Session 1b Paper 2

TRANSPORT INFRASTRUCTURE AND AID EFFECTIVENESS IN THE PACIFIC ISLANDS REGION : A STRATEGY FOR REFORM

Colin A. Gannon
Senior Economist
Transport, Water & Urban Development
World Bank

David. J Bray
Private Consultant
Adelaide
Australia

Ian Gordon
Private Consultant
Adelaide
Australia

ABSTRACT

In most of the South Pacific Island States, high levels of foreign aid have financed the accumulation of a large stock of transport infrastructure. The major challenge now confronting the island governments is looking after the valuable stock that has been established However, maintenance and replacement of the existing stock is not sustainable from domestic resources The accumulated stock and the standard assets are low, delivery effectiveness is limited, and bilateral donors finance rehabilitation and reconstruction but are relucent to *maintain* infrastructure Premature and higher cost rehabilitation and reconstruction are often substituted for effective and systematic routine and periodic maintenance This raises infrastructure and user resource costs and impairs domestic economic performance and potential growth. *Maintenance* of existing assets is the key issue, not new investment. Policies and recurrent budget allocations have *not* reflected this priority Island governments need to formulate a strategy to reform the overall management of their transport infrastructure which includes the sectoral allocations of external assistance

Contact Author

Colin A Gannon
Senior Economist
The World Bank Group
Headquarters
Washington DC 20433
USA
E-Mail CGANNON@WORLDBANK.ORG@INTERNET

ATRF 96

+ The views expressed in this paper are those of the authors and they should not be attributed to the World Bank, AusAID or any other organization.

I. INTRODUCTION

Background and Context

1. The region of the South Pacific contains several countries which differ significantly from other developing countries. The countries are very small; they are remote from their major export and import markets; their populations are dispersed, and often spread over many islands; living standards are moderate despite many constraints; an extended family social system and a strong subsistence sector results in a low incidence of absolute poverty. The international and domestic transport markets are thin (low volumes and relatively long distances); their composition of trade is imbalanced (exports are largely limited to bulk primary products and tourism services, while imports are principally manufactured goods); they are vulnerable to natural disasters, especially cyclones; *and* foreign assistance flows are a *very large* part of national income.

2. High levels of foreign aid have financed the accumulation of a large stock of transport infrastructure and the major challenge confronting the governments is looking after the valuable stock that has been established. The objective of this paper is to present an overview of transport infrastructure for five of the Pacific Island States namely, Kiribati, Solomon Islands, Tonga, Vanuatu and Western Samoa (hereafter denoted PICs) and discuss its sustainability, its maintenance, and a strategy for its management. This overview is based on a comprehensive study of the transport sectors of the countries undertaken by the World Bank.[1] The methdology, data assembled, and empirical analysis conducted in that study represent what may be the first investigation of the *total* transport infrastructure for a group of similar, albeit small, countries. Space limitation restricts this overview to a brief discussion; full documentation is provided in World Bank (1993)

The Maintenance Issue

3. Not all existing infrastructure may be worth maintaining: demand for some facilities may have shifted since its original construction, some facilities may have been over or under-designed originally, and some facilities may have relatively low social merit. Thus, proper assessment of the adequacy of existing *maintenance* requires determination of the case for preserving, and at what standard, individual pieces of existing infrastructure—sections of road, particular wharves, and specific airfields. Maintenance is warranted only if each separate piece of infrastructure, to which it is applied, is a valuable *asset*, i.e., the item of infrastructure is expected to generate economic/social benefits which exceed the (opportunity) costs of its long-term preservation and use. Such assessments require an extensive set of micro level "asset appraisals". However, it is also possible to gauge the overall sustainability of the stock of transport infrastructure at a macro level. Estimates of the physical scale and replacement

---

1 The World Bank (1993) study was carried out by the authors with financial assistance for Messrs Bray and Gordon (as consultants) provided by (then) AIDAB.

plus maintenance costs, in aggregate, can be examined relative to a country's national income and geographical extent, and these relativities can be compared across similar countries.

4. For all PICs the existing stock of transport infrastructure is extensive. This situation has arisen primarily from insufficient investment planning and project appraisal, inadequate attention to future maintenance obligations, and large external grant assistance. Identification of infrastructure for which maintenance is warranted is beyond the analysis presented here which is limited to the sustainability of the existing stock. This provides a sufficient basis to advance a strategy to reform the overall management of infrastructure and its maintenance, including the allocation of external assistance.

5. Maintenance of infrastructure in the PICs is shaped by several background circumstances: the accumulated stock is very large relative to country size, recurrent budget resources and user charges are low, delivery effectiveness is weak, and donors willingly finance rehabilitation and reconstruction but are reluctant to *maintain* infrastructure. Premature and higher cost rehabilitation and reconstruction are often substituted for effective and systematic routine and periodic maintenance. Aspects of external financing, in effect, foster a form of "moral hazard" for governments; i.e., perceived readily available support for major rehabilitation reduces (and may eliminate) the willingness of PIC Governments to commit an adequate share of their own resources to proper maintenance of their assets.

6. Adequacy of maintenance for transport infrastructure in developing (and indeed developed) countries is not a new issue. Numerous studies by multilateral and bilateral assistance agencies have set out the global nature of the maintenance problem, and provided specific analyses through sectoral or subsectoral transport studies in various countries. See, for example, World Bank (1990) and Australian International Development Assistance Bureau (1988). Deterioration of infrastructure can result in substantial adverse consequences to a nation's economic performance. Poor maintenance not only increases infrastructure costs it also imposes other costs and reduces economic efficiency. For example, inadequate maintenance of infrastructure leads to higher vehicle operating costs, reduced productivity of port operations, and results in foregone social benefits from airfield closures. These additional costs reduce economic performance and are avoidable. Although quantification of the effects of under-maintenance of transport infrastructure is well developed for roads e.g., see Highway Design and Maintenance Standards Model, World Bank (1987), it is less systematically advanced for other modes.

7. *Prior* to project decisions recurrent maintenance cost requirements are not given sufficient attention in feasibility studies. Once a project is completed, the effects of deferred and under-maintenance of transport assets are often not transparent in the short term and the intermediate effects, which give rise to increasing transport user costs as the system decays, are often ignored or underestimated in setting budget priorities. In the longer term, full consequences have often been masked by external assistance for replacement and/or upgrading. In general, in the PICs, *maintenance* of existing assets is

the key issue, not new investment. Policies and recurrent budget allocations of PIC governments have *not* reflected this priority.

Towards a Management Framework

8. An overall strategy for infrastructure maintenance, covering management, financing and delivery does not exist in the PICs. In this paper, attention is directed at management, and in particular, an assessment of the sustainability of the transport infrastructure and its management implications.

II. Maintenance and Sustainable Infrastructure

9. This section examines the maintenance of existing infrastructure and its sustainability. This is achieved by establishing information in seven areas: (i) an inventory of transport infrastructure; (ii) replacement cost valuation; (iii) maintenance levels to keep the entire stock in good condition; (iv) comparison of assessed and actual maintenance expenditure; (v) implications of inadequate maintenance; (vi) existing levels of cost recovery by mode; and (vii) sustainability of the existing stocks.

Transport Infrastructure Inventory[2]

10. There has been a pervasive lack of data on transport infrastructure and its maintenance. No ministry or department holds an adequate inventory of assets (with the exception of the Solomon Islands Port Authority) and there has been no detailed information which would serve management needs at the network, project or operational levels.

11. Assembly of a physical inventory of the existing stock of transport infrastructure in the five PICs was a major undertaking of World Bank (1993). Key results are presented in Table 1. This covers transport infrastructure in the public sector which represents the overwhelming majority of facilities in the PICs. The most extensive data are for roads. Sealed roads represent less than 8 percent of the total road length, except in Western Samoa where they account for 14 percent. Earth roads represent a majority of total road length in Western Samoa, Kiribati and Tonga, reflecting the ability to construct reasonable graded roads in the primarily coral/sand soils in these countries. By contrast, in the Solomon Islands and Vanuatu, where the more difficult terrain and loam/clay soils make base grading difficult, a much smaller share of roads are earth formed. The major role of inter-island water and air transport in Solomon Islands and Vanuatu is also shown by the large number of formal jetties and airfields in each of these countries. The length

[2] The data reported here as drawn from World Bank (1993) primarily relate to 1991. More recent data for all PICs were not available. However, the general inferences drawn are unlikely to have changed significantly since that time.

of road in proportion to land area, population and GNP is greatest in Tonga, and least, generally by a considerable margin, in the Solomon Islands.[3] The substantial stock of road infrastructure in most PICs stems in part from the provision of accessibility to a population which is widely dispersed and low in density.

Table 1: Pacific Islands-Transport Infrastructure Inventory, 1991

	Kiribati	Solomon Islands	Tonga	Vanuatu	Western Samoa	Total (or Average)
Road Length (km)						
Sealed	36	101	109	115	300	661
Unsealed engineered	289	700	492	926	522	2,929
Earth	496	500	1,273	719	1,250	4,238
Total	821/a	1,301	1,874	1,760	2,072	7,828
Share of Road Length (%)						
Sealed	4	8	6	7	14	(8)
Unsealed engineered	35	54	26	53	25	(37)
Earth	60	38	68	41	60	(54)
Total	100	100	100	100	100	(100)
Marine (number)						
Major ports	1	2	1	2	1	7
Major jetties	1	30	4	16	2	53
Total	2	32	5	18	3	60
Aviation (number)						
Airports/sealed runways	2	1	1	2	1	7
Other airfields	14	21	5	26	2	68
Total	16	22	6	28	3	75

/a Excludes road length on Kiritimati; the relatively high non-sealed road lengths as reported for Kiribati warrant further confirmation.

Source: World Bank (1993)

12. The physical coverage of the existing infrastructure in each PIC can be gauged broadly for the road subsector, since roads are described by type and length. For aviation and marine facilities, aggregate physical capacity is less amenable to assessment; for these modes, total replacement cost is a more suitable aggregate. In relation to roads, most PICs have reasonably substantial physical networks, especially on their main islands. (See Table 2) In general, the density of roads by various measures (land area, population, vehicles, and GNP) is *high* in the PICs, relative to the other countries.

---

3 The density of roads (length in relation to land area) should be interpreted with caution as the proportion of land which is inhabited and/or used in productive activity varies significantly across the PICs. In addition, a majority of population typically resides in small villages around the coast (circumference) of the islands. This geographical form tends to increase road length per capita and reduce road density.

Table 2: Pacific Islands - International Comparison of Road Subsector Indicators /a

	Population /b	Land Area (km^2)	Population (density (people/km^2)	GNP/ Capita (US$) /b	ODA/ Capita (US$) /c	Road Length (km)	Road Density (Length per) /d Land Area (km/'000 (km^2)	Road Density Capita (km/'000 people) /e	Road Density GNP (km/ US$'000 /f	Road Density Registered Vehicle (km/veh) /g	Road Replacement Value/GNP (%) h/	Road Replacement Value/Reg Vehicle (US$/000/veh) g/	Registered Vehicles/ GNP (Veh/US$m) f/ /g
South Pacific	(thousands)												
Fiji	732	18,270	40	1,540	74	4,994	273	11.5	4.4	0.13	..	..	..
Kiribati	67	710	100	650	243	721	1.156	12.3	17.9	0.79	41	17.9	23
Papua new Guinea	3,800	463,000	8	700	87	23,846	40	5.5	7.7	0.55	..	..	..
Solomon Islands	304	27,990	12	430	192	1,301	46	3.9	8.6	0.36	30	12.6	24
Tonga	101	720	142	800	186	1,874	2,603	18.3	20.0	0.40	69	13.9	50
Vanuautu	151	12,190	13	820	260	1,760	144	10.7	12.3	0.38	56	17.3	32
Western Samoa	168	2,830	60	600	182	2,072	732	12.2	17.8	0.33	91	16.9	54
Caribbean, Americas and Europe													
Barbados	256	430	698	4,340	..	1,670	3,884	6.5	1.5	..	..	..	..
Belize	184	22,800	8	1,150	137	1,980	87	12.5	10.9	..	..	..	..
Costa Rica	2,500	51,000	49	1,190	88	2,850	559	11.4	9.6	..	..	..	..
Cyprus	695	9,000	76	3,590	..	6,830	759	10.2	2.8	..	..	..	..
Haiti	5,400	28,000	193	320	35	4,000	143	0.7	2.3	..	..	..	..
Jamaica	2,200	11,000	200	1,150	70	17,700	1,609	8.0	7.0	..	..	..	..
Africa and Indian Ocean													
Comoros	458	2,230	200	340	116	950	425	2.2	6.6	..	..	..	..
Congo	1,800	342,000	6	1,140	75	10,940	32	6.1	5.4	..	..	..	..
Mauritius	1,100	1,850	500	1,490	57	2,590	1,398	2.5	2.3	..	..	..	..
Swaziland	761	17,000	41	800	53	2,820	166	4.0	5.0	..	..	..	..
Regions	(millions)												
Eastern and Southern Africa	201		18	310	..		53	2.9	11.5	..	35	..	..
Western Africa (excl. Nigeria)	90		10	270	..		41	3.6	9.4	..	33	..	..
East Asia and the Pacific	1,350		102	710	..		1,127	1.1	2.6	..	15	..	..
South Asia	1,008		197	220	..		328	1.7	6.5	..	13	..	..
Europe, Middle East & W. Africa	232		36	1,795	..		162	4.5	3.1	..	20	..	..
Latin America and the Caribbean	350		19	1,190	..		117	6.3	3.8	..	13	..	..
Total (incl. Nigeria)	3,327		52	..	..		118	2.3	3.9	..	16	..	..

/a Some data relate to different years and hence nominal comparisons need to be interpreted with caution.
/b 1988 population and GNP for South Pacific countries except PNG. Population and unadjusted GNP in 1984 for PNG and other countries, and median GNP/capita in 1984 for regions.
/c 1987 or 1988 as data available.
/d Road length in 1991 for South Pacific countries except PNG; 1984 for PNG and countries in other regions.
/e Estimated population in 1991 for South Pacific countries except PNG; 1984 for PNG and countries in other regions.
f/ GNP in 1988 inflated by 5% p.a. to indicative 1991 prices for South Pacific countries except PNG; 1984 data for PNG and for countries in other regions.
/g Registered vehicles for latest year available.
/h 1991 for the South Pacific countries except PNG; 1984 for PNG and other countries and regions. Replacement valuations are discussed below.

Sources: World Bank (1991a), (1989), (1988), and (1993).

13. Details of the estimated infrastructure replacement cost valuations are given in World Bank (1993), p 34. The capital stock values reveal that transport infrastructure in the PICs is not only high in broad physical terms, it is also *inordinately high relative to the capacity of each economy to sustain it.* On a uniform annual basis, the capital replacement cost value of transport infrastructure is estimated to represent 10.0 percent of GNP, on average, across all five PICs. For individual PICs, this share of GNP varies from a high of 13.1 percent in Western Samoa, to a low of 5.3 percent in Solomon Islands. The stock value of transport infrastructure is also very high relative to other countries; for example, road density, in terms of its replacement cost value to GNP, is of the order of two to three times higher.

14. For the marine and aviation subsectors, Table 3 provides indicators of estimated infrastructure replacement values relative to use. International trade is a high proportion of GNP in the PICs and most of this trade is by sea. The ratio of marine annual capital costs to value of international trade flows (on average 2.9 percent) indicates that full recovery of port costs may be possible. The main port accounts for the lion's share of the total marine subsector replacement cost in all PICs, except Vanuatu. Port performance measures need to be established to examine cost recovery for these main facilities and to confirm their sustainability. Aviation activity also varies considerably among the PICs.[4] The replacement cost of aviation infrastructure at the main international airport of each PIC is generally high in proportion to international passenger movements, though expected growth in international passenger movements (particularly in Vanuatu), and the high proportion of travel between Western and American Samoa will affect the overall comparative costs. Sustainability of all existing aviation infrastructure is problematic; it requires detailed assessment of the prospects for cost recovery and the economic warrant of major airport facilities.

15. The inordinately high levels of transport infrastructure in the PICs strongly indicate that *the replacement of many existing infrastructure facilities would not be warranted—and, in addition, that the maintenance of such facilities may not be justified* (at least at existing standards). Plainly, this is not an appealing conclusion for PIC Governments. Large flows of external assistance to the PICs, relative to their domestic economies (as indicated by the levels of ODA per capita shown in Table 2) have resulted in an accumulated stock of transport infrastructure which is non-sustainable. As this entire stock matures (and perhaps even increases), full replacement through overseas aid

---

4 The ratio of passenger movements to GNP in Western Somoa is relatively high as a result of the large social travel involving American Samoa, and links with Western Samoans resident in the USA, New Zealand and Australia. Nationals from Tonga in these three countries also contribute to the similarly high ratio for Tonga. The tourist industry in Vanuatu has recovered rapidly in recent years and the ratio of passenger movements to GNP is expected to become higher than indicated in Table 3. International aviation is less important to Kiribati while domestic aviation is relatively more important in the Solomon Islands and Vanuatu.

Table 3: Pacific Islands - Marine and Aviation Indicators, 1988/1991

	Kiribati	Solomon Islands	Tonga	Vanuatu	Western Samoa	Total or Average
International Trade (US$ million) /a	27.5	186.2	56.5	66.2	88.4	424.8
Share of GNP (%)	59	137	68	59	89	66
Value/Capita (US$)	351	590	548	485	534	533
Marine:						
Annual Capital Cost of Marine Assets (US$ million)	0.74	1.93	2.24	3.08	2.20	12.39
% of the value of international trade /b	2.70	1.00	4.00	4.70	2.50	2.90
Aviation:						
International Air Passenger Movements ('000)	27	30	67	40	186 /c	66
Movements per US$ million of GNP /d	147	233	721	290	1,597	613
Annual Replacement Value of Principal Airport (US$ per international passenger movement /e	35	27	39	57	16	35

/a Estimates for 1988/89; merchandise imports and exports only.

/b Replacement value of marine assets, on an equivalent annual capital cost basis (7 percent discount rate over 30 years; capital recovery factor 0.081) divided by total merchandise imports and exports in 1988 in US$ inflated by 5 percent per annum to indicative 1991 prices.

/c Visitor arrivals account for half of international passenger movements through Western Samoa. 35 percent of visitors arrivals in Western Samoa are from American Samoa

/d For 1988

/e Replacement value in 1991 prices. International passenger movements estimated for 1988.

Sources: World Bank (1991a) and World Bank (1993).

can also be expected to become non-viable.[5] Unwarranted existing facilities can cause further inefficiencies in (a) attracting unjustified scarce maintenance resources, (b) influencing demand, notably affecting the best choice of infrastructure/ mode by users, and (c) distorting investment responses of agents in other sectors which use transport services. Therefore, a high priority needs to be given to the reassessment of all existing substantial infrastructure and to the identification of those facilities that are no longer warranted (including those for which even modification, such as reduction in standard, is also not warranted). Proper allocation of, and priorities for, maintenance resources can only be made after the existing stock of infrastructure is rationalized, i.e., facilities which are warranted and justify maintenance are clearly identified.

[5] While external (bilateral) assistance to the PICs may be expected for the foreseeable future, the levels and sector "preferences" are unclear. Moreover, PICs Governments and donors need to consider the opportunity cost/effectiveness of aid allocations.

16. Since substantial transport infrastructure may not be warranted, interpretation of the patterns of investment across the PICs needs to be made with caution. Notwithstanding this, estimated patterns are largely as expected. While aviation and marine transport are intrinsic components of the transport task in the Pacific Island States, roads account for the majority of the value of transport assets in each PIC (from almost two-thirds in Western Samoa to a little under one-half in Vanuatu). The spatial distribution of population shapes modal shares of infrastructure. For example, the concentration of activity on the two main islands in Western Samoa is reflected in the high share in roads and low share in marine assets.[6] The relatively new major airport terminal and runway facilities in Vanuatu and Tonga account for the very large proportion of the value of aviation infrastructure in these countries.

17. The large investment in ports, jetties and airports in Vanuatu and Tonga in the 1980s is reflected in the very high value of infrastructure per capita, and as a share of GNP, in these countries. Corresponding to this is the low imputed average economic productivity of the infrastructure. On a per capita basis, the Polynesian countries of Western Samoa and Tonga, and to some extent Vanuatu, have established a larger stock of transport infrastructure, relative to GNP, than Solomon Islands and Kiribati (see Figure 1).[7] Comparable figures covering all transport infrastructure valuations are not available for other countries.

18. The replacement value of infrastructure takes no account of its current condition. Except for recently completed works, the current "value" of facilities will be considerably lower than the replacement cost due to deterioration with age and lack of maintenance. Systematic information on the physical condition of transport infrastructure in the five PICs is not available. Some past studies have identified rehabilitation needs for selected infrastructure in terms of so called "maintenance overhang", i.e., the rehabilitation requirements resulting from past inadequate maintenance (based on original design standards) to restore warranted assets to "good" condition. "Working" estimates of "overhang" have been assembled based on these studies.[8] Estimates of the maintenance overhang are documented in World Bank (1993). The estimated overhang is greatest in the road sector; it is less in the marine and aviation sectors, reflecting the more heavily engineered nature of assets in these subsectors and the greater pressure, for economic and technical reasons, to ensure major assets in these subsectors, meet international operational standards (for example, those set in aviation by ICAO). As stressed, not all existing infrastructure may warrant rehabilitation.

---

6 This is exacerbated by the exclusion of two deteriorated (and unlikely to be redeveloped) facilities from the inventory of marine assets in Western Samoa.

7 The increase in infrastructure with GNP across the PICs is consistent with the normal observation that transport (and complementary infrastructure) services are income elastic.

8 Where no data exist, estimates were based on evidence from discussions and limited field inspections. In some cases there is insufficient information to permit even broad estimates to be prepared.

Maintenance and Expenditure

19. A strategy for efficient maintenance of warranted infrastructure and standards would require determination of: (i) the optimal level and programming of maintenance; (ii) sustainable financing, including targets for cost recovery and appropriate user charges; and (iii) institutional capacity to support effective delivery of maintenance. The examination of maintenance reported here is limited to an analysis of the identified entire stock of existing transport infrastructure.

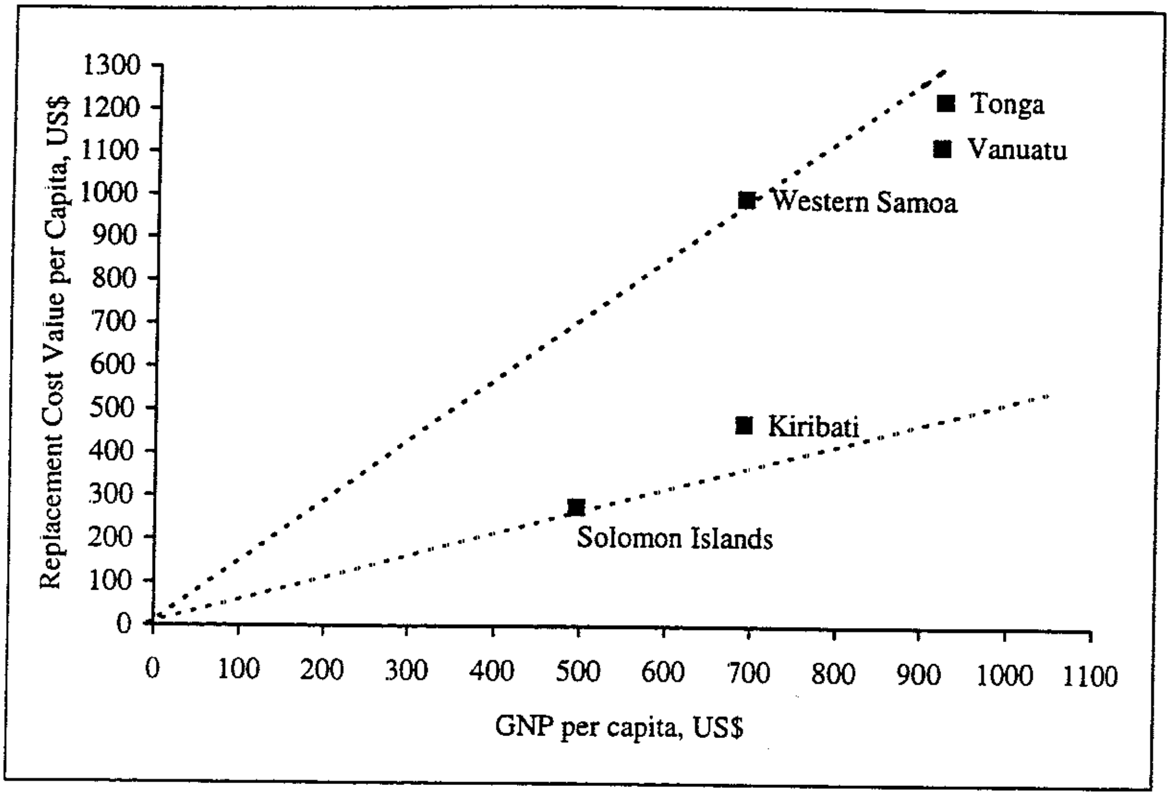
20. Optimal maintenance expenditure is that level which, if effectively applied, would result in the *lowest total transport system costs*. Total system costs are the sum (on an equivalent annual basis) of the life-cycle costs[9] for infrastructure (sustained in relation to an established standard, over its potential economic life) plus user operating resource costs. These relationships are not well understood for conditions in the PICs and therefore "optimal maintenance" cannot be determined. The approach adopted is pragmatic; that level of maintenance which would keep the existing infrastructure in good condition is estimated. This is termed "assessed maintenance"; It does *not* represent warranted maintenance. However, by estimating assessed maintenance levels, the sustainability of the existing infrastructure, the shortfalls between actual and assessed maintenance, and the level of cost recovery can be placed in perspective. Moreover, the reduction in total transport system costs that could be achieved by increasing maintenance from actual to assessed levels can be estimated.

21. Annual costs of maintenance are analyzed for each mode. An annual expenditure of assessed maintenance for roads is estimated using an average annual cost per kilometer for each of the three categories of road covered in the road inventories. The assessed annual costs of maintenance for marine and aviation facilities are estimated on a cruder basis. "Best practice" maintenance costs, in the absence of estimates current of the resources required to undertake routine and periodic maintenance, are estimated by applying an "industry rule of thumb" percentage factor to the estimated current

---

9 Strictly, the overall optimal maintenance program should be jointly determined with the corresponding optimal design standard; it is associated with the minimum total system costs of construction, maintenance and user costs (under prescribed user charge and vehicle/vessel/aircraft size regimes) In the study reported here the focus is on maintenance per se; the question of "best" standards, vehicle sizes and compliance are important ones in the PICs, but are set aside. It might be noted that it is not immediately transparent in the environment of the PICs, whether undermaintenance, *if persistent*, should be matched by higher or lower standards relative to those associated with assessed effective maintenance. Such choices should be made based on total transport system costs, i.e., infrastructure *plus* user/operator costs For roads with the low traffic volumes in the PICs, the small and uncertain incremental benefits, and the limited implementation effectiveness, it may be "rational" to keep to lower (e.g., unpaved) standards.

Figure 1. Pacific Islands—Infrastructure Value vs. GNP (per capita), 1991



replacement cost of the asset. This maintenance factor includes periodic maintenance as an average equivalent annual value; this spreads the "lumpy" nature of maintenance uniformly in a financial sense uniformly in a financial sense over the economic life of the infrastructure.[10]

22. Actual and assessed maintenance costs for all transport infrastructure, including roads, as estimated for 1991, are presented in World Bank (1993), p 42. In brief, assessed expenditure on routine and periodic maintenance of roads is estimated to be on average 2.9 percent of GNP Actual road maintenance is, on average, 31 percent of assessed

---

[10] The method used to determine assessed maintenance expenditure of road, marine and aviation assets should normally be applied to the replacement cost of assets net of once-off costs that are incurred for green field situations, such as land acquisition and site preparation. Data limitations do not permit such costs to be treated systematically in the present analysis Land acquisition costs are generally not included in the replacement value of assets. The inclusion of costs such as site preparation are unlikely to result in substantial distortion, and needs to be seen in the context of order of accuracy of the existing data and analysis

maintenance, and 1 percent of GNP.[11] Both assessed and actual expenditure on road maintenance are high relative to the size of the PIC economies. Yet estimated actual expenditure on maintenance falls well short of assessed maintenance in all PICs. The assessed levels of road maintenance range from 6 percent of government expenditure (Tonga) to 27 percent (Vanuatu). *Such levels of road maintenance expenditure are non-sustainable*; substantial rationalization of existing roads and standards is required.

23. Assessed maintenance expenditure associated with marine infrastructure is relatively low. The gap between actual and assessed maintenance expenditure is least in the Solomon Islands, where the commercially oriented and largely autonomous Solomon Islands Port Authority is in a position to exercise cost recovery measures, budget for maintenance, and control of its assets. However, there is very low expenditure on maintenance of other marine assets in the Solomon Islands and overall actual marine maintenance expenditure is one-half the assessed level. Actual maintenance expenditures are well below assessed maintenance levels in Vanuatu (with two major ports and sixteen jetties) and Tonga (where substantial investment has been made in port facilities at Nuku'alofa). Much of the investment in marine facilities in these two countries has been made during the 1980s and, so far, the effects of deferred maintenance are small.

24. Assessed maintenance expenditure in the aviation sector is, as with the marine sector, small in absolute terms. Notwithstanding the need to meet international standards for airside facilities, actual expenditure is generally only between a quarter and a third of that estimated to be associated with sustainability of all aviation assets. Low maintenance in the past has been feasible, in part, because Vanuatu, Western Samoa and Tonga have had new runways and passenger terminals constructed at their respective gateway airports with grant aid during the 1980s. However, on the basis that these new facilities are warranted, a substantial increase in maintenance expenditure is implied to sustain the infrastructure over the long term.

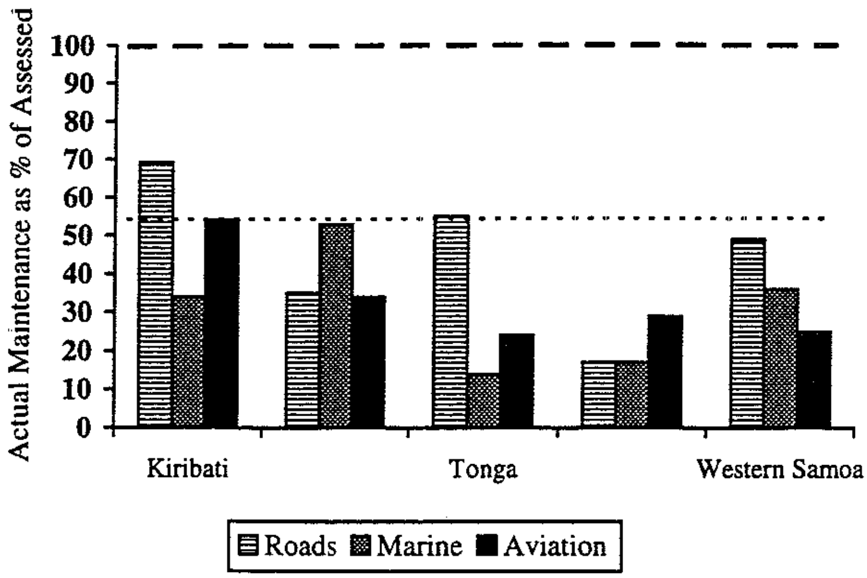
25. The ratio of actual to assessed maintenance expenditure for the five PICs as a whole is very similar for each mode (31, 28 and 28 percent respectively, for roads, marine and aviation). However, there are significant differences between the countries, as shown in Figure 2. Maintenance expenditure at the assessed level for all infrastructure would require a 10 percent increase in *total* government current expenditure. This increase is unrealistic. Limited expenditure on maintenance in the past has been made possible by substantial external assistance to rehabilitate neglected existing infrastructure.

26. Inadequate maintenance increases total transport system costs through higher *capital* replacement costs because of the shorter economic life, higher *maintenance* costs because, in most cases, infrastructure is more difficult to maintain once it has

---

[11] In thirty-four Sub-Saharan African countries (over the period 1986-88) road maintenance expenditure was only about 0.2 percent of GNP; see World Bank and Economic Commission for Africa (1990). (This is not to suggest these lower levels were optimal.)

Figure 2. Pacific Islands—Actual vs. Assessed Maintenance



deteriorated, and higher transport *user* costs as deteriorated infrastructure increases damage to vehicles, vessels and freight and increases transit times. Higher total transport costs reduce overall economic performance; increases in the resource costs of collecting, handling and distributing goods lead to general price increases, weaker export competitiveness and a reduced share of export income to producers.

Implications of Inadequate Maintenance

27. The implications of inadequate maintenance of transport infrastructure in the PICs are examined by estimating total transport system costs (life cycle costs for existing infrastructure plus user costs) with current actual maintenance and those that would be associated with assessed maintenance. The results are set out in Table 4 which reveals that the total *capital* costs of transport infrastructure is 46 per cent higher under actual maintenance relative to assessed, i.e., US$79.7 million compared to US$54.5 million. The incremental benefit-cost ratios for improved maintenance are well above 1.0 and tend to be highest in the aviation sector. In addition to savings in life-cycle infrastructure costs, improved maintenance involves user-cost savings. Transport user operating costs can be estimated most readily for the road subsector.[12] Vehicle operating costs rise with inadequate road maintenance because of the increased fuel consumption, more rapid

---

12 Estimates for the PICs are indicative as they are based on transfer of (road) life-cycle relationships from other countries.

Table 4: Pacific Islands - Capital, Maintenance and User Costs of Infrastructure

	Kiribati	Solomon Islands	Tonga	Vanuatu /a		Western Samoa	Total or Average	/a
Equivalent Annual Capital Cost of Infrastructure with Actual Maintenance (US$ million) /b								
Roads	2.1	7.3	9.8	12.4		14.9	46.5	
Marine	0.9	2.7	3.4	3.7		2.6	13.4	
Aviation	0.7	2.1	4.3	8.3		4.3	19.8	
Total	3.7	12.1	17.5	24.5		21.9	79.7	
Equivalent Annual Capital Cost of Infrastructure with Assessed Maintenance (US$ million)								
Roads	1.5	4.6	6.4	8.0		10.1	30.7	
Marine	0.7	2.0	2.4	2.9		2.1	10.0	
Aviation	0.6	1.4	3.0	5.9		3.0	13.8	
Total	2.7	8.0	11.8	16.8		15.2	54.5	
Additional Annual Capital Cost of Infrastructure Resulting from Inadequate Maintenance (US$ million) /c								
Roads	0.6	2.7	3.4	4.5		4.8	15.9	
Marine	0.2	0.8	1.0	0.8		0.6	3.4	
Aviation	0.2	0.7	1.3	2.4		1.3	5.9	
Total	1.0	4.1	5.8	7.7		6.7	25.2	
Incremental Cost of Shifting from Actual to Assessed Maintenance (US$ million) /d								
Roads	0.10	1.8	0.7	7.1	[2.3]	1.5	11.2	
Marine	0.08	0.2	0.6	0.4		0.2	1.5	
Aviation	0.08	0.1	0.3	0.5		0.3	1.4	
Total	0.26	2.1	1.6	8.0	[3.3]	2.0	14.1	
Benefit/Cost Ratio /e								
Roads	6.4	1.5	6.0	0.6	[1.9]	3.1	1.4	
Marine	6.1	3.3	1.6	1.9		2.6	2.2	
Aviation	7.7	4.7	4.2	4.4		3.9	4.3	
Total	6.5	1.9	3.6	1.0	[2.3]	3.2	1.8	
Roads:								
Vehicle Operating Cost (US$ per km) /f	0.26	0.25	0.23	0.21		0.2	0.23	
Vehicle Operating Cost Penalty								
Annual Cost (US$ million)	0.4	2.1	1.2	2.1		1.9	7.7	[7.6]
% of GNP	0.8	1.4	1.3	1.5		1.6	1.4	[1.6]

/a The figures shown [ ] thus, represent road maintenance costs for Vanuatu, based upon the unit maintenance costs by road type for Solomon Islands. These are included as the Vanuatu data were regarded as questionably high

/b Equivalent Annual Cost calculated at 7 percent discount rate and economic lives based on nature of infrastructure for roads, marine and aviation.

/c Difference between annual capital cost of infrastructure with current and assessed maintenance

/d Difference between current and assessed annual maintenance cost.

/e Ratio of savings in equivalent annual capital cost resulting from assessed maintenance to the incremental annual cost of the improved maintenance.

f/ Average vehicle operating cost (net of taxes and duties) on paved roads in good condition

/g Indicative differences in economic road vehicle operating costs between current road conditions and roads in good condition

Source: Country Maintenance Survey Annexes, Volume Two of World Bank (1993).

vehicle depreciation and greater need for repair, increased spoilage of freight, and reduced accessibility which result from rougher and impassable roads. Increasing road maintenance to the assessed level across all five PICs is estimated to have an incremental benefit-cost ratio of 2:1. Savings in annual vehicle operating costs under assessed maintenance of roads are equal to about half of the savings in equivalent annual capital replacement costs because of low traffic volumes. However, *the annual savings in vehicle operating costs alone exceed the additional maintenance cost to achieve them*.

28. Quantification of the cost penalty of inadequate maintenance in the marine and aviation subsectors is far less developed than for roads. Increased port operation costs result from inadequately maintained port facilities. For example, the load-carrying capacity of wharves and jetties may be reduced by insufficient deck and pile maintenance, and equipment may be in disrepair. Increased port costs and delays add to the cost of imported goods and make exports, most of which pass through sea ports, less competitive on international markets. Safety for port workers may also be reduced. Quantification of these implications was not possible. While major airports are not generally at risk of closure because of inadequate maintenance, such closure would have a severe impact on travel and, in particular, tourism. Deterioration of airport terminals and other public facilities will have an adverse impact on user perception and marketing credibility. Provincial and local airfields are more prone to closure. In the Solomon Islands, for example, about two airfields are closed each month, often because of maintenance problems which can be easily remedied.[13]

Maintenance Incidence and Responsibility

29. The incidence of costs and financial savings from improved maintenance will differ. A high proportion of transport infrastructure investment in the PICs, including rehabilitation, is funded through donors. The external contribution to maintenance is generally limited to the provision of equipment and technical assistance. In the absence of additional donor grant assistance for maintenance, improved maintenance requires additional outlays by the Governments of the PICs. The savings in rehabilitation costs to external donors would be about 80 percent greater than the increased maintenance outlays. Infrastructure user cost savings will accrue directly to vehicle operators; where these operators are providing a transport service for others (passengers and shippers), the savings should be passed on to these individuals, since the structure of the transport service markets in the PICs, by and large, is effectively competitive.

---

[13] Examples include failure to mow airfield grass, at a cost of US$220 per month, and the lack of a replacement windsock, with a value of US$75. The economic loss associated with a foregone (or deferred) flight, due to airfield closure, can be substantial. For example, in the Solomon Islands, the airfare for a one-hour flight is US$51 greater than the tariff for the alternative 24-hour ships journey. The (minimum) premium which air travelers are prepared to pay over the fare for sea travel is high in proportion to the cost of some critical elements of airfield maintenance.

30. While the need for aid funds for transport infrastructure in the long-term will be reduced if maintenance is improved, there will remain a need for assistance, particularly in the near term. However, total transport infrastructure maintenance should be considered against competing needs for external assistance. Major bilateral assistance to the PICs is provided by Australia, New Zealand and Japan. See World Bank (1993), pp 52-53. Although the difference between existing and assessed maintenance represents a small percentage of existing capital project assistance, total infrastructure (replacement and assessed maintenance) costs represent an inordinately high proportion of total assistance. This brings into question the long-term sustainability by donors of the entire accumulated stock of existing transport infrastructure.

31. The benefits and costs associated with shifting to "assessed" maintenance as indicated here do not take into account the costs of implementing and securing improved maintenance. These costs include the additional management, administration supervision, and training involved. However, the number of personnel that would be required is small.

32. There is scope for increasing local funds. A "surrogate market" for road services, as might be established by a roads board and roads fund, as discussed in World Bank (1994), has not been pursued in the PICs, perhaps primarily because of the dominance, to date, of aid flows. There are direct user fees in the maritime and aviation sectors, but the income from them is usually funneled to government consolidated `revenue. The limited direct link between income collected by infrastructure supply agencies and the capital and recurrent funding provided to them weakens the obligation of the agencies to justify the price and quality of their infrastructure to users. This separation of revenue and cost functions reduces more broadly the incentive for efficient development, use and maintenance of transport infrastructure. Improved accountability between agencies and their users "clients" should be established; greater autonomy and commercialization of the agencies should be introduced. By and large, there is no hypothecation of revenue from existing user charges for maintenance of transport infrastructure in the five PICs. These circumstances may justify exploration of the use of formal "earmarking" of revenue from additional tariffs on users for warranted maintenance. Preferably, this should be based on the "representative users" board concept. Such steps alone are insufficient; they need to be supported with strengthening capacity, management and effectiveness in delivery.

33 There is little knowledge of the level of cost recovery in each transport subsector at present. Cost recovery was estimated for each mode, in each of the five PICs, using available data on revenue, and estimates of infrastructure capital and maintenance costs. Details are provided in World Bank (1993). In brief, on average, revenue from vehicle registration and license fees, and driver license fees, is 8 percent of the cost of operating the road system (including maintenance at the assessed level). Even with the inclusion of all revenues from import duties on vehicles and fuel attributed to road cost recovery, the implied level of cost recovery in the roads subsector is 34 percent. It is improbable that total revenue from road users can be increased sufficiently to achieve full cost-recovery, even in Tonga and Western Samoa, where implied cost recovery is relatively high. This

circumstance parallels over-investment in road infrastructure, and its non-sustainability, at least at original design standards.

34. Geographical equity issues arise in considering full cost recovery from user charges. The issue of providing and cost-sharing reliable access for small, often remote, communities needs to be considered in a much broader context, including threshold service and indirect approaches such as the location of services as a partial substitute for transport.

35. Across PICs, port fees may be relatively low in some locations. However, an almost fourfold increase in revenue is estimated to be required to meet the long-term cost of sustaining the present maritime infrastructure. This indicates that there has been over-investment in port infrastructure and is not likely that all of marine infrastructure can be sustained. A fivefold increase in revenue is estimated to be required to meet the long-term minimum cost of sustaining aviation infrastructure in the five PICs. As with the marine sector, over-investment in aviation infrastructure is indicated, and the Governments of the five PICs will not be able to sustain all of their aviation infrastructure from their own resources.

36. Finally, in moving to increased user charges and levels of cost recovery, these should be consistent across subsectors to promote efficient choice of mode. In the PICs at present, modal competition is limited, but occurs in domestic transport, principally between road and marine. Therefore, user charges, in relation to costs, should be consistent between these subsectors.

III. CONCLUSIONS AND STRATEGY FOR REFORM

- Each PIC has a substantial stock of valuable transport infrastructure. However, maintenance and replacement of the existing stock is not sustainable from domestic resources.

- To date, external donors have rehabilitated infrastructure left to deteriorate to compensate for maintenance deficiencies. This raises infrastructure and user resources costs and impairs domestic economic performance and growth.

- Primary responsibility for assets rests with each PIC. At the same time, since external assistance to the PICs can be expected to continue, there is merit in the provision of direct external grant support for maintenance. But this involves the risk of weakening local "ownership". Therefore, this should involve establishing a "compact" between governments and donors covering a realistic program and timetable for increased mobilization of domestic resources for maintenance (including where appropriate increased user charges), highlighting priority assets and rationalization of the existing stock, and strengthening institutional capacity for overall asset management.

References

Australian International Assistance Bureau (1988), *Outer Islands Airfields, Project Identification, Vanuatu,* prepared by McIntyre & Associates.

World Bank (1987), *The Highway Design and Maintenance Standards Model,* Washington, DC.

World Bank and Economic Commission for Africa (1990), "The Road Maintenance Initiative - Building Capacity for Policy Reform", prepared by the Economic Development Institute and the World Bank (Africa Technical Department, Infrastructure Division), Washington, DC, June.

World Bank (1993), *Pacific Islands Transport Sector Study (in Seven Volumes); Volume 1: Transport Issues - A Regional Perspective; Volumes 2-7: Country Surveys,* Report No. 10543—EAP, Washington, DC, March.

World Bank (1995), *Managing and Financing Roads: An Agenda for Reform,* Africa Technical Series Paper No. 275, Washington, DC, March.