6,445	26	59	15					3,368	0	75	25		
COUNTRIES = 19																												
SUM		350	18,859			583,940	2,218,085	11.8	6.3	3.8	511,691				251,647								260,044					
AVERAGE				1,668	-0.03							2.7	1.5	0.9		44	32	24						24	43	33		
ALL REGIONS																												
COUNTRIES = 85																												
SUM		3,328	63,581			1,935,939	7,512,387				1,819,491				1,025,756								792,735					
AVERAGE				582								2.9	0.5	0.9		32	42	26						31	36	33		

(*) 1973-83

(1) Not Available