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AIR TRANSPORT ALTERNATIVES
VS
SURFACE TRANSPORT IN THE SAHEL

PHASE I - PREFEASIBILITY STUDY
FOR

AID
WASHINGTON, D.C.

CILSS
OUAGADOUGOU, UPPER VOLTA

VOLUME I - EXECUTIVE SUMMARY

APRIL 1, 1983

F O R E W O R D

This report constitutes Phase I of a pre-feasibility study sponsored by the Agency for International Development to explore opportunities for operating lighter-than-air craft for the transport of cargo and passengers in the Sahelian states of West Africa.

It represents a two-man effort conducted by Norman J. Mayer, a National Aeronautics and Space Administration aerospace engineer, expert in the lighter-than-air field, and Richard L. Braida, a Department of Transportation international transport economist. Mr. Robert Desbiens, a Comite Permanent Inter-Etats De Lutte Contre La Secheresse Dans Le Sahel (CILSS) economist based in Ouagadougou, was instrumental in the design of the study and provided data as well. All work was performed in Washington, D. C.

Phase I work was intended to determine whether a more detailed Phase II analysis is warranted. Phase II, in-depth field work to provide missing data, verify and refine original observations, and prescribe the implementation aspects of an actual operation, was made contingent upon the outcome of this Phase I analysis.

The report is in three volumes, as follows:

VOLUME I - Executive Summary

VOLUME II - Principal Text

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VS

SURFACE TRANSPORT IN THE SAHEL

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INTRODUCTION

In the fall of 1982, in response to an initiative of the American Embassy in Ouagadougou and CILSS, AID/Washington authorized a pre-feasibility study to be undertaken on the use of LTA (lighter-than-air) airships as an alternative transport mode in the Sahel.[1/] In view of the Sahelian environment - vast sparsely populated areas, low population densities, low trading volumes, high road construction costs - it was thought that airships might offer a lower-cost transport medium than surface modes, particularly as an alternative to building and maintaining costly new roads in difficult terrain, and possibly for special applications. During the process of study conceptualization it was agreed that the economics of the airship should be compared with those of alternative aircraft systems - those in place as well as potential candidates - and in turn the merits of air transport should be compared with those of existing surface modes.

Phase I of the study was to be conducted in Washington.

Financial analyses were carried out on the basis of the most current data available pertaining to trade volumes and flows, commodity composition, transport costs, and freight rates. Modal comparisons were predicated upon system transport costs rather than upon freight rates, and costs were adjusted to the present, assuming a 10 per cent annual rate of inflation. Since this was a preliminary study largely reflecting magnitudes of costs, financial rather than economic values were used, with the observation

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[1/] The Sahel countries include Cape Verde, Chad, The Gambia, Mali, Mauritania, Niger, Senegal, and Upper Volta. See Figure 0.1.

that if Phase II work were undertaken, closer approximations stemming from field verification of present costs, tariffs and traffic and incorporating trade volume projections would be the basis for more precise financial and economic appraisals.

Further, time did not permit the study of socio-economic benefits which might accrue from airship investments; this subject would be appropriate for Phase II work.

Phase I gauged present Sahel transport and examined whether the airship could better satisfy current general and particular transport needs.

Available data, adjusted to the current year, were utilized and current volumes of trade were assumed. This was considered responsive as a first effort in view of relatively low growth rates and the lack of more precise data. Phase II would include similar analyses, and projections of changes in commodity flows.

The seasonality of cash-crop flows is a significant factor in determining vehicle fleet requirements. Without adequate storage at production or collection sites or in the ports, agricultural commodity shipments are more constrained to the harvest period.[1/] This has resulted in larger vehicle fleet inventories than those which would otherwise be required, with consequent vehicle underutilization and higher unit operating costs per ton-km of transport performed. However, on this initial level of analysis the seasonality factor is not taken into account; we assume a proportional effect on all modes.

1/ The peak period for crop transport is during the dry season - from about November to April.

Cost comparisons conform with the following guidelines:

1) The airship system represents a new capital investment, and both capital and operating costs are reflected in its cost analysis.

2) Existing roads, railroads, and elements of air transport systems are considered sunk investments, and, though the costs of these investments may not be fully amortized, in modal comparisons no capital recovery costs are charged for the use of existing facilities. However, their maintenance costs will be reflected in calculating system costs.

3) In situations where surface transportation is non-existent or totally inadequate and a new investment would be required, the capital cost of the surface facility as well as its maintenance cost are reflected in comparing the cost of that investment with that of the airship system.

Emphasis has been placed on point-to-point transport, largely in partial competition with existing surface systems. For this reason only the conventional nonrigid airship was chosen, since it is the least energy - intensive type and offers the potential of being the least expensive to manufacture and the most cost-effective airship from the standpoint of long-range cargo transport.

Current prices for new equipment are used throughout in aircraft system comparisons. However, used fixed-wing aircraft with substantial residual life often can be obtained at substantial reductions in price. Sensitivity analyses testing the effect of aircraft prices on total system costs are reflected herein.

U.S. prices and operating costs were used, except for fuel costs, which were based upon estimated current Sahel prices. Fuel today is one of the most important cost elements in aircraft operation.

While ocean freight rates from Europe to West African ports are assumed equal, they vary; e.g., Dakar vs. Abidjan. Since this affects the delivered cost of commodities and the relative attractiveness of the repective routes to inland points, it should be taken into account in any more detailed analysis. Port charges were assumed to apply to all modes.

The age of data varied; while technical data were current, information on Sahel trade flows and tariffs tended to be older. To the extent possible these data warrant review and upgrading in a Phase II.

The desirability of proceeding to Phase II may best be determined by the Field after review of the Phase I findings.

EXECUTIVE SUMMARY

1.0 Background

Phase I of a two-phase pre-feasibility study of the use of lighter-than-air craft and alternative forms of transport for the movement of commodities and passengers in the Sahel has been completed. This represents an effort undertaken in Washington, D. C. to be followed by a second phase, field work in the Sahel, if the preliminary findings vis-a-vis the use of lighter-than-air (LTA) craft in the Sahel supported further investigation.

Based upon data largely obtained in the United States, this very preliminary study compares the merits of airship and alternative air transport systems with those of competing surface transport modes in the Sahel.

Of the eight Sahelian countries, four-Chad, Mali, Niger and Upper Volta-are landlocked and require transit access routes to seaports; three - The Gambia, Senegal, and Mauritania-border the sea, and have direct access to world markets; one, Cape Verde, is an insular nation with seaports and airfields.

Economic and transport profiles of the eight countries were developed, to identify transport problems - particularly those for which air transport, and specifically airships, might offer a better solution.

The economies of the Sahel countries were analyzed and the composition and magnitudes of their production, imports and exports were examined. Alternate routes over which imports and exports flow and internal distribution systems were studied. Present modal alternatives were considered and their respective costs were quantified.

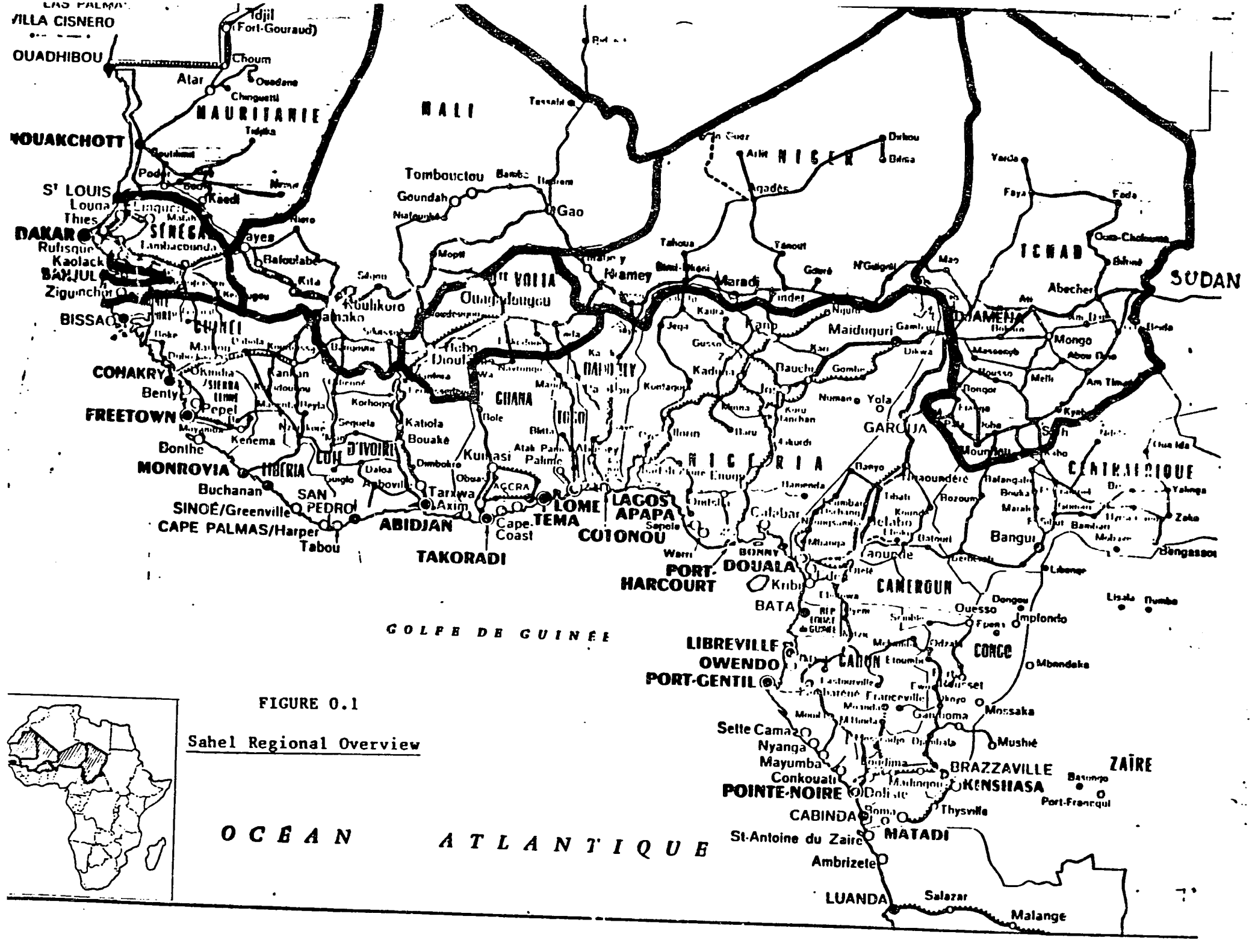

FIGURE 0.1

Sahel Regional Overview

The four inland countries - Chad, Mali, Niger and Upper Volta-were singled out for principal attention because of their sizable lesser developed areas, their remoteness from seaports, their consequent dependence on other countries for transit privileges, and the additional costs imposed upon their exports and imports by transit-related expenses.

Internal transportation is a critical problem in these four countries; in two, seasonal flooding isolates large areas. Their vast size, sparse, dispersed populations and consequently limited transportation infrastructure contribute to other problems of economic development and national unification. For these reasons they were chosen as subjects for several scenarios in which airships were tested against other aircraft and surface modes.

As originally conceived, the study was to focus solely on the feasibility of employing dirigibles in Sahel transport. By consensus the scope of analysis was expanded to consider all forms of air transport, in competition with each other and with surface modes.

In the past two decades of independence the Sahel countries have successfully expanded their road transport networks, which are now largely in place, serving areas of principal population concentration and economic activity.

Air transportation has played a minor role in Sahelian development during this period. However, changing conditions call for a re-examination of transport sector goals and objectives and the means of achieving them and air transportation may have new potential in this regard, particularly in an era of rising construction costs, which have contributed to the rejection or postponement of a number of road and rail projects.

Sahelian transport facilites can be identified in the following three categories:

Category 1

Principal infrastructure for moving imports to inland destinations and minerals and agricultural cash crop exports to ports. Primary and secondary roads and rail facilities fit in this category.

Category 2

Feeder roads and rail spurs from areas of surplus agricultural production and mineral extraction to road and rail trunklines.

Category 3

Infrastructure to facilitate the delivery of social and administrative services and to encourage the political integration of outlying areas.

Arid areas of the northern Sahel and floodable sections such as those in Chad and Mali are regions of low population density and limited economic activity. Some of these areas may have potential wealth in minerals, oil and gas for future development. Surface tracks are the principal form of access now and most are not all-weather routes. Present needs fit Category 3 and these areas are potential candidates for air transportation.

A natural consequence of surface transport development has been the growing burden of infrastructural maintenance, which for lack of resources, both financial and human, has been difficult to support and so has been inadequate. With limited wherewithal and rising costs the Sahel countries are hard pressed to maintain existing infrastructure, much less further expand existing networks through new construction.

With a view to serving their people, further integrating their nations and developing their resources, the CILSS member states expressed their wish to examine current, more cost-effective means of satisfying transportation requirements, and this pre-feasibility study is a reflection of that intent. It is an incipient examination of the role that air transportation might have in future Sahel development.

2.0 Summary of Findings

On the basis of the findings cited below a Phase II effort which includes analysis of more specific applications of LTA and conventional air transport within the Sahel is warranted.

1) The use of aircraft, either airships or airplanes, as a least - cost means of providing required transport services under certain Category 3 (low volume/high cost) conditions warrants consideration. It is suggested that aircraft, including dirigibles, could be linked in networks with existing trunkline roads, serving as extensions of those roads over long distances in outlying regions of low population and traffic density, and that such linkages could provide transport service at costs less than the alternative cost of road construction and maintenance. These networks would involve complementary radio communications for flexibility in aircraft routing, and perhaps storage facilities.

In Scenario 3 of this study, where a 2-ton payload capability was cited, a currently available light dirigible, the AI-600, was more efficient than all other aircraft examined and would be far less costly than an equivalent road/truck system if installed. However, a light heavier-than-air (HTA) aircraft such as the BN-2B (1-ton payload)

might be a more attractive solution for lower capacity missions. This demonstrates the need for more precise estimates of actual transport demand in outlying areas, with projections for the future so that the type of aircraft selected would be most suited to the need. Such data would be obtained in the Phase II field effort.

2) With regard to the transport of large volumes of general cargo, the study indicated that neither airships nor airplanes could compete with existing high traffic density surface modes in carrying general cargo from ports to inland destinations. While the 40-ton dirigible compared very favorably with the efficient L-100 airplane,[1/] no aircraft could complete with existing rail and road modes; their costs were from 1.5 to 4 times those of imputed tariffs used in comparison of surface transportation alternatives. However, the superior quality of service offered by air transport could attract sufficient cargo at the higher freight rates to warrant such operations on some lesser scale, and it is proposed that demand elasticity analyses for air transport be conducted as an element of Phase II work.

In a very preliminary examination of costs related to the extension of the railway from Parakou, Benin to Niamey, Niger for purposes of mining support and regional development, it appeared that the capital costs alone of an equivalent capacity airship system would be well in excess of that of a railroad, and that the airship alternative would therefore not be feasible in this application.

[1/] Less attractive by only 1 per cent in one scenario and more attractive by 8 per cent in another.

- The airship is best suited to serve areas which require all-weather services; which are not presently served by all-weather surface or air transport, where the cost of providing and maintaining such service facilities would be high relative to available cargo; or where heavy-lift capabilities might be required in combination with STOL or VTOL operation.

- Neither weather nor terrain would prevent the use of dirigibles as transports.

- Conventional nonrigid dirigibles are more economical as their size increases.

- Hybrid dirigible costs are approximately double those of conventional dirigibles.

- Ground facilites would be required.

  o Existing airfields, particularly the feeder airports, would probably not need expansion to accommodate conventional or hybrid dirigibles in normal operations.

Specific load - carrying requirements and conditions of terrain determine the airship's relative attractiveness vis-a-vis other aircraft types. While air transportation can be superior to surface modes under conditions cited herein, the air transport solution is not necessarily limited to the prescription of dirigibles; there are a number of aircraft alternatives. Conventional heavier-than-air aircraft may represent the least-cost solution where equal payloads are to be transported and the terrain is favorable enough to permit the construction of small, well drained landing strips. On the other hand, airships may be the superior choice when their transport capability (ton-kilometers) approaches or equals the capability of airplanes or where the terrain does not permit the construction of suitable landing strips for conventional aircraft.

3.0 Methodology

The characteristics of several competing airplanes, helicopters and airships were compared in these analyses, based on U.S. operating costs (which will require modification to Sahelian levels in the event of in-depth studies). The total (life cycle) costs of air systems were determined, and costs per ton-km were compared against those of existing modes.

Cost comparisons conform with the following guidelines:

1) The airship system represents a new capital investment, and both capital and operating costs are reflected in its cost analysis.

2) Existing roads, railroads and elements of air transport systems are considered sunk investments, and, though the costs of these investments may not be fully amortized, in modal comparisons no capital recovery costs are charged for the use of existing facilities. (Scenarios 1 and 2).[1/]

3) In situations where surface transportation is non-existent or totally inadequate and a new investment would be required (Scenario 3), the capital cost of the surface facility as well as its maintenance cost are reflected in comparing the cost of that investment with those of the aircraft systems.

Emphasis has been placed on point-to-point transport, largely in partial competition with existing surface systems. For this reason only the conventional nonrigid airship was chosen, since it is the least energy -

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[1/] Moreover, maintenance and rehabilitation costs of surface modes may not be fully reflected in the imputed tariffs used in the cost comparisons. This aspect would be addressed in greater depth in the Phase II analysis.

intensive type and offers the potential of being the least expensive to manufacture and the most cost-effective airship from the standpoint of long- range cargo transport. Hybrid airships, combining airship and helicopter components, (See Figure 0.2) are discussed for special applications, but are not considered for regular transport service because of their higher capital and operating costs.

Current prices for new equipment are used throughout in aircraft system comparison. However, used fixed-wing aircraft with substantial residual life often can be obtained at substantial reductions in price. Sensitivity analyses testing the effect of aircraft prices on investment and operating costs are reflected herein.

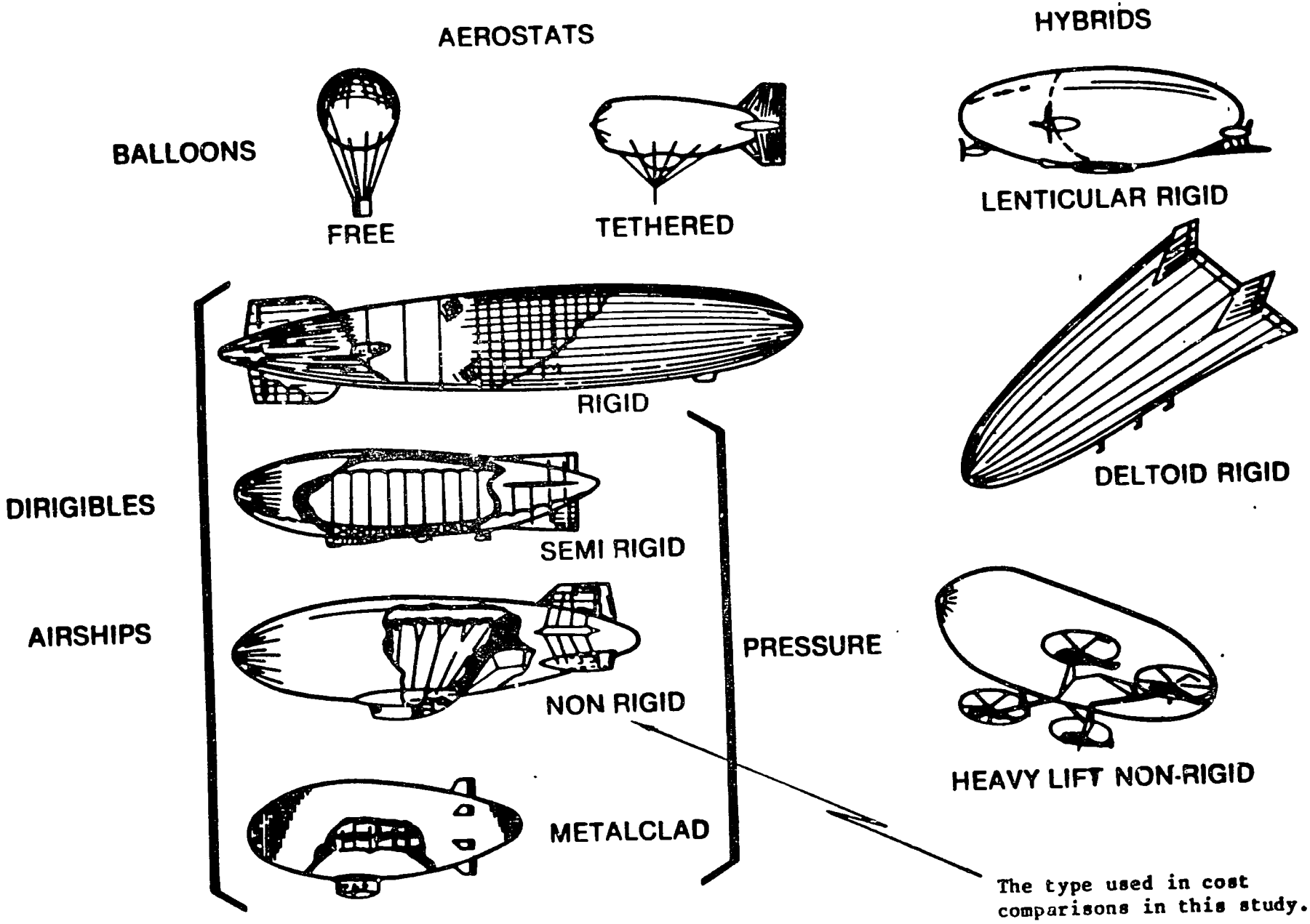
U.S. prices and operating costs were used, except for fuel costs, which were based upon estimated current Sahel prices. Fuel today is one of the most important cost elements in aircraft operation.

4.0 Scenarios

Three scenarios, representing contrasting international and domestic transport requirements, were developed. In the first two scenarios - one a two-country and the other a multi-country operation - the airship is in competition with other aircraft and with existing surface transportation modes; the third scenario, representing a domestic operation in Chad, called for an airship to furnish transport service in an environment where no alternative all-weather surface routes exist, and which would require expensive road construction to provide a reliable equivalent service.

FIGURE 0.2

TYPES OF LIGHTER-THAN-AIR AIRCRAFT



The performance and costs of various hypothetical nonrigid airships were compared against three very efficient turbo-prop airplanes in the first two scenarios. The airship type selected for comparisons with other aircraft and with surface modes was the conventional nonrigid type illustrated in Figure 0.2, in three alternative hypothetical sizes: 10,20, and and 40-mt payload. These scenarios dealt with the carriage of substantial tonnages of import and export cargo. Although direct operating costs for airships in the first two scenarios were attractively lower than for airplanes of equivalent payloads, the inital investment expense for airships and their corresponding ground facilities tended to place them on a par with airplanes in the first scenario, and left them less expensive in the second.

In the third scenario - a domestic air service in Chad - a currently available 2-ton capacity airship, considered more appropriate for that service, was used in the model.

As a consequence of including road construction costs in the modal comparisons, air transport was found less costly for low volume service than road transport. Airships were more cost-effective than the turbo-prop aircraft. The use of existing DC-3s and DC-4s (or their successor HTA aircraft) in the same service was considered. These have operational limitations which might preclude their utilization, such as the need for improved runways. However, if suitable landing strips are available and if cargo amounts and size can be handled by these aircraft they may be the least costly solution to system improvement. Their relatively higher operating costs likely would be offset by low acquisition costs, already written off.

Scenario One

This was a cost comparison of airships on a new direct air freight route (Conakry, Guinea - Bamako, Mali) carrying Malian imports and exports, in contrast with other aircraft and other modes on three competing surface routes, in which rehabilitation costs were included for one of the routes considered. In this environment, 40-ton airships and the L-100 airplane were found to be equal competitors and superior to other aircraft. However, they were considerably more costly than the Dakar, Senegal-Bamako rail route and the Abidjan, Ivory Coast-Bamako road route, and slightly more expensive than a third surface route, Conakry-Bamako, which required the upgrading of a substantial road section.

Scenario Two

In this scenario, an international freight service linking Abidjan, Ivory Coast with Bamako, Ouagadougou, Upper Volta and Niamey, (and other points, tonnage warranting) was examined.

In Scenario 2 it was found that existing routes, i.e.: Dakar - Bamako, Abidjan - Bamako, Abidjan - Ouagadougou, Lome, Togo - Niamey, and Cotonou, Benin- Niamey could handle the transport requirement at considerably less cost, since they represent sunk investments requiring no amortization of infrastructure.

In this scenario 40 ton class airships were more cost-effective than L-100 airplanes. Both 20-ton and 40-ton airships are more effective on this route than F-27 and DHC-5 airplanes, but all aircraft are more costly than surface transport.

The quality of airship service is superior to that of ground service in terms of delivery speed and reduced cargo damage and loss; however in view

of the existing jet transport services on these routes, it is doubtful that an airship service could be competitive.

In both Scenarios I and II no air system analyzed offered the current low transport costs of existing surface modes, largely because capital costs were not charged against existing systems, which are considered sunk investments. No new alternative mode can compete on this basis.

Scenario Three

Aircraft were used for a utility operation which combined routine cargo and passenger service with administrative and emergency transport. An itinerary linking N'Djamena, Chad with population centers in central and southern Chad was selected. Roads there are largely tracks and traffic volumes are low.

A currently available 2-ton airship with VTOL performance was compared with 2 airplanes of similar capacity on the basis of total cost per hour of operation and was found to offer substantially lower costs.

The 2-ton capacity airship was the optimum vehicle over other air and surface means. In this scenario all-weather roads did not exist throughout the itinerary; therefore the cost of constructing all-weather road links, where required, was included in the cost of the surface mode.

5.0 Current Aircraft Technology

The characteristics of real and hypothetical aircraft designs were listed against those of airplanes and helicopters of various types to establish a basis for comparison in the several transport scenarios. These comparisons were made between selected models of turbo-prop airplanes with demonstrated high efficiency and real and hypothetical airships. All-jet

transports and helicopters were not used in the point-to-point comparisons because of their limited effectiveness in such service. The conventional non-rigid airship shown in Figure 0.2 was chosen for these comparisons.

Principal Features of the Airship

It offers superior take-off and landing capabilities in constricted or undeveloped areas, equal to or better than those of other aircraft which have a STOL capability. It can provide a commodious cargo compartment greater than the interior volume of an aircraft of the same payload capacity without performance penalties. This enables it to carry more low density cargo as well as cargo of larger size or unusual proportion. It can also carry oversize cargo externally with only a slight effect on performance. It can be converted from cargo to passenger use; a 40-ton LTA could carry 200 or more passengers. Among aircraft, its service speed is relatively low. However, a combination of cargo and passenger transport capacity might satisfy a need, particularly if passenger fares were low. In all cases, the fuel consumption of airships is much less than that of airplanes with equivalent cargo capacity.

Conventional airships are at their maximum lifting capacity at sea level; flight at higher altitudes is accomplished by sacrifices in payload. The maximum altitude for which nonrigid airships are usually designed is 10,000 feet. (3,048 m)

Climatic Effects

Aircraft of all types are designed to operate in many areas of the world in a variety of climates. Temperature, humidity, and rain have relatively little effect on aircraft performance in flight. On the ground, provision must be made where blowing sand or dust is encountered to protect engines against contamination.

All aircraft are affected by winds in flight to the extent of retarding or augmenting speed over the ground. These effects are in direct proportion to flight speed.

Ground surface conditions are much less important for airships than for airplanes.

Airships and airplanes require certain ground facilities and equipment for year-round operation. The most important for major maintenance is a hangar. Other operations, such as daily servicing, can be performed outdoors. In the case of airships, a low mooring mast is required.

U.S. data on these vehicles indicate that airplanes offer lower direct operating costs per ton - km for carrying equivalent payloads, but that airships could have lower costs on the basis of equivalent productivity. The sensitivity of these comparisons to fuel costs shows that as fuel prices exceed U.S. costs, airships offered lower operating costs in both categories.

Most of the advanced technology development planned for the future is aimed at improvements in airplane and helicopter design. However, some of these advancements in aerodynamics, structures and materials, propulsion, and controls may also apply toward improved airships and would result in increasing the efficiency of this type.

6.0 Prevailing Sahel Transport Conditions

Since most Sahel countries produce and consume many of the same types of commodities and their market size is relatively small, there is little traffic between them. Livestock constitute a principal element of existing trade and a sizeable portion of this is trekked. Trade between Mali, Upper

Volta, Niger and the Ivory Coast was analyzed. It was found that only 8 per cent of this group's inter-country trade flowed between the first three (Sahel) countries and that 92 per cent was between them and the Ivory Coast.

The proportion of commodities falling into the high value cargo category is lower in the basically agricultural economies of the Sahel than elsewhere; consequently, a lower percentage exists of goods for which promptness of delivery is a key factor and which, in turn, can support the higher costs of air transport.

Analysis of existing transport modes led to the following general conclusions concerning their respective qualities of service and costs:[1/].

Existing Railroad

- Lowest cost mode in terms of prevailing tariffs.
- Poorest service; slow passage over a 1,200-km route may take from 3-weeks to a month; cargo damage and pilferage more prevalent. Higher inventory costs are involved.
- Most suitable for low value - large volume cargo such as most mining output in the Sahel and agricultural exports such as groundnuts and cotton.
- Usually offer passenger service as well.
- Most rail lines operate at a loss and as road systems improve are losing ground to road transport.

Existing Road/Truck Transport

- Higher unit cost than railroad (almost twice) but less than air service.

[1/] Exclusive of waterways, which have relatively less significance.

- Quality of service better than rail but poorer than air service. Faster; e.g.: 3-7 days vs. a month for rail on a 1,200-km run; less loss through pilferage and cargo damage.
- As primary road systems improve from graveled to paved surface and cargo shifts from rail to road, the size of the trucks engaged in long hauls is increasing; from 10 - 15 mt to 25 mt - 35 mt and up to 40 mt per unit. Operating costs do not increase proportionately and unit freight costs tend to decline.
- The superior service attracts higher value cargo which can pay the premium of higher costs per ton-km.

Existing Air Service

- Domestic systems usually operate at a loss because of limited high value cargo availability, poor quality of service contributing to low passenger demand and shorthaul domestic routes. During the rainy season air passenger traffic tends to rise abruptly, reflecting the lack of all-weather surface transport.
- Presently cargo transport is less significant than passenger travel in domestic feeder services. In some cases government employees on business make up half the passenger volume.

While the present levels of passenger and cargo traffic appear relatively low for some countries, there is at least in one case (Niger) an example of moderate but steady growth of domestic air traffic in both categories. Conversely, significant levels of domestic air traffic were achieved in Chad previous to the outbreak of civil war in that country. Both examples suggest that an untapped potential for increased use of air transport may exist within the outlying regions of the Sahel.

- Because of ASECNA assistance flight operations in the region are better coordinated than are other modes.

International Air Service

- The volume of international air cargo originating in the Sahel is limited, and the flow inbound is considerably greater than outbound.

The pervasive lack of financial and technical resources among the Sahel countries calls for emphasis on improvements in the operational efficiencies of existing systems, even while their expansion or the introduction of new systems is considered.

Quality of Service

Up to a point, shippers are willing to trade the higher costs of truck transport over rail transport in the Sahel for reductions in non-market costs. These non-market costs include cargo damage, pilferage and loss, and inventory costs occasioned by the slowness of rail transport. Higher speed, higher cost truck services are favored over lower cost but lower speed rail services when general cargo, with its high preference for low travel time, is shipped.

Likewise, air transport, which offers a service superior to road transport, is attractive to high value cargo; however air transport freight rates are higher than those of road transport.

On the other hand, given the generally poor quality of the road network (due in part to vehicle axle overloading) coupled with the accelerated depreciation of the vehicle fleet, it could be argued that current levels of road transport freight rates considerably understate the true economic costs of road transport in the Sahel relative to the air transport alternative.

Incidence of Transport Costs

The incidence of transport costs in the Sahel countries and its net effect upon demand are a significant consideration. Reports indicate that on a number of surface routes, both road and rail, freight rates are below average costs. Rates in many instances do not include allowances for depreciation of equipment; and road user-charges, which impact upon vehicle operating costs - in turn reflected in freight rates - are frequently inadequate to provide for appropriate road maintenance. Consequently, the shipper obtains a subsidized transport service - subsidized by the carrier, who may not be charging for depreciation of its equipment, and subsidized by the Government, which is not assessing carriers enough to offset road deterioration caused by the carriers' vehicles, ofttimes overloaded. Moreover, capital costs of the road or rail system are usually not included in the tariffs.

As a consequence of these hidden subsidies, surface freight rates tend to be lower than actual system economic costs.

From the standpoint of the shipper, this undercosting of transport services enhances the attractiveness of truck and rail transport over air transport, and under current conditions it is these lower freight rates against which the airship would commercially compete for cargo and passenger traffic capture.

In an economic sense, the incidence of costs is less relevant; it is the total real economic costs which should be compared in modal analyses.

7.0 Factors for and Against Air Transport Use in the Sahel

7.1 Factors Mitigating Against Air Transport Use in the Sahel

The following factors bear on investments in any form of air transport, including airships:

1) Most primary and secondary routes between areas of population concentration (which represent sites of greatest transport demand) are already in place. Transport by aircraft was found more costly per ton-km than by surface mode when surface transport infrastructure was already constructed.

2) The unit value of a large proportion of Sahel exports - and imports to a lesser degree - is low, compared with those of the industrialized countries. Slower, cheaper surface transport tends to be more attractive to lower-value cargoes than does higher cost air transport.

3) Aircraft are probably not economically feasible for the movement of small loads over short distances from farm to market. Feeder road and trail construction and maintenance will still be required for that purpose.

An air transport system provides service between take-off and landing points and does not directly serve intermediate points, whereas a road/truck or rail surface system can provide that service, which is necessary for communications, domestic commerce, social welfare, polical administration, and further economic development. On the other hand, airships preserve the advantage of greater flexibility relative to conventional fixed wing aircraft in terms of their potential to service possible intermediate points.

4) The introduction of a new air transport system most likely would not lead to the abandonment of surface infrastructure already constructed or to

the reduction of its maintenance costs, and might not necessarily lead to reduced expenditures for new surface route construction. The new system, moreover, would represent additional capital and maintenance costs, for which resources in the Sahel countries are scarce.

5) The shortage of trained technicians and managers in most Sahel countries is a constraint. Introducing any new system would tax human resources already thinly spread and would likely require a long-term program of training.

7.2 Factors Favoring Airship Use in the Sahel

1) The airship can be the least-cost solution to transport requirements when:

i) Adequate surface routes are not in place, and if constructed and maintained the total cost of these routes, plus the operating costs of surface vehicles required to move the same amount of cargo, would exceed the capital and operating costs of the aircraft and its infrastructure.

(In this regard Scenario No. 3 was positive; Scenarios 1 and 2 were negative.)

ii) A VTOL capability is required. Typical conditions which call for this function are:

a) The terrain is so rough, restricted (or flooded) that landing fields can be constructed and maintained only at high cost.

b) The delivery is a one-time task which does not warrant the preparation of an airstrip and no road can be used as a substitute landing strip.

2) When an aircraft is needed for emergency relief assistance in an area where ground conditions or load requirements do not permit the use of smaller less costly HTA aircraft. Representative of emergencies are the following:

a) Medical evacuation of sick and injured.

b) Transport of medical personnel and supplies to stricken areas.

c) Disaster relief shipments of emergency foodgrains.

3) When heavy or oversized pieces of cargo which cannot be carried overland or within a conventional HTA aircraft require transport. Examples of such cargo are the following.

- Units of heavy road construction equipment.
- Hydrological equipment for agricultural development.
- Mining equipment for exploration or mine development.
- Electric power and communications equipment (tower).

4) High fuel costs favor airships, which consume considerably less fuel per ton-km of transport than do HTA aircraft. The higher the fuel costs the more attractive airships become as a viable transport alternative.

7.3 Factors Relevant to Airship Use in the Sahel

1) A most attractive feature of the airship is its vertical take-off and landing capability, which permits it to land in rough terrain (or in areas interdicted by flooding). However, in the Sahel the terrain is generally flat or rolling, permitting the preparation of relatively low cost airstrips adequate for smaller HTA aircraft. Under these conditions, if the VTOL capability is not essential, air transport alternatives will not be limited to the airship, and the airship does not gain a particular advantage from this capability. But in areas subject to annual flooding the airship retains its VTOL advantages.

2) The airship has had only one commercial use in recent years and that is for aerial advertising in the U.S. and Germany. If possible, its viability in other commercial use should be proven under more hospitable and more easily controlled conditions than would be found in the Sahel.

8.0 Special Applications

Airship Service to Isolated Areas

With respect to outlying areas with limited cargo and passenger potential where competing surface transport facilities do not exist, the airship may offer the least-cost solution to providing an adequate service. This would depend upon the magnitude of tonnages requiring transport and the nature of the terrain, since small aircraft offering lower cost services might in some cases suffice. The airship proved attractive in a Chad scenario.

Beyond point-to-point cargo transport, in the report several other applications are discussed which appear attractive for airships. For conventional airships, a potential exists for operation as a fuel tanker, particularly during the rainy season. Another application may include use in coastal waters for oceanographic research and exploration.

Conventional or hybrid airships operating as short range heavy lifters could be cost effective for a number of missions in undeveloped and remote areas for:

1. Oil and gas exploration.
2. Development and servicing of mining sites.
3. Pipeline construction and servicing.
4. Cargo transport, including emergency food shipments and/or medical supplies.

In addition, these types offer benefits for:

1. Maritime cargo unloading.
2. Transport of hydrological equipment.
3. Construction and transport of buildings or other civil works.
4. Power plant construction.
5. Power line construction.
6. Refinery and plant construction.
7. Logging.
8. Offshore oil platform construction.

Airship Applications in the Early Phases of Oil and Gas and Mineral Extraction.

The transport of personnel, heavy equipment and even pipeline materials could be facilitated regardless of the season and condition of surface routes, and the working season correspondingly prolonged. The extent of savings through airship service before a permanent surface route is required for gas or oil transmission or mineral transport could be determined through further analysis, if it is expected that known oil and gas and mineral deposits in the Sahel might be developed in the next decade. The use of airships, particularly in the early stages of these projects, could offer economies which would measurably enhance the economic viability of such undertakings, and this should be reflected in their pre-project feasibility studies.

Data relative to the development of the Tambao manganese mine in Upper Volta and the related 340-km rail extension from Ougadougou to Tambao, received from CILSS too late to be considered in this report, would be utilized in supplementary analysis.

9.0 Recommendations for Phase II and Further Efforts

i) The introduction of the airship or other aircraft as a surrogate for roads under conditions of low traffic density accompanied by high road construction cost merits further consideration, because air transport may offer a highly attractive alternative to road building in these situations.

Operating from terminal points of the road/rail network, aircraft could extend transport services to isolated areas at less cost than other modes. Radio communications and storage facilities at the terminal intermodal points would be appropriate. Such a system might provide at least cost services meeting minimum acceptable standards and postpone costly road construction until such future time that traffic would warrant a road.

Phase II field work would be required vis-a-vis specific routes already proposed for surface transport improvement. Data should be gathered on present and projected passenger trip and cargo volume, storage and communications requirements, and the comparative cost and quality of air service vs. road construction vs. present operation on existing tracks. A quantitative analysis would compare alternatives.

The product of this effort would be the identification of specific route links for which such service might be adequate, and the preliminary designation of a domestic or regional network interfacing with road and rail modes and extending transport services to points difficult or costly of access. (See list of candidate routes, Attachment 1.)

ATTACHMENT 1

ROUTE	KM	QUALITY	EST'D. COST CFAF BILLIONS	COMMENTS
CHAD				
N'Djamena-Abeche	720			Paved or Engineered for 150 km to Karme; balance is track; 570 km.
N'Djamena - Sahr				
N'Djamena-Moundou				Surface route includes Bongor-Lai section proposed for reconstruction and paving at $404,000/km.
N'Djamena-Faya Largeau	780			Paved or Engineered for 210 km to Mouzarak; track beyond; Dates and agric. inputs are principal commodities transported.
CHAD- CAMEROON				
Moundou-Guidjiba-N'Gaoundere	304		18.7 ($76.0 million)	Presently track; major and minor; paving has been proposed; balanced commodity flow; 50,000 mt/yr inbound and outbound.
MALI				
Mopti-Tomboctou	600			Niger River, Mopti-Tomboctou-Gao.
Bamako-Kayes	450			Presently served by rail and air; a road track exists.

ROUTE	KM	QUALITY	EST'D. COST CFAF BILLIONS	COMMENTS
NIGER				
Zinder-Agadez	380	Earth	27.0	Upgrading to paved standard under consideration: present earth road unsuitable for heavy axle loadings. Nigerian mining and oil exploration; heavy lift; Elevation: 500-1,000 m.
Tanout-Birni-Kazoe	145		4.0	
Arlit-Iferounane-Bilma-Djado				Djado: Petroleum, Uranium; Bilma: Agricultural Development.
UPPER VOLTA				
Ouagadougou-Tambao	339			Rail; Tambao managanese deposits.
Tambao-Tin Hrassan	35			Rail; Tin Hrassan limestone deposits.
Fada N'Gourma-Bilanga	74	Earth		Largely needed for East ORD administration of Integrated Agricultural Area Development Project in Bougande District. The cost of upgrading to all-weather laterite surface, determined in a 1982 AID-financed study, resulted in an unacceptably low internal rate of return.

AIR TRANSPORT ALTERNATIVES
VS
SURFACE TRANSPORT IN THE SAHEL

PHASE I - PREFEASIBILITY STUDY
FOR

AID
WASHINGTON, D.C.

CILSS
OUAGADOUGOU, UPPER VOLTA

VOLUME II - PRINCIPAL TEXT

APRIL 1, 1983

AIR TRANSPORT ALTERNATIVES

VS

SURFACE TRANSPORT

IN THE SAHEL

A REPORT ON PHASE I

OF A

PRE - FEASIBILITY STUDY

for the

AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D. C.

and the

COMITE PERMANENT INTER-ETATS DE LUTTE
CONTRE LA SECHERESSE DANS LE SAHEL
Ouagadougou, Upper Volta

by

Norman J. Mayer, Aeronautical Engineer, NASA
and
Richard L. Braida, Transportation Economist, DOT

VOLUME II - PRINCIPAL TEXT

Washington, D. C.
April 1, 1983

ABBREVIATIONS, ACRONYMS AND TERMS

ADT	Average daily traffic
Aircraft	Air vehicles, both lighter-than-air and heavier-than-air
Airship	A lighter-than-air aircraft (Dirigible)
ASECNA	Agence pour la Securite de la Navigation Aerienne en Afrique
CFM	Chemin de Fer du Mali
CIDA	Canadian International Development Agency
CILSS	Comite Permanent Inter-Etats de Lutte Contre la Secheresse Dans le Sahel
CMN	Compagnie Malienne de Navigation
CTOL	Conventional Take-off and Landing
DOC	Direct operating costs
DOT	U.S. Department of Transportation
FED	Fonds Europeen de Developpement
FW	Fixed Wing
HTA	Heavier-than-Air
LTA	Lighter-than-Air
M $	Millions of dollars
NASA	National Aeronautics and Space Administration
OCBN	Organization Commune Benin-Niger des Chemins de Fer et des Transports
OCDN	Organisation Commune Dahomey - Niger
p.a.	per annum
RAN	Regie de Chemin de Fer Abidjan - Niamey
STOL	Short Take-off and Landing
VOC	Vehicle operating costs
VPD	Vehicles per day
VTOL	Vertical Take-off and Landing
NRC	Nigerian Railway Corporation

CURRENCY EQUIVALENTS

Currency Unit	=	CFA Franc (CFAF)
1 French Franc	=	50 CFAF
1 CFAF	=	2 Mali Francs
47 Ouguiya	=	U.S. $1.00
2.33 Dalasi	=	U.S. $1.00
45.7 Cape Verde Escudos	=	U.S. $1.00

CFAF per U.S. $1.00[1/]

1970	277.71
1971	277.03
1972	252.21
1973	222.70
1974	240.50
1975	214.32
1976	238.98
1977	245.67
1978	225.64
1979	212.72
1980	210.00
1981	235.00
1982	300.00
1983	330.00 (est'd)

SYSTEM OF WEIGHTS AND MEASURES

1 kilometer (km)	=	0.62 miles (mi)
1 meter (m)	=	3.28 feet (ft)
1 centimeter (cm)	=	0.39 inches (in)
1 square kilometer (km)	=	0.386 square miles (sq. mi)
1 liter (l)	=	0.22 imp. gallons
	=	0.26 U.S. gallons
1 kilogram (kg)	=	2.204 pounds
1 metric ton (mt)	=	2,204 pounds
$1m^3$ gasoline	=	1,902 pounds = 0.86 mt.

1/ Average rate for the year.

AIR TRANSPORT ALTERNATIVES

VS

SURFACE TRANSPORT IN THE SAHEL

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I. Current Aircraft Technology

A. Classes of Aircraft

The major delineations among aircraft types are depicted in Figure 1. Two major classes can be identified: Heavier-than-air (HTA) and Lighter-than-air (LTA) aircraft.

HTA aircraft are further subdivided into two classes: fixed wing (airplanes) and rotary wing (helicopters and autogyros). Rotary wing types are capable of vertical take-off and landing (VTOL).

Some airplanes are designed for short take-offs and landings (STOL). These are usually propeller-driven types with lower wing and power loadings and with somewhat reduced transport efficiency than conventional take-off and landing (CTOL) types.

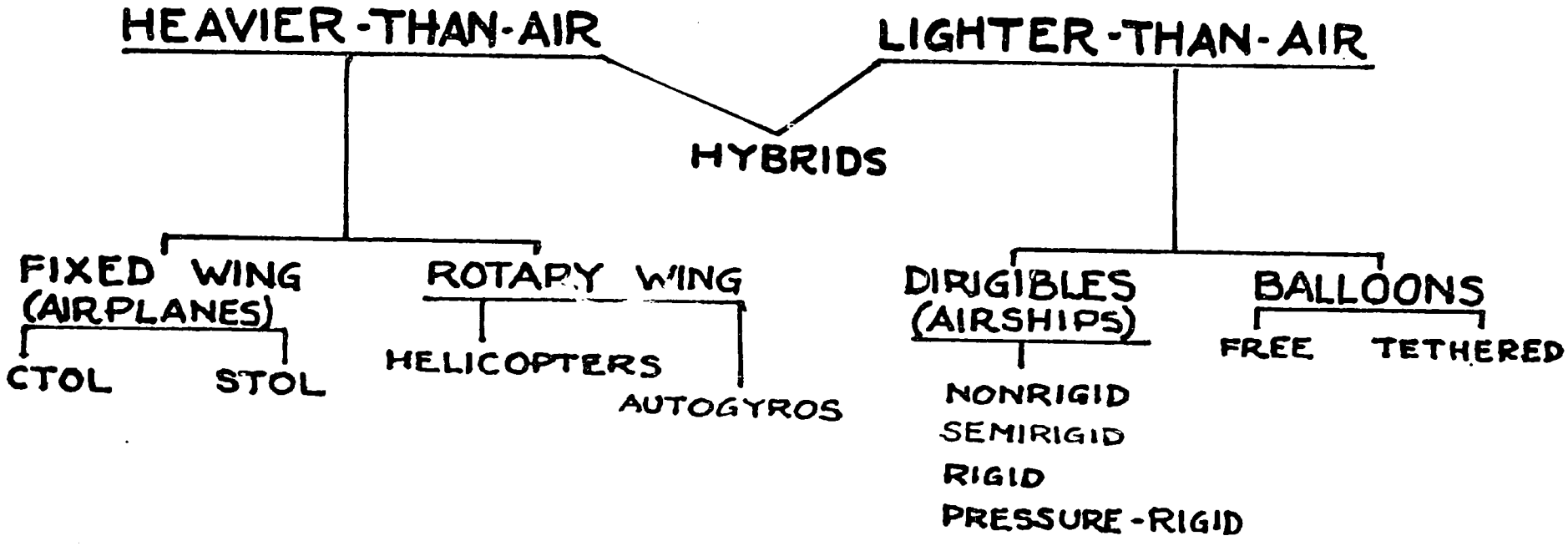
All LTA aircraft can be either VTOL or STOL vehicles. Where lift is derived mainly by static means (displacement) and where control is achieved by movable tail surfaces, the type is referred to as a conventional or classic dirigible or airship. Newer types now under development combine HTA and LTA components and characteristics and are designated "Hybrids."

The airships studied herein include both real and hypothetical types. The former class is represented by firms developing airships for the civil market or as experimental vehicles to demonstrate a concept. The hypothetical types were selected from a previous study.[1/]

[1/] Reference 26.

FIGURE 1

CLASSES OF AIRCRAFT



Aircraft Characteristics

1. Airplanes

Airplanes are classified according to their configuration and function. They are either STOL or CTOL type, as previously defined. All STOL transports currently in operation are propeller driven airplanes using either turbine or reciprocating engines. Reciprocating engines for airplanes are no longer available in sizes above 500 H.P. from the major manufacturers; therefore airplanes above about 5,000 lbs. in weight empty are powered by turbine engines. The STOL airplanes in this study are in this class. Since this is a preliminary study, all aircraft were used at their advertised cruise speeds and maximum take-off weights. While this combination provides maximum productivity, it compromises the STOL performance somewhat. Table 1 indicates the turbo-prop airplanes considered in this study.

Another type of turbine-prop driven airplane is the less-than-60-seat CTOL airliner. This type has been developed to a high degree of efficiency and is currently used in many intra- and inter- national African services.

Jet airliners are in use in both long and short haul operations, particularly in the U.S. Since this study involved distances of approximately 1,000 km or less between airfields, the jet transport was not used in making comparisons because its higher fuel consumption would have favored this type less than the prop driven airplanes.

TABLE 1

Airplanes

Turbo - Prop Transports

MANUFACTURER	MODEL	PAYLOAD (MT)	HP	CRUISE SPEED (KM/HR	WEIGHT EMPTY (KG)	AVAILABLE MT - KM PER HR	COST ($MILLIONS)
			S H O R T	R A N G E			
BEECH U.S.	B-100	.91	1430	491	3439	447	1.187
BRITISH AEROSPACE (U.K.)	J-131	1.48	2000	468	3450	693	2.300
CESSNA (U.S.)	441	.91	1250	450	2580	410	1.225
DEHAVILLAND (CAN)	DHC-6	1.13	1304	338	3320	382	1.250
EMBRAER (BRAZ)	EMP-110	1.44	1500	417	3515	600	1.700
FAIRCHILD SWEARINGFN (U.S.)	METRO II	1.50	1880	459	4172	689	2.150
			M E D I U M	R A N G E			
BRITISH AEROSPACE	HS-748	3.53	4160	447	12226	1578	6.500
DE HAVILLAND	DHC-5	8.16	6266	336	11138	2743	5.040
FOKKER (NETH)	F-27	5.97	4280	479	11948	2860	7.400
ANATROV (SOVIET)	AN-26	5.50	5640	440	15020	2420	---
			M E D I U M -	L O N G	R A N G E		
VICKERS	810/840 (VISCOUNT)	6.58	7960	574	18753	3777	*
LOCKHEED	188 ELECTRA	9.82	15000	652	25986	6403	*
LOCKHEED	L-100	23.5	17472	555	27715	13724	11.50

* No Longer in Production

2. Helicopters

Commercial helicopters have maximum payloads of up to 12 tons. Only one U.S. helicopter, the Boeing 234, is presently manufactured in this higher weight class. Many others are available and are made in several countries, with payloads of up to 2 tons. The helicopter's VTOL capability is its major advantage, making it possible to land on any surface which can support its weight. This feature also includes the ability to hover for long periods and maintain an accurate geo-stationary position. As a result unique utilitarian functions can be performed, ranging from public service (rescue and medical) to commercially profitable operations such as placing of equipment and personnel on sites inaccessible by road, saving hours or days of construction delays and cost by direct transport, and in certain logging missions.

The high fuel consumption, high initial cost, and greater maintenance expense of helicopters do not allow them to be directly competitive as air transports. None, except a utility aircraft in Chad (Scenario 3), was considered in this study. Table 2 contains the characteristics of various helicopters.

3. Airships

LTA aircraft, airships or dirigibles are the least familiar class of aircraft; hence many erroneous notions exist concerning their capabilities and characteristics. As shown in Figure 0.2 airships are classified according to their method of construction. In the case of hybrids this is a configurational grouping which can be sub-classified. The construction classification also denotes by what manner the airship maintains its shape.

TABLE 2

Helicopters

MANUFACTURER	MODEL	PAYLOAD (MT)	HP	CRUISE SPEED (KM/HR	WEIGHT EMPTY (KG)	AVAILABLE MT - KM PER HR	COST ($ MILLIONS)
AEROSPAT (FR)	A5350D	0.50	615	237	1070	119	0.428
AEROSPAT (FR)	DAUPHINE SA-365N	1.18	1470	277	1888	327	1.760
AEROSPAT (FR)	AS-332B	1.59	3510	291	3920	463	4.200
AGUSTA (ITALY)	HIRUNDO 109A	0.68	840	267	1415	182	0.885
BELL (U.S.)	206B-111	0.45	420	225	843	101	0.279
BELL (U.S.)	214 ST	1.81	3250	296	4286	536	3.900
BOEING (U.S.)	234	8.38	8150	263	9219	2204	20.000
SIKORSKY (U.S.)	S-76	1.27	1300	269	2483	342	1.660
SIKORSKY (U.S.)	S-64	11.34	8600	272	8724	3084	*

* No Longer in Production

Table 3 contains technical specifications for airships. The hypothetical vehicles listed are compared as to size in Figure 2 a.

Rigid Airships

Best known as Zeppelins, they have a fixed framework which defines the hull form, supports the outer cover or fairing and encloses the gas which is contained in separate cells. Propulsion units can be mounted in various locations along the hull. A control and cargo/passenger car is usually located on the bottom side forward. Passengers and cargo can also be carried within the hull. Stability and control are provided by fins and rudders near the stern.

Nonrigids and Semirigid Airships

Nonrigids and semirigids are called pressure airships, since they require a slight positive internal pressure to achieve and maintain their hull contours.

The pressure airships (and the pressure-rigids) normally have a single cell for the lifting gas. Pressure is maintained by a system of air cells (ballonets) which can be inflated or deflated to compensate for gas volume changes.

TABLE 3

Airships

MANUFACTURER	MODEL	PAYLOAD (MT) 2/	HP	CRUISE SPEED (KM/HR)	WEIGHT EMPTY (KG)	AVAILABLE MT - KM PER HR	COST ($ MILLIONS) 3/
Conventional							
AIRSHIP INDUSTRIES (U.K.)	S-500	1.60	380	93	3185	149	1.26
AIRSHIP INDUSTRIES (U.K.)	S-600	2.25	500	93	3664	209	1.43
AIRSHIP INDUSTRIES (U.K.)	S-5000 4/	24.22	---	130	20172	3146	6.86
WREN SKYSHIPS (U.K.)	R-30	12.70	6580	185	16355	2349	8.00
1/	5-t	6.43	1033	136	8830	874	3.214
1/	10-t	12.31	1420	136	13795	1674	4.849
1/	20-t	24.00	2059	136	22319	3264	7.647
1/	40-t	47.22	3093	136	38751	6422	13.027
Hybrids							
PIASECKI (U.S.)	HELISTAT	22.7	5100	102	28776	2315	---
GOODYEAR (U.S.)	HLA 4	50.0	8760	148	57733	7400	48.651
AFROLIFT (U.S.)	CYCLO-CRANE	1.8	360	83	---	149	---

1/ Hypothetical Design

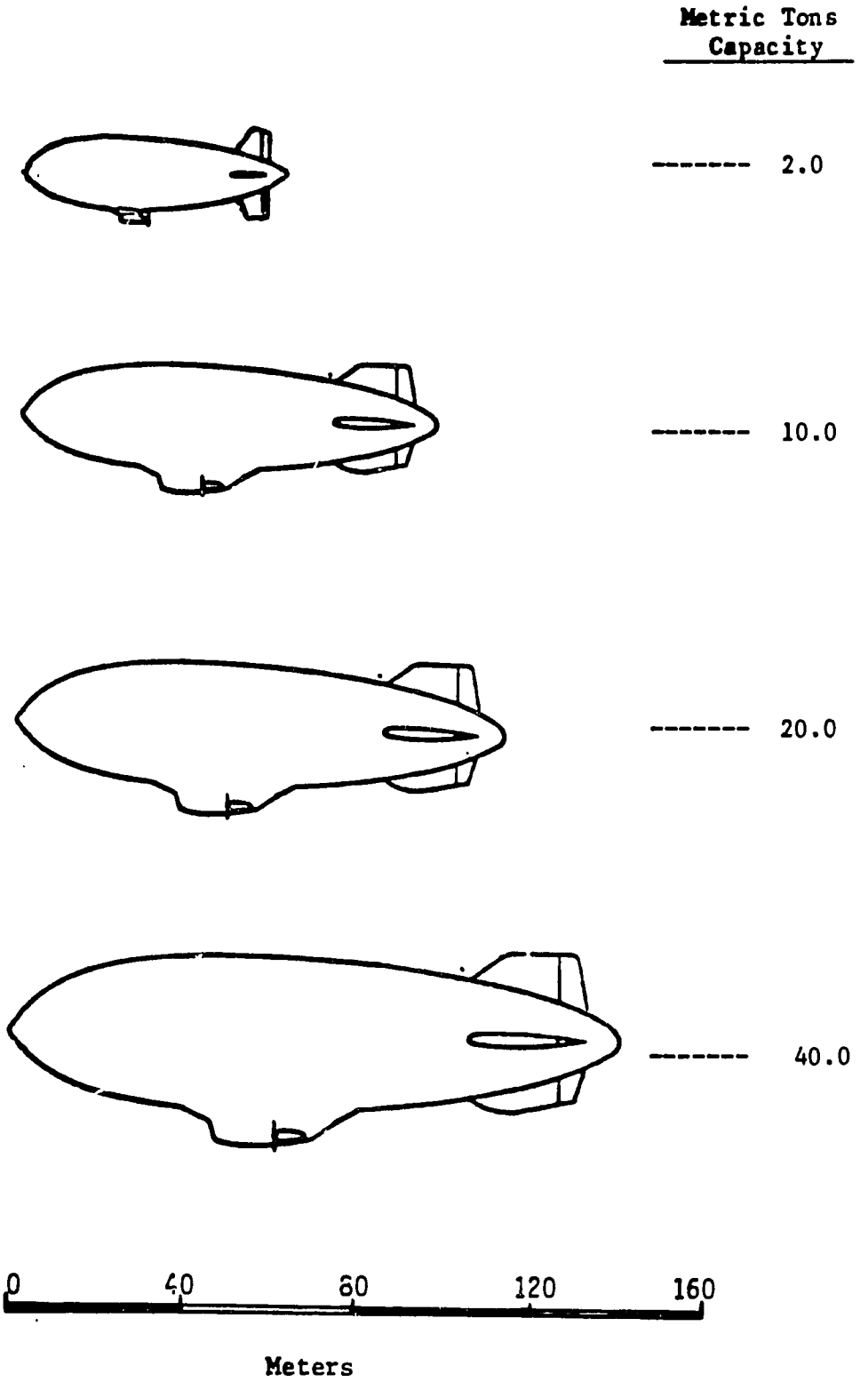
2/ At 2000 ft. Altitude

3/ Estimates for Production Quantities

4/ Proposed Design

FIGURE 2 a

COMPARISON OF AIRSHIP SIZES



Nonrigids

All of the applications studied in this report are based upon the nonrigid airship type since the sizes required are within its range of efficiency and achievability and it is the least costly airship type. Characteristics of existing and hypothetical nonrigids are indicated in Table 3, under "Conventional."

The design of nonrigids is the most advanced of all types. It experienced a concentration of effort beginning just before World War I which continued to 1962. Recent activity is also primarily concentrated on this type. Figure 2 b shows the principal features of a large naval nonrigid airship.

A small modern nonrigid is shown in Figure 3.

Semirigids

The semirigid is assisted by means of a longitudinal keel which is a rigid structure.

Pressure-Rigids

A fourth class is the pressure-rigid which requires internal pressure for structural integrity but which also has a hull formed by rigid framework. This system is a necessity for metal skinned airships, (metalclads), of which an early type is shown in Figure 4.

Neither semirigids nor rigids have been built since the 1930's. The need for the former has generally disappeared because of improvements in the nonrigids. The rigid type is costly to build, but could be reconsidered for long-range transport where large hull volumes are required, since nonrigids are limited in this respect.

FIGURE 2 b

Features of a Non-Rigid Airship

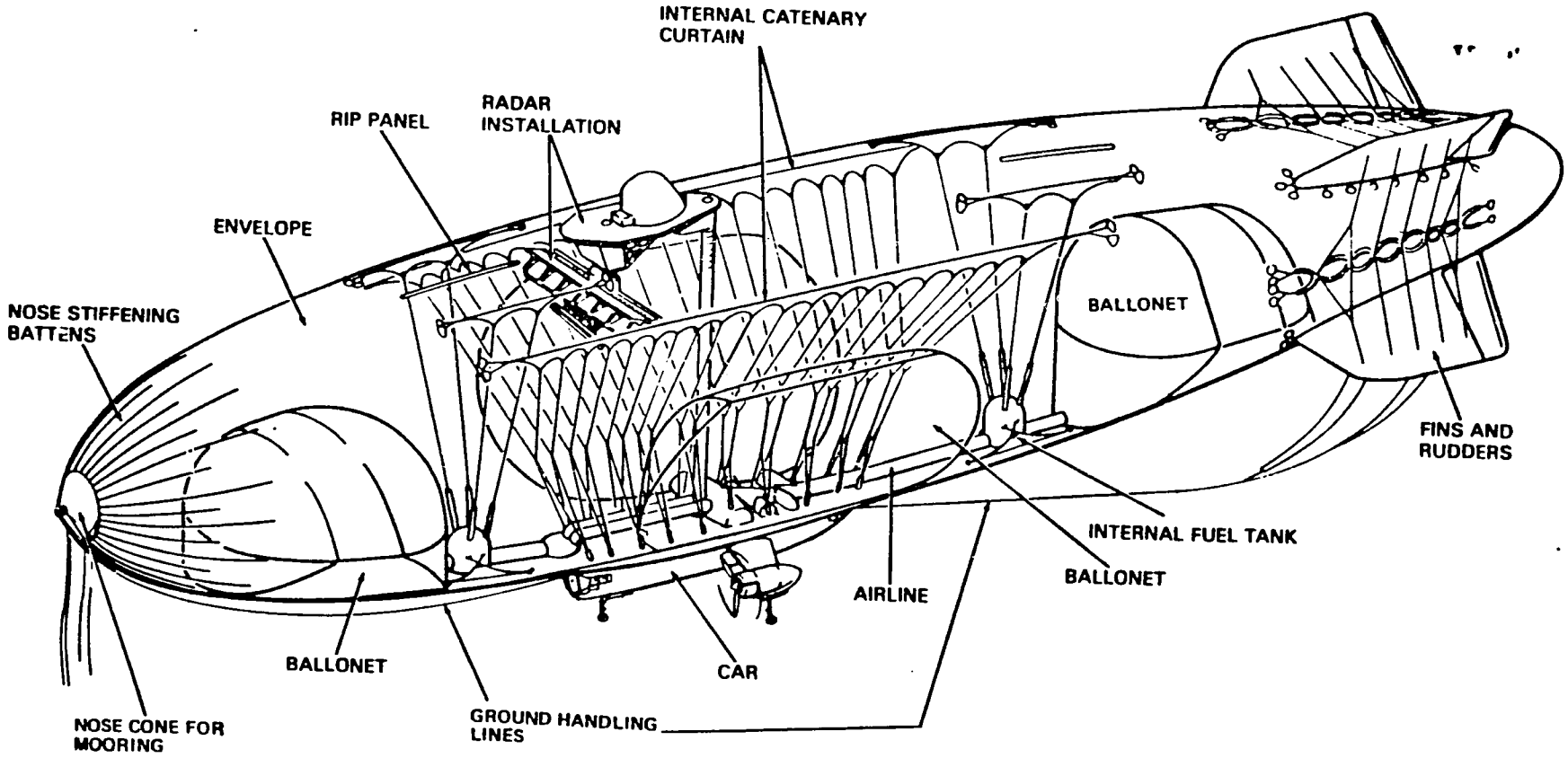


FIGURE 3

A MODERN NON-RIGID AIRSHIP

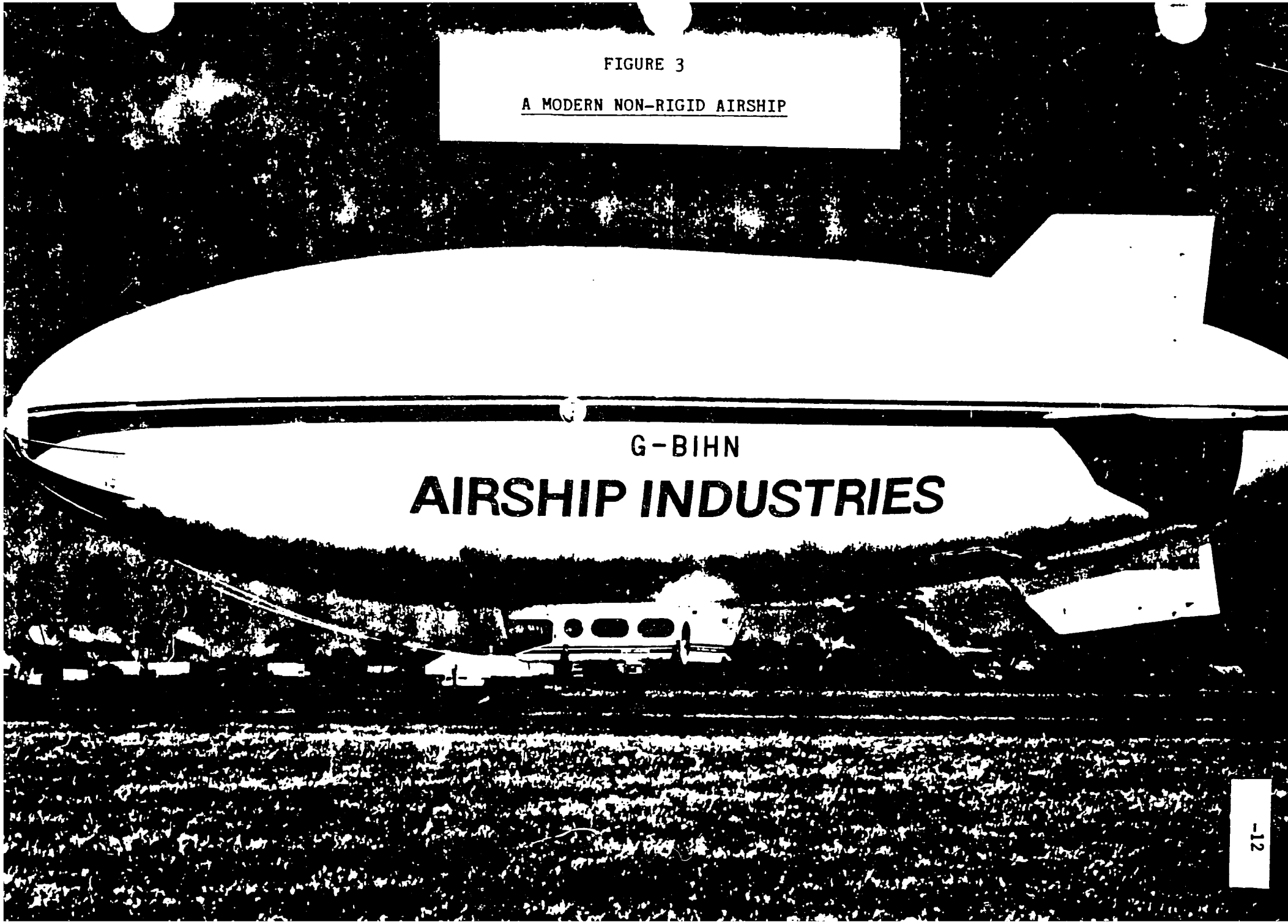
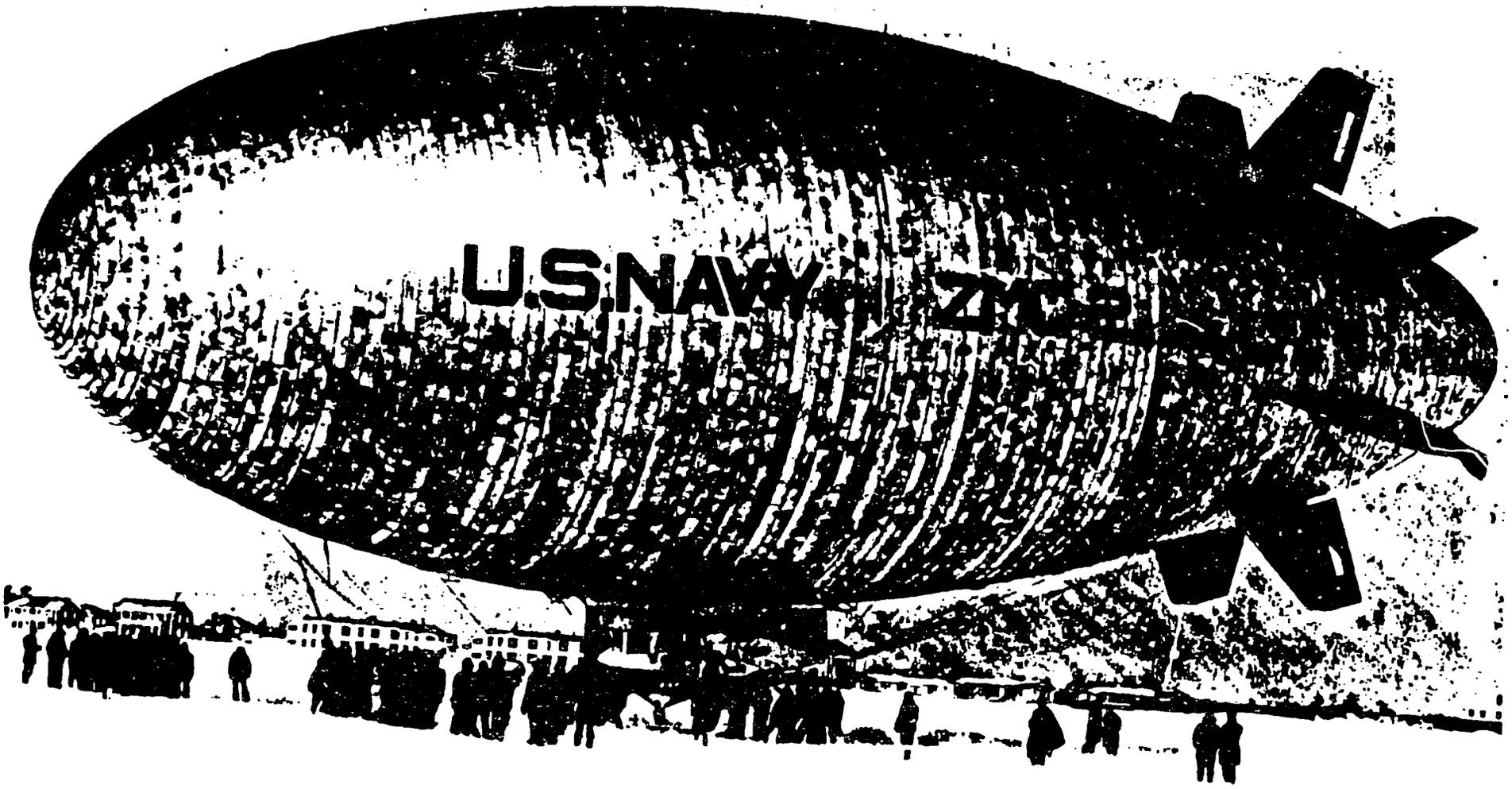


FIGURE 4

EARLY METAL SKINNED AIRSHIP



Hybrids

The so-called Hybrid has come into existence in recent years. Several variations have been built, primarily in model or small scale form. These aircraft derive their lift by a combination of aerodynamics and static buoyancy. One type, the Heli-stat or Heavy-lift airship, uses the lift of helicopter rotor systems for approximately half the total lift requirement and the gas lift for the remainder. A model of an advanced version of this type is shown in Figure 5. This aircraft would normally fly "heavy." The helicopter units would also provide high control forces to assist in hovering and in low-speed flight.

Another hybrid, the lifting body type, derives aerodynamic lift from its hull acting as an airfoil or wing surface. Thus it must be driven to achieve the total lift. An advantage is the ability to fly faster more efficiently. It also requires a smaller hull than conventional airships.

A further variation in concept is one which develops lift and control forces through vanes on wings attached to a gas-filled hull which rotates about its axis. This type requires less power and may offer greater economy of operation than the helicopter - airship hybrids. An experimental version is shown in Figure 6.

Airship Flight

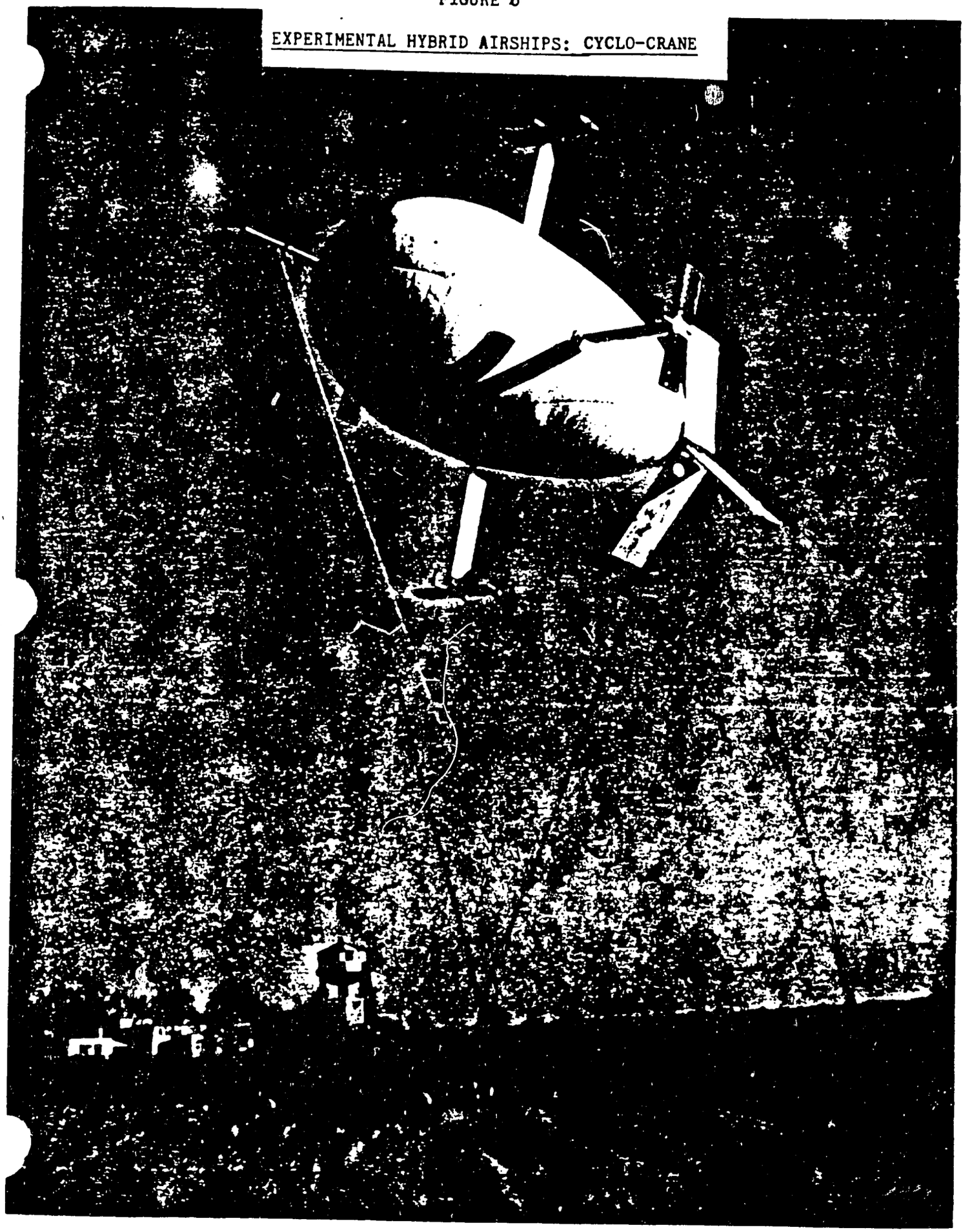
All LTA aircraft are most efficient at low altitudes, where the atmospheric density and resultant buoyancy effect are the greatest. As airships rise their lifting gas expands and displaces a greater volume of air. This same effect occurs as temperatures rise, causing the gas to expand. Since airships are constructed not to change shape, the total hull

FIGURE 5

HELI-STAT OR HEAVY-LIFT HYBRID AIRSHIP

FIGURE 6

EXPERIMENTAL HYBRID AIRSHIPS: CYCLO-CRANE



volume remains constant. Therefore gas expansion must be allowed for in the flight plan. The degree to which this adjustment is required depends upon the particular conditions of altitude, pressure, and temperature that will be encountered. The net effect on performance is that increases in altitude or ambient temperature decrease lifting capacities for any given airship. Conversely, if an airship is designed to operate at higher altitudes or temperature for a given payload it must be larger than one which would operate only at lower altitudes. In practice, airships are usually designed to fly up to a maximum altitude of about 10,000 ft. (3048 m) but this capability is not normally utilized, so that higher payloads may be carried.

Hovering Capability

Conventional airships are capable of hovering without power when in a condition of static equilibrium. This capability is often misinterpreted to conclude that cargoes may be loaded and discharged without landing, but in fact such operations are not practical unless certain other conditions prevail. The most important is control. Normally the control surfaces become ineffective at airspeeds below about 25 km/hr; changes in weight, lift, and position cannot be corrected at a fast enough response rate when flying below this speed to prevent large excursions of the airship away from the desired station location. It was routine for naval airships to refuel and rearm - even change crews at sea from surface vessels while hovering - because both craft maintained courses into the wind so that airspeeds were above the critical minimum values.

In the past, some airships were built with vertical thrusting propellers to compensate for changes in buoyancy and to allow take-offs and landings above or below equilibrium weights. The modern propulsion systems

described in Section II H, Current Developments, will allow this feature to be used again, with a greater efficiency to approach the goal of true hoverability.

The helicopter - aerostat combination hybrids will incorporate a high degree of controllability because of higher control power available from the helicopter units; these are intended to be true hovering airships.

Conventional airships are normally landed for loading and unloading. A hardened landing surface is not required since the landing gears carry very little of the airships' weight. Their main function is to arrest vertical descent and provide a point of contact. Therefore the prime requirement involves a cleared space to eliminate danger of collision with trees, buildings, etc. When the airship has landed, a mooring mast is used to anchor the ship and allow it to rotate with the wind. External assistance in the form of ground crews and/or mechanical equipment is also required to moor and release the airship. For handling in and out of a hangar, a mobile mast allows this operation to be conducted routinely and safely.

C. AIRSHIP APPLICATIONS

Airships have never been used in direct competition with airplanes. In the past, they have been best utilized as unique solutions to military and civil transport problems which arose, particularly the following:

Pre-World War I - Passenger intercity transport.

. World War I - Long-range bombers

. " " " - Long endurance reconnaissance.

Post-World War I - International air transport.

" " " " - Flying aircraft carriers.

World War II - Anti-submarine warfare.

Post-World War II - Airborne early warning and Anti-submarine warfare.

Gradually, many of these needs were better satisfied by airplanes; some were no longer considered important.

Current emphasis is on transport and utility, particularly in lesser developed areas where surface transportation has not been introduced. For transport the airship offers three potential advantages: economy, VTOL or STOL capability, and heavy-lift capability. In terms of utility, it allows for quick diversion to new routes, conversion to special emergency services, and alternative cargo or passenger use.

In this study, emphasis has been placed on point-to-point transport, in partial competition with existing surface systems. For this reason, only the conventional nonrigid airship was chosen, since it has the potential for being the least expensive to manufacture and operate. It is also the type which has experienced the most development and on which a substantial vehicle data bank exists. Later sections of this report discuss other types for different applications.

The primary mission was assumed to be the carrying of agricultural commodities and manufactured items. Passenger transport is equally possible, although no attempt was made to assess different systems for this purpose. Nonrigid airships carry payloads in a car located at the bottom of the envelope or hull (See Figure 3). Because the car is similar to an airplane fuselage, its interior can be modified to carry people or cargo.

The drag of the car is not as critical to an airship as to an airplane. Consequently it can be built with greater interior volume, accommodating bulky cargoes and offering more room per passenger. The cars of current nonrigid airships, for example, have from 4 to 8 times the interior room of airplanes of equivalent payloads. In addition, oversize cargo can be carried externally with only slight effect on airship performance.

D. Costs and Efficiency

1. Cost Indices

A primary figure of merit for all transport vehicles is cost per unit of productivity. A typical expression is dollars per metric ton-kilometer or ton-mile. All modes can be compared on this basis when equal mission capability is assumed, i.e., the vehicle is able to fulfill the transport task. Productivity alone consists of two factors: speed times cargo or payload capacity. Equal values for different modes can be achieved either by slow speed combined with high capacity or low capacity with high speed. Airplanes have generally followed the latter course but recently wide-bodied jets have made gains in both categories. When airships were used earlier as transports they were superior to airplanes because of high payload capabilities and because airplane speeds in those times were not significantly higher.

Transport efficiency is dependent upon a host of factors relating to vehicle performance and economics in terms of investment and operating costs.

Direct operating costs (DOC) are readily determinable, and pertain to the operation of the vehicle itself.

Indirect operating costs (IOC) include the administrative and support expense of the operation. These are more sensitive to local conditions and also are not usually included in publicly obtainable references.

Investment expense (capital cost) is a very significant part of a new system. Where road, rail, and air transport infrastructure is already in place these networks may have long since been paid for and are not included in cost data. But in assessing the establishment of new systems in developing countries, capital costs must be included for equitable modal comparisons.

Direct operating costs are frequently used for initial comparisons among aircraft, and are later augmented by the analysis of indirect and investment expenses. DOCs are usually expressed in dollars per block hour for air transport, stated as follows:

$$DOC = C_c + C_f + C_{de} + C_{od} + C_i + C_{ma} + C_{he}$$

Where: C_c = Crew costs (pilots)

C_f = Fuel costs

C_{de} = Aircraft depreciation

C_{od} = Aircraft obsolescence & deterioration

C_i = Aircraft insurance

C_{ma} = Aircraft maintenance

C_{he} = Helium cost (for airships)

Improvements in DOCs are closely related to energy consumption, which is highly sensitive to technology development. In the aircraft field, most research is concentrated on improving this parameter through new developments in aerodynamics, propulsion, structural design, and materials. A general comparison of various modes of transport on the basis of energy efficiency and DOC is shown in Figure 7.[1/]

Fuel prices are chiefly responsible for driving DOC's higher for airlines during the past decade, as shown in Figure 8. Airplanes are more sensitive to this change than airships or surface modes.

A more detailed comparison of DOC's is shown in Figure 9.[2/] These are plotted on the basis of equivalent payloads. Both STOL and CTOL airplanes are represented. For all types, a general trend towards lower DOCs is indicated for larger aircraft - due mainly to increased productivity. The speed differential is responsible for the superiority of airplanes over airships, expressed as lower direct operating cost per ton-km.

On the other hand if airplanes and airships are compared on the basis of equal productivity, as shown in Figure 10, the opposite result is obtained. That is, the direct operating cost of an airship which will provide "x" number of ton-km per hour will be less than that of an aircraft which can produce the same number of ton-km per hour. In this case, it is evident that higher payloads are cheaper to obtain in airships than in airplanes, even when including CTOL types.

1/ Values used are based upon data contained in Refs. 10, 23, 26-28.
Costs are U.S. costs.

2/ Based on references 4, 5, and 12.

FIGURE 7

ENERGY USE AND DIRECT OPERATING COSTS
(ALL U.S. COSTS)

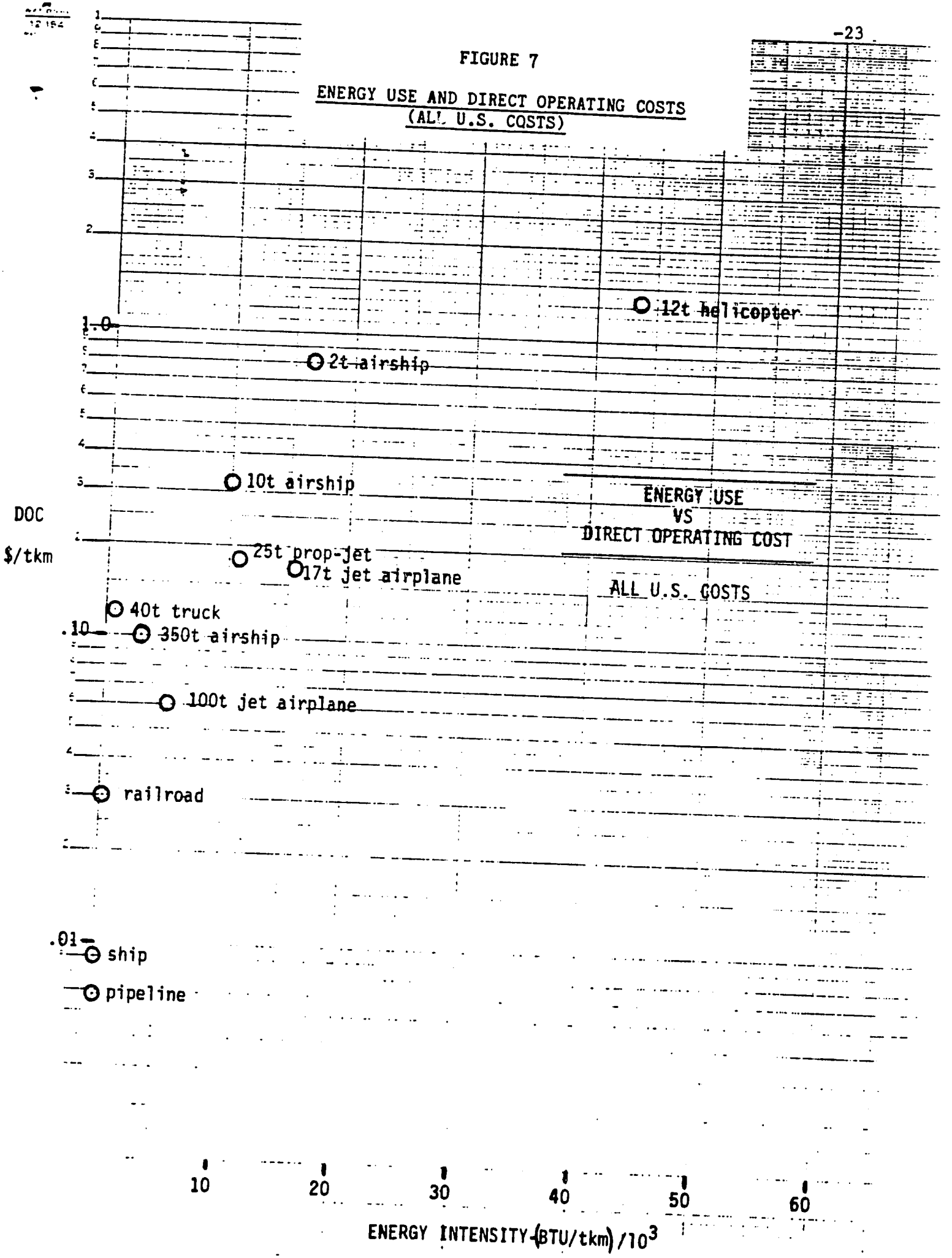


FIGURE 8

FUEL AS A PERCENTAGE OF DOC
FOR U.S. AIRLINES

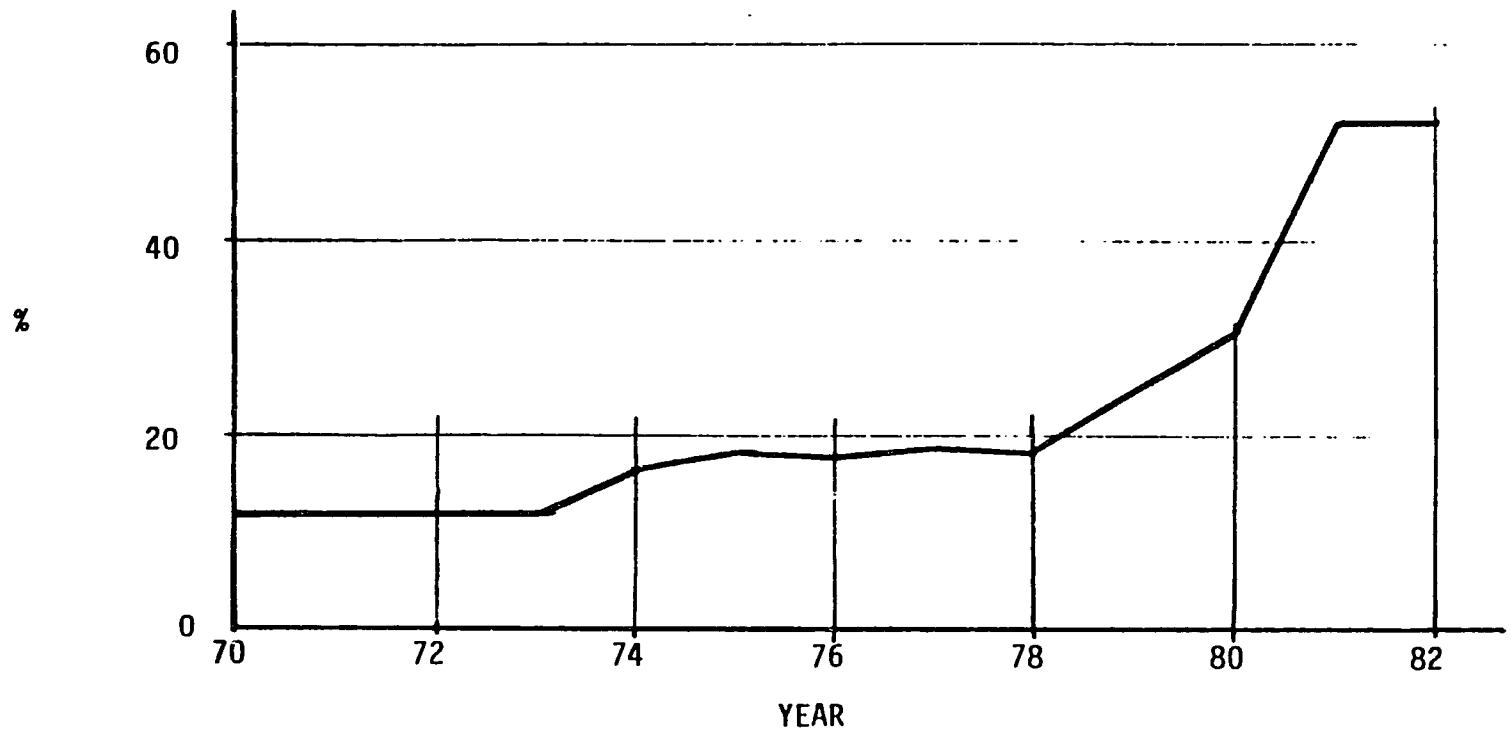


FIGURE 9

DIRECT OPERATING COSTS VS. PAYLOAD
(ALL U.S. 1981 COSTS)

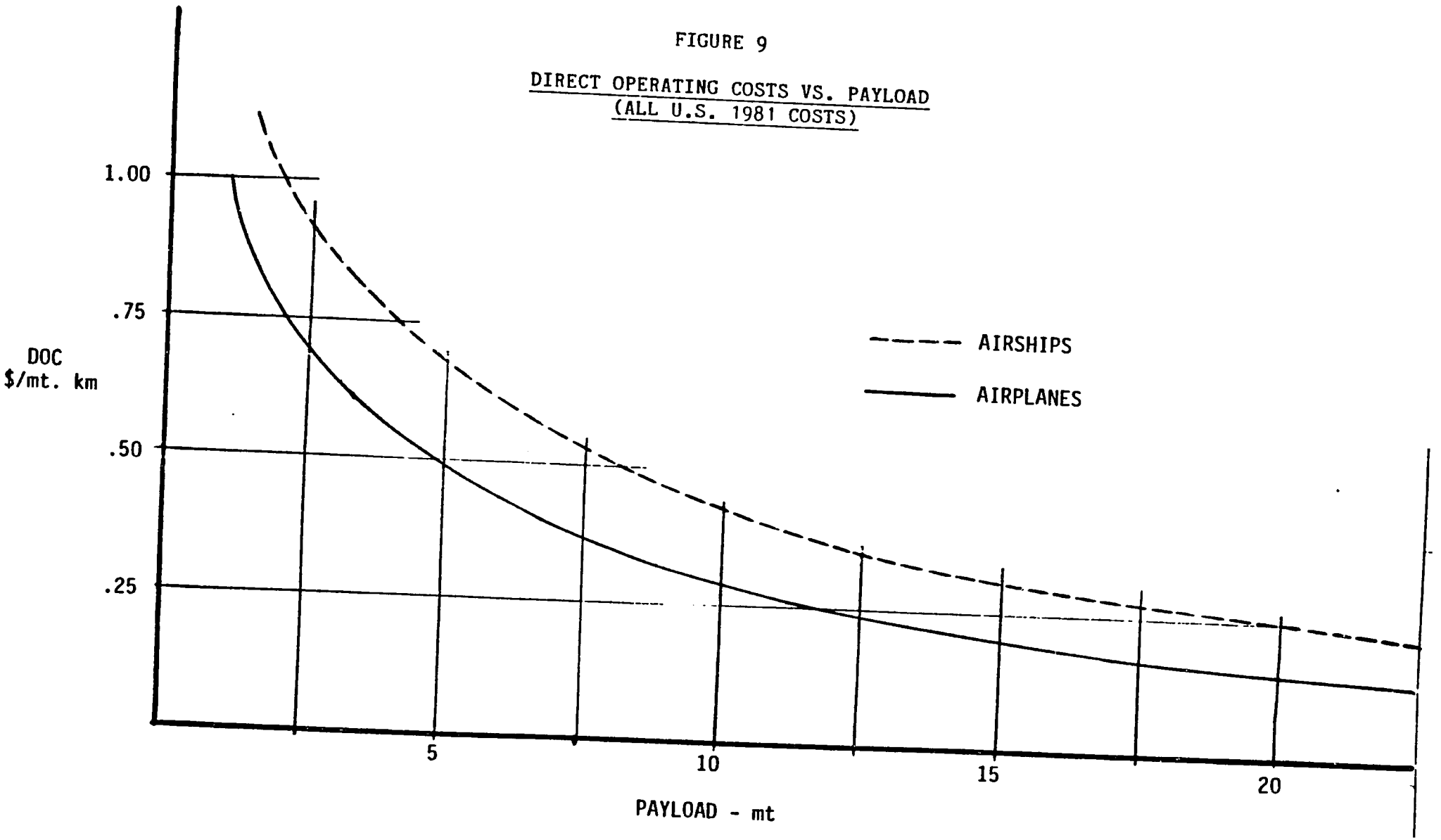
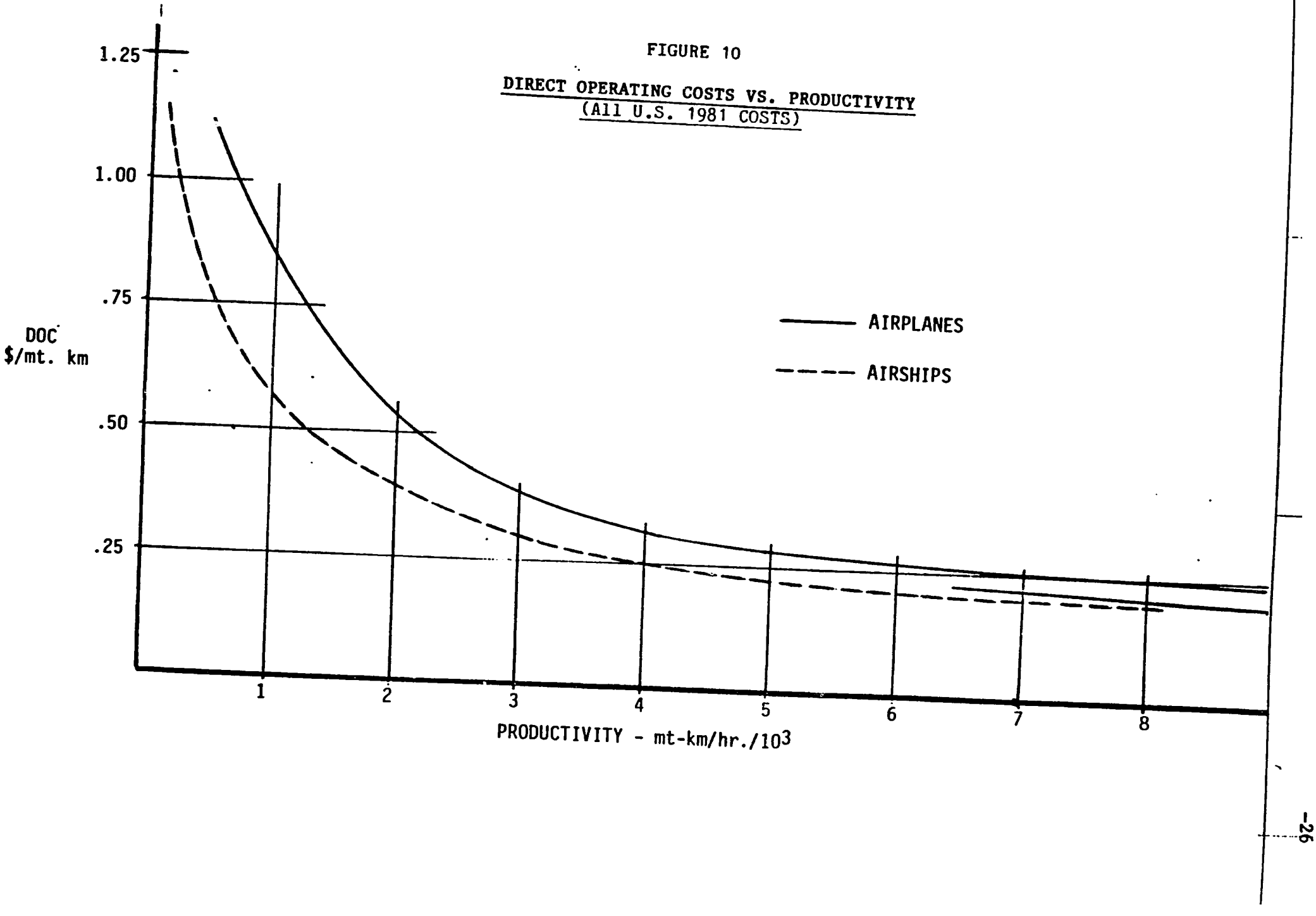


FIGURE 10

DIRECT OPERATING COSTS VS. PRODUCTIVITY
(All U.S. 1981 COSTS)



Helicopter values were not included in calculations for Figures 9 and 10 since they are not normally used for scheduled transport. Generally, as indicated in Figure 7, their DOCs are roughly twice as high as those of airplanes of equal productivity. The valuable services performed by helicopters are attributable to their unique VTOL capabilities which make them cost effective in a different sense. Specific cases applicable to the Sahel will be explored later.

2. Cost Sensitivity

It was assumed that neither airplanes nor airships had any special characteristics concerning the cost factors involved in calculating DOCs which would be changed significantly by Third World scenarios, with the exception of fuel costs. Airplanes are more sensitive to fuel costs than airships. This factor is explored for the two classes in Figure 11.

Several changes are apparent as fuel costs increase. As prices advance, most airships become cost effective even when comparing equal payloads. For example, both the 40 and 20-ton airships become more efficient than the 23-ton STOL airplane above $1.00/gal and $2.00/gal, respectively.

These comparisons are only indicators of choice which should be considered, since all aircraft do not have equal capabilities in other respects. No single size or type satisfies all requirements and there are many variations with different combinations of performance and capability. Each size and type has its own range of efficiency.

One other factor would influence aircraft system costs. This is the purchase price of the aircraft. Figures 12 and 13a show these effects on DOC and on investment.

FIGURE 11

FUEL EFFECTS ON D.O.C.

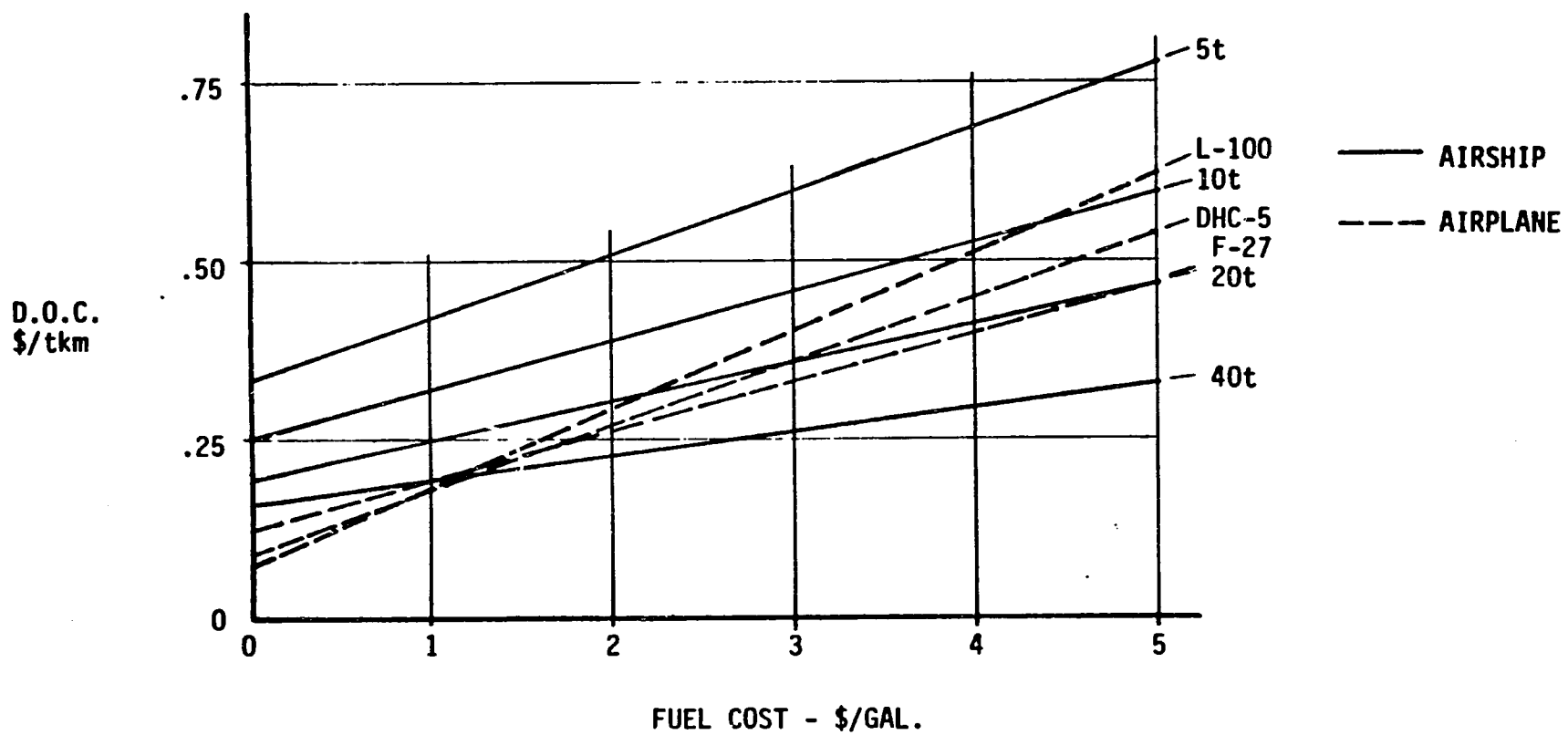


FIGURE 12

EFFECT OF PURCHASE PRICE
ON
DIRECT OPERATING COST

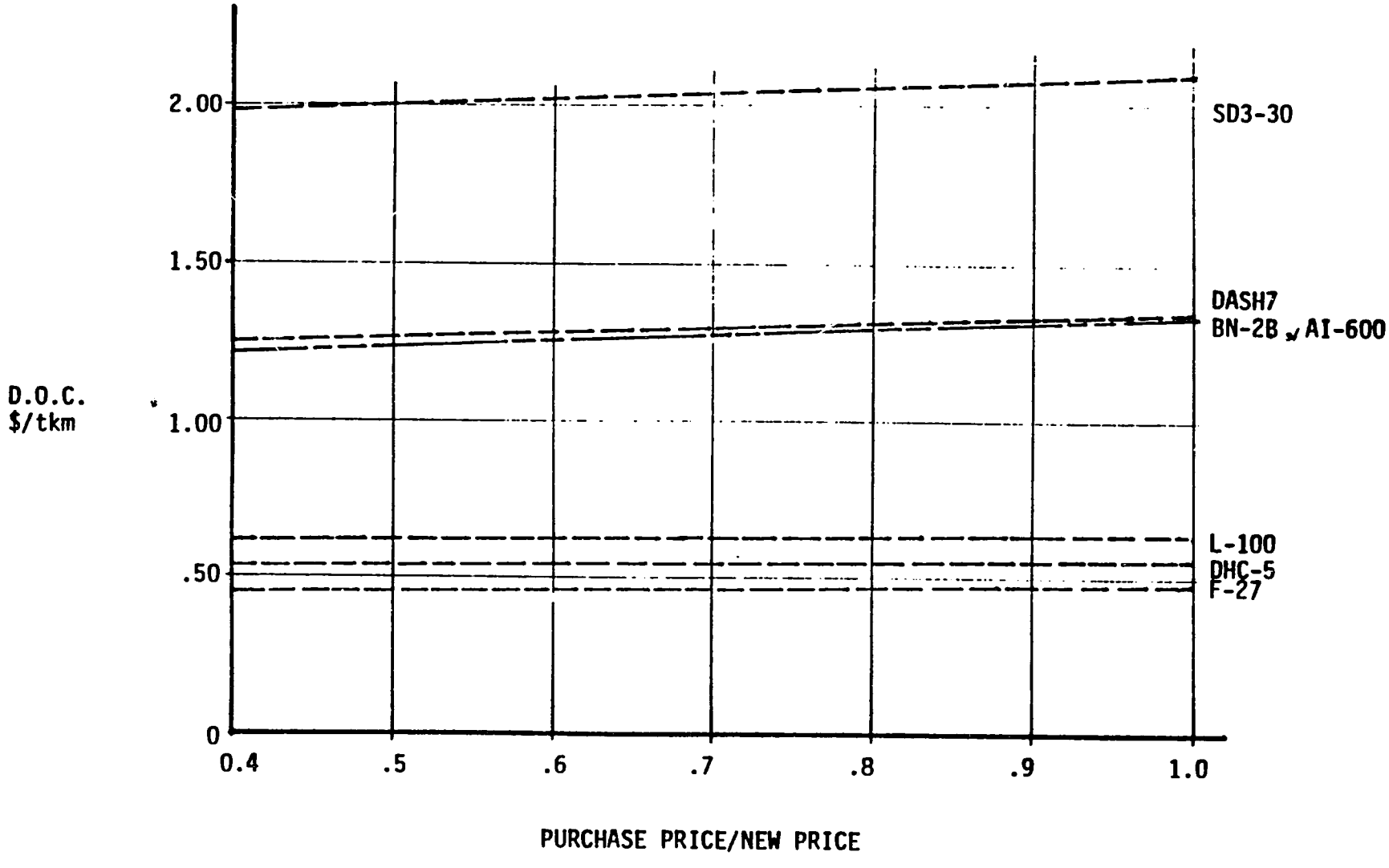
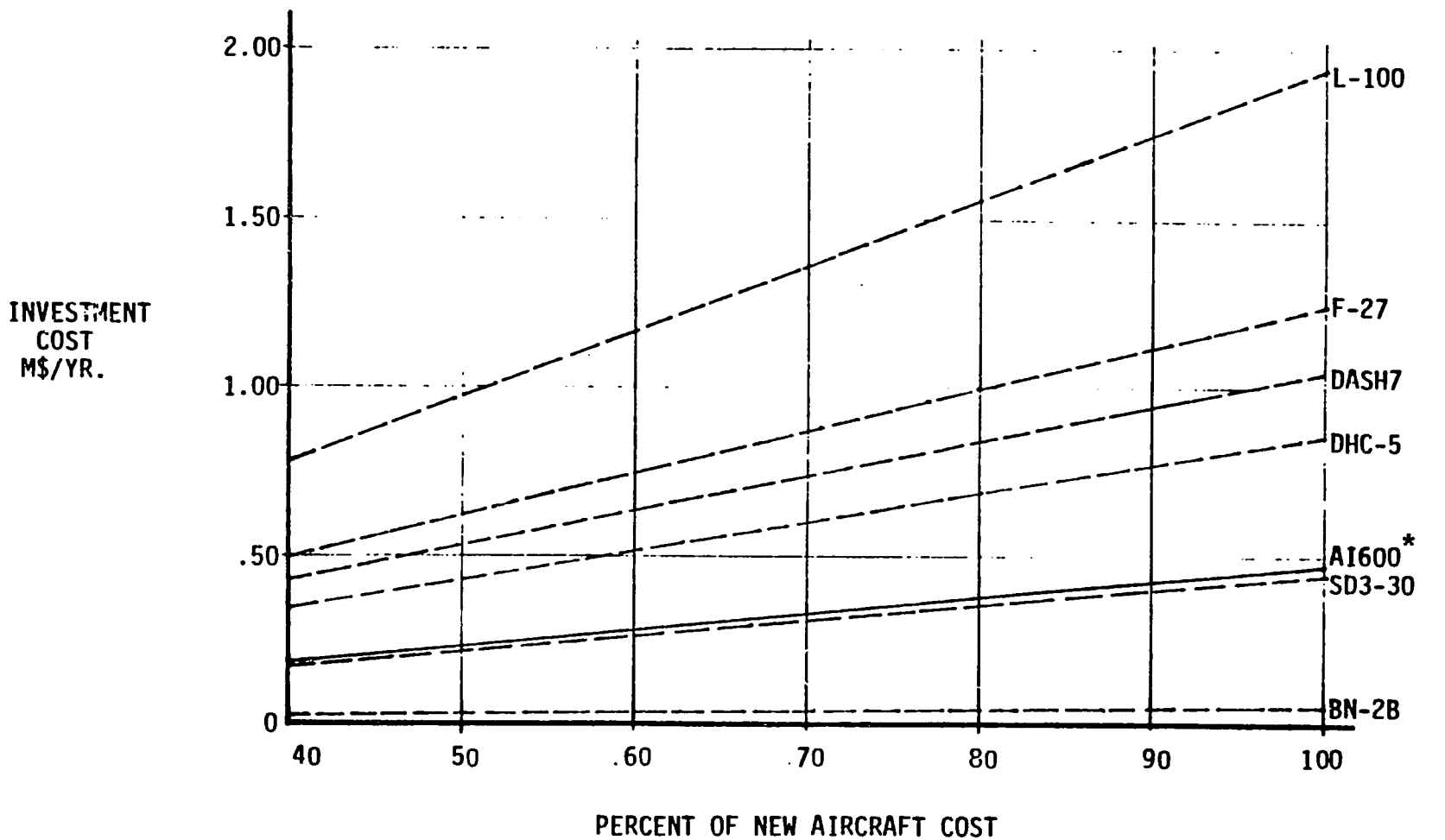


FIGURE 13 a

EFFECT OF PURCHASE PRICE
ON
INVESTMENT COST



*Dirigible

In summary, all else being equal, lowest cost systems are best. But all else is not equal if:

1. Time is critical to the payload being transported.
   a. Passengers usually prefer the fastest means.
   b. Construction projects may demand delivery at a particular time or in a particular season.
   c. Perishables or fragile cargoes are involved.

2. Higher risk is involved in alternate systems.
   a. Safety of passengers due to poor or hazardous roads.
   b. Damage to cargo may result.
   c. Alternates may be less reliable.

3. Lowest cost system is not available or is not suited to cargo.
   a. Lack of waterways, or service is seasonal.
   b. Pipeline limited to fluids.
   c. Cargo size or weight beyond capability or capacity of mode.

4. Unique transport capability is required.
   a. Vertical lift.
   b. No surface facilities available for handling cargo.

5. Investment costs for better system may be incompatible with economic and social conditions.
   a. Existing modes require all of present resources, and a new mode represents additional expense over existing modes.
   b. Funds not available for investment.
   c. Technical skills required to operate improved system may not be available.

E. Cargoes Vs. Aircraft Types

Cargo accommodation in aircraft is a combination of cargo density and size. Transport airline aircraft are designed to best accommodate cargoes weighing about 10 lbs./cu. ft. (160 kg/cu. m.). Denser cargoes would reach the maximum weight allowed before consuming available volume. This is not as serious as the opposite case where low density cargoes would cause the aircraft to fly at less than its payload capacity. Wide-bodied airplanes have alleviated the latter problem to some extent with their greater interior volumes.

Likewise, cargoes of large dimensions may be limited to ground systems if they exceed stowage dimensions, but helicopters and airships offer special features in this regard.

For short range transport, helicopters solve the size and volume problem by externally carrying their cargoes. This is a feasible method where speed is not critical. Non-rigids are limited by the size of car structure, similar to airplanes, but can also fly cargoes externally.

The loading and unloading of cargo is a critical aspect of all transport. By 1951, maritime carriers had developed the container cargo concept, which reduced the loading/unloading process from about 10 days to 1 day and increased the efficiency of ship operations materially.[1/] A similar idea is being applied to some air transport where the cargo is stowed in standard sized 8x8x20 ft. containers. Further developments designed to speed up cargo handling include hinged fuselage sections and mobile loading equipment.

[1/] Reference 24.

Although there are all-freight airlines, the primary use of airplanes is for the transport of passengers. The bulk of freight is carried by other means.

F. Climatic Effects

General - All Aircraft

Aircraft of all types are generally designed to operate in many areas of the world with a variety of climates. Special provisions must be made for extreme cold weather operations with regard to non-flight and start-up phases, but flight in cold air presents no particular problem over operations in more temperate zones. Likewise, in tropical areas, some special ground provision may have to be made where blowing sand or dust may be encountered, to protect engines against contamination. Light aircraft and some STOL types require relatively short runways. Earth or grass covered strips are usually adequate, due to low foot print pressures involved. However, heavy and continued rain would render these facilities unusable and could involve extensive repairs and maintenance expense. VTOL aircraft such as helicopters and airships are generally free from such limitations.

All aircraft are affected by winds in flight to the extent of retarding or augmenting speed over the ground. These effects are in proportion to flight speeds.

Airships

Conventional airships are at their maximum lifting efficiency at sea level. Flight at higher altitudes is accomplished by sacrifices in the gross lift. Hybrid airships are influenced by both LTA and HTA penalties

and benefits due to altitude. Airships can be operated in a VTOL or STOL mode. As discussed later, design features such as vectored thrust and control provide flexibility for changing surface conditions.

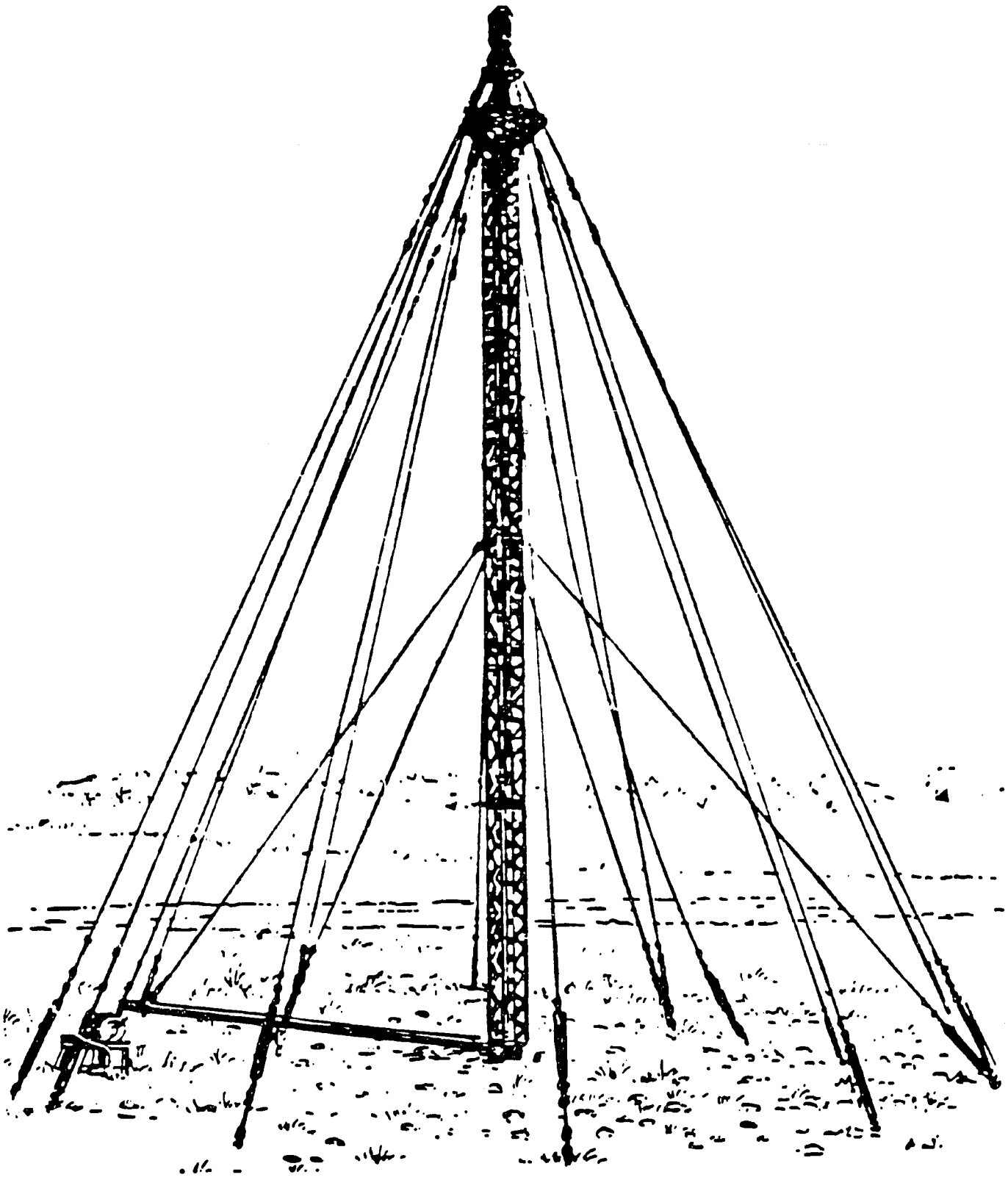
Airships can land and take off with about the same limitations of wind velocity as airplanes except that they must be aligned with the wind for the first and last phases of take-off and landing. This requirement influences the shape of the desired landing field (square rather than rectangular), but airships have been operated successfully under much less than optimum conditions. A VTOL take-off or landing would require a cleared space of about 2 airship lengths in dimension for safe operation, whereas a STOL operation would require approximatley 3 or more lengths. Ground surface conditions are much less important for airships than for airplanes. Airships are generally more sensitive to winds on the ground than are other aircraft. Usually some external assistance on the ground is required. Mechanical equipment, such as special tractors and mooring masts, has allowed this operation to be conducted with a minimum of manpower.

Some hybrid airships may use less of this equipment when under power. In all cases, when not powered, airships require a mooring mast for safe long-term parking. A typical fixed mast is shown in Figure 13 b.

Since airships are low altitude aircraft, they must be flown around areas of severe weather such as thunderstorms, rather than over these areas, as ore modern airplanes. Navigational equipment, such as radar, allows this to be done. Turbulence and high winds associated with such conditions are usually local and of short duration and flight plans can be temporarily altered if these conditions occur prior to take-off. If the airship is in

FIGURE 13 b

Typical Fixed Mooring Mast



flight, sufficient speed must be maintained to counter wind effects. All the airships considered in this study are postulated to have high enough power and speed to allow normal all-weather operation. Other conditions, such as rains and lightning, are not considered any more hazardous than they are for airplanes, since all airships are helium-filled. Airship accidents are considerably more survivable than those of airplanes, due to the very low impact probable in the event of a crash.

G. Logistics and Support

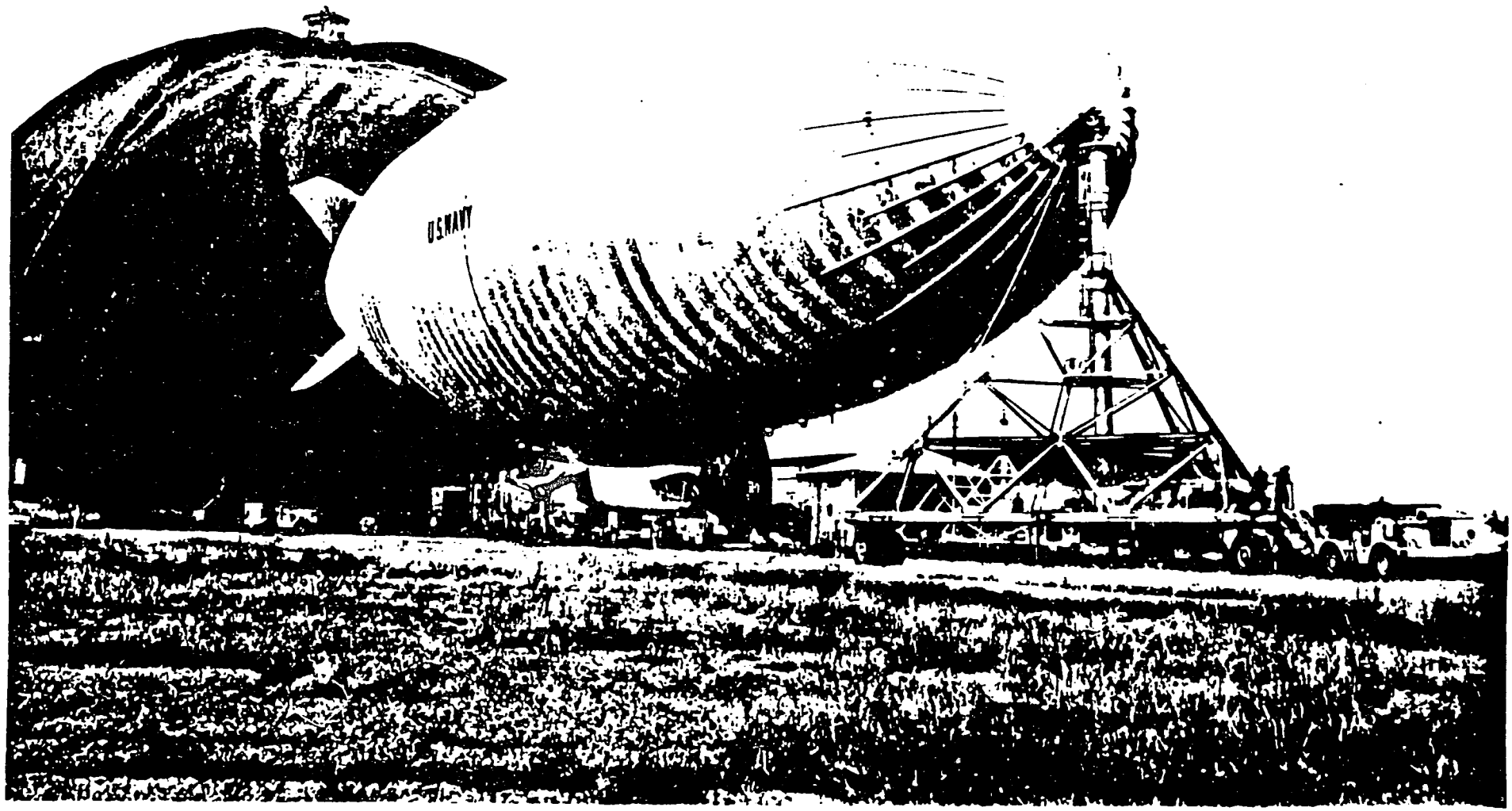
Airplane and helicopter operations are essentially an outdoor activity. That is, normal ground operations do not require hangaring. Fueling and routine servicing can be carried out in the open with the aid of proper ground equipment. A continuing operation requires the existence of a major maintenance base, involving a hangar and shop facilities. The size and complexity of this base are directly related to the size of the fleet. If several types of aircraft are involved, this will add to the maintenance base requirements.

Airships also can be operated entirely in the open, but again, a major maintenance facility is required for annual servicing, assembly, etc. This includes a hangar and shop facilities (which can be part of the hangar space). Figure 13 c shows a hangar, mobile mast (for docking and undocking) and mechanical ground handling vehicles (mules), a detail of which is provided in Figure 14.

Servicing during flight operations requires a fuel supply, air compressor (for tire inflation), and small spare parts. A supply of helium is required in addition for airships. Small quantities must be added

FIGURE 13 c

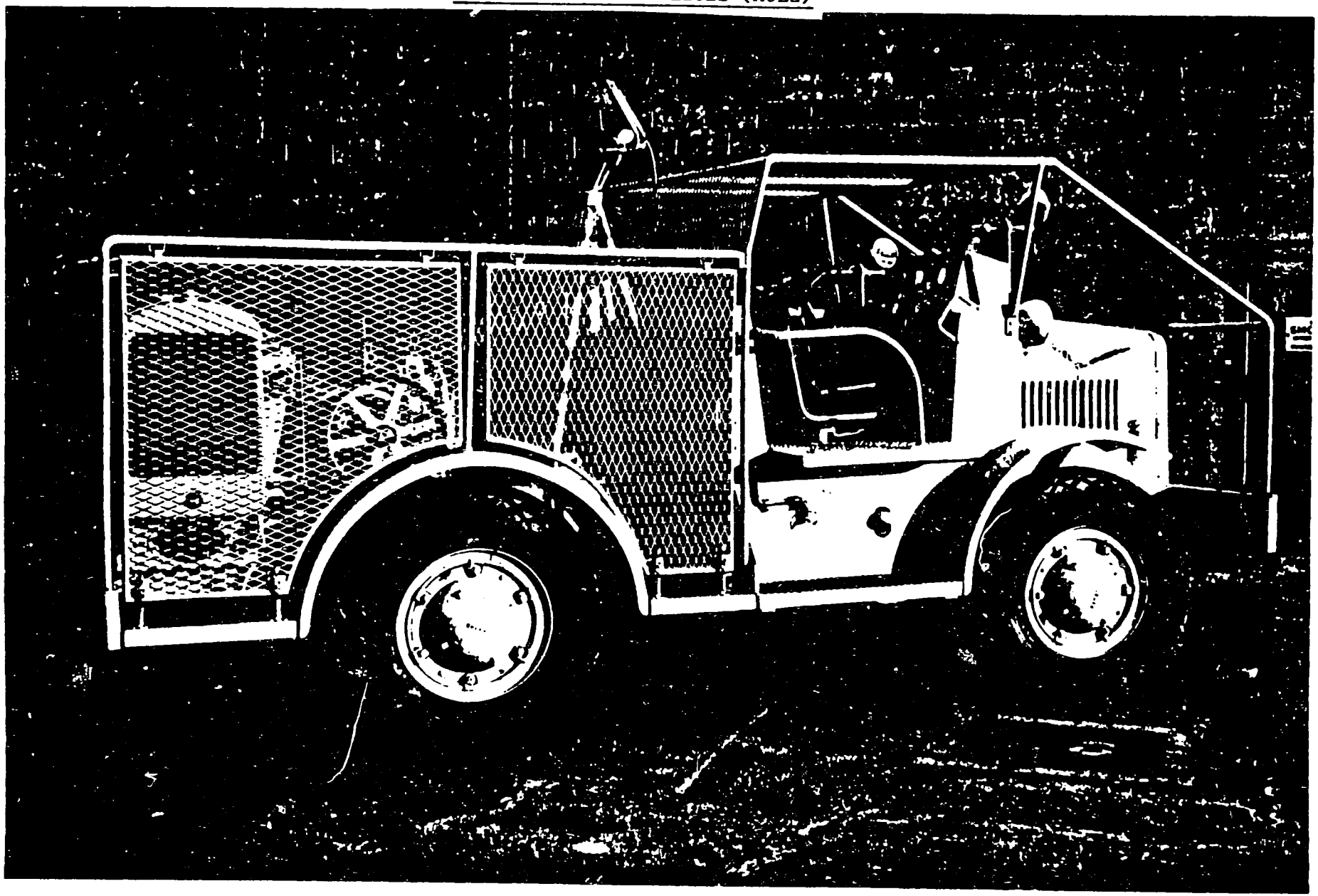
MOORED DIRIGIBLE AT HANGAR



GROUND HANDLING WITH MOBILE MAST & TRACTORS (MULES)

FIGURE 14

GROUND HANDLING VEHICLE (MULE)



occasionally to compensate for diffusion loss, valving, and leaks. Portable storage is suitable for this purpose. Larger quantities are required at the maintenance base.

H. Current Developments and Projected Benefits

1. Technology Improvements

General

Improvements in the efficiency of all types of aircraft are promised for the future. Many advancements are likely to be reflected in new aircraft designs within the next 15-20 years. The present high performance of aircraft has resulted from a more or less continuous research and development effort sponsored by both government and private enterprise in various countries.

Recently the impact of further technological advances was explored in a special study sponsored by the U.S. Presidential Office of Science and Technology Planning.[1/] These improvements would result from government sponsored research in the following areas:

Aerodynamics - Performance improvements from laminar flow wings and fuselages, higher aspect ratios, winglets, supercritical airfoils and better component integration were indicated. Laminar flow alone appears to offer a 20-25% reduction in fuel consumption and an 8% improvement in DOC.

Structures and Materials - New aluminum and titanium alloys and more extensive application of composite materials in primary structure promises a 10-15% reduction in gross weight. New configurations using multiple body designs would further reduce structural weight.

Propulsion - Fuel savings of 15-20% appear possible through improved turbo-prop and turbo-fan engines.

1/ Reference 2.

Control Systems - Fly-by-wire (electric) control systems offer another 10-15% improvement in fuel economy through more efficient flight attitudes and reduced loads.

Rotorcraft - Some of the foregoing applies to rotorcraft as well. Further improvements in DOC are projected through reduced maintenance and reduced fuel consumption. The productivity of helicopters will increase.

Circumstances for viable research and technology development in LTA do not exist. There is little industry to represent or advocate a consumer need for improvement and there is at present no commercial use of airships, other than for advertising. Research programs are practically impossible to justify, hence there is little or no present activity in this regard which involves the multi-million dollar levels of funding required for assured progress. Nevertheless, the state-of-the-art may be advanced as an outcome of developments occurring in the various disciplines even though they are primarily aimed at HTA applications.

One such improvement already being applied is the use of synthetic and composite materials. The British product, Airship Industries' Skyship 500 and the slightly larger Skyship 600 both employ molded composites in the car, tail, and mooring structures and synthetic (Kevlar[1/]) cables in the suspension system. The envelope is also an all-synthetic material, as are all other airship envelopes today. It achieves weight reduction through use of a single ply textile and film combination. The result of all these improvements is an 11% reduction in hull volume and a 32% improvement in payload over comparable older designs.

1/ T. M. Dupont de Nemours Corp.

Another directly applicable improvement would be in the use of advanced turbo-shaft propulsion systems to achieve lower fuel consumption and lighter weight. A further advantage from these engines would be in utilizing them for stern propulsion units. Heretofore designers have been prohibited from employing this feature even though it offered as much as a 50% increase in propulsive efficiency, because of the difficulty of concentrating heavier engines at the stern.

Higher strength synthetic materials such as Kevlar fabrics could allow a further 15% reduction in volume and a consequent improvement in drag and fuel consumption. This possibility is currently being investigated.

Adding up even these modest benefits would allow airships to remain as potentially competitive with other aircraft as they presently appear to be.

There is world-wide interest in the subject even though actual developments are limited. Countries presently engaged in development are the United States, Great Britain, Canada, and the German Federal Republic. Their activities are all carried on by private enterprises, none of which is receiving any benefits from government-sponsored programs. Details of each are described in Annex VI.

2. Third World Benefits

A common need of third world nations is that of adequate transportation. It is considered crucial to economic development, and "without it any economy would remain on a subsistence level."[1/] A common problem is the location

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1/ Reference 19.

of resource areas remote from centers of population or distribution. The development of the required transport system is a feedback scenario in which production rates and demand for the product increase in proportion to the transport capacity, which in turn is dependent upon production rates. In this regard air systems have great appeal since they are capable of providing services with a minimum amount of ground preparation and development time. As the volume to be transported increases, construction of road or rail systems with eventually lower operating costs may be justified.

The need for fast transport for some products such as perishables (fish, meats and produce) and for people will continue to justify operation and expansion of air systems as well.

A common basis for assessing the merits of different transport modes was developed under an earlier DOT study[1/] which indicated that air transport systems were the most attractive compared with road or water systems for developing countries when initial volumes were low. Within the air systems, lower costs were obtainable from the least expensive (older) aircraft even though their efficiency (as aircraft) was considerably less. As the volume of traffic increased, the improved productivity obtainable from more modern types caused them to become the better choice. In accepting these conclusions it must be pointed out that each aircraft and ground system considered was with the assumption that it was capable of the mission. This is probably true for normal terminal-to-terminal transport but it would not apply where special capabilities are required as previously discussed.

[1/] Reference 14.

Possibilities for the use of lighter-than-air vehicles in developing countries were assessed in a United Nations sponsored conference held in 1981,[1/] attended by representatives from 14 countries. Third World members reiterated two major needs and interests: maritime surveillance and development of remote areas with emphasis on transport of perishable produce and inter-island transport. Special health and medical service missions were also mentioned.

1/ Reference 19.

III. TRANSPORT PROFILES OF THE SAHELIAN INLAND TIER

While investigations of the transport systems of each of the eight Sahel countries are reflected in this study, four were chosen for particular attention because they seem to represent the conditions in which the conventional airship might make its best contribution. The countries are Chad, Mali, Niger, and Upper Volta. All are landlocked and 1,000 km or more from the sea over existing routes. Their areas are vast and their northern regions sparsely populated and poorly served by transport. Large sections in Chad and Niger are subject to flooding, and road construction and maintenance costs are high. These factors seemed to favor the particular operational capabilities of airships.

Present transport conditions are described in profiles of the four countries, which follow.

A. CHAD

Chad, Period 1965 - 1982

Civil disruption during a 17-year period of internal strife is the background against which Chad's level of international and domestic trade flows are considered. Data were not available on pre-1965 magnitudes of commerce.

International Transport Routes

By virtue of its geographic location, Chad is more closely connected with the Central African states than with the Western Sahel. The country is served by three principal external surface transportation routes to the sea: 1) the Cameroon Route via Garoua and N'Gaoundere to Douala; 2) the Nigerian route via Maiduguri to Lagos or Port Harcourt; and 3) the Transequatorial Route via Bangui and Brazzaville to Pointe Noire. Three other routes (4, 5, & 6) of lesser significant in terms of trade volume are the Benue, the Sudan and Libyan Routes. The geographic locations of these routes are shown in Figure 15. They are described in Table 4 and its footnotes.

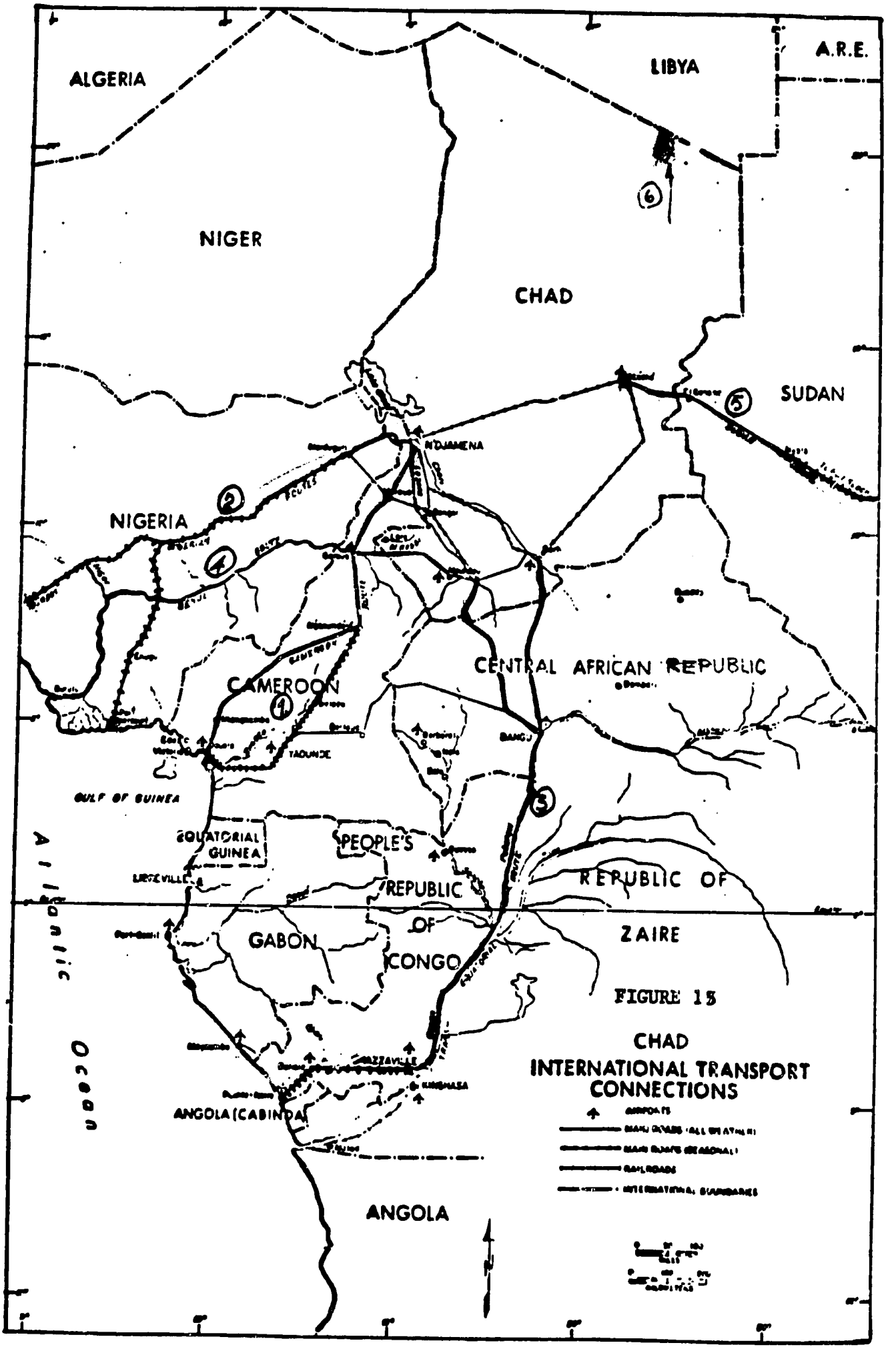


FIGURE 15

CHAD
INTERNATIONAL TRANSPORT CONNECTIONS

TABLE 4

International Trade Corridors

Route	Section	Length: Road	Length: Rail	Length: River	Total Length (km	No. of Transfers	Average Transit Time	Practicability	Remarks
1 The Cameroonian Routes									
a) Douala-NDjamena (1717 km)	Douala-N'Gaoundere N'Gaoundere-NDjamena	- 785	932 -	- -	932 785	1 (road-rail)	2-3 weeks	All-year	See Footnote 5.
b) Douala-Mundou (1674 km)	Douala-N'Gaoundere N'Gaoundere-Mundou	- 742	932 -	- -	932 742				
2. The Nigerian Routes									
a) Lagos (Apapa)-NDjamena (2040 km)	Lagos-Maiduguri Maiduguri-NDjamena	- 250	1790 -	- -	1790 250	1 (road-rail)	2-3 1/ weeks	All-year	See Footnote 6.
b) Port Harcourt-NDjamena (1690 km)	Port Harcourt-Maiduguri Maiduguri-NDjamena	- 250	1445 -	- -	1445 250				
3. The Transequatorial Routes									
a) Pte. Noire-Mundou (2450 km)	Pte. Noire-Brazzaville Brazzaville-Bangui Bangui-Mundou	- - 635	515 - -	- 1300 2/ -	515 1300 635	2 (road-river-rail)	4-6 3/ months	6-8 months	See Footnote 7.
b) Pte. Noire-Sarh (2450 km)	Pte. Noire-Brazzaville Brazzaville-Bangui Bangui-Sarh	- - 635	515 - -	- 1300 2/ -	515 1300 635				
4. The Benoué Routes									
a) Burutu-Mundou (1982 km)	Burutu-Garoua Garoua-Mundou	- 432	- -	1550 4/ -	1550 432	1 (road-river)	4-5 weeks	Benoue River navigable 2-3 months	See Footnote 8.
b) Burutu-NDjamena (2032 km)	Burutu-Garoua Garoua-NDjamena	- 482	- -	1550 4/ -	1550 482				
5. The Sudanese Route									
Abéché-Port Sudan (2623 km)	Abéché-Kyala Kyala-Port Sudan	570 -	- 2053	- -	570 2053	1-2 (road-rail)	-	All-year.	See Footnote 9.
6. The Libyan Route									
NDjamena-Tripoli NDjamena-Tunis (3000 km)	NDjamena-Tripoli NDjamena-Tunis	3000 3000	- -	- -	3000 3000				See Footnote 10.

Footnotes to Table 4

1/ Does not account for excessive port delays.

2/ Via Oubangui River.

3/ As a result of storage of goods in Bangui during the dry season, when river navigation is not possible.

4/ Via Benue River.

5/ Relatively simple administrative and customs procedures; same monetary zone; comparatively secure and reliable; some problems relative to priority accorded to Chadian goods at Douala.

The Cameroon route is 55% rail mode and 45% road.

Footnote 6/

No transfer is needed for some fuel transport; high risk of loss and breakage; long port delays in Lagos and Port Harcourt; difficult customs procedures; different road regulations.

The Port Harcourt route is 85% rail and 15% road; alternatively, from Apapa (Lagos) there is an additional 345 km of rail distance. Distances from the Nigerian ports to Moundou and Sarh are substantially greater than from Douala, Cameroon, but are less to N'Djamena and Northern Chad. Of the 80,000 mt of imports on this route in 1977, 65,000 mt constituted petroleum products and 15,000 mt other products. Flow was unbalanced; only 2,000 mt of exports took this route.

Footnote 7/

Long transit time with associated risk of loss, wastage and theft; poor condition of roads in CAR; barges can carry a full load on the Oubangui only from August-December, a period when road access to Bangui is the poorest.

The longest of all alternatives; it is 2,345 km to Moundou or Sarh, 3,710 km to N'Djamena. It involves two intermodal transfers (rail-river-road).

The Transequatorial route is price competitive with the other routes only for bulk commodities such as petrol products, cement, and fertilizer destined for southeast Chad. The river transport link, while inexpensive, is only navigable about 6-8 months of the year. Its lower efficiency is attributable to the problem of scheduling shipments within this period, which is severe, given ocean shipping schedules; capacity constraints

on the Congo Railroad and on the river barges, and poor road conditions in the CAR during the rainy season when the river is navigable. Delays of 4-6 months and accompanying storage and inventory carrying costs compound the problem. Consequently, this route is used less and less.

Footnote 8/

Suitable for bulk commodities; long waiting time at Nigerian ports of Wari and Port Harcourt. The seasonal (3 months/yr) Benue Route totals 2,040 km from Burutu, Nigeria to N'Djamena and 1,990 km to Moundou. This itinerary is 75% by river and 25% by road.

Footnote 9/

Poor condition of road between Abeche and the Sudanese railhead, Nyala; relatively inefficient Sudan Railway.

Footnote 10/

Passes through difficult and mountainous terrain; a politically troubled area.

Route Prioritization

i) The Cameroon Route: From N'Djamena by road to N'Gaoundere; then by rail from N'Gaoundere to Douala (Total: [illegible],717 km). Also, Moundou - Guidjiba - N'Gaoundere.

Except for petroleum products, which originate in Nigeria, over one-half of Chad's imports and exports are now carried on this route. Transit trade diverted substantially from the Transequatorial Route to the Cameroon route following the establishment of a railhead at N'Gaoundere.

Assuming satisfactory political relations between Chad and Cameroon, the Cameroon route should continue to increase its volume, diverting traffic from other routes for the following reasons:

i) The extension of the Trans-Cameroon railway to N'Gaoundere and the construction of a new paved road from there to within 20 km of the Chad border made this route equal to in distance and quality, if not better than, the Nigerian alternative. Although both Nigerian ports and Douala have congestion delays, these will continue to be more serious in Nigeria;

ii) The agreement between Chad and Cameroon trucking cooperatives on the sharing of freight from the railhead at N'Gaoundere should lead to more efficient and lower cost freight handling, and reduce storage pilferage and transit time; and

iii) Once the Moundou-Guidjiba road is built, almost all import and export traffic for southeast Chad should divert to this route, with the possible exception of petrol products. This area is the primary economic growth zone of Chad, and is expected to have the highest growth rate of imports and exports.

Other factors contributing to the diversion of traffic from the Transequatorial Route to the Cameroon route were the dissolution of ATEC (Agence Transequatoriale des Communications) in 1969, and physical improvement of the road link between Sarh and the Cameroon border via Moundou during 1965-70. Assuming satisfactory political relations continue between Chad and Cameroon, it is expected that the Cameroon route will attract an even larger share of Chad's transit trade, considering that:

(i) Chad and Cameroon are in the same monetary zone (CFAF), and have similar traffic regulations, including a transit trade agreement which requires the sharing of freight transported between N'Gaoundere and N'Djamena;

(ii) the construction of the Moundou-Guidjiba-N'Gaoundere Road would permit a reliable and 266 km shorter transport link between Southern Chad and the railhead at N'Gaoundere;

(iii) the Cameroon route compared to the Nigerian route has a lower risk of pilferage and damage, fewer delays due to port congestion and a larger overland transport capacity;

(ii) The Nigerian Route: From N'Djamena to Maiduguri by road; thence by rail to Lagos (Apapa) or Port Harcourt (1,695 and 2,040 km respectively). Some 92% of petroleum imports, amounting to 65,000 mt annually, originate in Nigeria and take this route.

(iii) The Transequatorial Route: From Southern Chad to Bangui, Central African Republic by road; to Brazzaville, Congo via the Oubangui River; then to Pointe Noire, Congo by rail (2,450 km total).

The Transequatorial Route carried 63% of the 1970 export tonnage and 47% of total tonnage transported on principal external routes. But by 1974, export tonnage on this route had declined to 30% and total tonnage to 15%, reflecting a shift to the Cameroon Route.

(iv) Other, Less Attractive Routes:

The Benue River through Northern Cameroon, then by road to the cotton producing areas of Southern Chad. The river is only seasonally navigable, minimizing the attractiveness of this route.

The Sudan Route The tonnage is low.

The Libyan Route The tonnage is inconsequential.

Table 5/6 indicates the distribution of total tonnnage (imports and exports combined) on these routes from 1966 to 1977, while Table 7 provides information on the distribution of import and export flows of dry cargo and petroleum on the several trade routes during 1976/77.

CHAD TABLE 5/6

Traffic Distribution on Principal External Routes, 1966-77

Route	IMPORTS 1966 Tonnage	%	1970 Tonnage	%	1974 Tonnage	%	1977 2/ Tonnage	%	Annual Rate of Growth 1966-74	EXPORTS 1/ 1966 Tonnage	%	1970 Tonnage	%	1974 Tonnage	%	1977 2/ Tonnage	%	Annual Rate of Growth 1966-74
Cameroonian Route																		
Petroleum Products	-	-	no.	no.	1500 2/	1	2000	1		-	-	-	-	-	-	-	-	
Cotton	-	-	no.	no.	-	-	-	-		2500	5	16500	23	17036 2/	37	35500	58	
Other Products	6000	5	no.	no.	43528	28	79500	43		-	-	4000	8	7590	16	3000	5	
Total	6000	5	13000	9	45028	29	81500	44	+29%	2500	5	19500	31	25476	53	38500	63	+34%
Nigerian Route																		
Petroleum Products	23215	21	52300	36	55345	37	65000	35		-	-	-	-	-	-	-	-	
Cotton	-	-	-	-	-	-	-	-		2220	5	703	1	-	-	-	-	
Other Products	15463	14	21000	15	26083	17	15000	8		2663	6	2200	3	1617	3	2000	3	
Total	38678	35	73300	51	81428	54	80000	43	+10%	4883	11	2903	4	1617	3	2000	3	-13%
Transcontinental Route																		
Petroleum Products	8000	7	20100	14	2340	2	2000	1		19650	42	31000	53	14525	30	12000	20	
Cotton	-	-	-	-	-	-	-	-		8400	18	11400	18	977	2	2000	3	
Other Products	48932	44	38200	26	13599	9	14000	7		28250	60	37600	63	13502	28	14000	23	-7%
Total	56932	51	58300	40	15947	11	16000	8	-15%									
Benoue Route 3/																		
Petroleum Products	1000	2	-	-	no.	no.	1000	1		-	-	-	-	no.	no.	-	-	
Cotton	-	-	-	-	no.	no.	-	-		10931	24	-	-	no.	no.	6500	11	
Other Products	7500	7	-	-	no.	no.	7000	4		-	-	-	-	no. 2/	no.	-	-	
Total	8500	8	-	-	9000 2/	6	8000	5	-0.4%	10931	24	-	-	6000 2/	12	6500	11	-7%
Total on Above Routes	111110	100	144400	100	151403	100	185500	100	+4%	46565	100	32600	100	48565	100	61000	100	+0.5%
Total on All Surface Routes	111910		no.		154470		191000		+4%	46646		no.		49276		61450		+0.7%

1/ Except cattle on hoof
2/ Estimates
3/ Benoue Route was temporarily closed from 1967-70. In 1971, cotton exports on this route amounted to 10,000 tons.

Sources: 1960 figures: The Transport Sector in Chad, 1969; Bank Report No. AN13 (Table 1).
1970 figures: Chad: Development Potential and Constraints; World Bank Country Economic Report, July 1974, p. 117.
1974 figures and 1977 estimates: Diagnostique Sur l'Industrie des Transports Routiers au Tchad, SEDES, Feb. 1977.

TABLE 7

Chadian International Transport
(1976/77)
(mt)

Dry Cargo

Transit Route	Imports Other Than Petroleum	Exports	Total Exports & Imports
Nigeria	15,000	2,000	17,000
Cameroon			
- via N'Gaoundere'	50,000	37,000	87,000
- via Benue & Others	36,000	8,000	44,000
- Transequatorial	14,000	14,000	28,000
Other Overland Routes	5,500	500	6,000
SUBTOTAL	121,000	61,000 1/	182,000
	Petroleum Imports		
Nigeria	65,000	---	65,000
Other Routes	5,000	---	5,000
SUBTOTAL	70,000	---	70,000
TOTAL	191,000	61,000	252,000

1/ Cotton exports account for about 54,000 tons.

SOURCE: - SEDES, "Diagnostique Sur l'Industries de Transport Routiers au Tchad," 1977.
- World Bank mission estimates.

Domestic Transport; Internal Routes

Principal agicultural activity is located in the southwestern part of the country, about 400 km south of N'Djamena. During the rainy season, from June to October, direct links between N'Djamena and this area are interdicted by extensive flooding. In the dry season, internal road transport is concentrated on the road link making up the triangle N'Djamena-Moundou (600 km); Moundou-Sarh (320 km) and Sarh-N'Djamena (560 km).

Since the most commercially active and productive area is flooded during the rainy season, construction of all-weather roads implies raising the roadbed above the flood level and providing expensive drainage structures. The resulting construction costs ($250,000-$500,000 per km), however, are not warranted by the volume of traffic expected to generate offsetting benefits. The introduction of airships, which require minimum supporting ground infrastructure and could largely avoid flooding interdictions, could have application here. Principal transport corridors, illustrated in Figure 16, and as detailed in Figures 17 and 18 are the following:

1) The Southern Corridor -- An E-W trunk connecting Moundou and Sarh in the cotton belt with the Cameroon and Transequatorial trunk routes in Cameroon and CAR respectively. This corridor is an element of the primary trade route which bears the most traffic.

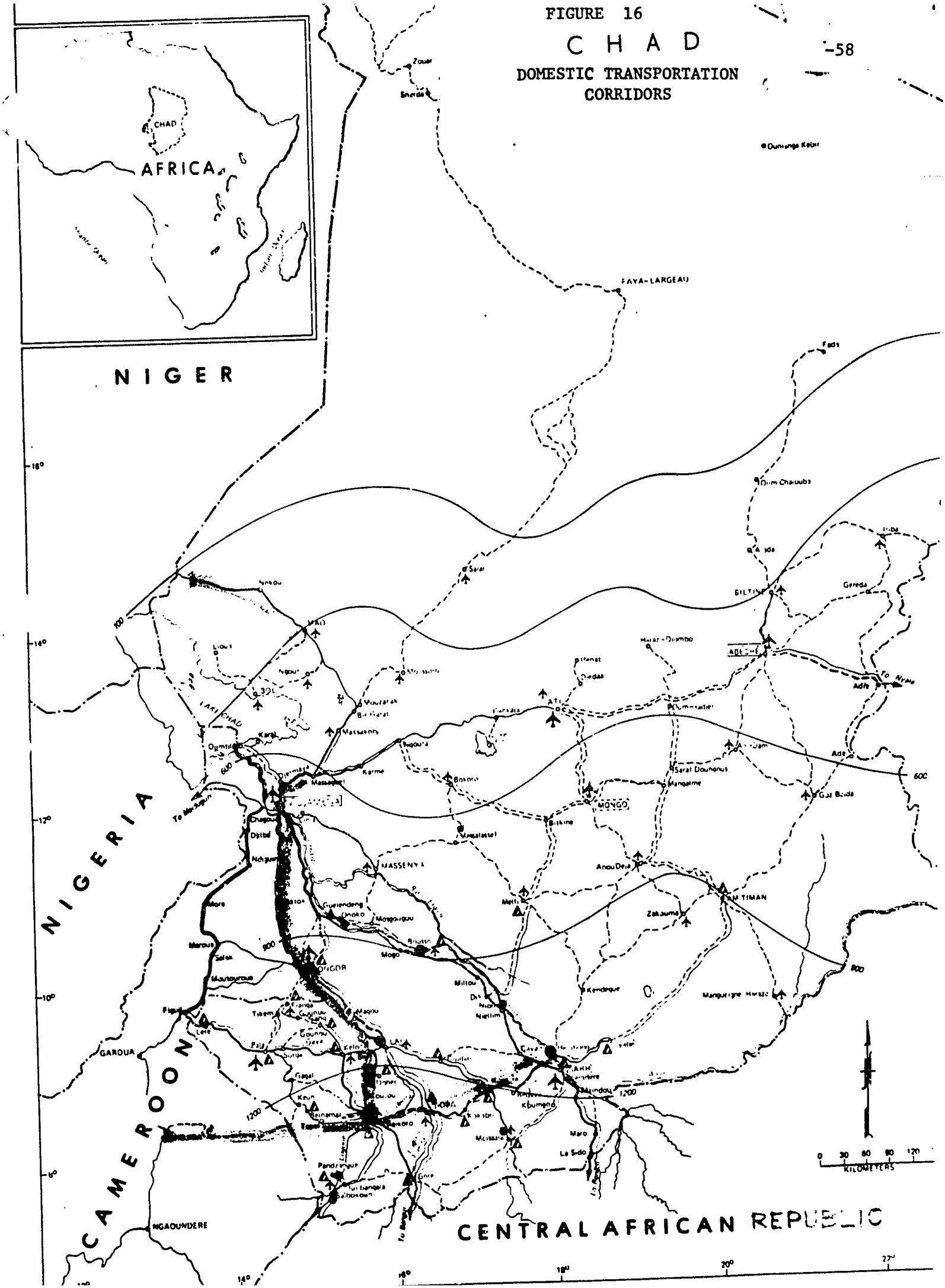
1974 Traffic

Dry Cargo Imports:	26,598 mt.
Dry Cargo Exports:	23,229 mt.
Petroleum Imports:	3,965 mt.

FIGURE 16

CHAD

DOMESTIC TRANSPORTATION CORRIDORS



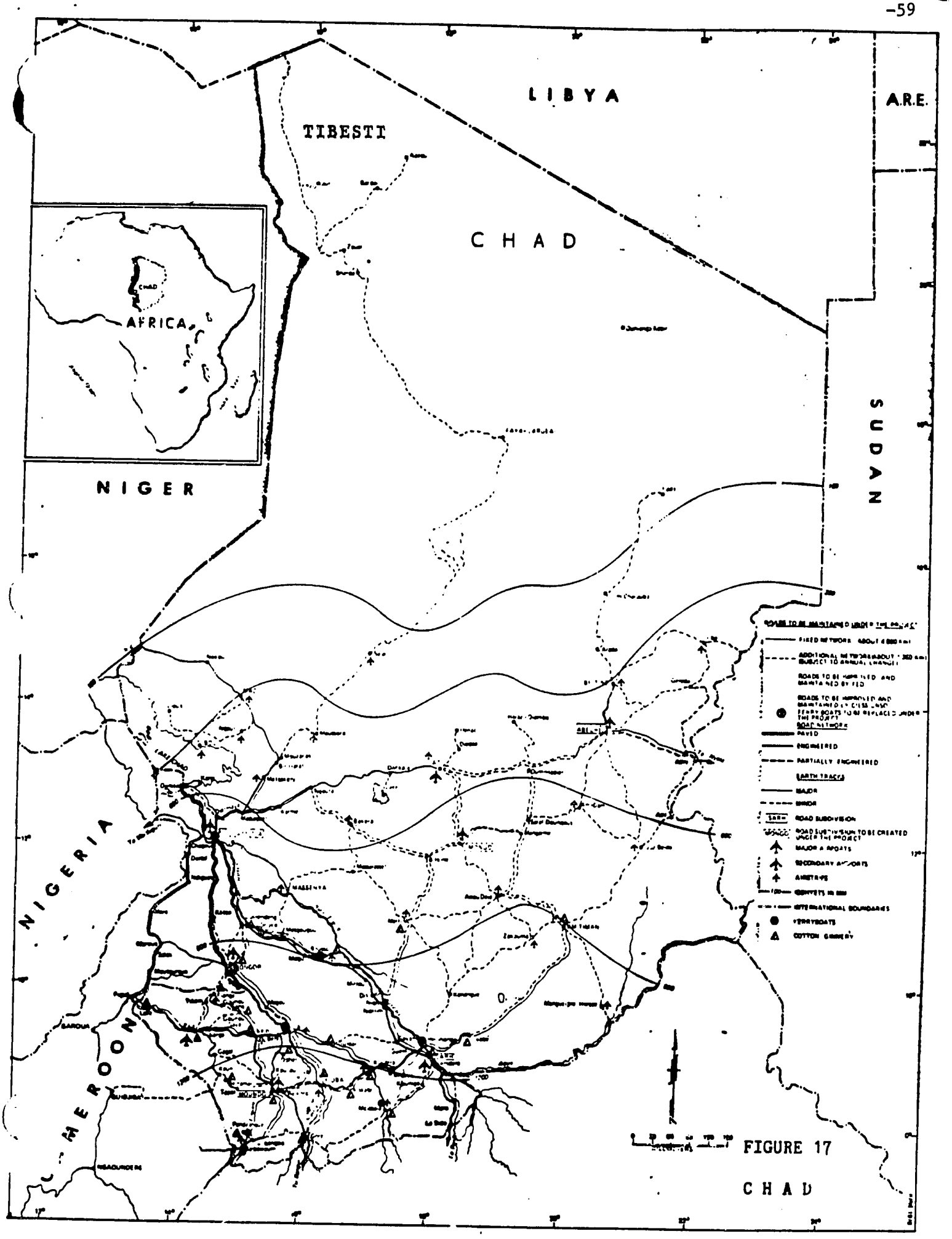
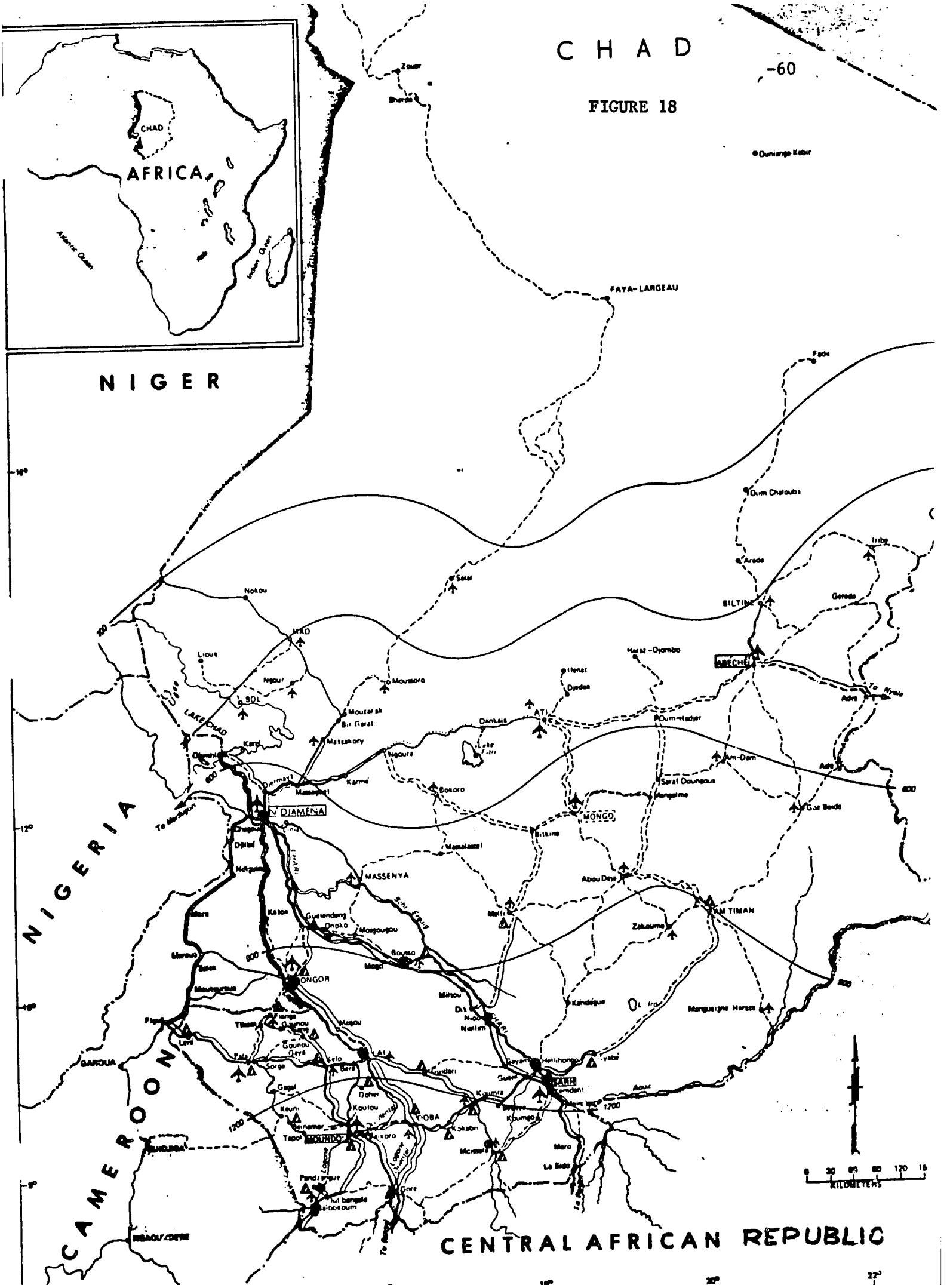

LIBYA
A.R.E.
TIBESTI
CHAD
AFRICA
NIGER
SUDAN
NIGERIA
CAMEROON
CHAD

FIGURE 17

FIGURE 18


CHAD
AFRICA
NIGER
NIGERIA
CAMEROON
CENTRAL AFRICAN REPUBLIC
FAYA-LARGEAU
BILTINE
ABECHE
ATI
MAO
MOUSSORO
BOL
LAKE CHAD
N'DJAMENA
MONGO
MASSENYA
MONGOR
LAI
SARH
KOUMRA
MOUNDOU
GAROUA
KILOMETERS

2) The Logone Corridor -- linking N'Djamena and the south; an important political and administrative link between the capital and the more populated and productive southern areas. However, surface transport investments in this corridor have not been found economically viable due to low levels of traffic and high construction costs.

1974 Traffic

Dry Cargo Imports:	6,777 mt.
Dry Cargo Exports:	314 mt.
Petroleum Imports	1,768 mt.

N'Djamena-Moundou (via Logone River barge). The Chari River is navigable from N'Djamena to Sarh between mid-August and mid-December. It carries about five percent of total domestic transport.

Upstream river traffic:

(N'Djamena-Moundou) -- 560 mt annually

Downstream river traffic:

(Moundou-N'Djamena) -- 1,110 mt annually

3) The Sahel Corridor -- connecting N'Djamena to Abeche, extending to Sudan, is a desert track with limited traffic and is viewed as a long-term objective for improvement. Road construction costs are high - estimated at $250,000-$500,000 per km - and traffic is low. At these prices surface transport improvement costs are prohibitive, considering the low traffic volumes.

1974 Traffic

Dry Cargo Imports:

N'Djamena-Abeche	0
Sudan-Abeche	438 mt.

Dry Cargo Exports:

Abeche-N'Djamena	0
Abeche-Sudan	74 mt.

Fuel Imports:

N'Djamena-Abeche	977 mt.
Sudan-Abeche	0

4) The Lake Chad Corridor - The Chari River, linking N'Djamena with Lake Chad, is navigable throughout the year.

Domestic Traffic

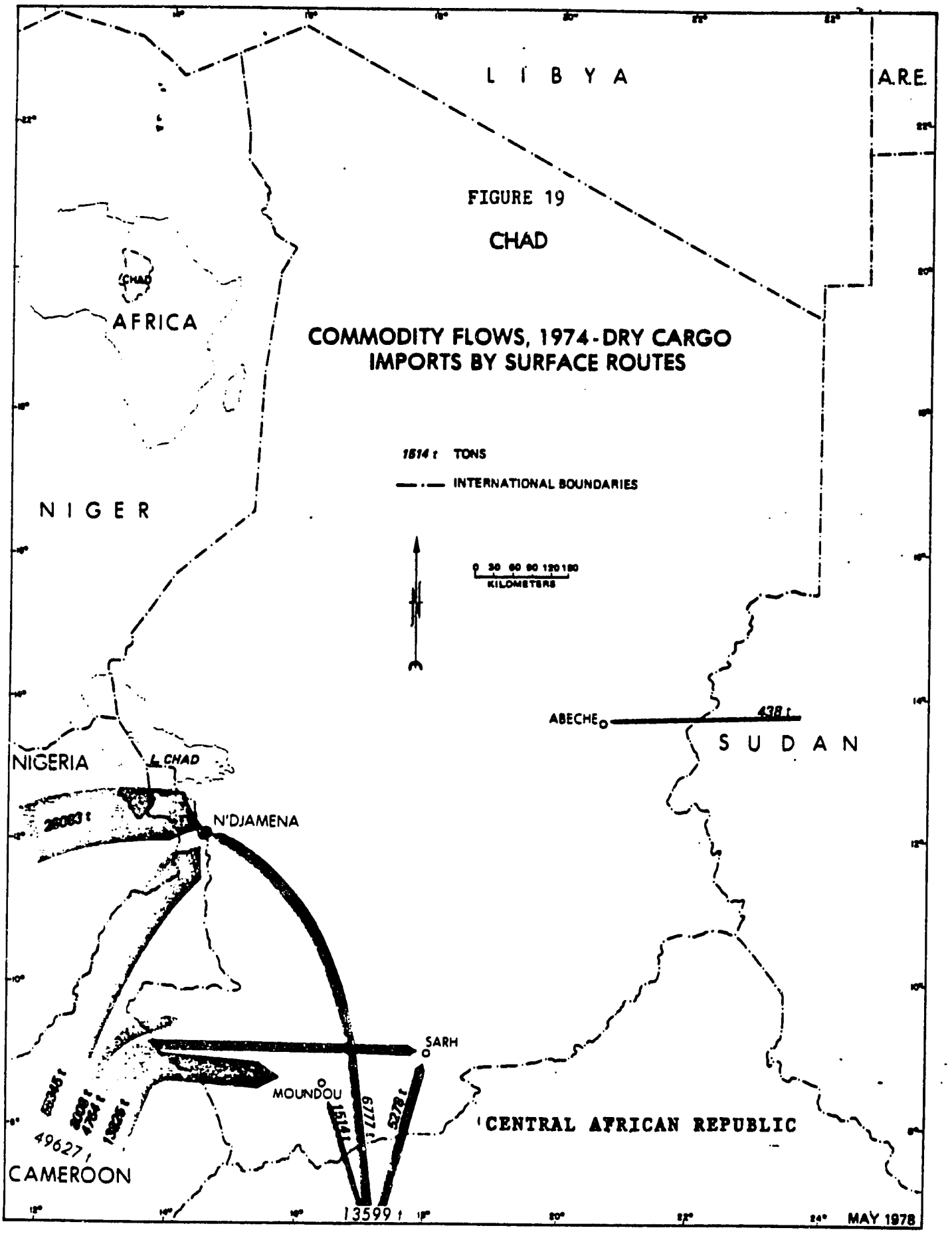
Table 8 shows the magnitudes of traffic flows in 1976/77 on internal routes. Of the total tonnage moved, 145,000 mt or 64% is seed cotton transported from farms to cotton ginneries.

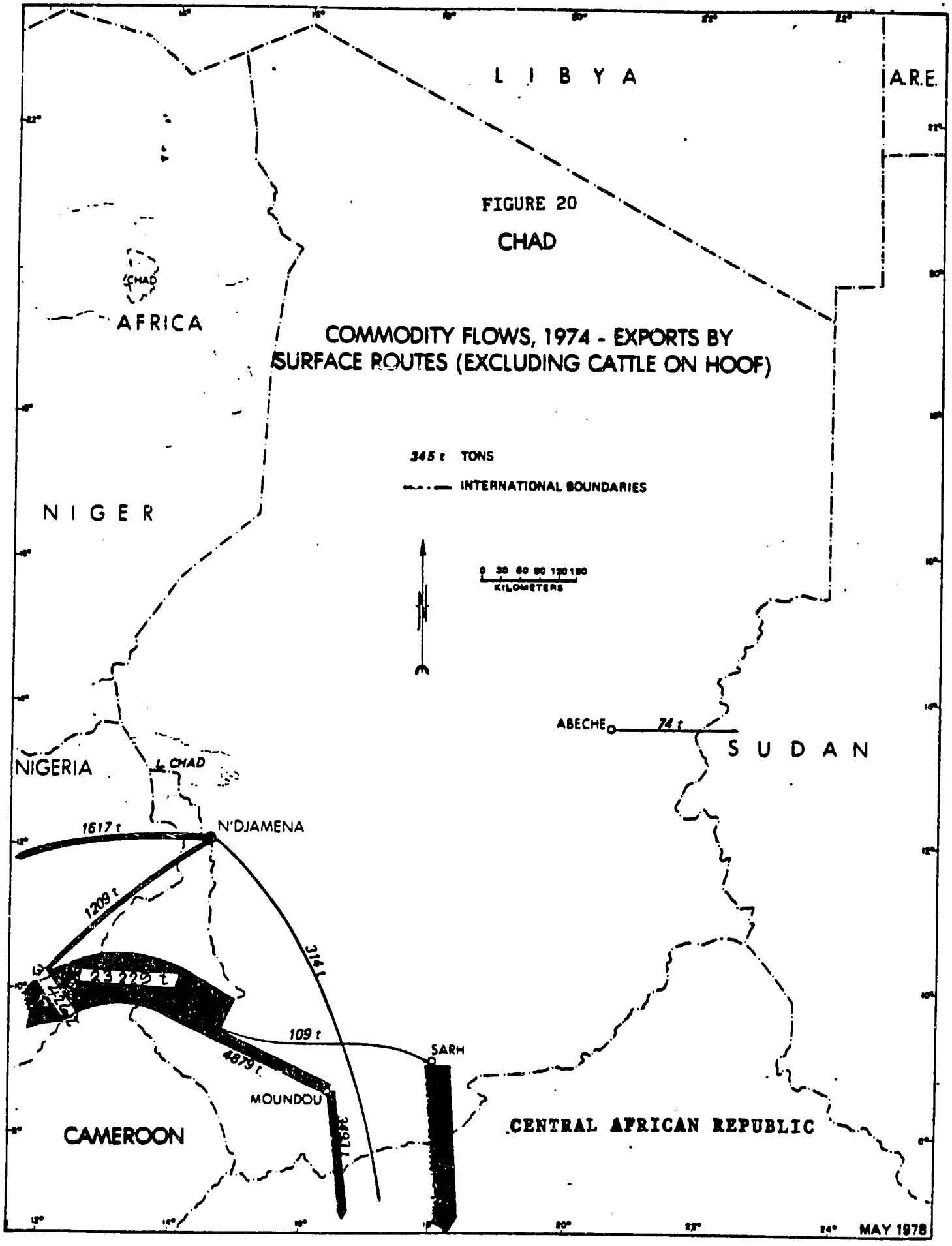
Figures 19, 20, and 21, reflecting domestic and international trade flows in 1974, graphically illustrate the relative tonnages in these corridors.

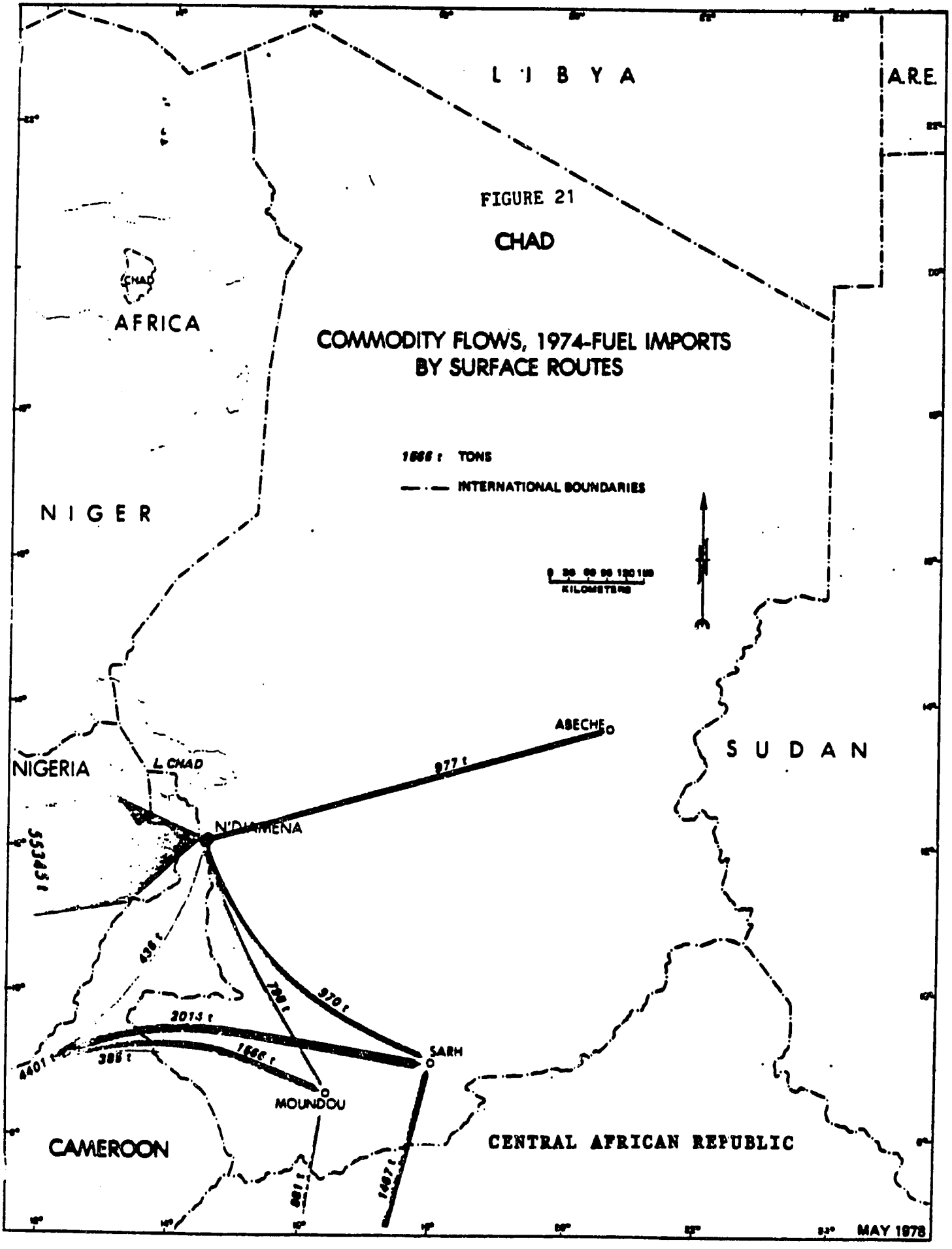
TABLE 8

Domestic Freight Traffic
(1976/77)

From:	To:	mt
N'Djamena	East and North	21,000
N'Djamena	South	
- Beer		20,000
- Other Merchandise		20,000
Sarh	Moundou	20,000
Farm To Ginnery Transport of Cotton		145,000
TOTAL		226,000 mt


LIBYA
A.R.E.
FIGURE 19
CHAD
CHAD
AFRICA
COMMODITY FLOWS, 1974-DRY CARGO
IMPORTS BY SURFACE ROUTES
1514 t TONS
INTERNATIONAL BOUNDARIES
NIGER
0 30 60 90 120 150
KILOMETERS
ABECHE
438 t
SUDAN
NIGERIA
L. CHAD
26083 t
N'DJAMENA
SARH
MOUNDOU
1514 t
6777 t
5278 t
CENTRAL AFRICAN REPUBLIC
49627 t
CAMEROON
13599 t
MAY 1978


LIBYA
A.R.E.
FIGURE 20
CHAD
CHAD
AFRICA
COMMODITY FLOWS, 1974 - EXPORTS BY SURFACE ROUTES (EXCLUDING CATTLE ON HOOF)
345 t TONS
INTERNATIONAL BOUNDARIES
NIGER
0 30 60 90 120 150
KILOMETERS
ABECHE
74 t
SUDAN
NIGERIA
L. CHAD
1617 t
N'DJAMENA
1209 t
314 t
109 t
SARH
4879 t
MOUNDOU
CAMEROON
CENTRAL AFRICAN REPUBLIC
MAY 1978


LIBYA
A.R.E.
FIGURE 21
CHAD
COMMODITY FLOWS, 1974-FUEL IMPORTS
BY SURFACE ROUTES
1666 t TONS
INTERNATIONAL BOUNDARIES
KILOMETERS
CHAD
AFRICA
NIGER
NIGERIA
L CHAD
N'DJAMENA
ABECHE
977 t
SUDAN
553431 t
436 t
700 t
970 t
2013 t
1666 t
386 t
4401 t
SARH
MOUNDOU
CAMEROON
CENTRAL AFRICAN REPUBLIC
1487 t
MAY 1978

Traffic on the classified road network (except for the paved road between Massaguet, N'Djamena and Guelengdeng) has averaged under 100 vpd and no significant increase is expected in the short to medium-term. The norm varies from 30-60 vpd on national roads to about 10 vpd on prefectural roads. Estimated traffic on the primary road network averaged 25-30 million veh-km p.a. while the commodity flow average 60-65 million ton-km p.a. during 1970-76.

Truck Transport; Demand, and Supply

By 1980 freight transport demand available for exploitation by Chadian transporters consisted of 94 million ton-km of dry goods transport on international routes, [1/] 55 million ton-km of dry goods transport on major domestic routes, and 55 million ton-km of fuel transport on international routes; that is, 149 million ton-km of dry goods transport and 55 million ton-km of fuel transport.

At the existing rate of truck utilization (40,000 km/year, and a load factor of 0.55), there is an 80% excess capacity for dry goods transport. For fuel transport, an undercapacity in the range of 13-45% is indicated, with utilization of tankers varying from 50,000 to 80,000 km/year.

It is unlikely that the load factor for dry goods transport can be improved to more than 65-75% as long as the disequilibrium between exports and imports prevails. This imbalance is further magnified because a large proportion of imports (55%) is destined for N'Djamena while most exports (over 90%) originate in the south. For fuel tankers, the load factor will continue to remain 50% as long as Chad remains an importer of fuel.

[1/] Imports other than petroleum: 39 million ton-km; exports: 55 million ton-km.

Furthermore, liberal vehicle import policies in the past (especially the Government purchase and subsidized resale of 100 trucks to CTT in 1977 under "Operation Fiat," and trucks furnished under drought-relief programs have created excess trucking capacity in Chad. The disequilibrium between supply and demand for freight transport has led to underutilization of the fleet and consequently high transport costs.

With improved scheduling and better coordination of fuel transport with supplies in Nigeria, the existing tanker fleet could cater to the present demand for fuel transport. However, at current levels of vehicle utilization, the tanker fleet would have to be increased in the future and the import of dry cargo trucks curtailed in order to strike a closer balance between transport demand and supply. This would help to lower unit operating costs by permitting an increase in the annual kilometrage travelled by each truck.

Inland and Lake Transport

The inland waterways system of Chad comprises Lake Chad and the Chari and Logone river systems. During the rainy season, the Chari provides the only means of surface access between N'Djamena and the south. Traffic is seasonal; although river transport is feasible on the Chari and Logone, the commerical exploitation of this transport mode is hampered by erratic river behavior. The Chari is navigable between N'Djamena and Sarh (850 km) from mid-August to mid-December, and the Logone between N'Djamena and Moundou (1,000 km) from September to late October. The River Chari from N'Djamena to Lake Chad is navigable throughout the year, but most transport tak place between November and April.

The total tonnage moved on the rivers and the lake by barge transport is about 15-20,000 tons per year. The available barge tonnage owned by three private companies is about 1,840 tons, but only 50-60% of the available capacity is actually utilized.

Air Transport - International

Total freight traffic (arriving and departing) declined from an all-time high of 29,000 tons in 1970 to 12,762 tons in 1976, corresponding to an annual rate of decline of 13% (Table 9). About 50% of the arriving freight originated overseas while the other 50% came from African countries, including transit shipments of perishable goods and fragile cargo from Douala. Departing freight included meat (about 3,000 tons), salted fish (about 3,000 tons), gum arabic (1,000 tons, of which about 800 tons originated in Sudan), resins, skins, hides, flowers (hibiscus), and diamonds. Meat exports dropped from 9,000 tons in 1971 to about 3,500 tons in 1976. The decline in Chadian meat exports can be attributed to: (i) the increase in international fuel prices which caused a significant rise in air freight tariffs (making the air transport of meat exports financially unattractive); and (ii) the purchase of cattle on the hoof by Nigerians at a higher price than that offered by the Chadian meat processing plants.

Despite Chad's potential to expand exports of meat, fish and horticultural products, it is unlikely that a significant increase in air freight will occur during the next five years, unless efforts are made to exploit the Middle East market for Chadian meat and fish exports. Substantial increases in air passenger traffic are also unlikely; the best that can be hoped for is that present levels are sustained.

TABLE 9

Air Freight; N'Djamena Airport
(mt)

Airports	1970	1971	1972	1973	1974	1975	1976	Annual Rate of Change 1970-1976
Arriving Freight								
N'Djamena (Int'l)	12609	10162	7398	9960	9116	8361	8132	- 7%
Domestic	1059	1139	945	965	600	370	338	-17%
SUBTOTAL	13668	11301	8343	10925	9716	8731	8470	- 8%
Departing Freight								
N'Djamena (Int'l)	13813	14578	8663	6917	8185	5614	4147	-18%
Domestic	1701	1184	225	180	199	185	145	-34%
SUBTOTAL	15514	15762	8888	7097	8384	5799	4292	-19%
TOTAL	29182		→				12762	-13%

Sources: - Bulletin de Statistique, Republique du Tchad, 1969-1976.

Domestic Air Transport

Given Chad's extensive area, dispersed population and high road construction costs, air transport offers a potential reponse to some transport needs. Moreover, domestic air links may be the only viable form of communication for the northern part of the country, and for flooded areas during the rainy season when roads are cut.

Aircraft

By 1980, Air Tchad operations were terminated. Air Tchad was an autonoumous corporation created in 1966 and operated by UTA (Union des Transporteurs Aeriens) with French personnel. The Government held 66% of the corporate stock and UTA the remaining 34%. The Air Tchad fleet consisted of two DC-3's, one DC-4 and a light passenger aircraft (Beechcraft Baron Be-58).

Air Tchad offered scheduled service between N'Djamena and ten interior cities (three flights per week to Abeche, two per week to Bol, Moundou, and Sarh, and one per week to Faya, Am-Timan, Pala, Bongor, Mongo and Ati).

Airports

N'Djamena's international airport (2,800-m runway) handles commercial jets, and of Chad's 44 airfields and airstrips, eight principal airports and three smaller fields are regularly served.

Although the national network of airports is sufficient, the airports are poorly designed and ground equipment is inadequate to facilitate development of all-season passenger and freight traffic. By agreement with the Government, ASECNA[1/] manages and operates the eight principal airports and three smaller airfields.

1/ Agence pour la Securite de la Navigation Aerienne en Afrique.

These and five additional small fields included in the agreement, which are not regularly operated and maintained, are specified in Table 10. Another 28 airstrips are under the jurisdiction of the Directorate of Civil Aviation.

Traffic

Domestic air traffic is marked by pronounced seasonal variations (Figure 22/23) with most traffic concentrated between June and November. The peaking of domestic air traffic during August and September is attributable to the poor condition of roads during the rainy season (almost impassable in many cases from June through September), when air transport serves as the only means of access to many population centers.

TABLE 10

Principal Airfields under ASECNA Management

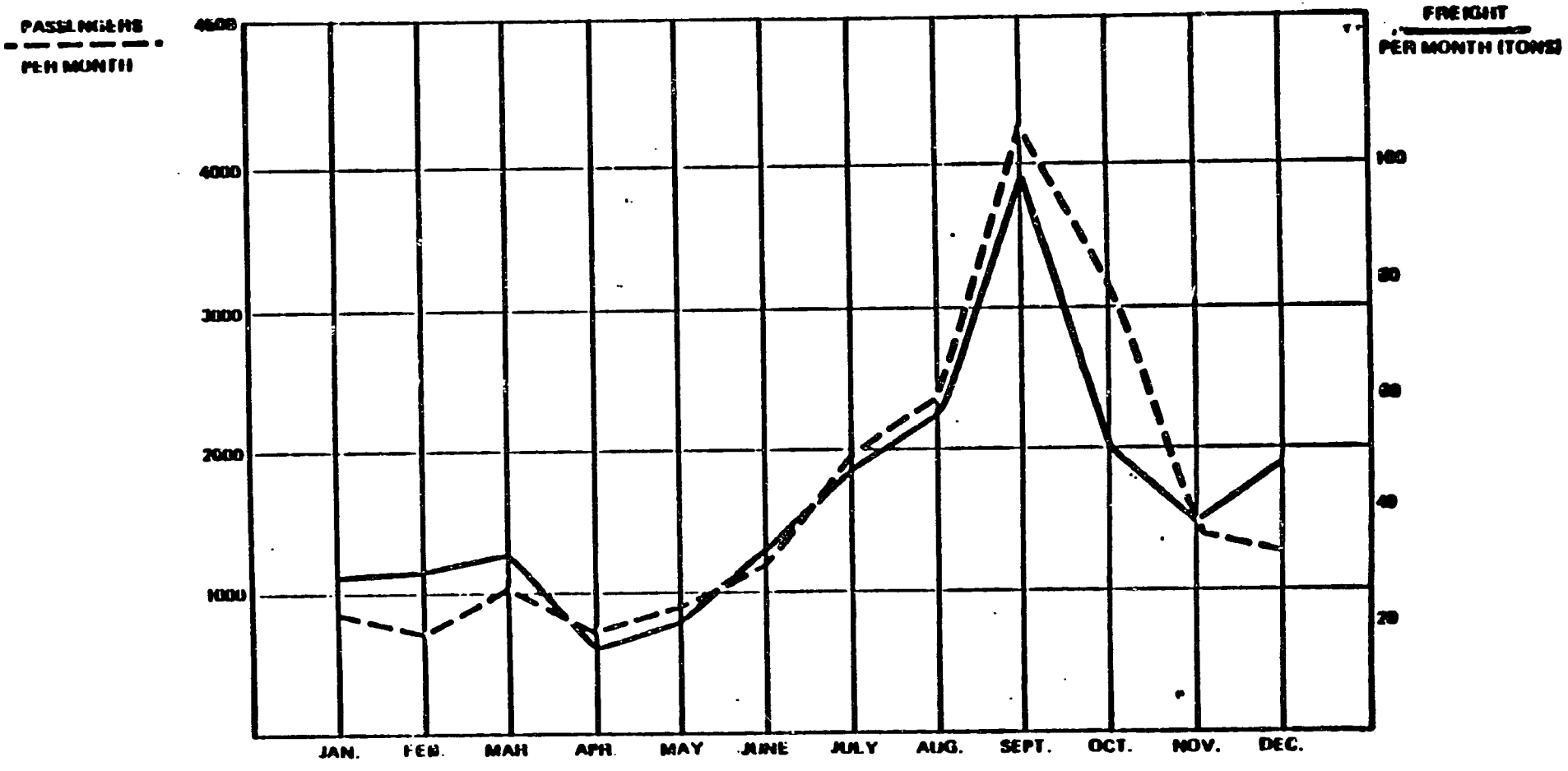
Location	Runway/Airstrip	Surface
N'Djamena (International)	2,800 X 40m	Bituminous Concrete
Sarh	1,800 X 40m	Laterite
Moundou	1,800 X 35m	Bituminous Surface Treatment on Laterite
Abeché	1,800 X 35m	Bituminous Surface Treatment
Faya Largeau	2,300 X 50m	Crushed Stone
Mongo	1,800 X 30m	Sand - Clay
Pala	1,600 X 35m	Laterite
Bongor	1,600 X 30m	Stabilized Earth
Am-Timan	1,500 X 20m	Brickbat
Ati	1,300 X 20m	Brickbat and Gravel
Bol	800 X 20m	Soil - Cement
Others 1/		
Bardai	1,800 X 58m	Sand and Gravel
Zouar	1,450 X 35m	Sand and Gravel
Ouniango-Kebir	1,320 X 20m	Sand
Fada	1,100 X 50m	Sand - Clay
Koro Toro	1,000 X 30m	Sand - Clay

1/ These airports have not been regularly operated and maintained by ASECNA.

Source: ASECNA, 1976.

FIGURE 22/23

MONTHLY INTERNAL AIR TRAFFIC–1975



Source: Air Ethiopia

Air transport demand serviced by Air Tchad in 1975 amounted to about 20,000 passengers, 490 tons of freight, and 75 tons of mail per year (Table 11). While passenger traffic remained fairly constant during 1970 to 1976 (See Table 13), there was a significant decline in demand for air cargo transport. Passenger demand was limited by the level of fares and the conventional form of service provided, which mainly served a limited sector of the population; about 50 per cent of passenger travel was related to government business. Air Tchad service gradually declined after 1968, when 3,466 flights hous were logged. By 1975 flight hours totalled 1,611 and by 1980 Air Tchad services were terminated. In 1981 very limited service was provided to N'Djamena and Sahr by foreign carriers. See Table 14.

With the restoration of internal order, there are social benefits accompanying the introduction of a year-round, rapid, and extensive air transport system in Chad. These could manifest themselves in extension of airborne medical services to rural areas, expeditious agriculture and livestock extension services and, not the least, effective and speedy relief to areas subjected to natural disasters such as flooding or prolonged drought.

Transport Costs and Route Selection

While the cost of transport from seaports to Chad destinations is substantial, it is not the principal determinant of route selection. Though the Nigerian route is less costly than the Cameroon route for all imports consigned to N'Djamena, these cost differences become insignificant when translated into retail prices in Chad.

TABLE 11

Air Tchad
Operations, Revenues, and Expenditures
(1973-76)

A. Operations

Year	Passengers	Freight (tons)	Mail (tons)
1973	13,415	646	93
1974	16,003	376	142
1975	19,830	490	74
1976	19,535	387	77

B. Revenues and Expenditures

Year	Revenues (CFAF million)	Expenditures (CFAF million)
1975	331	340
1976	347 1/	492 2/

1/ In 1976, CFAF 210 million was owed by the Government to Aid Tchad.
2/ In 1977, expenditures were expected to drop to CFAF 56 million as the costs of expatriate technical staff of Air Tchad were to be covered by a French Government subsidy.

SOURCE: Air Tchad, 1976.

TABLE 13

Air Passenger Traffic, 1970-1976

Airports	1970	1971	1972	1973	1974	1975	1976
Commercial Aircraft Arrivals & Departures							
N'Djamena Int'l Airport	6,162	5,732	4,678	4,223	4,219	3,757	4075
Domestic Airports	2,822	2,258	2,830	2,363	1,788	1,846	1963
Total	8,984	7,990	7,508	6,586	6,007	5,603	6038
Number of Arrivals (Passengers)							
N'Djamena Int'l Airport	28,752	30,611	30,162	27,614	26,859	35,101	28,544
Domestic Airports	10,655	9,653	12,196	10,063	8,274	9,938	10,981
Total	39,407	40,264	42,358	37,677	35,133	45,039	39,525
Number of Departures (Passengers)							
N'Djamena Int'l Airport	32,788	33,659	33,535	31,312	20,051	32,287	29,818
Domestic Airports	11,030	9,776	11,889	11,017	9,880	11,874	12,908
Total	43,818	43,435	45,424	42,329	38,931	44,161	42,726
Number of Passengers in Transit							
N'Djamena Int'l Airport	21,439	18,332	15,305	12,522	1,853	18,537	19,859
Domestic Airports	7,486	10,507	15,506	5,256	5,851	10,186	5,372
Total	28,925	28,839	30,811	17,778	7,710	28,723	25,231

1/ January-June 1976.

Source: -Bulletin de Statistique, Republique du Tchad, 1969-1976

TABLE 14

Chad Domestic Air Traffic - 1975 -1981

	1975	1977	1978	1979	1980	1981
N'DJAMENA						
Cargo (mt)	13,974	12,600	12,603	3,306	399	55
Airmail (mt)	---	216	222	50	6	---
Passengers	---	63,378	74,153	27,356	3,290	344
ABECHE						
Cargo (mt)	---	60	78	7	---	---
Airmail (mt)	---	6	6	0.5	---	---
Passengers	---	4,026	4,751	399	---	---
AM TIMAN						
Cargo (mt)	---	18	4	---	---	---
Airmail (mt)	---	2	0.3	0.2	---	---
Passengers	---	828	174	12	---	---
ATI						
Cargo (mt)	---	12	2	---	---	---
Airmail (mt)	---	1	0.3	---	---	---
Passengers	---	1,608	370	25	---	---
BONGOR						
Cargo (mt)	---	1	0.2	---	---	---
Airmail (mt)	---	0.2	0.1	---	---	---
Passengers	---	575	46	---	---	---
BOL						
Cargo (mt)	---	---	---	---	---	---
Airmail (mt)	---	0.7	0.1	---	---	---
Passengers	---	630	63	49	---	---
SAHR						
Cargo (mt)	---	123	119	16	---	---
Airmail (mt)	---	18	15	2	---	---
Passengers	---	4,690	5,722	626	---	---
MONGO						
Cargo (mt)	---	40	3	0.1	---	---
Airmail (mt)	---	3.	0.7	0.1	---	---
Passengers	---	1,941	563	24	---	---
MOUNDOU						
Cargo (mt)	---	162	185	10	---	---
Airmail (mt)	---	29	21	2	---	---
Passengers	---	4,978	6,124	351	---	---
PALA						
Cargo (mt)	---	2	7	---	---	---
Airmail (mt)	---	4	1	---	---	---
Passengers	---	350	439	---	---	---

Footnote to Table 14

Definition of Terms

"Cargo": Annual total metric tons of cargo arriving and departing airport. N'Djamena tonnage includes international as well as domestic cargo.

"Air Mail": Annual tonnage of international and domestic mail arriving and departing airport by air.

"Passengers": Total of persons arriving and departing airport by air, each arrival or departure constitutes one passenger trip ("passenger") N'Djamena count includes both international and domestic trips; transit passengers are not counted.

The wide range of differences between CIF values and retail prices is more a function of import duties and wholesale and retail markups than of differences in transport costs and other intermediary expenses between the ports and Chad destinations.

Transport Costs, by Route

Transport of Chad's imports is characterized by the following cost considerations:

i) The Nigerian route is less costly than the Cameroon route for all imports from overseas destined for N'Djamena, as indicated by a comparison of intermediary costs (retail price less CIF cost) shown in Table 15/19.

ii) These differences in costs become insignificant when translated into retail prices; and

iii) The retail price in Chad of imported goods via the cheaper Nigerian route is 15% to 280% greater than the CIF price, depending upon the commodity.

The choice between routes is primarily governed by factors other than cost - principally the following: risks of pilferage and damage; delays in delivery due to port congestion; lack of overland transport capacity; inter-modal transfers; and preferences for incurring tax, transport, and handling expenses within the CFAF monetary zone rather than in Nigerian currency. Except for fuel transport, these factors have contributed to make the Cameroon route the preferred external corridor.

TABLE 15-19

C H A D

Retail Price of Selected Items in N'Djamena as a Function of Import Routes and Comparison of Retail Prices with CIF Costs

Product	Retail Price in N'Djamena (CFAF/ton) Cameroonian Route	Nigerian Route	% Difference	CIF Port Cost	Nigerian Route Retail Price N'Djamena/CIF Cost
Flour	114565	109582	4.3	67,979	1.612
Sugar	198625	194993	1.9	99,996	1.950
Tea	504154	480475	4.8	170,020	2.826
Reinforcing Steel	191174	186692	2.4	69,948	2.669
Corrugated Iron	322607	317301	1.6	104,852	3.806
Cement	57734	60178	4.2	15,811	3.806
Fertilizer	93372	89742	4.0	52,511	1.709
Textiles	4700269	4688495	0.3	1,520,264	3.084
Ceramics	350044	337110	3.8	130,264	2.574
Insecticides	652568	647226	0.8	562,805	1.150
Soap	326352	313482	4.0	127,484	2.459

1/ For Nigerian route.

Moreover, the wide range of differences between CIF values and retail prices is more a function of commercial and taxation factors than differences in intermediary costs. Two bulk commodites, flour and cement, are illustrative of this condition: the import duties on flour are CFAF 1,622 and CFAF 461 per ton for the Cameroon and Nigerian routes respectively, but on cement, they are CFAF 9,552 and CFAF 8,660 respectively. The wholesale and retail markup on flour is about CFAF 19,500, and on cement about CFAF 11,000, while the CIF value is CFAF 68,000 per ton, and of cement CFAF 15,170 per ton. There is no reason to believe, therefore, that a decrease in transportation costs will necessarily be reflected in lower consumer prices or that routing of imports is sensitive to small changes in relative transport prices betweeen alternative transport routes.

(i) The Transequatorial Route is price competitive with the other routes only for bulk commodities such as petrol products, cement, and fertilizer destined for southeast Chad. The river transport link, while inexpensive, is navigable only about six months of the year. The problem of scheduling shipments within this period is severe given ocean shipping schedules, capacity constraints on the Congo railroad and the river barges, and poor road conditions in CAR during the rainy season when the river is navigable. Delays of 4-6 months and accompanying storage and inventory carrying costs compound the problem. Consequently, traffic on this route continues to decrease.

(iii) For fuel transport to N'Djamena, the Nigerian route is the cheapest, the international transit cost being CFAF 1,745 per hectoliter. The port of origin is Apapa, Nigeria. By contrast, the Transequatorial route from the port of Pointe-Noire, via Bangui to N'Djamena costs approximately CFAF 2,610 per hectoliter. However, for delivery to Sarh, the transit cost via Bangui

is only about CFAF 2,000 per hectoliter. As the internal cost of moving petroleum products between Sarh and N'Djamena is about CFAF 610 per hectoliter, the delivery of petroleum products via the Nigerian route to Sarh would cost about CFAF 2,355 per hectoliter in total transit costs from Apapa. This suggests that for the N'Djamena area, there is a competitive advantage in using the Nigerian route for fuel transport, whereas for the Southeast, it may be cheaper to use the Transequatorial route.

Road Transport Tariffs and Costs

The financial cost of truck operation on selected routes is compared with tariff levels in this section. Except for the Maiduguri, Nigeria-N'Djamena route, tariffs are lower than truck operating costs. The rationale for this pricing behavior is explained herein.

Road Transport Tariffs

Government-established freight rates for truck transport on domestic and international routes in 1977 are shown in Table 20. Chadian tariffs were considerably lower than those in neighboring Cameroon.

Road Transport Costs

The average financial cost of truck operation in terms of CFAF/ton-km for different load factors and annual kilometrage is contained in Table 21, while Table 22 contains further detail.

TABLE 20

Principal Road Transport Tariffs; 1977 4/
(Excluding 4.4% Taxe de Chiffre d'Affaires)

A. INTERNATIONAL ROUTES

1. **Dry Goods**

Item	Tariff (CFAF/ton-km) Routes to N'Djamena: Cameroonian (To N'Gaoundéré)	Transequatorial 1/ (To Bongui)	Nigerian (To Maiduguri)
Sugar	13.3	14.0-20.0	21.2
Cotton	17.0	16.53	15.87
Metal Sheets (+7m)	19.0	16.6-21.4	28.4
Flour	13.5	12.3-15.9	27.4
Cement	13.5	14.1-18.2	28.4
Other Merchandise	18.0	14.8-19.1	28.4

2. **Fuel**

Routes	Tariff (CFAF/m³-km)
Nigerian Route	
- From Lagos	11.76
- From Kano	13.95
- From Maiduguri	20.00
Transequatorial Route	17.0-19.3

B. DOMESTIC ROUTES

Item	Tariff (CFAF/ton-km) N'Djamena to: Kousseri	Moundou	Abéché	Tracks in Sahelian Zone
Cement	13.8	13.2	20.6	25-46
Flour	10.8	10.1	17.5	25-46
Metal Sheets	14.7	14.1	23.8	25-46
Other Merchandise	14.7	14.1	19.0	25-46
Fuel 2/	16.1	16.1	20.7	-
Transport for the Army 3/	20	20	30	20-46
Transport for Petroleum Exploitation	19.5	19.5	-	33
Beer 3/	-	12.4	-	

C. COMPARATIVE ROAD TRANSPORT TARIFFS IN CAMEROON
(From N'Gaoundéré to North Cameroon, Chad, and CAR)

Item	Tariff (CFAF/ton-km)
Metal Sheets	25.0
Rice, Flour, Sugar, Malt, Cement	20.0
Fertiliser	19.0
Cotton	20.0
Other Merchandise	24.0

1/ Tariff variable depending upon point of origin or destination in Chad.

2/ Price in CFAF/m³-km.

3/ Tariffs obtained under special contract.

4/ Covering only the road element of each multi-modal route.

Source: - Chad, "Decret No. 327/PR/TP/DT", December 4, 1974
- SEDES, 1977

TABLE 21

Average Financial Transport Cost of Truck Transport; 1977
(CFAF/ton-km)

	International Routes	Domestic Routes	Tracks in Sahelian Zone
i) Dry Goods			
Normal Annual Kilometrage	40,000	35,000	30,000
Truck 12 t Payload			
Load factor - 65%	28	30	40
- 55%	33	35	45
Truck-Trailer 26 t Payload			
Load factor - 65%	17	21	--
- 55%	20	24	--

Average Financial Transport Cost (CFAF/cu.m.-km)

International Route (N'Djamena-Lagos)

ii) Petroleum Products			
Annual Kilometrage	70,000	80,000	90,000
Tanker - 30 cu.m. (90% Load Factor)	14.0	13.5	13.0

Financial Cost of Transport; Detail
(in early 1977 prices)

	Transport Cost (CFAF/ton-km)					
	International Routes		Domestic Routes		Tracks in Rebel Zone	
A. Transport of Dry Goods						
Annual Kilometrage	40,000	60,000	30,000	50,000	20,000	40,000
Truck 12 t Payload						
Load Factor - 55%	29.2-33.2	27.1-31.5	38.7-41.7	28.0-38.3	47.0-48.1	43.1-43.8
- 65%	24.6-30.4	22.8-28.3	26.0-36.1	23.6-32.6	42.1-43.2	37.0-38.2
- 75%	21.5-26.2	19.9-24.5	22.2-30.9	20.4-28.1	36.5-37.5	32.0-33.2
- 100%	16.0-19.6	14.8-18.9	17.0-23.1	15.3-21.3	27.2-28.1	24.0-24.8
Truck-Trailer 26 t Payload						
Load Factor - 55%	18.5-22.2	17.2-20.3	22.3-26.9	19.7-24.1	-	-
- 65%	15.7-18.7	14.5-17.0	18.9-23.2	16.8-20.5	-	-
- 75%	13.6-16.3	12.6-14.8	16.5-19.6	14.5-17.7	-	-
- 100%	10.2-12.2	09.4-11.3	12.2-14.7	10.9-13.4	-	-

	Transport Cost (CFAF/m^3-km) International Route (Approximately 100% Paved)		
B. Fuel Transport			
Annual Kilometrage	70,000	80,000	90,000
Tanker 30 m^3, 50% Load Factor	11.6-16.0	10.6-15.7	10.3-15.5

Note: (a) Lower bound values are based on purchase of some fuel, spare parts, and tires in neighboring countries, and the best surface type for a given route category, as applicable;
(b) Upper bound values are based on purchase of all commodities in Chad, and the lowest surface type for a given route category as applicable.

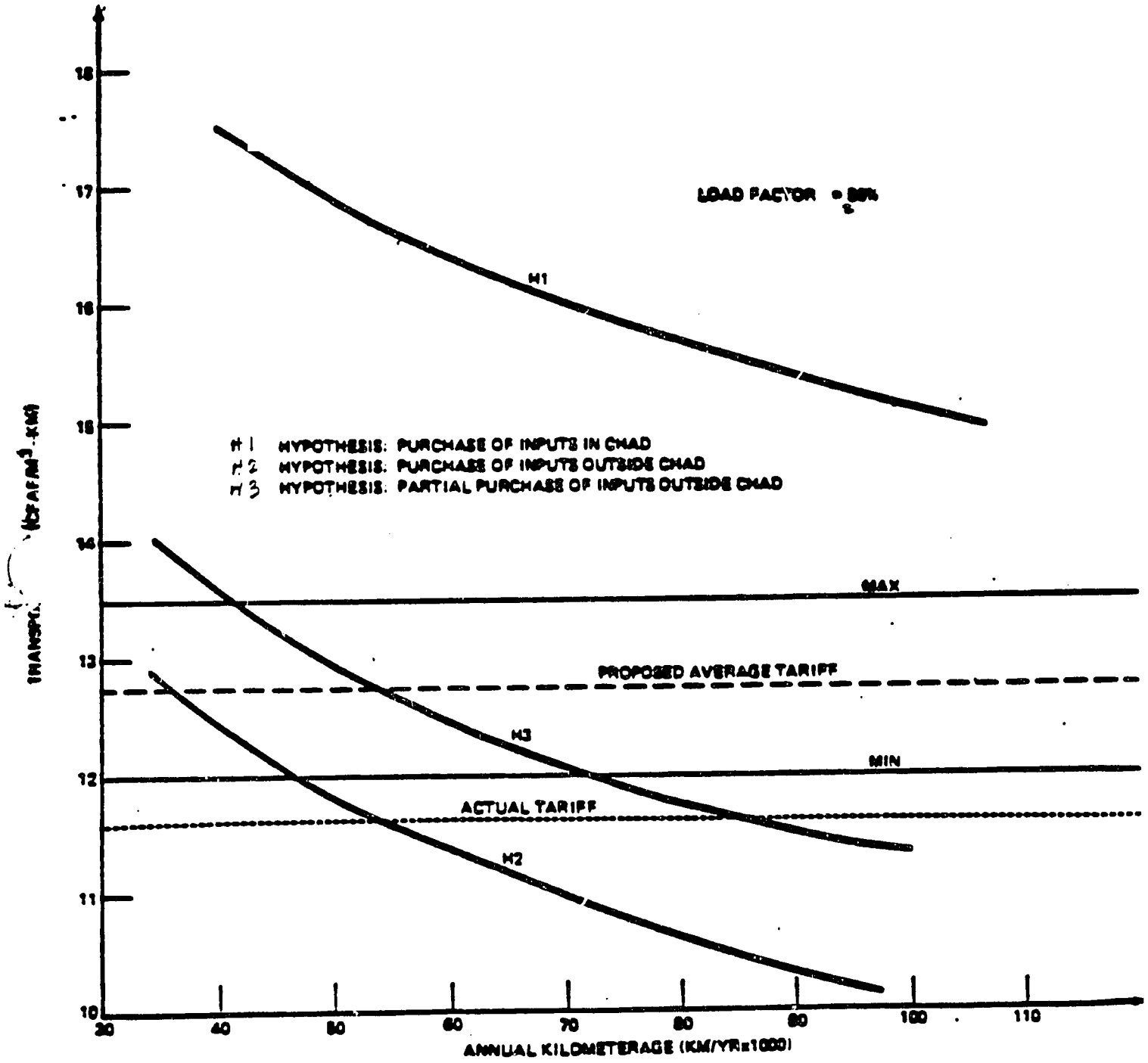
Source: Adapted from ORGATEC, 1977.

Figures 22 a-e provide cost curves for several truck types under several alternative assumptions of truck maintenance supply sources. They compare existing tariffs with transport costs and indicate actual and appropriate freight rates.

Except for the tariffs on the Maiduguri-N'Djamena route, existing road transport trariffs are lower than transport costs (in some cases as much as 25-50%). Factors that have permitted trucking operations at tariffs that are apparently lower than transport costs are the following: first, most transporters only consider out-of-pocket expenses and are not duly concerned about vehicle replacement; secondly, the purchase of fuel and spare parts in Nigeria helps to reduce the

FIGURE 22 a
CHAD

FINANCIAL COST OF FREIGHT TRANSPORT, NET OF TAXES
SEMI-TRAILER
ROUTE 1: PAVED

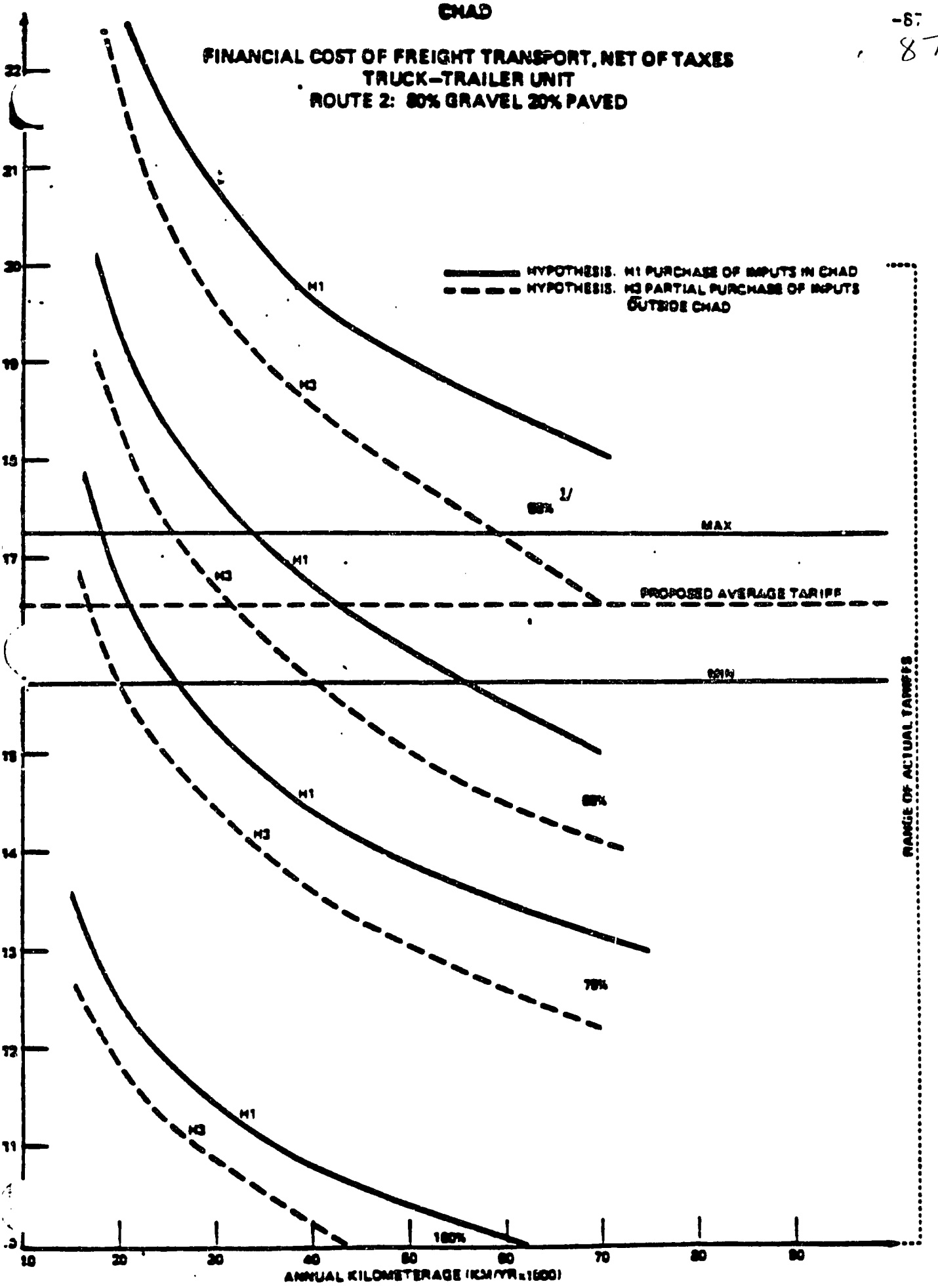


SOURCE: ORGATEC, 1977

FIGURE 22 b

CHAD

FINANCIAL COST OF FREIGHT TRANSPORT, NET OF TAXES
TRUCK–TRAILER UNIT
ROUTE 2: 80% GRAVEL 20% PAVED



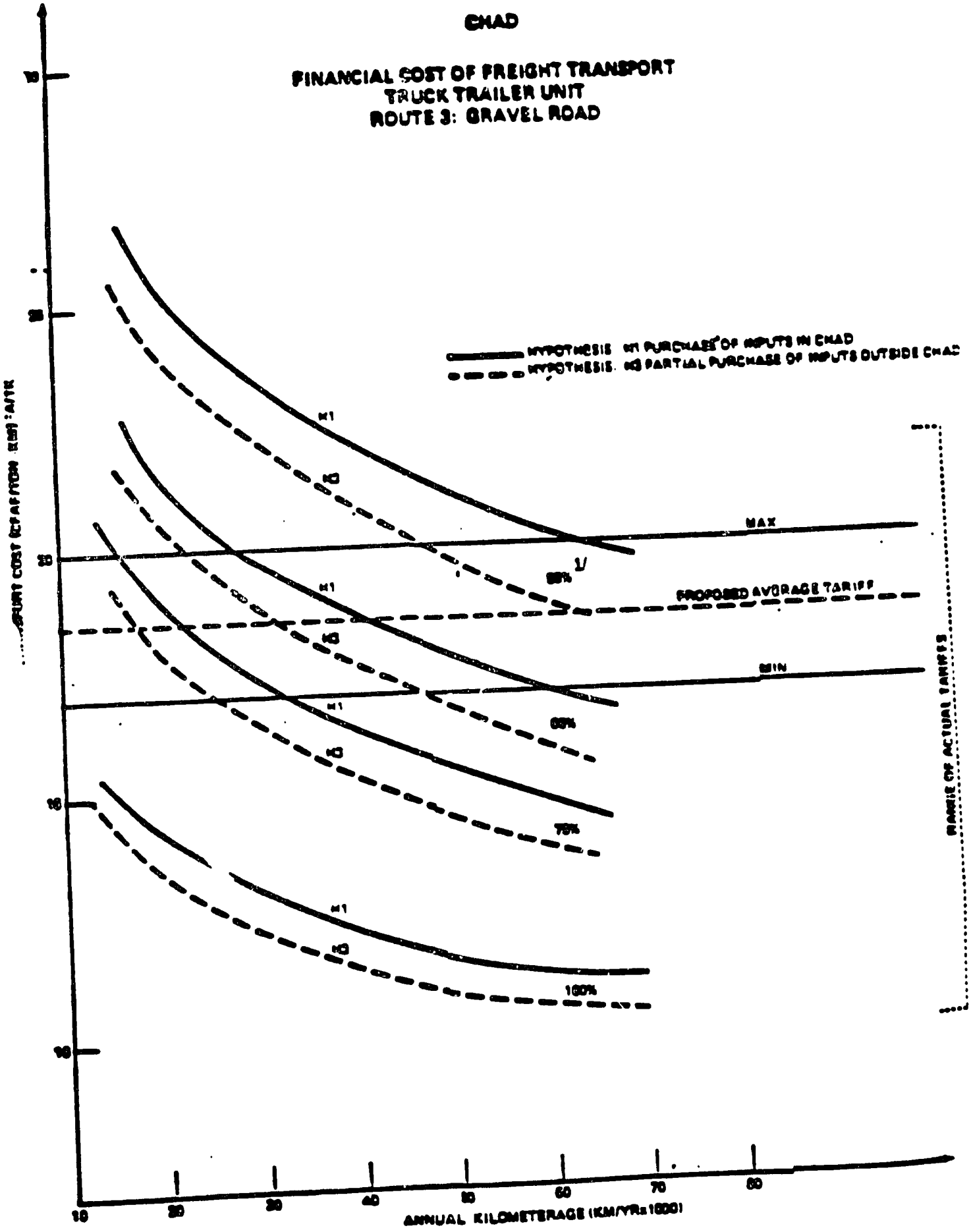
1/ FIGURES IN % ARE LOAD FACTORS

SOURCE. ORGATEC. 1977

FIGURE 22 c

CHAD

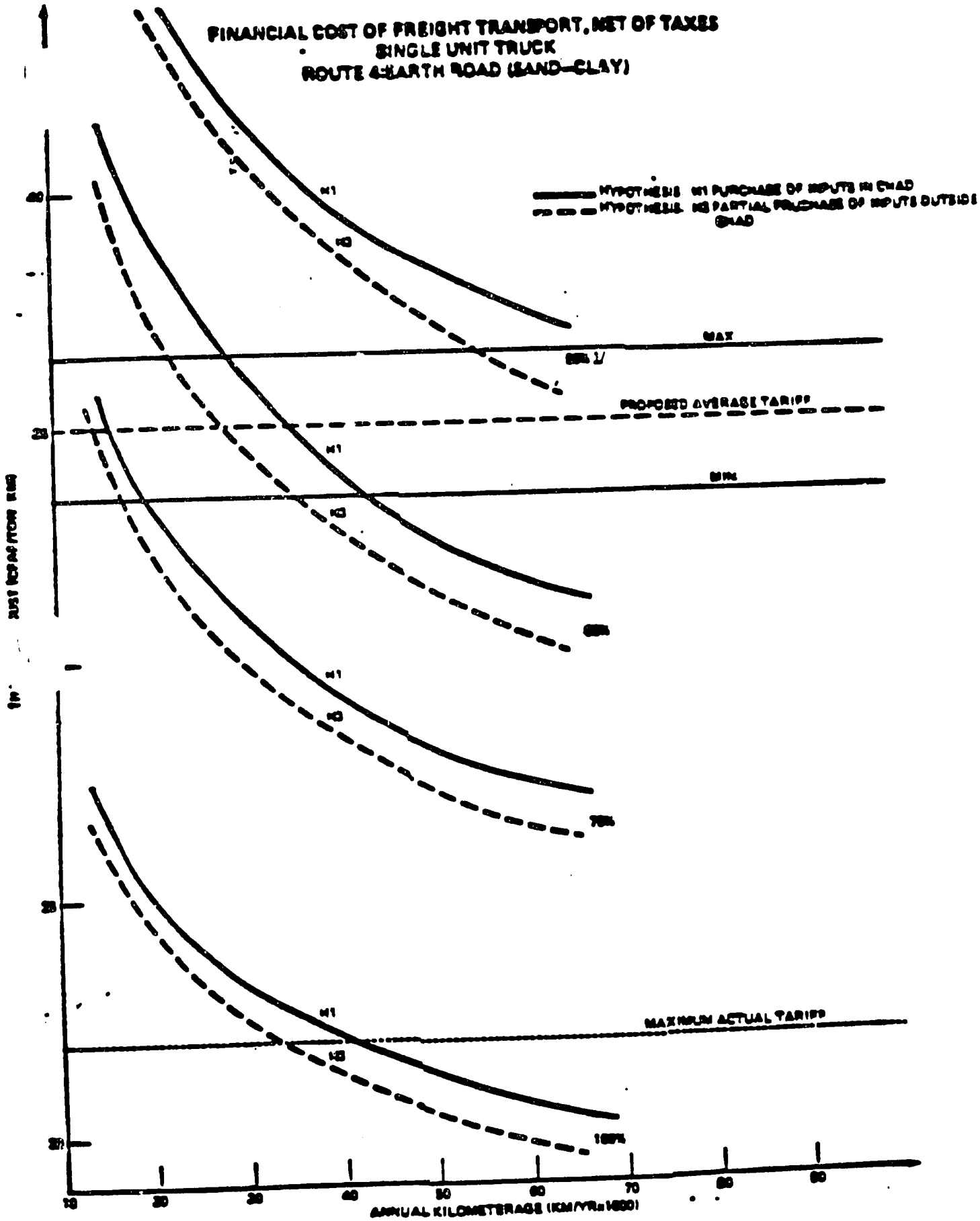
FINANCIAL COST OF FREIGHT TRANSPORT
TRUCK TRAILER UNIT
ROUTE 3: GRAVEL ROAD



1/ FIGURES IN % ARE LOAD FACTORS.

SOURCE: ORGATEC, 1977

FIGURE 22 d
CHAD

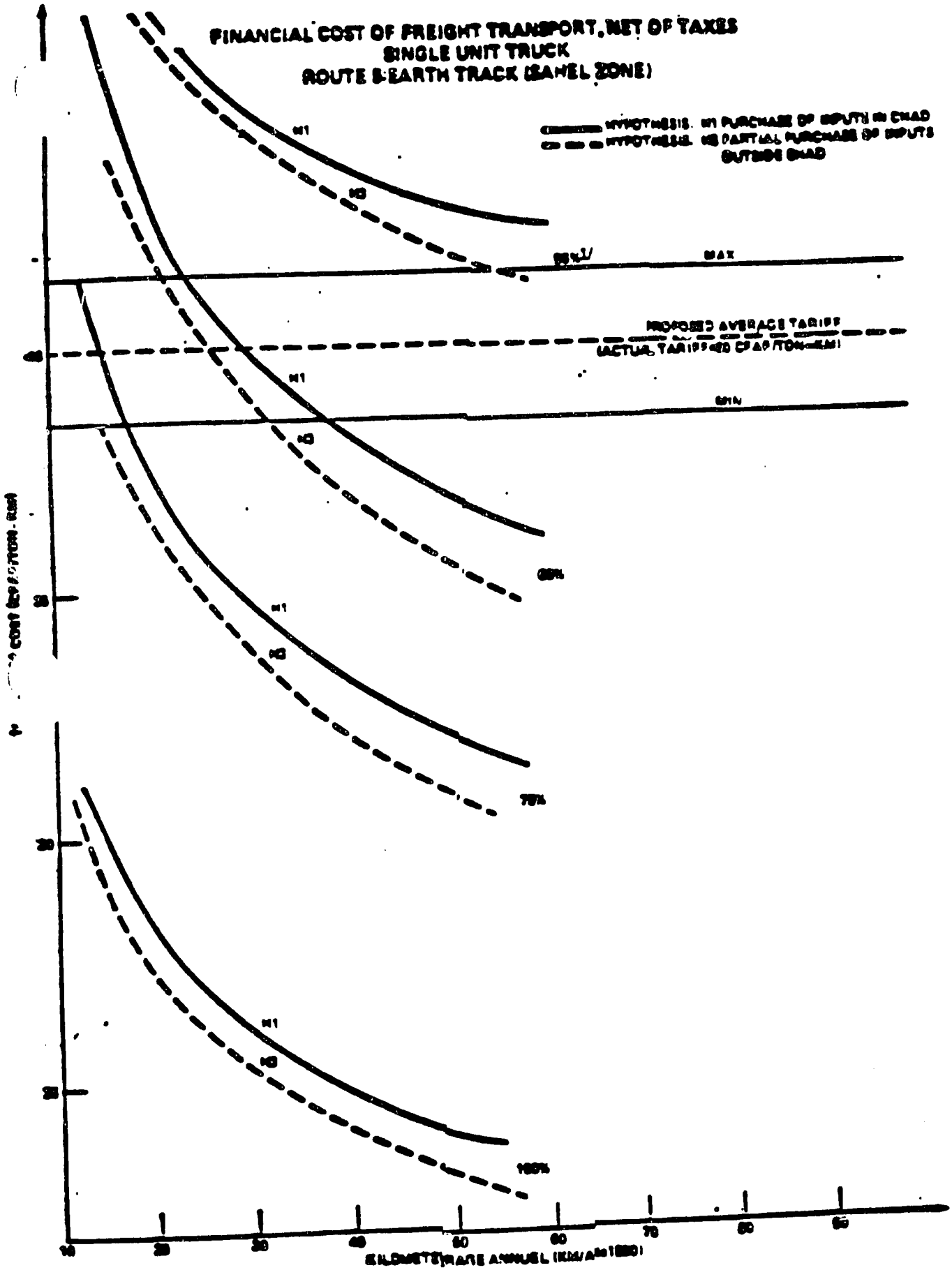


1/ FIGURES IN % ARE LOAD FACTORS

SOURCE: SRGATEC 1977

FIGURE 22 e

CHAD



1/ FIGURES IN % ARE LOAD FACTORS

SOURCE: SOGATEC, 1977

high cost of transport operations; and finally, the subsidized import of about 100 trucks under "Operation Fiat" has helped to postpone the day when large scale vehicle replacement would be required. The incidence of transport cost decreases by CFAF 1-1.5 per ton-km if spare parts, fuel, and tires are assumed to be purchased in part outside Chad. A major factor contributing to high transport costs is the low rate of truck utilization. If the load factor were to increase to 0.75-0.90, the resulting transport cost would be within the range of existing tariffs. However, owing to the structural imbalance between exports and imports, the lack of effective coordination among shippers, carriers, and transport intermediaries, and the fact that a large proportion of imports (55%) are destined to N'Djamena while most exports (over 90%) originate in the south, it is unlikely that vehicle utilization can be improved much above a 60-65% load factor although there is scope for increasing annual haul distances through better control of truck supply.

Influence of Transport Costs on Prices of Imported Consumer Goods and Agricultural Exports.

The variation in the price structure of a number of commodities from the CIF price (port of entry) to retail price in N'Djamena is traced in Table 23 as a function of international transit routes. The average cost of transport per ton between Douala and N'Djamena was about CFAF 34,000 in 1977 (Table 24). Except for sugar and flour, transport costs account for at most 20% of the difference between CIF and retail prices. High import duties, distribution costs and markups are the primary contributors to high import prices in Chad. Therefore, it appears unlikely that a reduction in transport costs on international routes will have an appreciable effect on

TABLE 23

Intermediary Costs Between CIF Price, Port of Entry, and Retail Price in N'Djamena
(CFAF/ton in 1974 Prices)

Item	CIF Price, Port of Entry	Port Charges	Handling & Storage Cost at the Port	Transport Costs	Duties and Taxes	Distribution Costs and Commercial Mark-up	Retail Price
Reinforcing Steel							
- Cameroonian Route	70,000	175	9,885	19,660	42,504	49,090	191,174
- Nigerian Route	70,000	140	11,675	15,590	41,348	47,939	186,692
- Transequatorial Route	70,000	590	10,346	25,515	42,133	51,335	199,919
Corrugated Metal Sheets							
- Cameroonian Route	164,800	175	10,280	19,680	64,361	123,501	322,687
- Nigerian Route	104,800	140	12,139	15,590	63,205	121,436	317,301
- Transequatorial Route	104,800	590	10,741	26,110	63,990	127,868	334,107
Tea							
- Cameroonian Route	170,000	523	17,995	27,189	182,040	185,613	584,154
- Nigerian Route	170,000	172	12,580	23,628	180,557	102,538	480,475
- Transequatorial Route	170,000	972	17,387	38,364	181,750	108,248	516,721
Sugar							
- Cameroonian Route	100,000	125	5,820	15,945	1,997	-	127,467 1/
- Nigerian Route	100,000	140	7,070	15,690	431	-	194,131
- Transequatorial Route	100,000	690	8,470	25,925	1,102	-	136,187
Flour							
- Cameroonian Route	68,000	125	8,515	18,780	1,822	19,003	114,565
- Nigerian Route	68,000	140	8,673	13,290	461	19,018	109,582
- Transequatorial Route	68,000	490	8,001	28,203	959	20,086	115,736
Tires less than 15 kg							
- Cameroonian Route	2,835		740		1,985	1,410	6,970
			(Douala-N'Djamena by Air)				
Light Truck							
- Cameroonian Route	1,130,600	1,120	32,169	185,500	560,000	398,015	2,245,437
Heavy Truck 4.12 t Payload							
- Cameroonian Route	4,295,760	2,950	62,510	175,000	1,590,966	1,690,283	7,812,437

1/ Wholesale price to factory.
Source: [illegible], 1977.

TABLE 24

Transport Costs, Duties, and Taxes on Selected Items Destined to N'Djamena via Douala

(1977)

	Transport Cost 1/ (CFAF/ton)	Duties	Taxes	Transport Cost Per Ton-Km 1/ CFAF	$
Equipment Spare Parts	43,769	35%	15.2%	25.49	0.082
Cement	29,088	25%	15.2%	16.94	0.055
Sugar	31,875	0%	0.2%	18.56	0.060
Flour	31,875	0%	0.2%	18.56	0.060
Metal Goods	39,427	30%	15.2%	22.96	0.074
Fertilizer	31,875	0%	15.2%	18.56	0.060
Trucks	Variable	35%	20.2%	---	---
Tractors	Variable	15%	20.2%	---	---
Trailers	Variable	20%	15.2%	---	---

Transport Costs, Duties, and Taxes on Fuel from Refinery in Lagos

	Transport Cost 1/ (CFAF/m^3)	Duties (CFAF/m^3)	Taxes (CFAF/m^3)
Gasoline (Super)	29,000	5,000	13,500
Gasoline (Regular)	29,000	5,000	13,500
Kerosene	29,000	1,000	-
Diesel	29,000	-	16,000

SOURCE: - ORGATEC, 1977
- World Bank Staff Estimates.

1/ In contrast to tariffs.

lowering final consumer prices in Chad, as long as taxes and distribution costs continue to account for the major portion of intermediary costs. On the other hand, an increase in transport costs would likely be accompanied by corresponding increases in transport tariffs and distribution costs, which, in turn, would have an inflationary impact on consumer prices. Transport costs alone account for US$140 for each ton of Chadian products (primarily cotton) sold on the international market. In 1977 it was estimated that the proposed international road link (Moundou-Guidjiba) to the trans-Cameroon railway (shorter by 270 km) would reduce transport costs by roughly CFAF 5,4000 (US$22) per ton.

Relative to imports, the combined effect of transport costs, distribution margin, and import duties and taxes on consumer prices is substantial, although transport costs account for only 15-20% of the final consumer prices. A ton of cement in N'Djamena costs the consumer about CFAF 55,000 compared to CFAF 10,000 at the port of Douala. By contrast, the cost of cement is about CFAF 29,000 per ton in Niamey compared to a cost of CFAF 12,500 at the port of Cotonou. Even in the case of commodities for which transport and distribution costs are subsidized, the consumer prices in N'Djamena are about 50% higher than prices CIF Douala.

Domestic Air Transport Tariffs; Air Tchad; 1977

Passenger Tariffs

Rates vary from CFAF 35/seat-km (DC-3 and DC-4 operations) to CFAF 41/seat-km (Baron Beechcraft operations).

These tariffs, equivalent in 1977 to US$0.23 -.27 per seat-mile, are of the same order of magnitude as those in the U.S. and U.K. for similar type trips, but are higher than the prevailing rates in other developing countries, where air travel is normally subsidized.

Freight Tariffs

Freight tariffs for shipments under 250 km vary from CFAF 0.23-0.37 per kg-km (CFAF 230-370 per ton-km), and for shipments over 250 kg from CFAF 0.15-0.20 per kg-km (CFAF 150-200 per ton-km). (1977)

Air transport tariffs from N'Djamena to outlying domestic airports are specified in Table 25.

Water Transport Freight Rates

Water transport tariffs currently in force were established by the Government in 1974. Transport tariffs on the Sarh-N'Djamena itinerary are CFAF 9,000-9,600 per ton; on the Moundou-N'Djamena itinerary CFAF 12,000 per ton, and between N'Djamena and Lake Chad, about CFAF 4,800 per ton. These translate into CFAF 10-20 per ton-km compared to about CFAF 14 per ton-km by road transport for comparable items. As a result of its small scale, the high unit cost of operation and seasonality, water transport is expensive. The present tariff structure reflects the advantageous position of water transport as the only direct surface transport mode between N'Djamena and Southern Chad during the rainy season.

TABLE 25

Air Transport Tariffs from N'Djamena to Outlying Domestic Airports 1976/1983[1/]

DESTINATION	DISTANCE (KM)	1976 FREIGHT TARIFF-CFAF/KG <250Kg	=>250kg	/mt	1976 $/mt	1976 $/ton-km	1983[2/] $/mt	1983[2/] $/ton-km	PASSENGER TARIFF CFAF/seat
Abeche	645	150	105	105,000	439	0.68	856	1.33	23,350
Am-Timan	575	105	90	90,000	377	0.66	735	1.28	20,750
Ati	375	85	70	70,000	293	0.78	571	1.52	13,200
Bol	150	55	---	---	---	---	---	---	6,100
Bongoi	200	70	60	60,000	251	1.26	489	2.44	8,250
Faya-Largeau	780	175	140	140,000	586	0.75	1,142	1.46	27,300
Mongo	390	85	70	70,000	293	0.75	571	1.46	13,200
Moundou	400	85	70	70,000	293	0.73	571	1.43	16,450
Palu	300	70	60	60,000	251	0.84	489	1.63	12,350
Sarh	489	85	70	70,000	293	0.61	571	1.19	17,450

1/ Includes tax (4-5%)
2/ 1976 prices inflated by 10% annually to develop 1983 estimates.

SOURCE: Air Tchad, 1976.

Government Strategy for Transport Development

The Government has considered as essential elements in Chad's short-term economic development program the paving of road links between N'Djamena and Sarh via Bongor and Lai to provide an all-weather connection between N'Djamena and the agricultural southwest region, and constructing the Moundou-Guidjiba road to provide a shorter (by about 270 km), more reliable, and less expensive international route to the Trans-Cameroon railway and the seaport of Douala. It sees the country's political integration being reinforced by all-weather roads linking Abeche with N'Djamena and Sarh.

Prospective Transport Investments

International Routes

Despite the complexity of the transportation problems in Chad, their solution could help to spur economic growth. The incidence of high transport costs not only has a debilitating effect on the competitiveness of Chadian exports but also results in higher prices for imported goods. In 1977, surface transport costs from Chad to ocean ports averaged about CFAF 34,000 (US$139) per ton. For cotton exports, transport costs were 15-20% of the CIF Europe price of cotton. With reductions in production costs reaching their limit, the competitiveness of Chadian cotton exports in the world market will be maintained only by a reduction in transport costs. A similar situation holds for the export of gum-arabic by air. According to Societe Nationale de Commercialisation du Tchad (SONACOT), the government agency entrusted with the export of this commodity, the cost of collection and local surface transport amounts to over 25% of the sale price in Europe. These examples show that possibilities for expanding

the production of export commodities will remain constrained as long as transport costs continue to account for a relatively large share of the final market price.

TRANSPORT DEVELOPMENT PROSPECTS

Considering Chad's uncertain development prospects, and a limited growth potential for transport demand, investment opportunities in the transport sector are becoming increasingly limited.

Moundou-Guidjiba Road; 304 km

This proposed road project consists of the construction of a 304-km paved road linking Moundou in Chad with N'Gaoundere in Cameroon via Guidjiba; 116 km would be located inside Chad. The purpose of the project is to provide a reliable, all-weather international road link to the Trans-Cameroon railway and to the seaport of Douala. The project cost in 1977 was estimated at CFAF 14.0 billion, together with CFAF 5.7 billion for contingencies (CFAF 18.7 billion or about $76 million. Construction of this international link would reduce the distance between Moundou and N'Gaoundere by about 266 km and link Chad's cotton belt directly with the railhead at N'Gaoundere.

The main objective in selecting a specific cotton export route should be its efficiency in expediting cotton exports along with its compatibility with import traffic requirements. As cotton producing areas are also centers of import consumption, the route selected for special development should have adequate traffic in both directions to justify its improvement. A 1969 network analysis showed that the Moundou-Guidjiba route met these requirements and would serve as the optimal route for about 70-80% of cotton exports as well as the least-cost route for a majority of imports destined for the

southwest, assuming 85% of imports destined for Moundou and 50% of imports en route to Sarh would pass through Moundou. Preliminary estimates of economic feasibility showed that this route would carry a base level traffic of about 80-100,000 mt/yr,[1/] especially in view of the significant diversion of traffic from the Transequatorial to the Cameroon route during the past few years. The primary benefits would be the reduction in distance between Moundou and N'Gaoundere by 266 km and savings in vehicle operating costs and road maintenance expenditures. As the northern portions of the Cameroon road and rail network are underutilized, marginal benefits would also accrue to the Cameroon transport network. A priori, the Moundou-Guidjiba road project appears to be an attractive proposal. Its economic justification, however, needs to be evaluated further as existing technical and economic studies date back to 1979.

Airship potential: The use of airships from Moundou to N'Gaoundere warrants consideration. Volumes of exports and imports amount to about 50,000 mt each way. The air distance from Moundou to the railhead at N'Gaoundere is about 290 km. While the elevation at Moundou is only 200 m, at N'Gaoundere it is between 1,000 and 2,000 m; this could disqualify the airship, because payload capacity decreases with elevation.

An alternative to this operation is to run the airship the longer distance between Moundou and Douala Port; this could also be considered.

1/ Cotton exports in 1977 amounted to 54,000 mt.

Domestic Routes

An initial step toward improving air transport infrastructure was taken by IDA in providing funds for minor rehabilitation of airstrips. Many questions, such as potential demand for air transport and type of aircraft and airport infrastructure best suited to Chad's needs have not been studied; there is a growing need to address these questions. Not only do long distances, bad roads, and continuously increasing costs of new road construction indicate that air travel may be the cheapest form of transport, but it is indeed the only available means of reaching many sections of the country. This situation is likely to prevail even if construction of some all-weather roads could be economically justified.

The Logone Corridor, linking the capital city of N'Djamena with the southern corridor, Moundou and Sarh, is annually interdicted by flooding of the Logone River. The road carries a low volume of traffic, but provides an administrative link between the capital and the area of most significant agricultural production. Present proposals for transport improvements in the Logone Corridor are not economically viable and are well beyond the Government's financial capability; air transport may be a suitable substitute. The approximate distance between Moundou and N'Djamena is 400 km.

The Bongor-Lai Road; 198 km. This project comprises the construction of a 198-km paved road section in the N'Djamena - Moundou route, all-weather, -permanent connection via Bongor, Lai and Doba. The project is estimated to cost about U.S.$80 million. Annually, the Bongor-Lai road is inundated by the floodwaters of the Logone River to a depth of 0.5-1.0 m and road traffic is completely discontinued for 5-6 months.

The existing road is difficult to maintain at an acceptable standard; physical improvements through upgrading and regravelling are likely to be washed away during the rainy season. The road provides the main link between the pastoral north and the more productive south; but the present alignment and absence of adequate drainage structures impose restrictions on transport resulting in frequent loading and unloading, seasonal use, and long detours through Cameroon during the rainy season. A better road could eliminate these problems and help integrate the country by establishing a permanent liaison facility between the national capital of N'Djamena and the commerical and administrative centers of Bongor, Lai, Moundou, Doba and Sarh in the south. But on economic grounds, the project is not viable, given the costs involved (US $404,000/km) and the low level of traffic (under 50 vpd). There is relatively little economic interdependence between the N'Djamena area and the southeast; because the cotton grown in the southeat is exported directly to ports in the Congo and Cameroon, the proposed road is not essential for the evacuation of the principal cash crop. Imports consumed in the southeast arrive in part from Nigeria via N'Djamena but only because wholesalers are presently located there. Except for petroleum products originating in Nigeria, the flow of imports could easily be diverted to the same route used by cotton exports. Only modest amounts of domestically produced food crops move between these two areas. In addition to petroleum products, the principal products transported between the North and South are manufactured goods imported through N'Djamena, and beer and soft drinks from the brewery in Moundou and the bottled beverage plant in Sarh, amounting to about 25,000 mt/yr. Even if the road were economically justified, routine maintenance amounting to CFAF 23.7 million p.a. and periodic maintenance costing CFAF 712.8 million every six years would be outside the

Government's budgetary resources, even assuming modest increases in the Road Fund during the next 5-10 years. Maintenance costs could be even higher since the Logone River perennially inundates its banks and could conceivably erode the road embankment. This road, however, does have considerable political and administrative benefits, and some economic merit if considered within the context of a regional multi-sector development project for the Logone basin. A change in alignment farther away from the Logone River could result in significant construction cost savings but this proposal is, at present, unacceptable to the Government.

As an alternative, the air mode should be considered. (See Scenario 3).

The Sahel Corridor connects N'Djamena with Abeche eastward near the Sudan border. There is presently a desert track. Traffic volumes are low and road construction costs would be high (between $250,000 and $500,000 per km). Consequently, road construction is economically unfeasible. Air transport may be the appropriate solution, if intermittent service could be provided at relatively low cost. The Government considers this link a necessary element in the political integration of the country. Air distance N'Djamena - Abeche: 650 km.

The Sudan Route

In terms of the future development of alternative international transport corridors, the Sudan route should be evaluated. If livestock development takes place in the Sahel zone as planned, the possibility of using the railhead at Nyala (570 km from Abeche) for transport of livestock, meat products, and gum arabic to Port Sudan (2,623 km from Abeche) for the potential Middle East market deserves consideration. Sudan railway network improvements

under the IBRD Fourth Railway Project (1977) give further credence to this proposal. For exports originating in South Chad such as rice, the Sudan route would be shorter (combined land and sea distance) for products destined to the Middle East.

Development of Domestic Air Transport

Given Chad's vast size and sparsely distributed population (2-3 persons/sq. km in the Sahel zone and 15-20 persons/sq. km in the arable areas of the South), further development of air transport may be important in meeting the country's transport needs. During the period 1970-76, there were no new investments in the road infrastructure, primarily as a result of the high cost of road construction (estimated at US $250,000-500,000 per km) and the low level of economic activity. Under these circumstances, air transport can be a more cost-effective transport mode. The current situation in Chad, as reflected in high road construction costs, low traffic volumes, and an average distance between urban centers in excess of 200 km, lends itself to this consideration.

A transport study[1/] in the Llanos region of Colombia indicated that road investments, for the initial 80 km, required at least 30,000 to 40,000 tons of initial traffic per year in order to be "economic." As the distance increased, a road required at least 7,000 more tons of initial volume per year for every 16 km increase in distance; hence, a road 300 km in length required at least 130-150,000 tons per year. This study demonstrated that

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1/ Ref. 14.

at relatively low traffic flows (under 100,000 tons per year) and long distances (over 200 km), air transport was the economically preferred mode, at an economic rate of return of about 12%. For a higher rate of return, say 15%, the road, being a capital-intensive technology,[1/] became less and less appealing.

The air transport infrastructure program should be designed to: (i) offset the insufficiencies of the road network, because the country's size is so great that roads could only become a factor in regional integration in the long run; and (ii) ensure that air transport plays an appropriate role in the movement of people, mail, and freight (mainly perishables and high unit value items).

Under the present investment plan it was envisaged: (i) to provide the infrastructure needed to allow the development of efficient air transport; (ii) to furnish Air Tchad with an aircraft fleet adapted to the air transport demand and the available infrastructure; and (iii) to ensure regular payments to Air Tchad for services provided to the Government.

The tariff structure should be such that it would permit the amortization of the new aircraft fleet and also help in increasing the demand for air transport.

1/ In the sense that ground transport requires high initial investment and low operating costs, whereas air transport requires relatively low initial investment but higher operating costs.

B. MALI

International Transport Routes

Mali's transport corridors to the sea are illustrated in Figure 29.

Ninety percent of Mali's foreign trade transits the Port of Dakar, Senegal or Abidjan Port in the Ivory Coast. Bamako is about equidistant from Dakar via railroad and Abidjan via road or a combination of road and rail (about 1,225 km). However, operations on the two routes differ considerably in quality.

The traffic split shown in Table 26 demonstrates the increasing attractiveness of the Abidjan Route due mainly to higher reliability. By 1977 Abidjan was handling 53 per cent of Mali's foreign trade, while Dakar was servicing 47 per cent.

These two corridors are expected to be Mali's principal outlets to the sea in the forseeable future.

In 1977, the most recent year for which complete data are available, imports totalled 351,000 mt, while exports amounted to 189,000 mt.

Dakar-Bamako Corridor; Rail; 1,223 km

Dakar-Bamako is served by a railway involving long travel time, loading delays at Dakar and not infrequent cancellation of freight trains. The track in Senegal is in poor condition and lack of cooperation between the two managements has reduced capacity. Dakar Port has an exclusive wharf for Mali and a bonded area where traffic is cleared by customs. In 1978 the total tonnage of Mali imports on this route amounted to 199,000 mt and was treble the magnitude of Mali exports. (See Table 27).

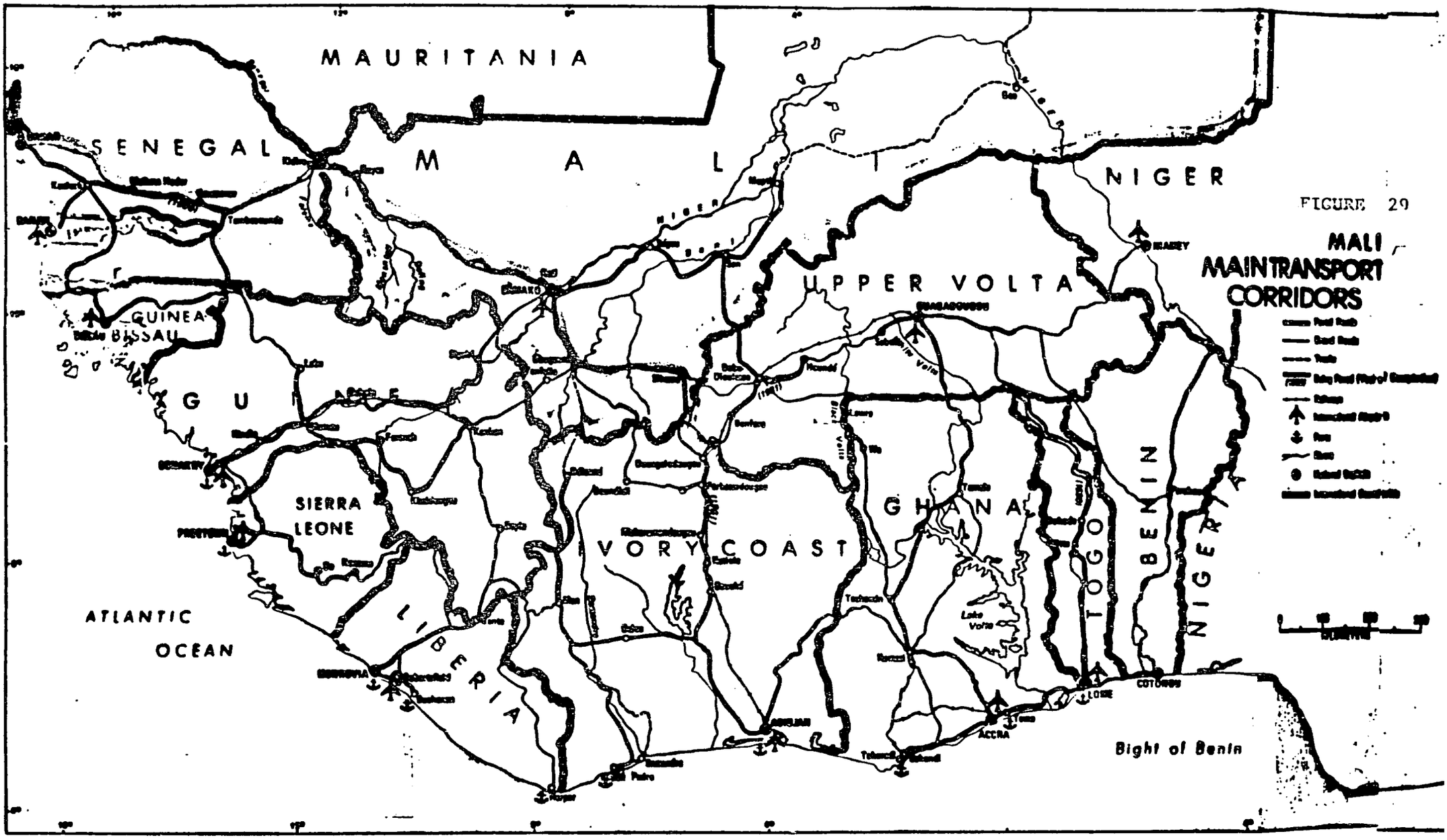
MAURITANIA
SENEGAL
MALI
NIGER
UPPER VOLTA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
GHANA
TOGO
BENIN
NIGER
ATLANTIC OCEAN
Bight of Benin
Lake Volta
BAMAKO
OUAGADOUGOU
NIAMEY
ABIDJAN
ACCRA
LOME
COTONOU
MONROVIA
FREETOWN
BANJUL
DAKAR
MALI MAIN TRANSPORT CORRIDORS

FIGURE 29

TABLE 26

Mali

Foreign Trade by Routes

(1964-1978)

	1964		1965		1966/67		1972		1973		1974		1975		1976		1977		1978	
	'000 Tons	%	'000 Tons	%	'000 Tons	%	'000 Tons	%	'000 Tons	%	'000 Tons	%	'000 Tons	%	'000 Tons	%	'000 Tons	%	'000 Tons	%
Imports																				
Via Dakar	148	67	157	79	179	69	141	67	205	57	248	55	175	48	145	49	152	43	199	
Via Abidjan	74	23	43	21	80	31	69	33	164	43	199	45	192	52	154	51	199	57	n.a.	
	222	100	200	100	259	100	210	100	369	100	447	100	367	100	299	100	351	100	n.a.	
Exports																				
Via Dakar	40	74	25	34	29	39	64	81	54	57	52	57	78	61	94	56	92	49	65	
Via Abidjan	14	26	49	66	45	61	15	19	41	43	40	43	50	39	75	44	97	51	n.a.	
Total both routes	54	100	74	100	74	100	79	100	95	100	92	100	128	100	169	100	189	100	n.a.	
Total foreign trade																				
Via Dakar	188	68	182	69	208	63	205	71	259	56	300	56	253	51	239	51	244	47	264	
Via Abidjan	88	32	92	31	125	37	84	29	205	44	239	44	242	49	229	49	276	53	n.a.	
Total both routes	276	100	274	100	333	100	289	100	464	100	539	100	495	100	468	100	520	100	n.a.	

Source: Mali, Office National des Transports

TABLE 27

Mali

Freight Traffic on Mali-Senegal Railway (Dakar-Bamako)
(mt ooo's)

Year	1959	1964/ 1965	1965/ 1966	1966/ 1967	1967/ 1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
International Mali Traffic	248	188	182	208	186	237	207	248	205	259	300	256	239	244	264
Mali imports	161	148	157	179	140	181	141	160	141	205	248	175	145	152	199
Mali exports	87	40	25	29	46	56	66	88	64	54	52	78	94	92	65
Mali Section															
Total traffic (international and local)	300	218	217	242	236	296	297	324	280	354	386	350	326	332	342
% international of total over section	83	86	84	86	79	80	70	77	73	73	78	73	73	73	77
Senegal Section															
Total traffic /1 (international and local)	n.a.	1,394	1,685	1,785	1,536	1,652	1,710	1,847	1,908	1,897	1,886	1,746	1,584	1,645	1,667
% international of total over section	n.a.	13	11	12	12	14	12	13	11	14	15	15	14	15	15
(% in ton -km)	n.a.	(43)	(38)	(39)	(40)	(44)	(44)	(41)	(39)	(45)	(47)	(48)	(50)	(49)	(49) /2

/1 Estimates based on average of fiscal year (July-June) statistics.
/2 Estimate.

Source: Mali Railways and Senegal Railways

Current Imports via Dakar: Foodstuffs, mainly sugar and flour, total about 60,000 mt/yr, and petroleum products, 35,000 mt/year. (Imports in general have dropped since 1980 due to reduced economic activity in Mali and consumption of petroleum has declined by about 20% due to the commissioning of the Selingue Hydroelectric plant now feeding Bamako, which led to the closure of the thermal power plant.)

Current Exports via Dakar: Groundnut products between Bamako and Dakar; 30,000 mt/yr are now reduced to zero due to low production and increased conversion of groundnuts to oil locally. Movement of cotton seeds and other agriculture products, about 10,000 mt/yr originating from the Bamako-Sikasso-Segou areas, is now reduced to 5,000 mt/yr due to low production.

Inasmuch as the Mali Railway in recent years has had an adequate investment policy and management has taken appropriate action to tackle financial and technical problems, the Railway's basic policies are not an issue today. The CFM's economic role is not likely to change in the near future partly because no financing is in sight for a road from Bamako to the Senegalese border. In the longer term, however, the situation may change. Significant increases in the tariffs of the Senegalese Railway may be necessary to allow for cost recovery of ongoing and planned investments, making competition with Ivory Coast routes increasingly difficult.

Abidjan-Bamako Corridor; Road; 1,225 km

Two events were responsible for spurts in Mali's use of the Ivory Coast route: the interruption of traffic on the Mali-Senegal railway between 1960 and 1963, and the 1973-74 drought when the Senegal railway did not have the capacity to handle the relief supply traffic. As indicated above, more than

half of Mali's foreign trade is carried over the Ivorian route. In the near future, even after completion of the Tambacounda-Kayes road in Senegal, it is very likely that Mali will continue to allocate a significant part of its foreign trade traffic to the Abidjan route despite the higher cost (about CFAF 20,000 per ton). The Port of Abidjan is relatively efficient but does not have special facilities for Mali.

In 1977, 93 per cent of traffic between Abidjan and Bamako was over the nearly all-paved road, mostly with large, efficient trucks, while 7 per cent was by rail from Abidjan to Ouangolodougou, Ivory Coast, thence by road to Bamako. (See Table 28.) Since paving of the Upper Volta road from Bobo Dialousso westward to the Mali border connecting with Sikasso, Bobo is an alternate railhead for Malian cargoes. However, because of political differences stemming from an incident a few years back, it is not used by Mali.

Road Routes in the Corridor

Abidjan-Manankoro-Bougouni-Bamako.

Because the Bougouni-Bamako section (163 km) is in poor condition[1/] 90 per cent of the trucks use an alternate routing: Abidjan-Sikasso-Bamako, which is 200 km longer and more expensive, but a better road and the preferred routing.

Summary

Both the Dakar-Bamako and the Abidjan-Bamako corridors have sufficient capacity to carry Mali traffic, except under unusual circumstances such as

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1/ Scheduled for reconstruction in 1985-86.

TABLE 28

Mali Traffic through Ivory Coast
(thousand tons)
(1964-1977)

	1964			1965			1966/67			1972			1973			1974			1975			1976			1977		
	Imp	Exp	Total	Imp	Exp	Total	Imp	Exp	Total	Imp	Exp	Total	Imp	Exp	Total	Imp	Exp	Total	Imp	Exp	Total	Imp	Exp	Total	Imp	Exp	Total
Railway - Total	na	na	na	na	na	na	48	15	63	38	7	45	52	29	81	97	na	na	16	na	na	10	1	11	9	13	22
Via Ouangaladougou (Ivory Coast)	na	na	na	na	na	na	(18.5)	(6)	(24.5)	na	na	na	na	na	na	(33)	na	na	(15)	na	na	(10)	(1)	(11)	(9)	(13)	(22)
Via Bobo-Dioulasso (Upper Volta)	na	na	na	na	na	na	(29.5)	(9)	(38.5)	na	na	na	na	na	na	(64)	na	na	(1)	na	na	(0)	(0)	(0)	(0)	(0)	(0)
Road (mainly via Segou)	na	na	na	na	na	na	32	30	62	31	8	39	112	12	124	102	na	na	176	na	na	144	74	218	190	84	274
Total Ivory Coast routes	74	14	88	43	49	92	80	45	125	69	15	84	164	41	205	199	40	239	192	50	242	154	75	229	199	97	296

Source: Mali, Office National des Transports

can be reached during only 5 months. Presently, two transfer points are necessary: either Nouakchott and Rosso, or Dakar and Saint Louis. In summary, without major investment the Senegal route is likely to maintain a marginal role in international access to Mali.

The Niger River; Upriver from Bamako; 1,000 mt/yr

Very limited traffic occurs upriver from Bamako between Bamako and Kankan and Kouroussa in Guinea.

Upriver commercial boats can, 5 months out of the year (July-December), link Bamako to Kouroussa, (374 km) or Kankan, (385 km using the Mila, an affluent of the Niger River) in Guinea. The traffic is very low-some 1,000 mt and 3,000-4,000 passengers annually, and if the Bougouni-Kankan Road is paved it will be even lower in the future.

Transport Costs on International Routes

Table 29 shows comparative transport costs to and from Bamako via the Dakar and Abidjan routes for selected commodities, in Mali Francs, and in 1978 prices. According to these figures, the Dakar route is the less expensive for practically all imports and exports to the from Bamako and in some cases, such as petroleum, it is more than 50% cheaper than the Abidjan route. The same ratio applied at the end of 1981, despite increased traffic on the Senegal Railways, as shown in Table 30. Dakar's advantage holds whether the the road or the road and railroad route is considered for the Abidjan link. However, for some imports such as petroleum products and cereals, whose destinations are the eastern cities-Sikasso, Segou and

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1/ Sevare is located on the Niger River within 12 km of Mopti.

TABLE 29

Transport Costs for Mali Export-Import Traffic /1
Comparison between Dakar and Abidjan for Origin/Destination in Bamako
(in Mali Francs/ton - December, 1978 prices)

Product	Dakar-Bamako Route: Terminal Costs Dakar Port	Rail tariff Dakar-al	Rail marginal costs in Mali	Total	Road Abidjan-Bamako: Terminal Costs Abidjan Port	Truck Rate	Total	Road/Rail Abidjan-Bamako: Rail tariff Ivory Coast & Port Costs	Transshipment rate at Bamako	Truck rate Bamako-Bamako	Total	Cost Differential: Abidjan (road) over Dakar route	Abidjan (road/rail) over Dakar route
Exports													
Cotton seeds	6,273	11,372	5,727	23,372	2,880	41,418	44,298	11,982	1,100	19,230	31,848	20,926	8,476
Cotton fibers & textiles	11,604	12,730	5,392	29,726	6,404	47,211	53,615	15,372	3,430	21,930	39,740	23,889	10,014
Groundnuts /2	5,268	15,173	3,510	23,950 /3	2,856	28,130	34,016 /4	10,672	1,100	13,070	27,848 /4	10,066	3,898 /4
Groundnut cake /2	5,678	8,100	3,359	17,137 /3	2,880	28,130	34,016 /4	13,382	1,100	13,070	28,678 /4	16,879	11,541 /4
Karite	8,265	8,743	5,110	22,058	2,880	28,138	31,018	11,462	1,106	13,070	25,640	8,920	3,342
Imports													
Cement	5,346	15,463	5,890	26,699	2,918	37,510	40,428	12,618	1,340	17,423	31,381	13,729	4,383
Fertilizers	5,328	12,346	5,890	23,724	5,346	37,510	42,816	16,290	1,326	17,423	35,139	19,092	11,415
Foodstuffs (cereals)	4,552	12,634	5,890	23,078	4,634	37,510	42,144	16,364	1,160	17,423	35,155	19,066	12,077
Sugar	4,680	16,234	5,890	26,804	3,476	37,510	40,986	15,693	1,326	17,423	34,447	14,182	7,643
Salt	5,322	12,895	5,890	24,107	3,618	37,510	41,128	11,352	1,326	17,423	30,101	17,021	5,994
Petroleum products /4													
gasoline/petrol	-	15,175	5,890	21,065	-	48,060	48,060	-	-	-	-	27,003	-
gas-oil/fuel-oil	-	12,988	5,890	18,878	-	41,773	41,773	-	-	-	-	22,895	-

/1 Actual tariffs outside Mali and marginal costs in Mali. Comparison omits difference in maritime transport rates between the two ports: Abidjan is on average 10% more expensive than Dakar for Mali-bound traffic; no difference for traffic originating in Mali.
/2 Transport costs for groundnut products based on actual geographical center of production 306 km west of Bamako.
/3 Costs from groundnut production area to Bamako.
/4 Includes rail marginal costs (MF1890/ton) from groundnut production area to Bamako, and transshipment to truck (MF1100/ton) at Bamako
/5 Cost differential is between Dakar/Abidjan and groundnut production area rather than Bamako.
/6 Petroleum products originate at refineries in Dakar and Abidjan and therefore no port costs exist. The road/rail route, with transshipment at Bobo-Dioulasso in Upper Volta, has not been used since 1976.

Source: Mali Railways, National Transport Office and Bank estimates.

February 1979

TABLE 30

Comparison of Transport Tariffs For Petroleum Products to Bamako via Abidjan and Dakar
(1981)

I. **Abidjan-Bamako** (road)		
Abidjan-Zegoua	(755 km)	MF 33,282
Zegoua-Bamako	(470 km)	20,719
	1225 km	MF 54,001 1/
I. **Dakar-Bamako** (rail)		
Dakar-Mali border	(640 km x MF 31.2/km)	MF 19,968 2/
Mali border-Bamako	(583 km x MF 12.5)	7,288 3/
	1223 km	MF 27,256

1/ source: Office National Transports, Mali Data as of April, 1981.
2/ source: Senegal-Contract Plan, December, 1981.
3/ source: Mali Railways, 1982 Budget.

Mopti--as well as exports of cotton from the regions around these cities,- the Abidjan route is cheaper and more convenient.

In establishing a principle to allocate traffic to and from Mali, four considerations other than rates are particularly relevant.

- Reliability because of poor storage facilities in Mali which do not allow "bumper stock." This tends to favor road transport rather than rail.
- Fast door-to-door service; important for perishable goods.
- Capacity to accommodate peaks; especially importation of relief supplies.
- Need to have more than one route to reduce the effect of a breakdown in communication.

Reflecting these factors, Malian traffic on the Abidjan route has been increasing, and by 1977 it exceeded Malian traffic on the Dakar-Bamako route for the first time (53% vs. 47% via Dakar).

A number of key issues on the existing Dakar and Abidjan routes, which affect the cost of Mali's access to the sea, have not been adequately addressed by the Government: (a) the extent to which decisions on the allocation of import traffic between the two routes are being made on the basis of least transport costs and whether existing procedures and regulations are leading to significant misallocations; for example, petroleum products continue to be imported via Abidjan at almost twice the transport cost from Dakar, in addition to their higher prices (ex-refinery), indicating that importers are not bearing the differential costs but that they are being passed to

the Treasury or directly to consumers; (b) the deterioration of the competitiveness of the railway system may result from projected tariff increases in the Senegal portion (these tariff increases are likely to be needed to recover investments planned for deferred track maintenance and equipment renewal and will compound the effect of recent tariff increases); (c) the issue of facilitation of Mali traffic, that is, the simplification of documentation and procedures for transit traffic and facilities available to Mali in Dakar and Abidjan Ports. These same issues apply equally to the introduction of any new system, such as airships.

Internal Transportation

Domestic transport facilities include roads, rail, waterways and an internal feeder air service. The respective magnitudes of traffic in ton-km are represented in Table 31.

Roads

The road network totals 13,000 km, of which 1,650 km are paved and an additional 4,284 km are all-weather. In the northeastern area, where roads are lacking, most movements of grain and petroleum are barged on the Niger River.

Rail

The 641-km CFM Railway serves western Mali, connecting Bamako/Koulikouro with the Senegal Railway (CFS) at the Mali border near Kayes. The Kayes area is served solely by rail.

Domestic rail freight traffic mounted to 58,000 mt in 1981, while cement transported to Bamako from Dramou near Kayes, averaging 45,000 mt/yr, dropped to zero in 1981 due to serious production problems.

TABLE 31

(Distribution of Traffic by Transport Mode)

(1980)

	Ton-Km (million)			Passenger-Km (million)		
	1966	1973	1977	1966	1973	1977
Road	113	310	247	400	720	992
Rail	116	156	149	68	95	129
Waterways	41	30	22	31	20	28
Aviation	n.a.	16	n.a.		65	

Source: Mali Transport Plan Study, SEDES, 1980

Domestic passenger traffic has been growing steadily at about 4 per cent per year over the last five years. The traffic demand growth is explained by the total lack of road transport services in the Bamako/Kayes corridor. It is also significant that this growth in traffic has taken place despite the poor quality of service. New rail coaches anticipated are likely to give the quality improvement required to sustain this growth.

Inland Waterways

The 1,650 km of existing inland waterways are navigable somewhat less than 7 months of the year. Because of rock outcroppings, the Niger is unnavigable beyond Ansongo in eastern Mali. Further development of waterways is not in prospect, but river traffic will be kept at its present level by improving the efficiency of the present system.

Niger River; Downriver or "Grand Bief" Section (Koulikouro to Asongo, Eastern Mali

River transport volumes are under 60,000 tons annually. The Compagnie Malienne de Navigation (CMN) carried an estimated 32,000 mt in 1977 and the private sector, 25,000 mt.

The Niger "Grand Bief" is navigable from Koulikouro[1/] to Ansongo (1,408 km) and there are three main sections:

i) Koulikouro - Mopti (506 km)

This section is the most used; it is navigable from June to December, except for the Fanchon - Markala section, which is navigable year - round because of the Sansanding Dam.

[1/] Near Bamako; downriver.

ii) Mopti - Tossaye and iii) Tossaye - Ansongo

These sections of the river are navigable between 6 and 8 months per year.

Some of the Niger's tributaries are also navigable. the Niger River itself for 224 km downriver from Ansongo into Niger is not navigable, but thereon to the sea (2,000 km) it is again navigable.

Rice, millet and wheat account for more than 60% of the tonnage carried; imported commodities such as salt, sugar, etc., and domestic produce such as groundnuts, cotton, gum arabic and fish for another 25%, the remainder being divided between petroleum products and building materials. Total freight volume has been dropping to the present level since 1969. With the development of the paved road between Bamako and Mopti, the river has continued to lose traffic to Eastern Mali (Gao Area) roads. A consequence is that traffic is extremely unbalanced: downstream haulage exceeds upstream movements by a ratio of 3.5:1 in tonnage and by 10:1 in terms of ton-km. The average haul of CMN[1/] is 750 km downstream and 300 km upstream. River transport has suffered a further setback as a larger share of Mali imports are being channelled through Abidjan instead of Dakar and movements from Abidjan, consequently, reach Eastern Mali by road from the railroad at Ouangolodougou, Ivory Coast and Bobo Dioulasso, Upper Volta and no longer by river from Koulikouro.

1/ Compagnie Malienne de Navigation.

Air Transport

The international airport at Bamako/Senoue is complemented by 30 domestic feeder airports, 10 of which are active and offer limited service.

Domestic air traffic of Mali for the period 1977-1981 is indicated in Table 31 a which shows totals for arrivals and departures combined in terms of passengers, air cargo, and air mail for Bamako and the internal airports. It can be noted that air service to the domestic feeder airports is almost entirely in passengers, with very little air cargo or air mail being transported domestically.

International air traffic of passengers and freight between Bamako and other African and European destinations in 1981 is reflected in Table 31 b.

Transportation Costs on Domestic Routes

Road Transport

While all freight and passenger tariffs, domestic as well as international, continue to be set by the Ministry of Transport, fares for road passenger service are now in practice set by bus operators and the Government is not enforcing official rates. Passenger fares generally reflect costs; freight tariffs are below costs, particularly for tariffs applicable to poor quality roads. For freight, while the Government retains control of truck import licenses, there is no control of entry *per se* and truckers are free to choose their routes.

Waterway Transport

Rates in 1978 were MF 10 for cereals, salt and cement and MF 19 to 21 for all other goods. In addition, some 47,000 passengers are carried, mostly as fourth-class deck passengers, at FM 6 per km, catering for

TABLE 31 a

Mali Air Traffic 1977-1981

	1975	1977	1978	1979	1980	1981
BAMAKO						
Cargo (mt)	3,241	4,347	5,434	6,940	6,662	5,834
Airmail (mt)	91	154	178	160	139	126
Passengers	80,372	104,795	115,275	136,793	124,482	133,605
GAO						
Cargo (mt)	---	---	42	42	39	64
Airmail (mt)	---	5	3	3	3	4
Passengers	---	7,206	6,863	6,863	7,961	9,879
GOUNDAM						
Cargo (mt)	---	0.5	---	---	0.1	---
Airmail (mt)	---	2	0.5	0.5	0.1	0.5
Passengers	---	2,326	500	500	85	420
KAYES						
Cargo (mt)	---	---	---	---	---	---
Airmail (mt)	---	---	---	---	---	---
Passengers	---	359	89	89	49	831
MOPTI						
Cargo (mt)	---	---	2	2	0.8	0.6
Airmail (mt)	---	4	2	2	2	1
Passengers	---	4,965	4,076	4,075	3,627	3,854
NIORO						
Cargo (mt)	---	---	---	---	---	---
Airmail (mt)	---	---	---	---	---	---
Passengers	---	4,165	3,218	3,218	2,607	3,101
TOMBOUCTOU						
Cargo (mt)	---	1	2	2	2	0.3
Airmail (mt)	---	3	2	2	3	2
Passengers	---	6,723	6,205	6,205	6,577	5,672

TABLE 31 b

Domestic and International Air Traffic

BAMAKO AIRPORT

(1980)

REGIONS / PAYS	PASSAGERS				FRET (En Tonnes)		
	ARRIVEE	DEPART	TOTAL	% TRAFIC INTERNATIONAL	ARRIVEE	DEPART	TOTAL
INTERIEUR	8 701	8 509	17 210	2	35,4	15,1	50,5
AFRIQUE							
ALGERIE	1 171	1 621	2 792		35,9	2,5	38,4
HAUTE VOLTA	1 956	1 863	3 819		3,5	27,9	31,4
COTE D'IVOIRE	13 940	12 982	26 922		349,9	330,6	680,5
NIGER	1 795	1 668	3 463		3,4	13,8	17,2
CAMEROUN							
CONGO							
MAROC	49	155	204				
SENEGAL	8 157	9 331	17 488		201,5	34,4	235,9
GHANA	226	466	692		10,6	0,6	11,2
SIERRA LEONE	165	486	651		4,6	0,8	5,4
GUINEE	6 434	4 [illegible]	10 703		40,8	109,3	150,1
AUTRES AFRIQUE	3 502	2 896	6 398		307,5	36,4	343,[illegible]
TOTAL	37 415	35 717	73 132	17	957,7	556,3	1 514
EUROPE							
FRANCE	18 122	19 330	37 452		2 280,4	1 958,8	4 239,2
ALLEMAGNE DE L'EST							
URSS	1 681	1 629	3 310		17,9	4,6	22,5
AUTRES EUROPE	35	92	127				
TOTAL	19 838	21 051	40 889	- 2	2 298,3	1 963,4	4 261,7
MOYEN ORIENT	1 458	1 059	2 517		1,8	7,1	8,9
DIVERS							
TOTAL GENERAL	67 412	66 336	133 748	7	3 293,2	2 541,9	5 835,1

themselves. The cost of freight haulage to CMN is between MF 14 and 15 per ton/km, which means that transportation of cereals and building materials is heavily subsidized.

Government Transport Development Strategy

If the Fifth National Plan is consistent with transport policy of recent years, government strategy is likely to follow these lines:

(a) continuation of the slow process of deregulation and reduction of the state-owned company's participation in the trucking industry where Government believes the private sector can play an effective roles:

(b) reinforcement of the role of the state in sub-sectors considered particularly strategic, notably international shipping and maritime transport, and promotion of the rehabilitation and improvement of Mali Railways and the national airline;

(c) embarkation on a substantial number of highway construction/improvement projects, with the main focus on roads that improve links with neighboring countries, particularly access to the sea, and which co-donors are willing to support, regardless of economic priorities;

(d) maintenance of control of the allocation of international traffic between the competing Abidjan and Dakar routes and retention of the policy of reimbursing petroleum companies for actual transport costs irrespective of optimal route choice;

(e) continuation of using the liquid asset part of the Road Fund to finance road construction; and

(f) retention of road user charges below the level needed to provide adequate funding of maintenance.

The Government has been successful in obtaining financing for further expansion of the highway network. Construction to paved standards of the Sevare-Gao Road (556 km) started in 1980 under German and Arab financing, and studies are being carried out to extend the road to the Algerian border; the Sikasso-Koutiala Road (128 km) is being built on a new alignment with FED financing, which will complete a direct, paved road between Mopti and the Ivory Coast border; the Faladie-Segou Road (223 km) has been reconstructed under a World Bank project; the Markala-Niono Road (71 km) in the Office du Niger Zone, is being built with African Development Bank financing. This upgrading and expansion is taking place despite the fact that the highway network is already extensive and the country has not been able to maintain it.

It is understood that the 1981-1985 National Development Plan recommends continued diversification of the routes to the sea as well as reinforcement of the domestic road network. A result of this growth will be continued aggravation of the highway maintenance problem.

Potential Routes for Airships

Bamako-Tombouctou (710 km); and possibly NE to Tessalit (570 km additional); a likely emergency and general purpose route.

Bamako-Conakry, Guinea (710 km air distance)

Conakry is the closest port to Bamako by a straight line but topography and existing roads make this route about 1,100 km long and difficult through Kankan, Yanfolila and Bougouni. This surface route is considered to be a priority by the Guinean Government. The FED financed a feasibility study of upgrading the Kankan-Mali border road, which showed an IRR of 7.5% at best. Both the Malian and Guinean Governments are contesting this result,

and have asked the FED to finance the detailed engineering. (Scenario 1 of this report considers the potential of airships on this route.)

First (Kayes) and Sixth (Gao) Regions

These regions, Kayes in the west and Gao in the east, do not have all weather road service.

Only the CFM railroad serves Kayes; while the Niger River serves Gao.

All-weather roads (or airships as a possible alternative) might be considered for these areas.

Development of Air Transport

There is an increasing recognition that in large African countries such as Mali, characterized by long distances, high road construction and maintenance costs and light traffic flows, air transport could play an important role. A World Bank paper, "Aviation and Development", dated June 1980, supports this view. While air transport generates the highest-operating cost of the various transport modes, with relatively less initial investment it provides transport links to areas not presently served by roads or can reduces from several days to a few hours the travel time between distant points connected by land or river transport.

C. NIGER

International Transport Routes

Transport times and distances to seaports are substantial, putting Niger at a disadvantage in world trade. (See Table 32 a.) Apart from uranium and some agricultural products, Niger has few recognized export possiblities. In addition, transportation and associated transit costs represent a large part (an average of 25%), of the price of imported goods.

High transport costs dramatically affect the import cost of low-value goods,[1/] mainly basic staples. In addition, access to ocean ports depends on the vicissitudes of political and economic relations with neighboring countries. Implications for Niger are the difficulties in planning the use of and investment in international transport links because of uncertainties, including political changes, which affect its maritime access routes. (See maps, Figures 30 and 31.) As a result, the distribution of Niger's overseas traffic, about 400,000 tons per year between the alternative ports of Abidjan, Lome, Togo, Cotonou, Benin, and Lagos, is affected not only by cost considerations, but also by other factors, including: (i) the efficiency of port operations and customs clearance procedures, (ii) delays and risks in delivery and transit, (iii) the extent of nationalization in Benin and resulting relationships between the agencies involved, and (iv) the preferences of private shippers and importers as well as the shipping lines.

1/ For example, transport costs plus associated port handling and transit charges between Cotonou and Niamey represented in 1979 about 146% of the CIF value of cement at Cotonou. The percentage ranges between 40% and 100% for basic staple foods but was only 7% for high value goods such as spare parts.

TABLE 32 a

Distances to the Sea from Relevant Points in Niger

Route	Kilometers
Niamey-Cotonou (Benin)	1,060
Road (all paved)	622
Rail (Parakou-Cotonou)	438
Niamey-Lome (Togo)	1,330
Road (900 km paved)	1,054
Rail (Blitta-Lome)	276
Niamey-Takoradi (Ghana)	1543
Road (all paved)	1276
Rail (Kumasi-Takoradi)	267
Niamey-Tema (Ghana)	1338
Road (360 km paved)	883
Lake Volta (Tamale-Akosombo)	380
Road (Akosombo-Tema; all paved)	75
Niamey-Abidjan (Ivory Coast)	1,685
Road (137 km paved)	540
Rail (Ouagadougou-Abidjan)	1,145
Niamey-Lagos (Nigeria) 1/	2,110
Maradi-Lagos or Port Harcourt (Nigeria)	1,440
Road (all paved)	200
Rail (via Kaura-Namoda)	1,240
Zinder-Lagos or Port Harcourt (Nigeria)	1,410
Road (all paved)	260
Rail (via Kano)	1,150
Maradi-Cotonou (Benin)	1,317

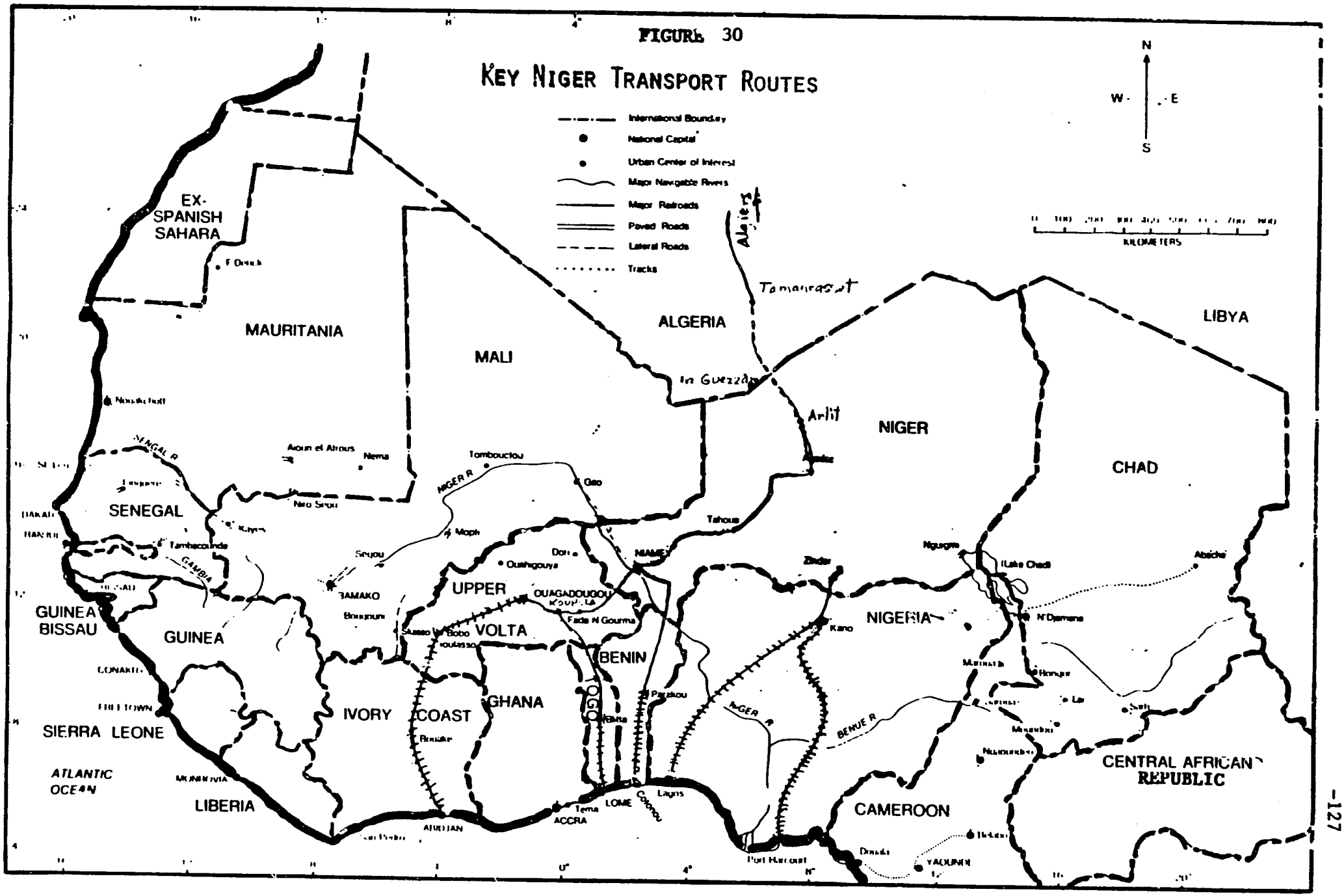
1/ via Kaura-Namoda

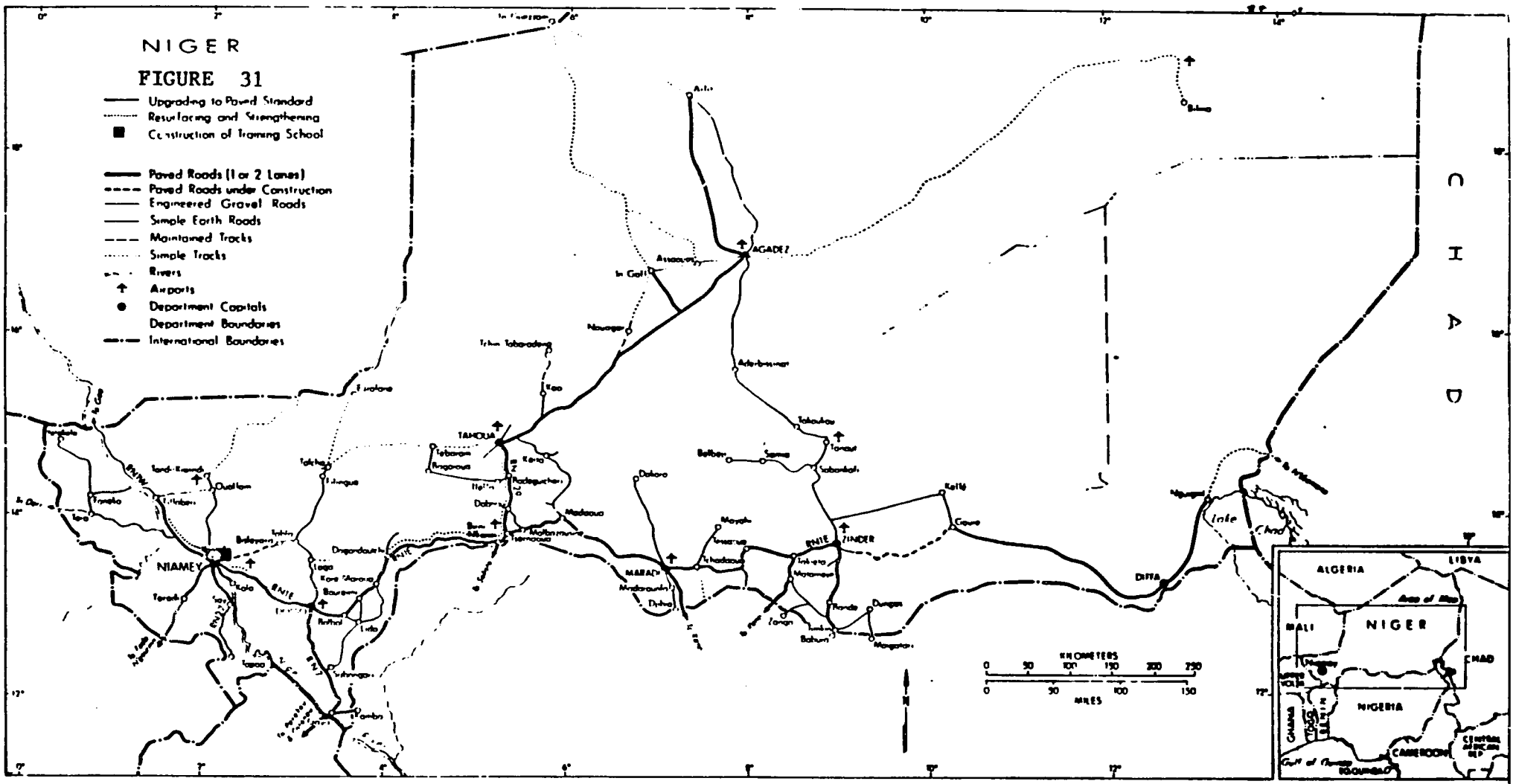
SOURCE: World Bank Estimates, 1978.

83/82

FIGURE 30

KEY NIGER TRANSPORT ROUTES




NIGER
FIGURE 31
Upgrading to Paved Standard
Resurfacing and Strengthening
Construction of Training School
Paved Roads (1 or 2 Lanes)
Paved Roads under Construction
Engineered Gravel Roads
Simple Earth Roads
Maintained Tracks
Simple Tracks
Rivers
Airports
Department Capitals
Department Boundaries
International Boundaries
NIAMEY
TAHOUA
AGADEZ
ZINDER
DIFFA
MARADI
CHAD
KILOMETERS
MILES
ALGERIA
LIBYA
MALI
NIGERIA
CAMEROON

Alternative Routes

There are six main alternative routes that Niger can use to apportion its international traffic. (See Table 33.) Only four of these routes are of real significance; they carry Niger's limited traffic (about 400,000 mt in 1980) to the southern ports of Cotonou, Lome, Abidjan and Lagos. The percentage of international trade of these various ports has varied over recent years due to overall transport costs categorized by market links, political considerations, time and administrative convenience. Changing tonnages on these routes via the principal ports between 1976 and 1980 are specified in Table 32 b.

TABLE 32 b

Transit Traffic Through Major Southern Ports; Niger
('ooo mt)

	1976	1977	1978	1979	1980	% of TOTAL
Cotonou, Benin	194	213	234	225	296	68
Lome, Togo	28	47	65	65	93	21
Abidjan, Ivory Coast	19	16	11	10	11	3
SUB-TOTAL	241	276	310	300	400	
Lagos, Nigeria[1/]	25	30	35	5[1/]	5[1/]	8
TOTAL	266	306	345	335	435	100

[1/] Nigeria route traffic: about 5,000 mt/yr for eastern Niger. Since 1979, oil products for the uranium mines (30,000 mt/yr) are refined in Nigeria and are not considered transit traffic. Total tonnage flow on Nigeria route is 35,000 mt/yr.

TABLE 33

Primary Import/Export Arteries of Niger

ROUTE	TRANSPORT MODE	DISTANCE (KM) MODAL	DISTANCE (KM) TOTAL	SEAPORT	ANNUAL TONNAGE (MT)	CARGO COMPOSITION	AVERAGE TRANSIT TIME
- Niamey-Gaya-Parakou (Benin)	Road	670					
Parakou-Cotonou (Benin)	Rail	430	1,000	Cotonou	296,000	Lower Value cargo	3 weeks
- Niamey-Koupela, (U. Volta)-Lome (Togo)	Road/Rail	1,054	1,330	Lome	93,000	Higher value cargo	3 days/1 wk
- Niamey-Koupela-Ouagadougou (U. Volta)	Road	276					
Ouagadougo-Abidjan (Ivory Cost	Rail	1,650		Abidjan	X15,000		
- Zinder-Kano (Nigeria)	Road						
Kano-Port Harcourt/Apapa or Lagos (Nigeria)	Rail	850		Port Harcourt/ Apapa or Lagos			
- Niamey-Algers (Algeria)	Road (Track)				X 6,000	Groundnuts	

1/ The cheapest route; transport costs are from 20% to 50% less than on other routes. A 1959 agreement within Benin established the Organization Communce Dahomey (Benin)-Niger (OCDN), which operates the Parakou-Cotonou railway and has exclusive right to charter road transport.

2/ Costs are only 20% higher than on 1/ due to cheap rail transport. Route carries a total of15,000 tons of imports and exports. Exports include meat and vegetables to the Abidjan market.

3/ About 20% more expensive than 1/. Connects Niger's central eastern region to Kano, Nigeria by road 3a/ about 120,000 MT of groundnuts (80% of groundnut exports) are usually routed to Kano and from there via the Nigerian Railway to Lagos; 50,000 MT of Niger imports are carried on this route.

4/ About 3.5 times more expensive than Nigeria route; tracks across the Sahara Desert.

The Benin Route; Niamey - Cotonou, Benin (1,060 km; Rail and Road)

Traditionally, the major part (70 to 75%) of the overseas traffic of Niger has been allocated to the Benin route, the shortest and cheapest link to the sea for Niamey and the major part of southern Niger. It carries the bulk of the transit traffic over the shortest route available (1,060 km, of which 438 km are by rail) subject to very low tariffs. The OCBN Railroad, jointly administered by the Governments of Niger and Benin, controls traffic on the Benin route. It operates the railroad from Cotonou to Parakou and charters all Niger transit traffic over the Parakou-Niamey road. General cargo is proportioned on a two-to-one basis between truckers from Niger and from Benin.

However, during recent years, Niger importers have become increasingly reluctant to allocate their traffic to the Benin route. Several unfavorable developments on the Benin route explain this change: (i) Port of Cotonou congestion during the period 1976-79 due to transit traffic for Nigeria; (ii) nationalization of Benin port and transport activities and restrictions on foreign enterprises in Benin, including those of Niger; (iii) OCBN's low tariffs for chartered trucking operations beween Parakou and Niamey and consequent reluctance of Niger truckers to ply to Parakou; and (iv) excessively long delays in payments by the OCBN system, particularly at Parakou and the port.

The average transit time between Cotonou and the Niger border at Gaya is about three weeks.

The Niamey-Cotonou axis, when properly and adequately operated, would continue to be the most attractive access route to the sea. The Benin

Government has recently reacted to the increased competition of Lome: (i) Cotonou port is being expanded and will have sufficient capacity to meet foreseeable needs; (ii) NITRA, a major transit company of Niger, has been allowed to operate in the port, and (iii) the Government is moving ahead with plans to pave the Dassa-Zoume-Parakou road (210 km). If administrative and procedural constraints can be removed by the time this road is completed in 1986, the Beninese route will offer to Niger users both the traditional slow but cheap OCBN rail/road alternative and a rapid, but more expensive all-weather highway access route for goods which require speedy delivery. Although these efforts constitute useful improvements for Niger importers and transport operators, it is unlikely that normal Niger traffic will fully revert to Cotonou as long as the OCBN system retains its virtual public sector monopoly on cargo handling and other port services at Cotonou. Despite this, low-value bulky goods such as cereals, oil products, sulfur, etc., will probably continue to be allocated to this cheaper route.

Extension of the Cotonou-Parakou Railway to Niamey was the subject of a feasibility study undertaken in 1979. The study did not prove the economic feasibility of the rail extension, and the proposal has been dropped for the present. (See also Section VIII, Larger Bulk Cargo Movements.)

Far from being a suitable nucleus for a greatly expanded railway system, the OCBN Railway suffers from a considerable number of shortcomings in terms of management, low productivity, high transfer costs, and limited demand prospects. The proposed construction of the Dassa-Zoume-Parakou Road which on its completion will provide a paved road from Cotonou to Parakou would inevitably divert traffic from the railway and ultimately further handicap the prospects of its financial viability. Since the railway is not always

the most efficient or least-cost mode of transport due to the additional costs of transfer involved, free competition between the systems of rail/road transport and road transport in Benin would be in the best interests of Niger.

The Togo Route (1,330) km; Road; or Road and Rail)

During the recent period of traffic decline on the Benin route, road links in Upper Volta and Togo were significantly improved and, although 20% more expensive, the Togo route to Lome became an acceptable and often a more rapid alternative.

The transit time between Lome and the Niger border is only 3-7 days, compared to 3 weeks on the Benin Route.

During recent years the Port of Lome has developed into a reliable outlet for Niger's international traffic. The principal Togolese route passes through Togo and Upper Volta to Niger by road. Niger imports on this route have increased from 28,000 mt in 1976 to about 93,000 mt in 1980. This growth developed to a large extent by: (i) Benin's political changes during the late 1970's; (ii) the severe restrictions imposed on foreign enterprises activities in Benin following the 1976 wave of nationalization which obligated Niger's private transit enterprises and their foreign partners to transfer most of their activities to Lome; (iii) the congestion experienced by Cotonou port during 1976/78; and (iv) the improvement of roads in Togo and Upper Volta. The Togo route has developed into an acceptable alternative to the Benin route for high-value equipment or industrial goods which can support higher transportation costs and for which promptness in delivery is a key factor.

The Abidjan Route (1,685 km; Road and Rail)

When Cotonou and Lagos were congested during the drought period, Abidjan was occasionally used to carry relief supplies bound for western Niger. Considering the high additional transportation costs (about CFAF 20,000 per ton), this traffic is not expected to develop in the future.

The Abidjan route totals 1,685 km, of which 1,145 km is by rail. Road tariffs are high, compared to other routes, but rail tariffs are low. Use of this route is limited by distance, costs, time and a combination of factors stemming from the capacity of RAN and of the port of Abidjan.

The Lagos Route

The rail/road route through Nigeria (about 1,400 km, of which 1,150 km is by rail) is not favored by Niger. Traffic is limited to petroleum products and some food grain imports and groundnut exports. Nigerian transporters disapprove of this route due to past performance of the Nigerian Railway Corporation (NRC). With the current measurable improvements in the operational efficiency of NRC, this route may develop into a serious alternative.

There are significant advantages in this route for some regions of Niger. For central and eastern Niger, where the uranium deposits are largely located and oil resources are known to exist, the route through Nigeria has distinct advantages, both by rail and road..

The Niger River Route (Gaya-Port Harcourt)

The river route via Niger from Gaya to Port Harcourt is not feasible, mainly due to the underdevelopment of the inland waterways in Nigeria.

The Algerian Route

The Algerian route is not a serious alternative; it is a long and difficult route; it is not fully developed, has very high tariffs and is practically unutilized.

Domestic Transportation

Domestic transport infrastructure consists of roads and airports. The main road network is triangular in shape (Niamey-Agadez-Lake Chad) with the tip extending from Agadez to Airlit and with the arms going from Niamey to Gaya on the border. The triangular base is the 1,850 km East-West Highway stretching from Tillabery-Niamey-Maradi-Zinder-Nguigmi.

Inter-model coordination is not a problem because road transportation is clearly the dominant mode and there is presently little Government intervention in the choice of transportation mode. Present Government policy places strong emphasis on the establishment of permanent land liaisons to connect the remote eastern and northern regions with Niamey and other major regional economic and administrative centers of the south. The development of air transport could have some potential in the future for selected categories of goods and services if the development of new resources such as uranium and oil materializes and where low traffic volumes do not justify substantial road investments.

Since most of the extension of the paved road network took place after 1975, an important and rapid increase in the cost of periodic maintenance works will occur in the early 1980s on the existing network.

Domestic air traffic of Niger from 1978 to 1980 is shown in Table 33 a, which indicates annual totals of passenger trips, air cargo and air mail. Figures represent totals of arrivals and departures at Niamey and the four principal domestic airports.

Table 33 b indicates the origins and destinations of Bamako air traffic in 1981.

TABLE 33 a

NIGER Air Traffic 1975-1980

	1975	1976	1977	1978	1979	1980
NIAMEY						
Cargo (mt)	6,024	7,088	9,195	13,808	15,076	13,902
Airmail (mt)	236	272	282	356	364	416
Passengers	67,178	73,493	85,766	112,853	125,641	123,293
AGADES						
Cargo (mt)	71	---	---	282	207	330
Airmail (mt)	4	---	---	7	8	9
Passengers	2,992	---	---	12,459	13,411	10,994
MARADI						
Cargo (mt)	25	---	---	10	24	25
Airmail (mt)	11	---	---	14	12	8
Passengers	2,395	---	---	4,570	4,686	4,125
TAHOUA						
Cargo (mt)	---	---	---	18	13	9
Airmail (mt)	---	---	---	5	5	5
Passengers	---	909	---	3,968	2,746	2,455
ZINDER						
Cargo (mt)	53	---	---	60	37	61
Airmail (mt)	14	---	---	10	14	16
Passengers	2,988	---	---	5,095	6,975	6,322

TABLE 33 b

Domestic and International Air Traffic
N I A M E Y - A I R P O R T (1980)

REGIONS / PAYS	PASSAGERS				FRET (En Tonnes)			
	ARRIVEE	DEPART	TOTAL	% 1980/1979	ARRIVEE	DEPART	TOTAL	
INTERIEUR	12 879	12 835	25 714	- 3	44,4	1 539,3	1 583,7	
AFRIQUE								
ALGERIE	2 808	4 171	6 979		14,5	12,4	26,9	
BENIN	1 275	1 642	2 917		34,2	41,7	75,9	
HAUTE VOLTA	5 248	3 693	8 941		62,4	16	78,4	
COTE D'IVOIRE	10 672	8 741	19 413		1 043,9	122,5	1 166,4	
TOGO	396	1 567	1 965		9,8	20,9	30,7	
MALI	2 388	2 541	4 929		55,1	12,1	67,2	
SENEGAL	2 465	2 489	4 954		164	14,2	178,2	
NIGERIA	593	348	941		46	-	46	
AUTRES AFRIQUE	3 717	1 211	4 928		374	62,7	436,7	
TOTAL	29 564	26 403	55 967	- 5	1 803,9	302,5	2 106,4	-
EUROPE								
FRANCE	16 882	18 559	35 441		8 555,7	1 434,2	9 989,9	
ALLEMAGNE	-	-	-		-	-	-	
GRANDE BRETAGNE	-	-	-		-	-	-	
ESPAGNE	-	-	-		-	-	-	
AUTRES EUROPE	-	-	-		192,8	-	192,8	
TOTAL	16.882	18 559	35 441	1	8 748,5	1 434,2	10 182,7	-
U.S.A.	-	-	-		-	-	-	
MOYEN ORIENT	3 160	3 011	6 171		28,2	-	28,2	
DIVERS	-	-	-		1	-	1	
TOTAL GENERAL	62 485	60 808	123 293	- 2	10 626	3 276	13 902	-

Transportation Costs

Road Transport

There is no official tariff for domestic freight traffic. These rates are negotiable on a case-by-case basis. The prevaling competition among truckers and the lack of tariff regulation of "middlemen" means that much of the decrease in vehicle operating costs resulting from road improvements will probably be transferred to producers and consumers. Present efforts to improve passenger transport services need to be pursued, especially inter-urban bus services.

Tariffs for freight traffic of the uranium mines are negotiated directly between the truckers and the mines. In principle, two-thirds of international traffic is handled by Niger truckers and one-third by foreigners, Beninese or Togolese. The prevailing competition among truckers and the lack of tariff regulation means that much of the decrease in vehicle operating costs resulting from road improvements is transferred to producers and consumers. Unlike freight haulage, passenger transport is poorly organized, and demand is higher than the present capacity.

Tariffs on the Benin Route

The OCBN Railroad which operates rail service between Cotonou and Parakou and charters trucks for transit traffic over the Parakou-Niamey Road, is deeply in debt. Revenue has stagnated since 1975. There is a large gap between tariffs and real costs and this is particularly true for passenger traffic. Table 34 provides information on transport costs for three types of cargo on the Cotonou-Niamey corridor.

TABLE 34

REPUBLIC OF NIGER

Cotonou-Niamey Transportation Costs, 1979

Merchandise		Cement	Rice	Tires
Lot (gross weight)		45 t	45 t	5 t/7[illegible] units
CIF Value Cotonou (F.CFA)		672.790 F	3.307.900 F	4.739.630 F
CIF Value/ton		14.950 F	73.500 F	67.701 F/units
Expenses - Cotonou				
Highway Tax	80 F/t	3.600	3.600	400
Stevedoring		53.460	53.145	14.030
Duty Stamp	1.800 F/shipment	1.800	1.800	1.800
Customs Clearance	1.000 F/shipment	1.000	1.000	1.000
Others	300 F/shipment	240	240	240
(1) Sub-total		60,100	99.785	17.470
(2) Transport DCBN				
Cotonou-Niamey	13.720 + 285 F/t	629.325		
	19.200 + 285 F/t		879.925	
	25.160 + 285 F/t			127.125
(3) Handling - Cotonou				
Administrative cost	925 F/dossier	925	925	925
Handling, delivery	2.500 F/t	112.500	112.500	12.500
Commission on revenue	0,25 CFA	1.345	6.615	9.479
Commission on expenditure	25 de (1) + (2)	13.988	19.910	2.892
Custom Brokers		9.045	24.806	47.396
(4) VAT	19,095 de (3)	28.413	31.310	13.087
Sub-total (3) + (4)		158.816	195.666	86.499
(5) Expenses - Niamey				
Transit Sheds	950 F/t	42.750	42.750	4.750
(6) Total Expenditure (1) + (2) + (3) + (4) + (5)		880.991	1.174.125	236.004
(7) Handling - Niamey				
Administrative Cost	1.000 F/dossier	1.000	1.000	1.000
Transit		49.800	49.800	3.900
Commission on Expenditure	25 sur (6)	17.620	23.483	4.720
Custom Brokers		18.091	49.613	94.793
(8) VAT	14,945 sur (7)	11.042	17.793	19.939
Sub-total (7) + (8)		84.953	136.888	119.352
TOTAL (1) to (8)	F	975.944	1.311.019	355,356
TOTAL (1) to (8)	F/t	21.688	29.134	71.11
CIF Value - Cotonou	F/t	672.790	3.307.900	4.739.630
Value rendered in Niamey	F/t	1.448.684	4.618.919	5.095.186

Source: Parakou - Niamey Study, BCEOM, 1979

Future Transport Development

The Government's objectives in the transport sector are based on the premise that in order to promote social and economic development, there is a clear need to improve internal and external communications by:

(a) improving and extending major road arteries such as Zinder-Agadez and Zinder-Goure together with transport services;

(b) improving secondary roads linking food deficit and surplus areas to the main road system;

(c) constructing and improving feeder roads serving agricultural development areas;

(d) making river traffic effective and studying the feasibility of extending a railway line to Niger; and

(e) improving the main airports.

The policy largely meets the needs of the economy and is expected to continue during the course of the current economic and social development plan (1979-83).

The 1979-83 investment plan for the sector, prepared at a time when important additional budgetary revenues were expected from the development of uranium exports, gives priority to five objectives: (i) construction of the uranium route, Tahoua-Agadez-Arlit (now complete); (ii) improvement and extension of the major primary trunk roads; (iii) development of secondary roads linking agricultural surplus areas to the main road system; (v) modernizing Air Niger. Since uranium revenues are expected to stablize or fall during the coming years, more than good management will be required on the part of the Government to maintain the existing program, which may have to

be curtailed, and since the most urgent needs of the country are now satisfied, the investment program for the transport sector will likely be scaled down in the future to correspond more closely to the country's own limited growth and resource prospects.

The scope for further reduction of highway investments is considerably wider after 1985, since no firm financing has been arranged for projects programmed after that date. Large projects, considered politically important but with moderate economic return, such as the Zinder-Agadez section of the Trans-Sahara Road (CFAF 27 billion) or the rehabilitation of the Goure-N'Guigmi road (CFAF 20 billion) could be executed in successive phases, possibly with lower standards.

Political considerations influence Government decisions on highway investment priorities. Niger is a large (1.3 million km^2) country, with its capital, Niamey, located about 2,000 km from the eastern provinces and connections tenuous between the capital and the peripheral regions. It has always been the objective of the Government to promote or to reinforce the feeling of national unity, especially in the southeastern areas where economic and religious links with neighboring countries, mainly Nigeria, are traditionally strong. Construction of the Zinder-Agadez road, and the rehabilitation of the politically important Zinder-Nguigmi road, also called "Route de l'Unite Nationale," as well as the border road to Mali will very likely continue to be considered priority projects.

Total public investments in the highway sector amounted to almost CFAF 30 billion for the period 1979-82, i.e., an average of CFAF 7.4 billion per year. Highway investment accounts for about 12% of total public investments;

a high percentage, which can be considered acceptable, in view of the size of the country and the rapid growth of road traffic since 1976. Heavy emphasis in public investment has been given to extending the secondary road network in areas where new rural development projects are being implemented and to eliminating the backlog in rehabilitation and upgrading works on the existing network.

The recent decrease in the price of uranium has already unfavorably affected public finances, creditworthiness and the balance of payments situation. The Government now faces the constraints inherent to most Sahelian countries: uncertainties concerning the revenue generating base of the economy; insufficient productive land, capital and human resources; and limited scope for productive investments in the manufacturing sector. It is obvious that the Government will have to extend its very ambitious 1979-83 public investment plan, CFAF 384 billion (1979 constant prices) over a longer period.

The uranium mining company privately financed the paving of the 650-km Arlit-Agadez-Tahoua Road, which connects with Rte. Nationale 29 and the export route to Cotonou.

River Transport

Efforts to develop modern river transport on the Niger River have recently been abandoned. The Societe National des Transports Fluviaux (SNITF) established in 1972 with the assistance of the Canadian International Development Agency (CIDA) to operate river transport between Gaya and Warri (Nigeria) has been recently dissolved. There is no serious hope for the company to resume its activities in the forseeable future until Nigeria moves ahead in developing its inland waterway system, involving major investments in construction of dams and canals. The improvements

required, mainly in Nigeria, include river regulation, major investments in construction of dams and canals, dredging, creation of river ports with supplying and bunkering facilities, river signalization, provision of terminal storage facilities, etc.

D. UPPER VOLTA

International Transport Routes

Access to the sea is available through three principal routes: i) the RAN railway from Ouagadougou to the port of Abidjan, Ivory Coast; ii) an all-road route from Ouagadougou and Koupela to Lome, Togo; and iii) an all-road route from Ouagadougou to Tema, Ghana. Table 35 reflects these alternatives and Figure 32 shows their geographic locations.

The Abidjan Route; 1,159 km; Rail

International traffic to Upper Volta is largely captive to this route, due to the long hauling distance and the high bulk of most commodities traded. The RAN railway to Abidjan carries from 80 to 90 per cent of Upper Volta's import-export traffic.

Import and export tonnages are unbalanced; Voltaic import tonnage via Abidjan totalled 152,000 mt in 1977, as compared with 39,000 mt of exports. See Table 36. An undetermined minor amount of this cargo is trucked between Abidjan and Ouagadougou. (The railway in 1977 also carried 9,000 tons of Malian imports from Abidjan to Ouangolodougou, Ivory Coast and 13,000 tons of exports in the other direction.)

Through the port at Abidjan passes both direct and indirect transit traffic. Intermediate or consumption goods, mainly imports such as oil products, cements and food products, are imported by Ivorian firms and

TABLE 35

Import/Export Arteries

ROUTE	TRANSPORT MODE	DISTANCE	SEAPORT	ANNUAL TONNAGE (MT)	CARGO COMPOSITION
Ouagadougou-Bobo Dioulasso-Abidjan	Rail	1159[1/]	Abidjan, I. Coast		
Ouagadougou-Koupela-Lome	Road	1000	Lome, Togo		
Niamey-Koupela-Lome	Road				Transit traffic to Niger; general cargo from Abidjan.
Diapaga, Eastern Upper Volta-Niamey	Road			6000	Bagged food grains; exports to Niger.
Ouagadougou-Tema	Road	1030	Tema, Ghana		

1/ of which 519 km are within Upper Volta.

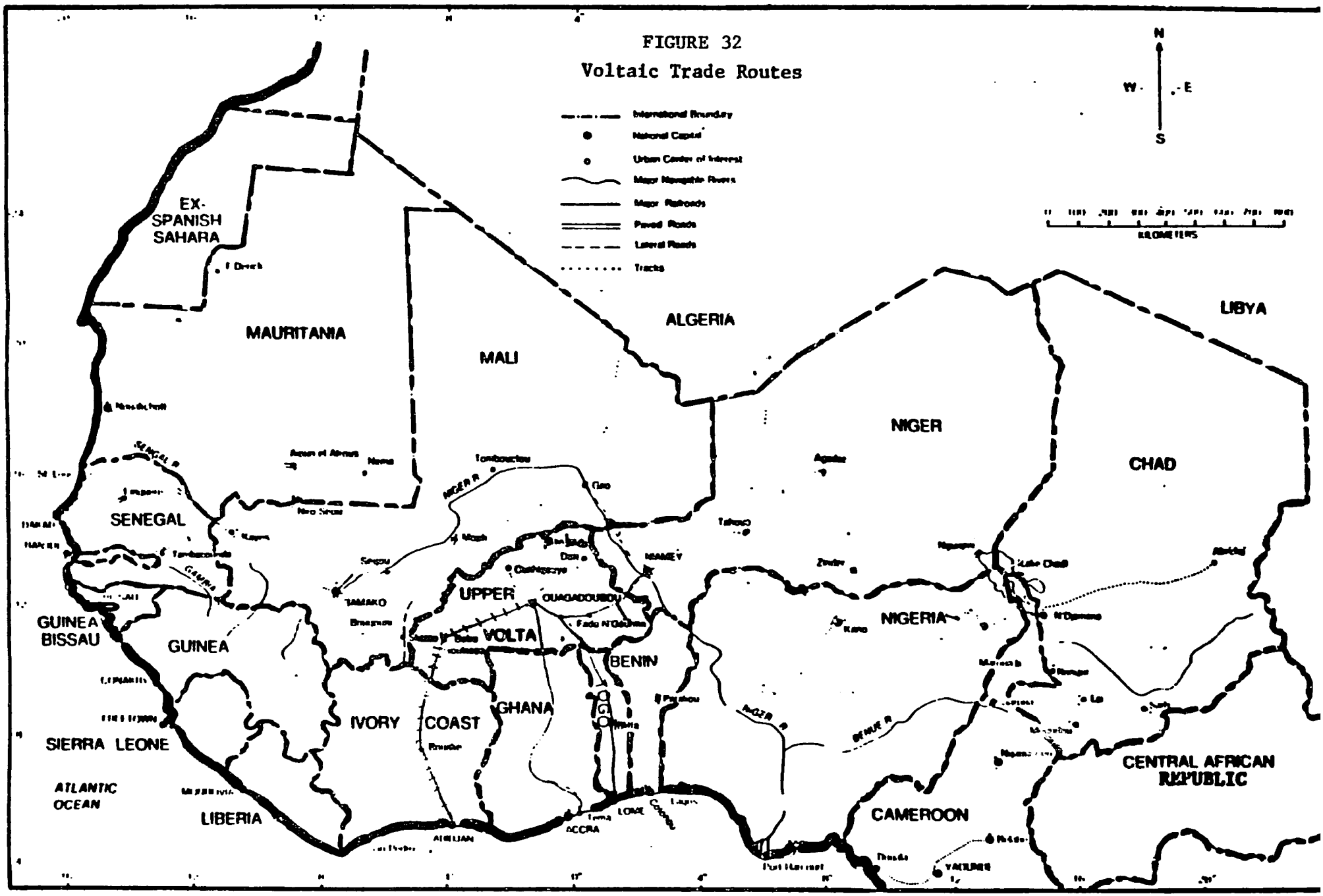


FIGURE 32
Voltaic Trade Routes

TABLE 36

UPPER VOLTA

Ship Traffic	('000 tons) 1971	1972	1973	1974	1975	1976	1977
Total Imports via Abidjan							
Oil (crude & products)	964	1,192	1,385	1,418	1,378	1,606	1,700
Clinker, cement	532	569	614	650	700	811	940
Food products	498	528	699	642	435	428	500
Others	622	676	770	848	907	1,420	1,590
Total	2,616	2,965	3,468	3,558	3,420	4,265	4,730
Total Export via Abidjan							
Refined oil	50	166	87	146	138	221	84
Coffee, cocoa	373	386	360	436	426	511	n.a.
Bananas	155	171	143	169	141	104	n.a.
Logs, timber	1,615	1,622	1,773	1,408	1,010	1,471	1,414
Wood products	136	129	172	202	169	214	n.a.
Other major exports	338	381	401	448	490	504	n.a.
Miscellaneous	70	105	155	230	245	407	n.a.
Total	2,737	2,960	3,091	3,039	2,619	3,432	3,134
TOTAL CARGO SHIP TRAFFIC ABIDJAN PORT	5,353	5,925	6,559	6,597	6,039	7,697	7,864
of which:							
Direct Transit Traffic							
Imports	304.2	304.2	437.4	545.9	308.2	397.2	495
Exports	123.4	123.4	146.5	109.2	79.1	283.9	196
Total	427.6	427.6	583.9	655.1	387.3	681.1	691
of which:							
Transit Traffic with Upper Volta							
Imports	101.2	101.2	119.5	103.1	65.2	98.3	152
Exports	35.6	35.6	37.2	32.7	17.1	68.7	39
Total	136.8	136.8	156.7	135.8	82.3	167.0	191

sorted, packaged or processed in Abidjan, then further exported to landlocked countries, mainly Upper Volta and Mali.

The RAN is increasingly serving international traffic where its competitive edge over road transport is undisputed; it handles 80-90% of the Voltaic traffic as well as part of the southern Malian traffic. This is now the most cost-effective route to the sea for the economically active western and central areas of Upper Volta, and Abidjan will continue to predominate primarily because of the variety and magnitude of backhaul cargo it offers.

RAN passenger traffic has continued to grow steadily at about 5.5% p.a. between 1970 and 1978. In 1979, migrant Voltaic workers made up about two-thirds of RAN's passenger traffic in passenger-km. See Table 37 which reflects this growth.

Koupela-Lome Route - 1,000 km; Road

By 1980, Voltaic exports via Lome totalled 30,000 mt on this paved road. Recently some Voltaic traffic has started to divert toward Lome due to the Abidjan cement plant's inability to meet Voltaic needs. About 40,000 tons of cement and general cargo were imported by road through Lome in 1978 and 1979.

At the port of Lome, the Voltaic Chamber of Commerce is operating two modern bonded storage areas for general cargo which were recently built with private banks' foreign financing. As the cement plants in Abidjan are reaching full capacity production, Upper Volta has started to import its cement from Togo, and with it to explore the trading opportunities through the port of Lome. It is too early yet to state whether a permanent trend is established to split international trading routes between the two ports.

TABLE 37

REGIE ABIDJAN-NIGER (RAN)

Domestic and Interstate Components of RAN Passenger Traffic

	1973	1974	1975	1976	1977	1978	Estimates 1979	1980	1981	1982
Ivory Coast										
Number of passengers ('000)	1657	1687	1755	2031	2204	2264	n.a.	n.a.	n.a.	n.a.
Mean distance (km)	140	146	154	177	173	156	"	"	"	"
Passenger-km (million)	234	248	270	360	381	354	"	"	"	"
Upper Volta										
Number of passengers ('000)	308	394	398	445	480	677	"	"	"	"
Mean distance (km)	177	174	172	176	171	170	"	"	"	"
Passenger-km (million)	55	69	69	78	82	115	"	"	"	"
Interstate										
Number of passengers ('000)	689	697	678	778	871	1077	"	"	"	"
Mean distance (km)	781	789	801	773	815	748	"	"	"	"
Passenger-km (million)	539	550	544	602	710	806	"	"	"	"
Total										
Number of passengers ('000)	2654	2778	2831	3254	3555	4018	4243	4488	4712	4948
Mean distance (km)	311	311	311	320	330	317	305	310	311	312
Passenger-km (million)	828	867	883	1040	1173	1275	1293	1390	1469	1543
Interstate p-km/Total p-km	65.1%	63.6%	61.6%	57.9%	60.5%	63.2%	n.a.	n.a.	n.a.	n.a.
Total passenger-km (million)	883	918	946	1040	1173	1275	"	"	"	"
% of p-km covered by this statistic	93.7%	94.2%	93.3%	100%	100%	100%	"	"	"	"
2nd class interstate p-km (million)	526	536	527	579	680	771	"	"	"	"
2nd class interstate p-km/Total p-km	63.6%	62%	59.7%	55.7%	58%	60.4%	"	"	"	"
Interstate 1st class p-km/ Interstate p-km	2.4%	2.7%	3.1%	2.2%	2.5%	2.7%	"	"	"	"

On this same route moved some 93,000 mt of Nigerien imports in 1980, amounting to 21 per cent of Niger's total trade. This traffic takes the routing Lome-Koupela - Fada N'Gourma-Niamey.

Ghana Route to Tema; 1,030 km; Road

Shippers prefer not to use this route because of present currency exchange difficulties and related problems. Present traffic is not recorded.

Other International Routes

The gravelled route from Fada N'Gourma to Niamey is a segment of the transit route from Niamey to Lome Port. Recently, it was the route used in trucking some 6,000 mt of bagged grain exports from the Diapaga area of Eastern Upper Volta to Niamey.

Summary

Currently, Upper Volta's access to the sea is an issue of coordination of transport policies and regulations among the contiguous states and of availability of information to carriers as to the backhaul opportunities at each port, rather than that of road infrastructure. These issues are dealt with particularly by the Conseil de l 'Entente.

Domestic Transportation System

Roads

The road network is represented in Figure 33. The trunk road system is made up of two radial subsystems with centers at Ouagadougou and Bobo Dioulasso. Traffic volumes are generally low, with few roads carrying more that 50 vpd. High transport costs and a lack of access roads are a deterrent to regional agricultural development.

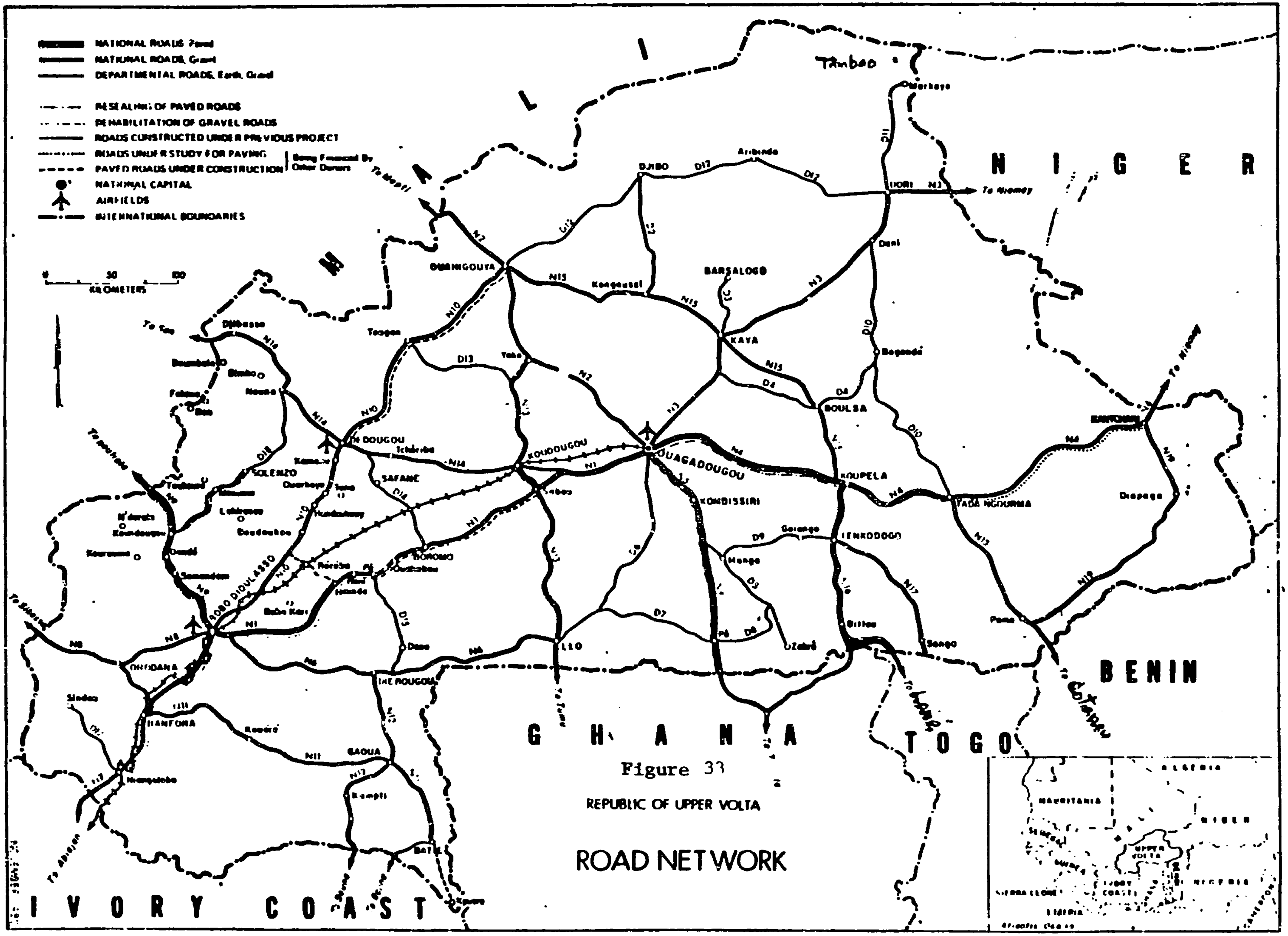


Figure 33

REPUBLIC OF UPPER VOLTA

ROAD NETWORK

Of the total network of roads, only 8,700 km of roadway are classified as national, departmental or regional roads. The rest fall under the rural roads category, under the jurisdiction of local authorities. Their aggregate length varies widely as new villages are connected to the classified network and old tracks are allowed to disappear when they fall out of use. In order to establish the maintenance needs of the country, consultants BCEOM inventoried, in 1979, some 11,000 km of roads and provided the following classification in Table 38 which was based upon the condition of the roads and their technical characteristics.

TABLE 38

National Road Inventory, 1979

	ROAD CONDITION					
	Paved	Lateritic	Earth	Tracks	Trails	Total
Administrative Classification		80% usable most of their length during the rainy season	often closed during the rainy season	generally closed during the rainy season	subject to disappearance when out-of-use	
National	857	1,563	560	1,401	225	4,606
Departmental	---	287	172	433	852	1,744
Regional	---	114	470	759	633	2,364
Non-classified	---	---	452	627	728	2,437
TOTAL (inventoried by consultants)	857	1,964	1,654	3,220	2,438	11,151

Eight hundred and fifty-seven km of road which form part of the main connections with neighboring countries are paved; the remaining national roads are primarily gravel, all-weather roads, but many sections are often closed to heavy vehicles for short periods after major rains. Paved roads were

constructed mainly with EDF financing from 1970 on and are generally in good condition. Some now need resurfacing. The older gravel and earth roads have been inadequately maintained and are in poor condition, marked by potholes and corrugated surfaces, which cause hazardous driving conditions. The terrain in the country is generally easy, but drainage is difficult and costly because of flat terrain and seasonal heavy rains.

Rail

As a consequence of road improvements, the RAN has been losing domestic freight to the trucking industry since 1973 when 18 million ton-km by rail were recorded. Domestic rail freight traffic is expected to level out at 3 million ton-km by 1985. See Tables 39 and 40. On the other hand, passenger traffic has increased.

Air

Data on Voltaic air traffic were available for 1977-1979 and 1981 for the two principal airports, Ouagadougou and Bobo Dioulasso. See Tables 38 a and 38 b.

Transportation Costs

The Abidjan Route

Tariffs on the RAN have been on the average 12% below average costs, according to a 1979 update of earlier cost studies. Upper Volta's interests lie primarily in cutting operating costs and improving the efficiency of the rail's management since tariff increases affect the cost of its goods traded through Abidjan which, in turn, are captive to the rail. The average tariff in 1981 was CFAF 16/ton-km. (U.S. $ .0681/ton-km.) Tariff increases of up to 10% in real terms during 1982-84 were under consideration. See Table 41.

TABLE 38 a

Upper Volta Air Traffic

	1977	1978	1979	1980	1981
OUAGADOUGOU					
Cargo (mt)	3,832	4,828	4,528	---	---
Airmail (mt)	222	237	248	---	---
Passengers	63,541	70,531	74,189	---	97,745
BOBO DIOULASSO					
Cargo (mt)	102	89	240	---	---
Airmail (mt)	47	36	34	---	---
Passengers	10,921	11,576	11,623	---	---
GOROM-COROM					
Cargo (mt)					
Airmail (mt)					
Passengers					
KANTCHARI					
Cargo (mt)					
Airmail (mt)					
Passengers					
PAMA					
Cargo (mt)					
Airmail (mt)					
Passengers					
DIEBOUGOU					
Cargo (mt)					
Airmail (mt)					
Passengers					
NOUNA					
Cargo (mt)					
Airmail (mt)					
Passengers					
SEBBA					
Cargo (mt)					
Airmail (mt)					
Passengers					

TABLE 38 b

Domestic and International Air Traffic

OUAGADOUGOU AIRPORT - 1981

REGIONS / PAYS	PASSAGERS				FRET (En Tonnes)		
	ARRIVEE	DEPART	TOTAL	% TRAFIC INTERNATIONAL	ARRIVEE	DEPART	TOTAL
INTERIEUR	4 875	4 713	9 588	- 26	4,2	21,6	[illegible]
AFRIQUE							
COTE D'IVOIRE	10 322	10 690	21 012		555	106,3	671,3
NIGER	3 853	4 415	8 268		28,1	53,4	[illegible]
MALI	1 558	1 386	2 944		4,5	5,6	[illegible]
SENEGAL	2 928	3 024	5 952		134	16,8	[illegible]
GHANA					4	4	
AUTRES AFRIQUE	2 396	2 333	4 729		15,9	19	[illegible]
TOTAL	21 057	21 848	42 905	8	751,5	201,1	[illegible]
EUROPE							
FRANCE	20 837	20 488	41 325		1 894,3	2 094,7	3 989
AUTRES EUROPE	197	198	395				
TOTAL	21 034	20 686	41 720	79	1 894,3	2 094,7	3 989
MOYEN ORIENT DIVERS	1 984	1 548	3 532				
TOTAL GENERAL	48 950	48 795	97 745	23	2 650	2 317,4	4 967,4

TABLE 39

RAN Freight Traffic Forecast

(000' tons)

	1973	1976	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1. Freight cars traffic*														
a. Special traffic 1/														
Petiaci Oil (IVC)	-	-	-	-	50	320	340	370	390	417	447	478	511	546
Sugar (IVC)	-	14	5	19	25	30	30	30	30	30	30	30	30	30
Cement (IVC)	24	22	12	19	25	30	30	30	30	35	40	50	60	60
Cement (Inter)	49	58	48	50	60	70	80	90	100	107	114	123	131	140
	73	94	65	88	160	150	480	520	550	589	631	681	732	776
b. Other basic traffic														
Ivory Coast (Domestic)	197	168	101	131	131	134	140	145	153	157	160	163	167	170
Upper Volta (")	59	43	20	17	15	14	17	11	9	9	9	9	9	9
International	353	346	354	431	392	410	432	453	479	493	549	525	542	557
	609	557	475	579	538	558	584	609	641	659	578	597	718	736
Subtotal (a) & (b)	682	651	540	667	698	1008	1064	1129	1191	1248	1309	1378	1450	1512
c. Rocks	179	102	40	55	40	200	200	200	40	40	40	40	40	40
d. Return oil tankers	61	57	47	54	75	201	215	234	247	262	281	290	317	336
Total freight cars	922	810	627	776	813	1409	1479	1563	1478	1550	1630	1716	1807	1888
2. Less than carload traffic	14	16	11	9	8	8	7	7	6	6	6	5	5	5
Total freight trains traffic	936	826	638	785	821	1417	1486	1570	1484	1556	1636	1721	1812	1893
3. Luggages	7	8	8	8	8	8	8	8	8	8	8	8	8	8
4. Express shipments	3	5	5	5	5	5	6	6	6	6	6	7	7	7
Total revenue earning traffic	946	839	651	798	854	1430	1500	1584	1498	1570	1650	1736	1827	1908
5. Service traffic	16	27	38	35	35	35	35	35	35	35	35	35	35	35
Grand total freight traffic	962	866	689	833	869	1465	1535	1619	1533	1605	1685	1771	1862	1943

1/Traffic allocated to the railway through long term contract arrangements or decision of Governments.

December 1980

TABLE 40

RAN Freight Traffic Forecast

(million tons-km.)

	1973	1976	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1. Freight cars traffic														
a. Special traffic[1/]														
Petrol Oil (IVC)	-	-	-	-	16	102	109	118	125	134	143	153	164	174
Sugar (IVC)	-	7	2	9	14	17	17	17	17	17	17	17	17	17
Cement (IVC)	8	9	6	8	11	13	13	13	13	15	17	22	26	26
Cement (Inter)	49	58	47	48	58	67	77	86	93	100	106	114	121	130
	57	74	55	65	99	199	216	234	248	266	283	306	328	347
b. Other basic traffic														
Ivory Coast (Domestic)	80	67	41	52	51	53	56	57	61	63	65	65	68	70
Upper Volta (")	18	14	7	6	5	5	4	4	3	3	3	3	3	3
International	322	330	344	414	371	388	406	427	453	465	481	497	513	527
	420	411	392	472	427	446	466	488	517	531	549	565	584	600
Subtotal (a) & (b)	477	485	447	537	526	645	682	722	765	797	832	871	912	947
c. Racks	11	6	2	3	2	8	8	8	2	2	2	2	2	2
d. Return oil tankers	51	50	49	53	58	102	110	119	126	133	141	149	157	167
Total freight cars	539	541	498	593	586	755	800	849	893	932	975	1022	1071	1116
2. Less than carload traffic	7	7	6	5	5	5	4	4	4	4	4	3	3	3
Total freight trains traffic	546	548	504	598	591	760	804	853	897	936	979	1025	1074	1119
3. Luggages	1	1	1	1	1	5	1	1	1	1	1	1	1	1
4. Express shipments	1	1	2	2	2	2	3	3	3	3	3	3	3	4
Total revenue earning traffic	548	550	507	601	594	763	808	857	901	940	983	1029	1078	1124
5. Service traffic	6	9	7	7	7	7	7	7	7	7	7	7	7	7
Grand total freight traffic	554	559	514	608	601	770	815	864	908	947	990	1036	1085	1131

1/Traffic allocated to the railway through long term contract arrangements or decision of Government.

April 1981

TABLE 41

RAN Tariffs and Traffic Projections
(1981-87)

	1980	1981	1982	1983	1984	1985	1986	1987
TRAFFIC								
Freight (Net tkm Million)	593.0	588.8	599.4	616.2	634.1	650.9	664.9	677.9
Rate of Increase %		-0.7	1.8	2.8	2.9	2.7	2.2	2.0
Petroci Traffic (Net tkm Million)			102.0	108.9	117.9	124.8	136.9	148.8
Rate of Increase %				6.8	8.2	5.9	9.7	8.7
Passenger First CL (Net vk Million)	87.0	92.2	97.6	102.9	108.2	113.5	118.7	123.9
Rate of Increase %		6.0	5.8	5.5	5.1	4.9	4.6	4.4
Passenger Second CL (Net vk Million)	1232.0	1305.9	1381.7	1457.7	1532.0	1607.1	1681.0	1755.0
Rate of Increase %		6.0	5.8	5.5	5.1	4.9	4.6	4.4
AVERAGE RATES AND TARIFF INCREASES								
Freight (CFAF/tkm)		16.0	18.4	21.3	23.0	24.8	26.8	29.0
Nominal Increase in Percent		14.3	15.5	15.5	8.0	8.0	8.0	8.0
Real Increase in Percent		3.0	5.0	5.0				
Petroci (CFAF/tkm)			18.0	20.2	22.2	24.5	26.5	28.6
Nominal Increase in Percent		11.0	10.0	12.2	10.2	10.2	8.0	8.0
Real Increase in Percent				2.0	2.0	2.0		
Passenger First CL (CFAF/vkm)	9.7	10.7	12.3	14.0	15.5	16.7	18.0	19.5
Nominal Increase in Percent		11.0	14.4	14.4	10.2	8.0	8.0	8.0
Real Increase in Percent			4.0	4.0	2.0			
Passenger Second CL (CFAF/vkm)	6.1	6.8	7.8	8.9	9.8	10.6	11.4	12.4
Nominal Increase in Percent		11.0	14.4	14.4	10.2	8.0	8.0	8.0
Real Increase in Percent			4.0	4.0	2.0			

Source: Second Regional Railway Project, SAR, December 1980

In Table 42 a comparison is provided of transport costs on the three principal routes. It shows that the Abidjan route was the least expensive per ton-km for break-bulk shipments and was nearly equal to Lome's rate for containers. The Ghana route (Tema) exceeds the Abidjan and Lome routes in costs for both break-bulk and container shipments and has the added disadvantage of a different currency. All-road vs road-and rail costs from Abidjan to Ouangolodougou, Ivory Coast are compared in Table 43 which is useful in showing relative freight rates to that point.

Domestic Truck Transport Rates

Tariffs fluctuate widely. Official tariffs for cereals and petroleum products were raised in February 1980 to CFAF 34/ton-km, and they are adhered to by the large transport firms. Usually, freight carriers charge 25-50 CFAF/ton-km for distances between 200 and 100 km and between 24-30 CFAF/ton-km for distances between 350-250 km. (See Tables 43 and 44 for Ivory Coast segment tariffs.)

Future Transport Development

Rail Extension, Ouagadougou-Tambao; 340 km

Recent reports point to government plans to finance a first section of rail line extension toward Tambao. Development of the Tambao manganese deposits would generate a transport requirement for the movement of about 600,000 tons of ore per year from Tambao to Ouagadougou, thence to Abidjan.

Roads

Government objectives for the sector have changed from constructing access routes to the ports to maintaining and rehabilitating the main road axes and further developing secondary agricultural roads, and expenditure

TABLE 42

Comparative Total Cost of Importing Goods from Europe to Ouagadougou via Alternative Ports

(CFAF thousands in 1975 prices, including taxes-for a 12,659 kg shipment of mixed general goods)

ITEM	Abidjan (via rail)	CFA/ TON-KM	Lome (via road)	CFA/ TON-KM	Tema (via road -)	CFA/ TON-KM
Land distance (km)	1,159		1,000		1,030	
Regular Shipment (Break-bulk)						
Value of goods, c.i.f. port	3,097		3,151		3,204	
Transit and transport	269	18.33	297	23.46	334	25.62
Total	3,366		3,448		3,538	
Shipment by Container						
Value of goods, c.i.f. port	3,143		3,198		3,204	
Transit and transport	313	21.33	255	20.14	303	23.24
Total	3,456		3,453		3,507	

Source: BCEOM, Transport Sector Survey

January 1977

Comparison of Transport Tariffs - Road vs. Rail (in CFAF)

Abidjan-Ouangolodougou

I. Per Appraisal Report
(First Railway Project)

	RAN (1)	Transhipment Cost (2)	Road (3)	Difference (3)-((1)+(2))
Cement	5205	557.5	8181	2418.5
Cereals northbound	6610	557.5	8181	1013.5
Miscellaneous commodities	8088	557.5	8181	(464.5)
Fertilizer	6124	557.5	8181	1499.5
Cotton fibers	6128	557.5	5575	(1110.5)
Groundnuts	4780	557.5	3400	(1937.5)

I. Reviewed as of June 1979

	RAN	Transshipment cost	Road	Difference
Cement	6026	1200	9795	2569
Cereals	9199	1200	15019	4620
Miscellaneous commodities	11794	1200	16978	3984
Fertilizer	7428	1200	15019	6391
Cotton fibers	8176	1200	15019	5643
Groundnuts	6350	1200	15019	7469

TABLE 44

Official Road Transport Tariffs in Ivory Coast
(CFAF)

	Units	Minimum Tariff (1)	Minimum Tariff (2)	Maximum Tariff (1)	Maximum Tariff (2)
Category A					
Cement	t-km	10	15	13	15
Category B					
Coffee, cocoa	t-km	17	20	17	20
Cargo (volume)	m^3-km	7	8	12	13
Cargo (weight)	t-km	16	19	19	23
Miscellaneous	t-km	19	23	22	26
Empty containers/cartons	t-km	12	14	15	18
Category C					
Chemicals & explosives	t-km	30	36	37	44

		Tariff Unique (1)	Tariff Unique (2)
Category D			
Petroleum products:			
- first 300 km	100 liter-km	2.4	2.64
- above 300 km	100 liter-km	2.16	2.38
- city delivery	100 liter	81	97
Category E			
Timber for export:			
- first 200 km	t-km	19.2	23
- between 200 and 500 km	t-km	16	19.10
- above 500 km	t-km	14.5	17.30
Timber for local industry	t-km	90% of above tariffs	10% less than above tariffs

(1) Per Appraisal Report as of October 23, 1976 (CFAF)
(2) As of February 22, 1979 (CFAF)

on road construction has been shifted from road paving to secondary agricultural road construction and rehabilitation. This trend, justified in the light of ongoing integrated regional development programs, requires an efficient highway maintenance organization.

The Government is engaged in improvement of the east-west oriented international trunk road from Ouagadougou to Niamey (a section of the proposed Trans-Sahelian Highway). Early in 1982, paving of the section from Koupela eastward to Fada N'Gourma was completed and FED is considering further assistance to pave the road to the Niger border, connecting with Niamey. Concurrently, Niger is planning to pave its section of the route, from the border to Niamey.

IV. REGIONAL AIR TRANSPORT

For large, sparsely populated countries such as Mali, Niger and Chad - characterized by long distances, high road construction and maintenance costs, and light traffic flows, air transport can play a significant role in satisfying regional transportation needs. While this mode involves the highest operating costs, it can represent the lowest total capital investment. It can provide access to areas inadequately served by roads, reducing travel time from days to hours, at a total cost less than that of roads.

However, those environments in which air transport may be the least cost mode are also less likely to produce the volumes of air freight and passengers sufficient to generate revenues adequate to make air service self supporting. For example, current annual domestic air freight tonnages in Chad and Niger amount to about 400 mt/yr in each country, while domestic passenger arrivals and departures total only about 20,000/yr.

Under such circumstances, subsidization of this least cost solution could be required indefinitely.

Aviation in the region is better coordinated than other modes as a consequence of the presence of the international infrastructure/ navigational aid agency (ASECNA), which provides necessary services at international airports and trains personnel.

Domestic airlines of the four inland countries provide local service and Air Mali also flies internationally in West Africa and to Casablanca and Paris. Integration of the existing domestic lines into a multinational regional airline could produce substantial economies in the form of

standardized equipment, better equipment utilization, improved schedules, additional stop-overs, and elimination of partially duplicated services. However, because of low traffic and short haul routes it is likely that subsidies would be required indefinitely.

International air transport services complementing domestic services are provided mainly by the Air Afrique/UTA Group which enjoys a de facto monopoly position. The most important feature of Air Afrique is the successful cooperative ownership by the member countries of a profitable international carrier, demonstrating that a group of countries can effectively work together to achieve economies of scale, cost sharing and better services than would be possible on an individual basis. Air Afrique holds the traffic rights between member countries and is the designated international carrier for each. In addition, it benefits from bilateral agreements negotiated with non-member countries. The consequence of this arrangement is that foreign airlines are at somewhat of a disadvantage in competing with Air Afrique in some markets, and national airlines are basically confined to domestic routes or regional routes not directly served by Air Afrique. As a consequence, the domestic airlines are not able to develop the most cost-effective route network by combining more profitable longer haul regional/international routes with low traffic, short-haul domestic routes. They are as a result hampered by low aircraft utilization and low passenger densities. All of these factors contribute to relatively high fares on some African domestic routes. Profiles of the domestic air carriers of the four inland countries are provided in Table 45.

TABLE 45

Profile of Regional Air Service

COUNTRY	AIRLINE	INVENTORY	SERVICE OFFERED	ANNUAL - TRAFFIC: FREIGHT (MT)	ANNUAL - TRAFFIC: PASSENGER ARRIVALS & DEPARTURES	ANNUAL - TRAFFIC: TRAFFIC TREND	OWNERSHIP	PROFITABILITY	COMMENTS
CHAD	AIR TCHAD	2 DC-3 1 DC-4 1 Beechcraft Baron Be-58	Abeche Bol Moundou Sarh Am-Taman Pala Bongor Mongo Ari	387	19,535	Decline in air freight 1970-75 Passenger traffic holding steady.	ChadGov't 66% UTA 34%	Revenue nearly covers operating costs; receiving financial assistance. French Gov't. paid cost of expat. technical staff Air Afrique covers minor main't. Main't costs high need fleet renewal.	Operated by UTA (Union des Transporteurs Aerien). Demand is seasonal, peaking in Aug-Sept, during the rainy season. Demand= 52% of capacity. Air Tchad wants to replace DC-3s and DC-4s with commuter type aircra in view of declining demand for air freight transport and desire to improve passenger service.
MALI	AIR MALI	1 B-727-100 1-IL-18 1-AN-24 2-DHC Twin Otter			18,000			Had deficit of CFAF 5 billion in 1981. Not subsidized by Gov't. Domestic traffic is in deficit somewhat compensated by int'l traffic.	A market for fresh meats and produc exists in West Africa and Paris.
		B-727	Operates internationally to Casablanca, Paris, Dakar, Abidjan, Accra, Douala, Brazzaville.	4,320 mt meat and produce airfreight.					Traffic levels are low; Aircraft utilization rate is low.
		IL-18 and AN-24	Freetown, Banjul, Dakar						Service is poor, due to infrastruct constraints and management limitati
			DOMESTIC FLIGHTS; 12 SCHEDULED						
		AN-24----------Area W of Bamako 2 DHC Twin Otter	Naro Nioro Kayes Kenieba	Load factor is 64% overall on internat'l. flights.					Air traffic is low to these sites w of Bamako. Railroad, only to Bamak
		B-727----------Area NE of Bamako IL-18 AN-24	Mopti Goudam Tombactou Gao Niamey						Domestic air ports need upgradings. Area is isolated; surface transport is limited, particularly when Niger River is in flood.
	MALI AIR SERVICE	3 aircraft available.					Private		

TABLE 45 cont'd

Profile of Regional Air Service

COUNTRY	AIRLINE	INVENTORY	SERVICE OFFERED	ANNUAL - TRAFFIC FREIGHT (MT)	ANNUAL - TRAFFIC PASSENGER ARRIVALS & DEPARTURES	ANNUAL - TRAFFIC TRAFFIC TREND	OWNERSHIP	PROFITABILITY	COMMENTS
NIGER									
	AIR NIGER	2 Hawker Siddeley 748 (50 pegr. ea.)							
			Niamey	n.a.	12,200[1/]				While the quality of land transport is improving, air service will remain important, particularly for passenger transport and emergency operations. G wants to upgrade Arlit airport to medium size aircraft (B-737) capability.
			Agadez	330	10,994				
			Zinder	61	6,322	Freight increased 100% 1970/1980.			
			Maradi	25	4,123				
			Tahoua	9	2,455				
			Arlit	---	---				
	TRANSNIGER								
	SMALL, PRIVATELY OWNED AIRCRAFT								An air taxi service.
									There are 14 public airstrips and 50 small private airstrips servicing mining and oil exploration companies in outlying areas.
UPPER VOLTA									
	AIR VOLTA	Turbo Props. Fokker	Ouagadougou				Mixed Private and Public.		
			Bobo Dioulosso						
			Garoua-Garoua						
			Kantchri						
			Mouna					Loses money on all routes except Ouaga-Bobo.	An international airport.
			Pama						" " " "
			Sebba						Both are managed by ASECNA. Air Afrique, UTA and Air Ivoire provide international service.
			Diebougou						Airstrips located at the major townships carry little traffic.

Origins and destinations of regional air transport flows are indicated for Upper Volta, Mali, Niger, and Mauritania in Tables 44 a and 44 b, which show the magnitudes of both international and domestic movements for 1980 and 1981. Passenger travel is seen to predominate over air cargo and passenger traffic to and from other African countries is about 50 per cent greater than travel to and from Europe.

Table 44 c shows for 1980 and 1981 the magnitudes of passenger and air cargo traffic between Abidjan and the Sahelian countries and with neighboring states related to Sahelian trade. Annual air cargo movements vary between 100 mt and 600 mt to or from any trading partner.

Annual tonnages of air cargo arriving and departing from principal regional airports during the same period are presented in Table 44 d.

In Table 44 e international air traffic between Dakar and other Sahelian and African countries is indicated for 1978. Dakar is the principal mainland destination for Cape Verde air travel, which is quantified in the table.

TABLE 44 a

Origins and Destinations

Regional Air Transport Flows

1980

AEROPORTS	PASSAGERS								FRET (EN TONNES) (mt)							
	INTERIEUR		AFRIQUE		EUROPE		AUTRES		INTERIEUR		AFRIQUE		EUROPE		AUTRES	
	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
HAUTE-VOLTA																
BOBO-DIOULASSO	4.700	5.342	625	779	-	-	42	84	131,8	63,6	1,6	0,5	-	-	-	-
OUAGADOUGOU	6.554	6.434	19.080	20.524	12.376	10.961	1.743	1.504	50	85,8	846,6	157	2.15[illegible]	[illegible]	-	-
TOTAL	11.254	11.776	19.705	21.303	12.376	10.961	1.785	1.588	181,8	149,4	848,2	157,5	2.159,[illegible]	[illegible]	-	-
MALI																
BAMAKO	8.557	8.287	31.644	31.073	20.125	21.659	1.712	1.425	0,6	2,7	1.340,7	688,8	2.722,[illegible]	[illegible]	-	-
AUTRES	9.290	9.867	877	872	-[illegible]	-	-	-	1,8	0,6	39,1	-	-	-	-	-
TOTAL	17.847	18.154	32.521	31.945	20.125	21.659	1.712	1.425	2,4	3,3	1.379,8	688,8	2.722,[illegible]	[illegible]	-	-
MAURITANIE																
NOUAKCHOTT	25.483	25.827	15.076	13.855	3.781	4.205	959	863	60,5	117,5	347,5	124,6	1.055,[illegible]	[illegible]	-	-
NOUADHIBOU	18.398	19.983	3.617	4.576	3.971	3.773	-	-	30	57,2	198,5	45,2	481,[illegible]	[illegible]	-	-
TOTAL	43.881	45.810	18.693	20.431	7.732	7.988	959	863	90,5	174,7	546	169,8	1.537,[illegible]	[illegible]	-	-
NIGER																
NIAMEY	12.879	12.835	29.564	26.403	16.882	18.559	3.160	3.011	44,4	1.539,3	1.803,9	302,5	8.749	[illegible]	[illegible]	-
AGADES	5.258	5.729	7	-	-	-	-	-	321,2	8,7	-	-	-		-	-
MARADI	2.028	2.095	-	-	-	-	-	-	17	7,4	-	-	-		-	-
ZINDER	3.349	2.973	-	-	-	-	-	-	42,4	18,7	-	-	-	-	-	-
TAHOUA	1.366	1.089	-	-	-	-	-	-	8	0,9	-	-	-	-	[illegible]	-
TOTAL	24.880	27.721	29.571	26.403	16.882	18.559	3.160	3.011	433	1.575	1.803,9	302,5	8.749	[illegible]		

TABLE 44 b

Origins and Destinations

Regional Air Transport Flows
1981

[illegible]	PASSAGERS								FRET (EN TONNES)							
	INTERIEUR		AFRIQUE		EUROPE		AUTRES		INTERIEUR		AFRIQUE		[illegible]		[illegible]	
	A	D	A	D	A	D	A	D	A	D	A	D	A		A	D
HAUTE-VOLTA																
BOBO	3 206	3 444	841	756					69	36,8	0,1					
OUAGA	4 875	4 713	21 057	21 848	21 034	20 686	1 984	1 548	4,2	21,6	751,5	201,1	[illegible]			
TOTAL	8 081	8 157	21 898	22 704	21 034	20 686	1 984	1 548	73,2	56,4	751,6	201,1	[illegible]			
MALI																
BAMAKO	[illegible] 701	8 509	37 415	35 717	19 838	21 051	1 458	1 059	35,4	15,1	957,7	556,3	2 299,	[illegible]	1,8	7,1
AUTRES	10 690	10 678	1 077	1 311	1				4,8	0,3	13		46			
	19 391	19 187	38 492	37 028	19 839	21 051	1 458	1 059	40,2	15,4	970,7	556,3	2 344,	[illegible]	[illegible]	[illegible]
MAURITANIE																
NOUAKC.	32 024	[illegible] 765	13 539	14 160	6 515	6 735	973	1 193	21,4	83	279,9	54,6	1 207,	[illegible]		
NOUADHIBOU	26 627	25 950	5 607	8 023	4 072	5 472		71	22,2	16,5	185,8	79,5	231,			
	58 651	61 815	19 146	22 183	10 587	12 207	973	1 264	43,6	99,5	465,7	134,1	1 431,			
NIGER																
NIAMEY	10 030	10 636	26 159	26 481	17 318	17 427	4 123	3 933	9,3	304,2	917,5	497,8	8 614,	[illegible]	[illegible]	
AGADEZ	3 251	3 069		3					160,4	4						
MARADI	1 774	1 698							21,5	3,9						
ZINDER	2 845	2 761							29,2	9						
TAHOUA	1 007	1 061							3,6	0,6						
	18 907	19 225	26 159	26 484	17 318	17 427	4 173	3 933	224	321,7	917,5	497,8	8 614,	[illegible]	[illegible]	

TABLE 44 c

Air Traffic; Abidjan with Sahel/Other Africa

REGIONS / PAYS	PASSAGERS				FRET (En Tonnes)		
	ARRIVEE	DEPART	TOTAL	% 1980/1979	ARRIVEE	DEPART	TOTAL
1980							
AFRIQUE							
BENIN	14 206	18 620	32 826		138,2	541,1	679,3
HAUTE VOLTA	7 653	8 365	16 018		96,3	210,9	307,2
NIGER	7 119	8 902	16 021		206,3	568,6	774,9
TOGO	21 956	26 508	48 464		97	528,7	625,7
CAMEROUN	8 024	8 758	16 782		60,1	106,3	166,4
GABON	7 057	5 278	12 335		17,1	86,7	103,8
CONGO	2 199	2 664	4 863		81,4	148,1	229,5
MALI	10 044	10 032	20 076		82,6	596,8	679,4
SENEGAL	21 165	23 015	44 180		316	350,3	666,3
GUINEE	3 920	4 188	8 108		12,9	170,5	183,4
MAROC	2 593	3 057	5 650		53,7	9,8	63,5
AFRIQUE DE L'EST	3 462	3 912	7 374		121,9	32,4	154,3
ZAIRE	1 085	1 116	2 201		12,3	13,6	25,9
GHANA	16 433	16 987	33 420		76,9	80,1	157
NIGERIA	30 764	21 703	52 467		294,8	63,9	358,7
SIERRA LEONE	2 695	2 762	5 457		29,3	74,4	103,7
LIBERIA	7 113	6 141	13 254		680	106,6	786,6
AUTRES AFRIQUE	2 219	2 362	4 581		934,5	73,2	1 007,7
1981							
AFRIQUE							
BENIN	16 794	18 546	35 340		62,7	797,2	859,9
HAUTE VOLTA	8 786	9 192	17 978		106,1	155,1	261,2
NIGER	6 697	8 335	15 032		78,5	379,6	458,1
TOGO	22 363	25 607	47 970		122,3	471,6	593,9
CAMEROUN	9 052	8 910	17 962		71,3	80,2	151,5
GABON	8 043	5 778	13 821		27,6	206,2	233,8
CONGO	3 088	2 782	5 870		26,6	77,7	104,3
MALI	9 903	10 799	20 702		94,6	198	292,6
SENEGAL	21 618	23 592	45 210		231,7	153,7	385,4
GUINEE	5 445	5 226	10 671		16,3	185,5	201,8
MAROC	4 293	3 987	8 280		87,7	54,1	141,8
AFRIQUE DE L'EST	7 427	6 653	14 080		85,4	34,2	119,6
ZAIRE	1 519	2 728	4 247		11,1	29,6	40,[illegible]
GHANA	15 741	16 537	32 278		34,1	159,6	21[illegible]
NIGERIA	27 050	22 750	49 800		217,[illegible]	132,4	[illegible]
SIERRA LEONE	3 474	2 981	6 455		17,3	88,1	[illegible]
LIBERIA	6 727	6 504	13 231		325,6	96,5	
AUTRES AFRIQUE	3 785	3 354	7 139		96,5	15 517,3	[illegible]

TABLE 44 d

Regional Airport
Air Cargo Tonnages
(1979-1980)
(mt)

1980

AEROPORTS	ARRIVEE 1980	ARRIVEE 1979	% 1980/1979	DEPART 1980	DEPART 1979	1980/1979	TOTAL 1980	TOTAL 1979	% 1980/1979	(1) 1980/1960
LIBREVILLE	16.265	20.712	- 21	10.660	10.935	- 18	26.925	31.647	- 15	3,75
ABIDJAN	12.211	12.544	- 3	19.841	17.717	12	32.052	30.261	6	3,62
NIAMEY	10.626	11.709	- 9	3.276	3.366	- 3	13.902	15.075	- 8	3,45
DOUALA	8.230	6.741	22	12.552	13.811	- 9	20.782	20.552	1	1,18
BRAZZAVILLE	8.214	7.677	7	2.733	2.478	10	10.947	10.155	8	2,80
D A K A R	7.310	6.734	8	9.299	10.447	- 11	16.609	17.181	- 3	2,79
COTONOU	5.803	4.545	28	1.072	1.060	1	6.875	5.605	23	4,84
PORT-GENTIL	5.475	5.264	4	1.760	1.270	38	7.235	6.534	11	2,80
TANANARIVE	5.327	4.239	25	5.391	4.395	22	10.718	8.684	23	1,86
L O M E	4.259	3.417	25	1.044	1.443	- 2	5.303	4.860	9	10,00
B A N G U I	4.204	7.408	- 43	521	3.474	-85	4.725	10.882	- 57	1,25
B A M A K O	4.065	4.049	0,3	2.597	2.871	-10	6.662	6.920	- 4	5,23
OUAGADOUGOU	3.056	2.759	11	1.671	1.769	- 6	4.727	4.528	6	6,72
YAOUNDE	1.846	1.458	27	988	625	54	2.834	2.083	36	1,60
NOUAKCHOTT	1.463	1.106	32	322	216	49	1.785	1.322	35	1,70
NOUADHIBOU	710	823	-14	132	118	12	842	941	-11	1,03
POINTE NOIRE	689	949	-27	426	876	-51	1.115	1.825	-39	-0,62
MARUA	211	210	0,4	432	382	13	643	592	9	-8,80
BOBO DIOULASSO	133	163	- 18	64	77	-17	197	240	-18	1,04
MOJAMBIQUE	294	2.171	- 86	105	1.135	-911	399	3.306	-88	-73,50
AUTRES AEROPORTS	7.599	6.748	13	4.880	2.777		12.479	9.525	31	

1981

AEROPORTS	ARRIVEE 1981	ARRIVEE 1980	% 1981/1980	DEPART 1981	DEPART 1980	% 1981/1980	TOTAL 1981	TOTAL 1980	% 1981/1980	(1) 1981/1960
LIBREVILLE	15 114	16 265	- 7	10 715	10 660	0,5	25 829	26 925	- 4	59,6
ABIDJAN	10 824	12 211	- 11	23 366	19 841	26	34 690	32 052	8	62
NIAMEY	9 564	10 626	- 10	2 363	3 276	-28	11 927	13 902	- 14	49,4
COTONOU	8 843	5 803	52	920	1 072	-14	9 763	6 875	42	38,5
DOUALA	8 104	8 230	- 2	12 910	12 552	3	21-014	20 782	1	2,3
DAKAR	6 309	7 310	- 14	9 775	9 299	5	16 084	16 609	- 3	52,7
BANGUI	5 751	7 797	- 26	715	2 733	-74	6 466	10 550	- 39	71,7
PORT GENTIL	5 486	5 475	0,2	2 084	1 760	18	7 570	7 235	5	13,4
LOME	5 155	4 259	21	835	1 044	-20	5 990	5 303	13	37,2
TANANARIVE	4 750	5 327	- 11	5 120	5 391	- 5	9 870	10 718	- 8	73,7
BRAZZAVILLE	3 405	8 214	- 59	1 090	2 733	-60	4 495	10 947	- 59	- 19,8
BAMAKO	3 292	4 065	- 19	2 542	2 597	- 2	5 834	6 662	- 12	38,8
OUAGADOUGOU	2 649	3 056	- 13	2 318	1 671	39	4 967	4 727	5	37
YAOUNDE	1 932	1 846	5	915	988	- 7	2 847	2 834	0,4	62,4
NOUAKCHOTT	1 504	1 463	3	243	322	-25	1 747	1 785	- 2	
POINTE NOIRE	806	689	17	415	426	- 3	1 221	1 115	9	- 33,9
NOUADHIBOU	639	710	- 38	175	132	32	814	842	- 27	60,9
MARUVOCA	235	211	11	534	432	24	769	643	19	9
BOBO DIOULASSO	69	133	- 48	35	64	-45	104	197	- 47	- 80,7
MOJAMBIQUE	38	294		17	105		55	399		
AUTRES AEROPORTS	7 642	7 599	0,5	2 433	4 880	-50	10 075	12 479	- 19	- 83

TABLE 44 e

Domestic and International Air Traffic

DAKAR AIRPORT
(1978)

REGIONS / PAYS	PASSAGERS				FRET (En Tonnes)			
	ARRIVEE	DEPART	TOTAL	% 1978/1977	ARRIVEE	DEPART	TOTAL	% 1978/1977
INTERIEUR	17.387	17.540	34.927	9	0,6	3,8	4,2	- 78,1
ALGERIE	639	611	1.250		8,2	1,8	10	
BENIN	364	957	1.321		6	40,6	46,6	
HAUTE-VOLTA	2.871	2.563	5.434		17,5	41,6	59,1	
COTE D'IVOIRE	20.763	17.638	38.401		371,1	564,6	935,7	
NIGER	1.947	1.622	3.569		5,9	24,1	30	
TOGO	2.390	2.206	1.596		8,1	67,5	75,6	
CAMEROUN	1.777	1.548	3.325		14,3	46,6	60,9	
GABON	3.472	2.469	5.941		27,5	39,4	64,9	
MALI	7.476	7.582	15.058		23,8	184	207,8	
MAROC	7.359	7.280	14.639		209,6	43,3	252,9	
MAURITANIE	11.573	11.355	22.928		69,3	260,5	329,8	
GHANA	2.625	2.147	4.772		27,5	21,8	49,3	
NIGERIA	1.945	2.345	4.290		24,9	22,7	47,6	
ZAIRE	1.080	791	1.871		10,6	114	124,6	
GAMBIE	5.418	4.875	10.293		83,5	162,2	245,7	
SIERRA-LEONE	2.355	2.574	4.929		20,6	71,4	92	
LIBERIA	3.014	2.328	5.342		118,2	101,7	219,9	
ILES CANARIES	15.694	16.662	32.356		356,7	168,6	525,3	
GUINEE	2.115	2.777	4.892		35,9	155,1	191	
BISSAU	3.008	3.051	6.059		0,8	3,4	4,2	
ILES DU CAP-VERT	2.195	2.541	4.736		0,8	9,8	10,6	
AFRIQUE DE L'EST	382	813	1.195		7,4	10,4	17,8	
AUTRES AFRIQUE	844	788	1.632		11,6	7,6	19,2	
TOTAL	102.170	97.523	199.693	2,9	1.439,7	2.162,7	3.552,5	7,7
AMERIQUE DU SUD								
BRESIL	3.435	3.583	7.018		78	45,6	123,6	
ARGENTINE	1.066	896	1.962		6,5	4	10,5	
CHILI	324	141	465		78,5	3,2	81,7	
AUTRES AMERIQUE DU SUD	53	92	145		-	1,5	1,5	
TOTAL	4.878	4.712	9.590	- 10	163	54,3	217,3	- 21,6

V. MODAL COST ESTIMATES AND METHODOLOGY FOR DETERMINING IMPUTED TRANSPORTATION COSTS

Among the Sahel countries road and rail tariffs range from high to less than compensatory. Ideally, freight rates would reflect the modal system cost, including profit. Annual modal system costs extend beyond direct operating costs, including vehicle depreciation, to encompass the cost of route maintenance. Ideally, they should include capital cost amortization as well, unless the infrastructure is already amortized.

The following conditions exist in a number of Sahel countries:

1) Truck tariffs and rail rates do not include adequate provision for vehicle and facility depreciation;
2) User charges, which are reflected in freight tariffs, are inadequate to cover the cost of adequate road maintenance.

On the other hand, while user charges included in the tariff may be adequate for road maintenance, the revenues may be diverted to other uses.

The Status of Infrastructure in Place

In this pre-feasibility study existing transport infrastructure is considered sunk investment against which only operations and maintenance (and not capital costs) are charged. On the other hand, airship systems, (and all other new investments) are charged both capital costs and operating and maintenance costs.

Assumed Values

To facilitate comparisons of airship system operations in competition with those of heavier-than-air craft and with surface transportation modes - road and rail - gross values were assigned to cost elements. These estimates were based upon cost data related to recent and current Sahel road projects adjusted for inflation, to reflect average costs and current prices.[1/]

Derived values utilized in the study were developed as indicated below.

Road Construction Costs

Estimates of construction costs for paved and graveled roads in the Sahel were obtained from a number of independent sources. These cost data were brought to imputed 1983 levels by adjusting CFAF prices upward for inflation at the annual rate of 10% [2/] from the baseline year[3/] to 1983. The equivalent U.S. dollar cost was determined by applying the current exchange rate to the adjusted CFAF price.

Unit costs of construction vary, since they are governed by a multitude of factors, including the nature of terrain; the quality of the route prior to its upgrading; the number and types of required drainage structures; the availability of suitable fill and surfacing materials; the delivered cost of inputs such as cement and reinforcing steel; the mode of construction; labor rates; site location; taxes; the degree of contractor competition; and other factors.

1/ See Annex I.
2/ Except for Chad, where 15% was applied.
3/ All cost data were 1978 or later.

For cost comparisons the following average costs relative to primary road construction have been utilized:

	$/km	Equivalent CFAF/km (millions)
Paved Road - Chad	260,000	85.8
Paved Road - Other Sahel	200,000	66.0
Gravel Surfaced Road - Chad	156,000	51.5
Gravel Surfaced Road - Other Sahel	120,000	39.6

Road Maintenance Costs

Current average annual costs for primary road maintenance, including routine maintenance and annualized periodic maintenance, are estimated to be as follows:

	$/Km	= CFAF/km (millions)
Paved Primary Roads		
Chad	3,900	1.287
Other Sahel	3,000	0.990
Graveled Primary Roads		
Chad	1,950	0.644
Other Sahel	1,500	0.495

Data on road maintenance costs in a number of Sahelian countries are contained in Annex I.

Vehicle Operating Costs

As the primary road networks have improved, the trucking industry has upgraded its equipment. Truck sizes are increasing on the long hauls from

the seaports to inland destinations and 35-ton, and even larger, tractor/trailer combinations are now common.

Table 46 indicates estimated current costs of operating heavy trucks on the primary road networks. These are the trucks most likely to be in competition with air transport.

TABLE 46

Heavy Truck Operating Costs

Payload (Mt)	Operating Cost CFAF/vehicle-km
10	160
15	193
25	247
35	284

Railroad Maintenance Costs

To determine an appropriate approximate annual cost for railroad maintenance we referred to the railway operating statistics of Statistics Canada. In 1981 the seven major Canadian railroads operated on 55,632 miles of railway. Their aggregate maintenance costs for that year were as follows:

	Canadian $
Railway maintenance	76.7 million
Equipment maintenance	87.2 million
Total maintenance	163.9 million
Annual maint. cost/mi	$2,946.
Annual maint. cost./km	$1,830.
Equals annual maint. cost/km	US $ 1,270 or CFAF 749,100/km.

Methodology for Modal Systems Analyses

A two-phase effort was planned, with field testing in a second phase, if the first phase results were promising. Phase 1 systems analyses in the home office compared the airship with other aircraft and with Sahel surface transport . All aircraft operational profiles were based upon estimated U.S. costs and U.S. operating experience, with one exception: The cost of fuel, a sizeable cost element in aircraft operation, was adjusted to reported Sahel price levels.

Since operational efficiencies are likely to be lower and capital and operating costs higher in the Sahel than in the U.S., this gave a positive bias to the relative attractiveness of every air transport alternative. This was a purposeful approach, with the desirable objective of reaching by expeditious means an initial determination of the relative merit of air transport, without extensive field work in the Sahel; if the air transport mode were not competitive with existing or projected Sahelian surface transport when the more favorable (lesser) U.S. cost data were applied to the air mode only, then air transport would be even less competitive when costs were subsequently adjusted (increased) in the field to reflect actual current Sahel operating costs and conditions.

It the results were conclusively negative, the analysis would be concluded at that point, without proceeding to Phase 2.

On the other hand, if on the basis of the U.S. cost estimates an air transport system was attractive in comparison with Sahel surface transport, it would be appropriate to refine the systems analyses in a Phase 2 field effort, which would introduce more accurate current and projected estimates of costs and trade flows. The refinement of air mode operating cost data to reflect current and projected Sahel conditions would likely reduce the attractiveness of air transport vis-a-vis surface transport, but perhaps not so much as to call for a rejection of air transport.

What resulted was a finding that in the selected scenarios no form of air transport was found to be competitive with existing surface transport infrastructure. In situations where the roads or rail did not exist, distances were substantial and transport volumes low, aircraft (and specifically airships) could well be the least-cost solution.

Modal Comparisons

In the analysis existing transport systems (which by definition constitute sunk investments) and future transport investments are costed differently for purposes of modal comparisons. To clarify the methodology followed, this section provides an overview of the cost elements involved.

Five alternative modal situations are addressed:

i) Road system; existing route and vehicles;

ii) Combined road/rail system; existing route and equipment;

iii) New road or new road/rail system.

iv) Air transport system; existing aircraft and supporting ground facilities;

v) New air transport system, including aircraft and ground facilities.

They are described in sequence below:

I. Road System; Existing Route and Vehicles

a. Road Route

Calculate annualized total cost of maintenance, routine and periodic.

- Prorate the road maintenance cost to the scenario in the same ratio as the scenario cargo tonnage bears to the total cargo tonnage on the route.

b. Port Charges

- Determine port charges per mt. This parameter is applicable to all modes.

c. Transit Charges and Transfer Charges, if any

- Determine cost per metric ton. Transfer charges would occur if there were a shift of cargo between trucks at border crossings.

d. Trucks

- Determine load factor and annual veh-km per unit.
- Calculate operating cost per veh-km, including maintenance and depreciation.
- Determine number of truck units required to carry the scenario cargo.
- Calculate the annual operating cost of scenario trucks necessary to move the given cargo.

e. Calculate modal cost per ton-km.

$$MC = \frac{a + b + c + d}{\text{ton-km}}$$

II. Combined Road/Rail System; Existing Route and Equipment

a. Road Element

- See Ia.

b. Port Charges

- See Ib.

c. Transit and Transfer Charges

- Determine cost per metric ton; transfer charge will be assessed for the intermodal shift of cargo.

d. Truck Element

- See Id.

e. Rail Element

- Calculate annual cost of rail section maintenance.
- Estimate annual cost of rail wagon and equipment operation and maintenance.
- Prorate these annual costs to the scenario cargo in the same ratio that the scenario tonnage bears to the total route tonnage.

f. Calculate modal cost per ton-km.

$$MC = \frac{a + b + c + d + e}{\text{ton-km}}$$

III. New Road or New Road/Rail System

Road and/or Rail Capital Costs

a. It is assumed that the construction cost is equally divided over all ton-km shipped on the road/rail system. Its magnitude can be easily determined by amortizing the construction cost over the life of the facility and allocating this cost to the daily tonnage.

b. Road and/or Rail Maintenance

- Prorate annual road/rail maintenance cost to the scenario cargo in the same ratio as the scenario tonnage bears to the total route tonnage.

c. Truck/Train Capital Costs

- If new equipment is required, allocate a prorated part of amortization to the scenario cargo. (See IIIa.)

d. Truck/Train Operating Costs

- See Id and IId.

e. Port Charges

- See Ia.

f. Transit and Transfer Charges

- See IIc.

g. Calculate modal cost per ton-km.

$$MC = \frac{a + b + c + d + e + f}{\text{ton-km}}$$

IV. Air Transport System; Existing Aircraft and Ground Facilities

a. Calculate Direct Operating Costs

- Base on the number of ton-km of production or service hours in the scenario.

b. Calculate Indirect Operating Costs

- Aircraft Maintenance and Service.
- Ground Crews.
- Maintenance and Operating Base Personnel.
- Administration and Overhead.

c. Port Charges

d. Airport User Charges

e. Calculate modal cost per ton-km.

$$MC = \frac{a + b + c + d}{\text{ton-km}}$$

V. New Air Transport System; Aircraft and Ground Facilities

a. System Capital Cost Amortization

- Amortize the cost of aircraft and ground facilities and equipment according to their respective service lives.

b.-e. - See IV a-d.

f. Calculate modal cost per ton-km.

$$MC = \frac{a + b + c + d + e}{\text{ton-km}}$$

VI. SCENARIOS OF AIRSHIP OPERATION IN THE SAHEL

From a number of possible Sahel applications[1/] three scenarios of airship systems operation were developed. They represent contrasting applications of airships to international and domestic transport problems. In each scenario, the cost of airship system operation is compared initially with those of other forms of aircraft, then with the cost of transport on existing surface routes, or on routes which would be constructed in order to provide equivalent service. In brief, the scenarios are as follows:

Scenario 1

Operation of airships and airplanes on a direct air route in comparison with other modes on three surface routes, one of which requires sectional reconstuction.

Scenario 2

Establishment of a regional airship service utilizing one seaport, with a four-country itinerary, and options for diversion when cargo warrants.

Scenario 3

A domestic airship transport service utilizing a smaller "airbus" type dirigible operating year-around on a fixed or varied itinerary, and available for emergency airlift assignments such as foodgrain drops and medical air evacuations.

In Scenarios 1 and 2 competing aircraft types and surface routes were alternatively assigned 50,000 mt of exports and imports to be moved in one year. The resultant total transport costs per ton for the respective routes and modes are compared.

1/ Other potentials are cited in Section VII.

In the third scenario analyses are made of the annual costs of providing 2,800 hours of air service on a four-stop domestic itinerary, comparing the airship with fixed-wing aircraft and with the construction of a road system provided with trucks.

Scenario 1, Conakry-Bamako Service

Background

This scenario is intended to test the feasibility of operating an airship between Conakry and Bamako, establishing a service in competition with the Dakar-Bamako and Abidjan-Bamako routes. (See Figure 35.) It calls for the annual diversion of 50,000 mt (10% of present Malian export and import cargo) from other ports to the Port of Conakry. This represents a total transport requirement of 36.5×10^6 ton-km per year. The airship also competes with a road which requires partial reconstruction and upgrading (Conakry-Bamako). The railroad/rail combination (rail Conakry to Kankan and road Kankan to Bamako) is not included as an option because of the reported deteriorated condition of the railway. It is in serious need of rehabilitation and cannot be considered a route for Sahel traffic.

By a straight line Conakry is the closest port to Bamako, (about 740 km) but topography and existing road alignments make the Conakry-Bamako surface route about 1,110 km long, and it is particularly difficult to travel on the section Kankan-Yanfolila-Bougouni (about 308 km). FED financed a study of the Kankan-Mali border section (140 km) but the rate of return was low. About 350 km of the Bamako-Conakry road is in an area of 500-1,000 m. elevation.

Malian foreign trade presently amounts to 500,000 mt, of which about 47 per cent takes the Dakar-Bamako route and 53 per cent the Abidjan-Bamako road. While the transport cost per ton-km on the Abidjan route is nearly twice that of Dakar-Bamako and ocean freight to Abidjan from Europe is higher than to Dakar, Abidjan continues to receive an increasing portion of the cargo. This is attributable to the better transport service in the Abidjan corridor: 3-7 days from Abidjan to destination, vs a month on the Dakar-Bamako rail line.

Air Mode Alternatives

The annual total costs of air cargo systems were calculated for both LTA and HTA systems. The LTA systems included three hypothetical airships of conventional design, using current technology. The HTA systems consisted of three modern airplanes: the Lockheed L-100 (Hercules), the Fokker F-27, and the DeHavilland DHC-5 (Buffalo). The L-100 and the DHC-5 are capable of STOL operation, but for this route it was assumed that all aircraft would utilize the airports at Bamako and Conakry which are adequate for maximum take-off weight operations.

The number of aircraft required, their transport capacities, and direct operating costs are listed in Table 47 A.

All of the airships are assumed to cruise at 136 km/hr. Airplane cruise speeds are taken as listed in Table 2. All aircraft operate for 2,800 hrs per year.

Indirect operating costs include personnel, ground vehicle servicing and administrative expense. The various items included are:

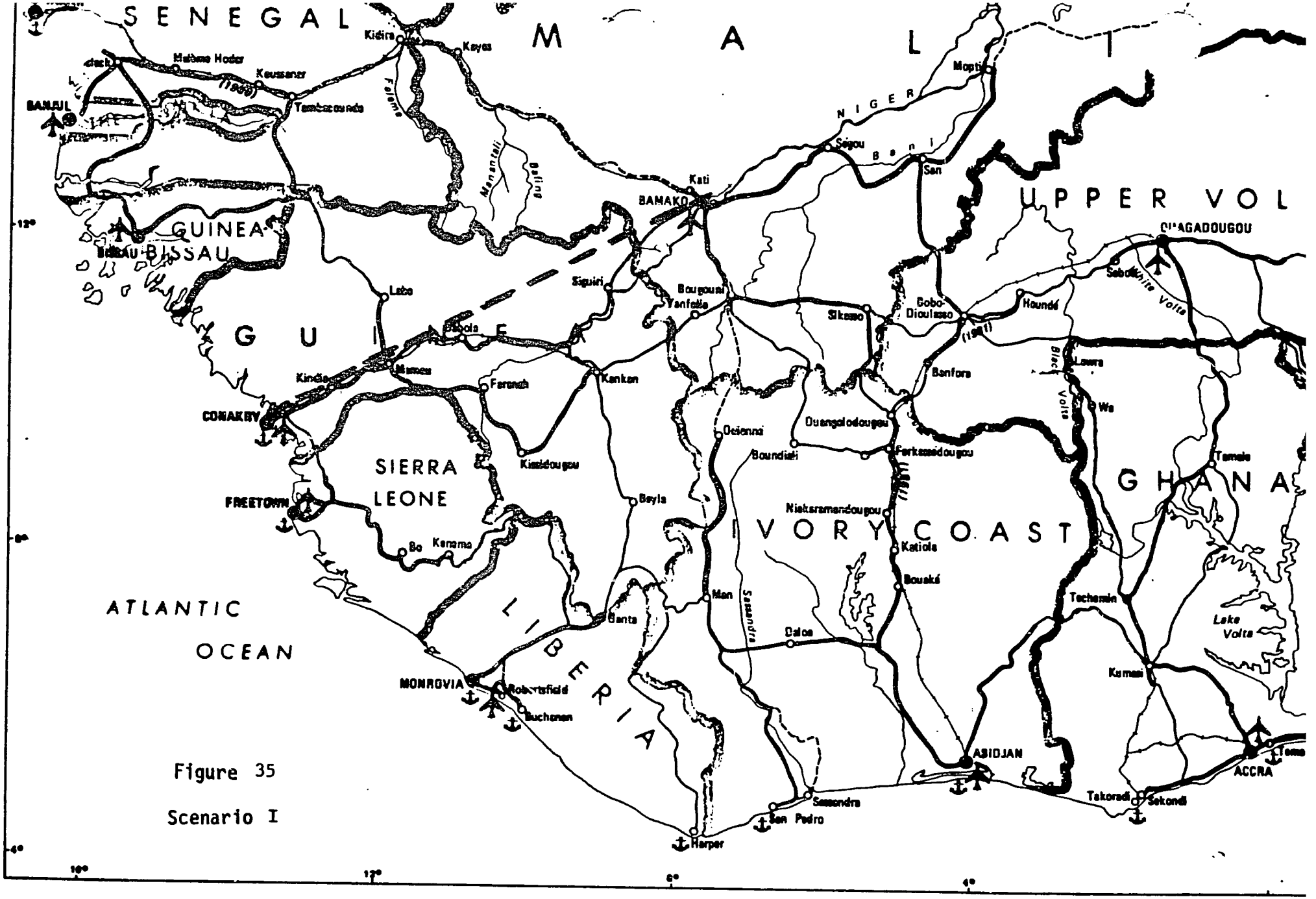


Figure 35

Scenario I

1. Vehicle maintenance and servicing - these are assumed as 10 per cent of the original cost per year, not including financing charges. For airships, these costs cover mechanical mules, masts, and tractor equipment. For airplanes, tractor costs only are included.

2. Personnel requirements

   Cargo handling and ground crew - the same personnel are assumed to handle both cargo and ground handling operations at each airport. For airships these include 2 supervisors and 12 other personnel; half this number are assumed for airplanes.

   Aircraft maintenance - a base manager, assistant, and six mechanics are assumed for all types of aircraft.

   Operations - a base manager, assistant, secretary and two clerical personnel are assumed for all types.

3. Administrative - these costs are assumed to be equal to the maintenance and operations expense.

Indirect operating costs are specified in Table 47 B.

TABLE 47 A

Direct Operating Costs

TYPE	AIRCRAFT MODEL	PAYLOAD	No. AIRCRAFT REQU.	D. O. C. $/T-Km	D. O. C. $/Yr (Millions)
L	10	12.31	7.79	.49	17.885
T	20	24.00	4.00	.36	13.140
A	40	47.22	2.03	.28	10.220
H	F-27	6.00	4.56	.47	17.155
T	DHC-5	8.16	4.75	.54	19.710
A	L-100	23.49	1.00	.40	14.600

TABLE 47 B

Indirect Operating Costs
($Millions)

TYPE	AIRCRAFT MODEL	VEHICLE MAINT. & SERVICE	GROUND CREWS	MAINT. & OPERATING BASE PERSONNEL	ADMIN & OVERHEAD	TOTAL I.O.C.
L	10	.015	.072	.191	.191	.469
T	20	.015	.072	.191	.191	.469
A	40	.015	.072	.191	.191	.469
H	F-27	.007	.024	.105	.105	.241
T	DHC-5	.007	.024	.105	.105	.241
A	L-100	.007	.024	.105	.105	.241

TABLE 47 C

Initial Investment Costs
($Millions)

TYPE	AIRCRAFT MODEL	GROUND VEHICLES	BASES & MOOR SITES	AIRCRAFT	TOTAL	COST PER YR.
L	10	.211	6.568	37.774	44.553	7.344
T	20	.211	9.420	30.856	40.487	6.615
A	40	.211	13.593	26.522	40.326	6.519
H	F-27	.025	1.406	33.744	35.175	5.885
T	DHC-5	.025	1.406	23.940	25.371	4.239
A	L-100	.025	1.406	11.500	12.931	2.149

An initial investment in aircraft and facilities is required. For the route chosen, two adequate airports already exist; therefore no airport construction is required. For LTA, mooring sites must be constructed and mechanical ground handling vehicles must be provided. The construction of a maintenance and operations base at one airport is also necessary. Initial investment costs are listed in Table 47 C.

In calculating these costs, the following amortization periods were assumed with interest at 15%:

Aircraft	15 years
Airfield and buildings	30 years
Ground vehicles	10 years

The total annual costs are summarized in Table 47 D.

TABLE 47 D

Total Costs Per Year
($Millions)

TYPE	AIRCRAFT MODEL	TOTAL OPERATING COSTS	TOTAL INVESTMENT COST/YR.	TOTAL ANNUAL COST	$/mt
L	10	18.354	7.344	25.658	514
T	20	13.609	6.615	20.224	404
A	40	10.689	6.519	17.208	344
H	F-27	17.396	5.885	23.281	466
T	DHC-5	19.951	4.239	24.190	484
A	L-100	14.841	2.149	16.990	340

In Table 47 D we see that the L-100 is slightly more economical than the LTA-40. Since the difference is about one per cent we may equate the two for purposes of these calculations. Table 48 compares the cost of the LTA-40 and L-100 with surface transport alternatives. While the quality of air service is superior to that of rail or road transport, the cost is considerably higher than that of the alternative surface routes.

Tests of the comparative imputed tariffs indicated an allowable margin of error in surface transport cost estimates of 408 per cent for the Dakar-Bamako alternative, and 179 per cent for the Abidjan - Bamako route, without exceeding Airship/L-100 costs on the Conakry-Bamako run. While this suggests that the bulk of cargo destined for Bamako would not select the Conakry-Bamako air route, it does not imply that a portion of the 200,000 mt of annual imports currently using the Abidjan-Bamako route might not be willing to pay a further premium for one-day service from Conakry to Bamako.

Therefore, a further step in the analysis would be to assume alternative levels of aircraft operation on the Conakry-Bamako run, determine the transport cost per ton at these service levels, and through a field survey determine whether the service offered at the required tariffs would attract sufficient cargo to warrant airship or other aircraft service. This would constitute an analysis of the demand elasticity for air transport services.

TABLE 48

Scenario 1 - Alternate Route Cost Comparison
Mali Exports and Imports

ROUTE	KM.	MODE	PORT COSTS (1978)	RAIL TRANSPORT COSTS (1978)	ROAD TRANSPORT COSTS (1978)	CFAF/mt (1978)	CFAF/mt AJUSTED to 1983	1983 AIR TRANSPORT COSTS ($)	EQUIV. $/mt 1983	ADD NEW CONSTRUCTION ANNUAL AMORTIZATION PAYMENT $/mt	TOTAL COST $/mt 1983 4/
DAKAR - BAMAKO											
	1,223	Rail	5,802	9,061	—	14,863	23,929	—	72 1/	—	72
ABIDJAN - BAMAKO											
	1,225	Road	3,202	—	23,606	26,807	43,159	—	131 1/		131
CONAKRY - BAMAKO											
	1,110		4,500								
	800	Paved Road	—	—	15,416 —						
	310	Gravel Road	—		8,990 —	28,906	46,539	—	141	198 2/	339
	740	Air LTA 40 Air L-100	4,500	—	—	4,500	7,245 ($22)	344	366	—	366
	740	AIR LTA 20	4,500	—	—	4,500	7,245 ($22)	404	426	—	426

Summary

Air transport does not appear to be cost competitive with the two principal surface routes taken by Malian exports and imports, nor is it particularly favorable with regard to a third route, Conakry-Bamako. The advantage of airship service is possible one-day delivery, as compared with three to seven days on the Abidjan-Bamako road route and one month on the Dakar-Bamako rail route. Except for the most valuable or perishable cargo air service would not be attractive. Whether there is adequate cargo to support one-day service could be estimated by means of the field study indicated above.

Scenario 2 - A Regional Service Route

A regional itinerary for the airship, linking Abidjan, Bamako, Ouagadougou, and Niamey is considered (with possible diversions to eastern Mali, and to Lagos, with a coastal return to Abidjan). See Figure 36. Relatively high value imports would be loaded at Abidjan for destinations inland. Interim stops could be made, if warranted. The airship would discharge imports and load exports at each airport. This service could carry passengers as well as cargo.

Background

This service would compete with the following established surface transport routes:

Dakar - Bamako	(rail)
Abidjan - Bamako	(road) and (rail/road)
Abidjan - Ougadougou	(rail)
Abidjan - Ougadougou-Niger	(rail/road)
Lome - Niamey	(road)
Cotonou - Niamey	(rail/road)

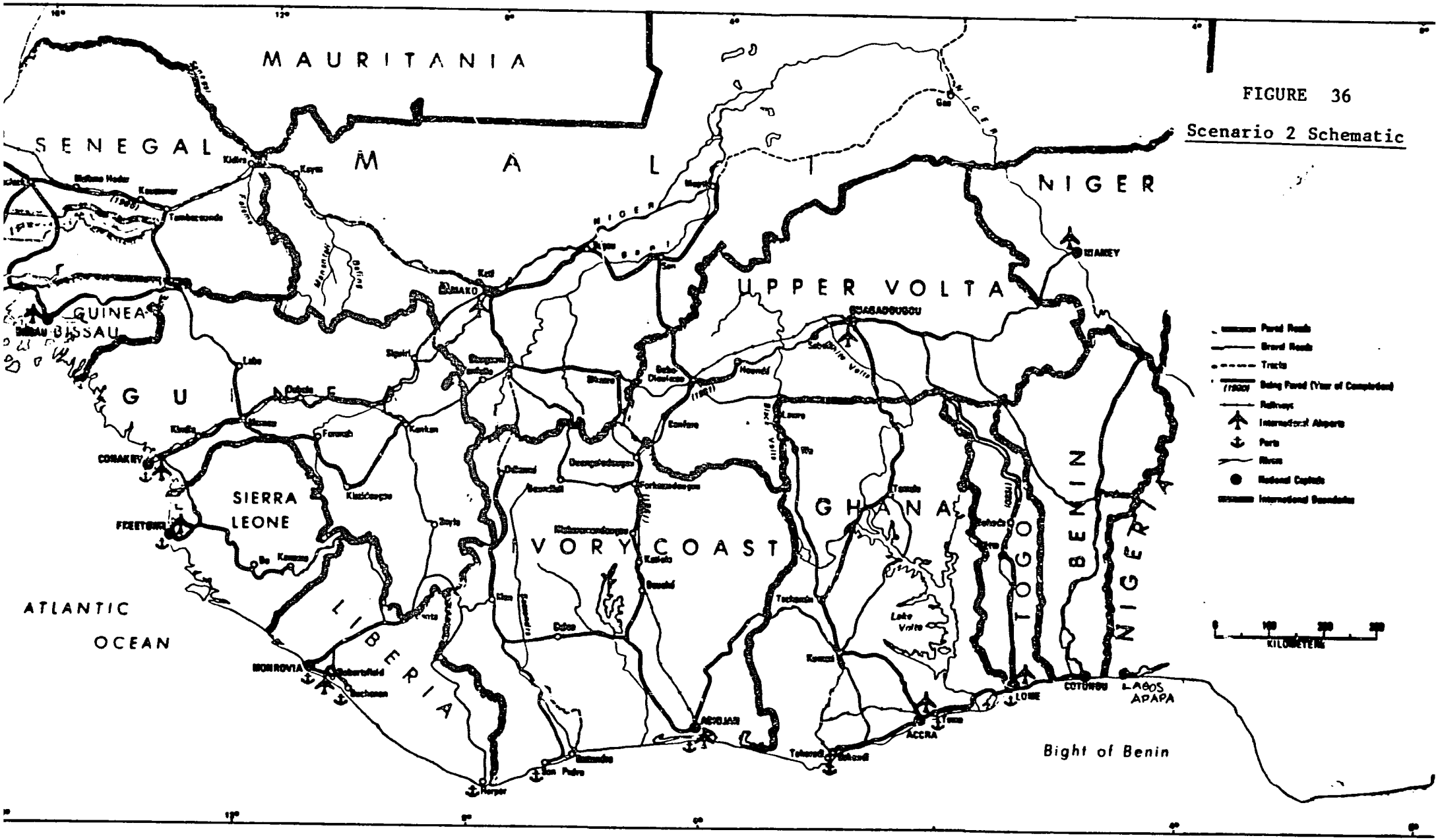


FIGURE 36

Scenario 2 Schematic

It would provide a new direct air connection for freight and passenger service between Bamako, Ouagadougou, Niamey, and Abidjan.

For the purpose of comparing airships with other aircraft on this itinerary, a total of 50,000 tons was selected as the cargo requirement. This represents a total transport requirement of 162.75×10^6 ton-km.

The total air distance of the scenario is 3,255 km, the longest track being from Niamey to Abidjan, 1,205 km. A maximum flight time of 8.86 hrs. is required for the airship, which is considered to be within the capabilities of one flight crew. It was not considered necessary for one vehicle (airplane or airship) to make the complete circuit; therefore the same

shorter range and more efficient aircraft were selected for comparison, as in the case of the Bamako to Conakry route, Scenario I.

All airports along this route are capable of handling the types of aircraft selected; therefore, for the airplanes no modification was considered necessary. For airships, mooring circles are required (one per airship).

The same requirements for maintenance bases, operations, and administrative costs are assumed as in the Bamako-Conakry case. They were adjusted for a larger number of aircraft and personnel.

Tables 49 A-D provide detailed comparisons of airships and turbo-prop aircraft on this itinerary.

Findings

The magnitudes of trade between Mali, Upper Volta, Niger, and the Ivory Coast, based upon U.N. Series D trade data are indicated in Table 50. They confirm that there is little trade between Mali, Upper Volta, and Niger; only eight per cent by value ($9 million) of the total group trade is registered between these countries, while 92 per cent of the trade is between them and the Ivory Coast.

Of the latter commerce, 58 per cent by value constituted exports from the Ivory Coast to the three countries and 42 per cent reflected imports by the Ivory Coast from them.

TABLE 49 A

Direct Operating Cost

TYPE	AIRCRAFT MODEL	PAYLOAD	HQ. REQU.	D. O. C. $/T-Km	D. O. C. $/Yr (Millions)
L	10	12.31	34.7	.49	79.75
T	20	24.00	17.8	.36	58.59
A	40	47.22	9.1	.28	45.57
H	F-27	6.00	20.2	.47	76.49
T	DHC-5	8.16	26.3	.54	87.89
A	L-100	23.49	4.5	.40	65.10

TABLE 49 B

Indirect Operating Cost
($Millions)

TYPE	AIRCRAFT MODEL	VEHICLE MAINT. & SERVICE	GROUND CREWS	MAINT. & OPERATING BASE PERSONNEL	ADMIN & OVERHEAD	TOTAL I.O.C.
L	10	.038	.180	.382	.382	.982
T	20	.038	.180	.191	.191	.600
A	40	.038	.180	.191	.191	.600
H	F-27	.014	.060	.210	.210	.494
T	DHC-5	.014	.060	.210	.210	.494
A	L-100	.014	.060	.105	.105	.284

TABLE 49 C

Initial Investment Cost
($Millions)

TYPE	AIRCRAFT MODEL	GROUND CREWS	BASES & MOOR.SITES	AIRCRAFT	TOTAL	COST PER YEAR
L	10	.528	12.660	168.259	181.447	30.272
T	20	.528	10.053	137.309	147.890	24.679
A	40	.528	14.000	118.890	133.418	22.185
H	F-27	.050	2.812	149.480	152.342	25.105
T	DHC-5	.050	2.812	132.552	135.414	22.262
A	L-100	.050	1.406	51.750	53.206	8.691

TABLE 49 D

Total Cost Per Year
$Millions

TYPE	AIRCRAFT MODEL	TOTAL OPERATING COSTS	TOTAL INVESTMENT COST/YR.	TOTAL ANNUAL COST	$/TON-KM
L	10	80.730	30.272	111.002	0.682
T	20	59.190	24.679	83.869	0.515
A	40	46.170	22.185	68.355	0.420
H	F-27	76.987	25.105	102.092	0.631
T	DHC-5	88.384	22.262	110.646	0.680
A	L-100	65.384	8.691	74.075	0.455

TABLE 50

Regional Trade[1/]
($ Million)

FROM /TO	MALI	IVORY COAST	NIGER	UPPER VOLTA
Mali	---	10.7	2.3	1.2
Ivory Coast	21.4	----	10.5	29.4
Niger	(minimal)	1.4	----	0.2
Upper Volta	3.0	31.6	1.0	---

A further consideration is the nature of the commodities in trade and the consequent degree of shippers' demand for the higher quality, higher cost air transport.

The U.N. Series D trade data further show that exports of livestock by Upper Volta, Mali, and Niger to the Ivory Coast constitute a major part of their export trade with that country. In turn, the three countries import foodstuffs, petroleum, manufactured items and chemicals from the Ivory Coast. While part of the livestock are trekked to the abbatoir at Abidjan, a large percentage is transported there from Ougadougou and Bobo Dioulasso in rail cars on the RAN railway. This traffic is likely not to change to air transport. In addition to livestock, Upper Volta exports crude materials and basic manufactures to the Ivory Coast.

1/ Does not include transit traffic; 1976 and 1979 U.N. Series D trade data.

Of all this trade, the most attractive cargoes for airship transport are machinery, basic manufactures and chemicals from the Ivory Coast, which totalled about $23 million in 1976.

Observations indicate that exports from the Ivory Coast to the other three countries, combined with their transit cargo via Abidjan, constitute the bulk of the potential market for air transport, and that there is likely to be less cargo available for the backhaul to Abidjan than inland bound from that port.

Transit Cargo

Transit traffic volumes in the Abidjan corridor are indicated in Tables 51 and 52. Roughly 520,000 mt of commodities are transported, of which about 70 per cent are imports and 30 per cent exports. The unbalanced nature of these trade flows contributes to underutilization of equipment and higher tariffs.

TABLE 51

Transit Cargo in the Abidjan Corridor
(mt 000s)

TO AND FROM	IMPORTS	EXPORTS	TOTAL
MALI (1977)			
By Road	199	97	296
By RAN Rail[1/]	9	13	22
NIGER (1980)			
By Road	7	4	11
UPPER VOLTA (1977)			
By RAN Rail	146	33	179
By Road	6	6	12
TOTAL	367 (71%)	153 (29%)	520

1/ To Ouangolodougou, Ivory Coast railhead, thence by road to destination.

TABLE 52

Scenario 2 - Transit Cargo
Abidjan, Lome, Cotonou

COUNTRY; ROUTE	EXPORTS	IMPORTS	TOTAL	ROUTE DISTANCE (km)	AVG. TRANSIT TIME	ESTIMATED CFAF/TON-KM
ABIDJAN CORRIDOR						
MALI						
Bamako - Abidjan (Road or Rail/Road)	110,000	208,000	318,000	1,225	3-7 days	35.2
UPPER VOLTA						
Ouaga - Abidjan (Rail or Road)	39,000	152,000	191,000	1,159	----	33.1
NIGER						
Niamey - Abidjan	4,000	7,000	11,000	1,685	----	----
NIGER TO OTHER PORTS						
Niamey - Cotonou (Rail/Road)	----	----	296,000	1,060	3 weeks	26.9
Niamey - Lome (Rail/Road)	----	93,000	93,000	1,330	3-7 days	50.3

A schematic diagram, Figure 37, illustrates the routes, tonnages, and distances involved in this scenario.

Because trade between Mali, Upper Volta, and Niger is minimal, it does not appear that potential traffic between Bamako, Ouaga and Niamey at this time supports a direct regional air service on that 1,090-km leg of the itinerary. Existing routes separately provide surface transportation from Abidjan to these population centers, and air cargo is carried to and from Abidjan by Air Afrique and UTA.

Regarding the routing of the airship from Niamey to Abidjan via Lagos and Cotonou, an opportunity might develop in the long run for further exchange between the basically agricultural economies and Nigeria and the Ivory Coast supplying manufactures.

Figure 53 indicates the imputed values of current tariffs on the several routes.

FIGURE 37

SCENARIO 2; ROUTE SCHEMATIC

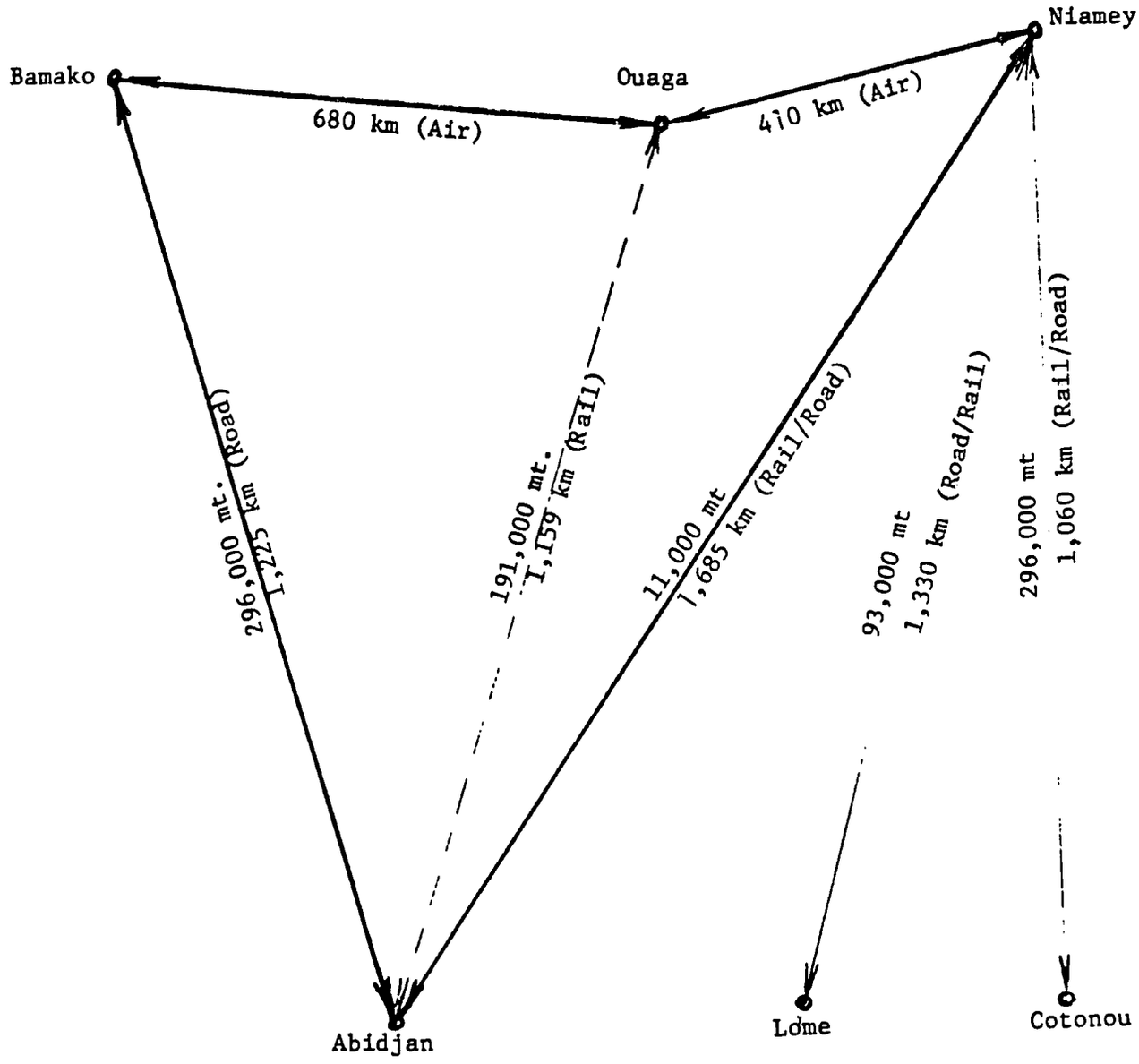


TABLE 53

Scenario 2 - Four Country Regional Service Route

ROUTE	KM	MODE	RAIL TRANSPORT TARIFF (CFAF)	ROAD TRANSPORT TARIFF (CFAF)	CFAF/TON-KM (BASELINE YEAR)	CFAF/TON-KM ADJUSTED TO 1983	EQUIV[3/] $/TON-KM) 1983
ABIDJAN CORRIDOR							
	1,225	Road	----	21.883	21.883	35.243	0.107
ADIDJAN-OUAGADOUGOU							
	1,159	Rail	20.53[2/]	----	20.53[2/]	33.06	0.100
LOME - NIAMEY							
	1,330	Road	----	23.46[2/]	23.46	50.30	0.152
COTONOU-NIAMEY							
	1,060	Rail/Road	----	18.36	18.36	26.89	0.082

AIRCRAFT

Average Cost Per Ton-Km

LTA	10	0.682
LTA	20	0.515
LTA	40	0.420
HTA	L-100	0.455
HTA	F-27	0.631
HTA	DH-5	0.680

Footnotes to Table 53

1/ Includes port charges.

2/ 1975 tariffs; all other rates are 1978 levels - Imputed current tariffs were derived by applying a ten per cent annual inflation factor to 1975 and 1978 tariffs. This is believed to be in line with recent cost increases.

3/ Inputed tariffs on surface routes are shown to be in the range of $.08 -0.15 per ton-km, vs $0.42 for the most efficient aircraft, an LTA 40 airship.

Summary

Preliminary cost estimates indicate that the LTA-40 airship at $.42 per ton-km is the most attractive of all the aircraft tested in Scenario 2. At $.42, its transport cost is from 3 to 5 times the imputed tariffs of the surface modes on the several routes. (See Table 53, right-hand column). Thus, the surface transport tariffs as calculated herein could be in error by from 176 per cent to 412 per cent before reaching the levels of estimated air transport costs.

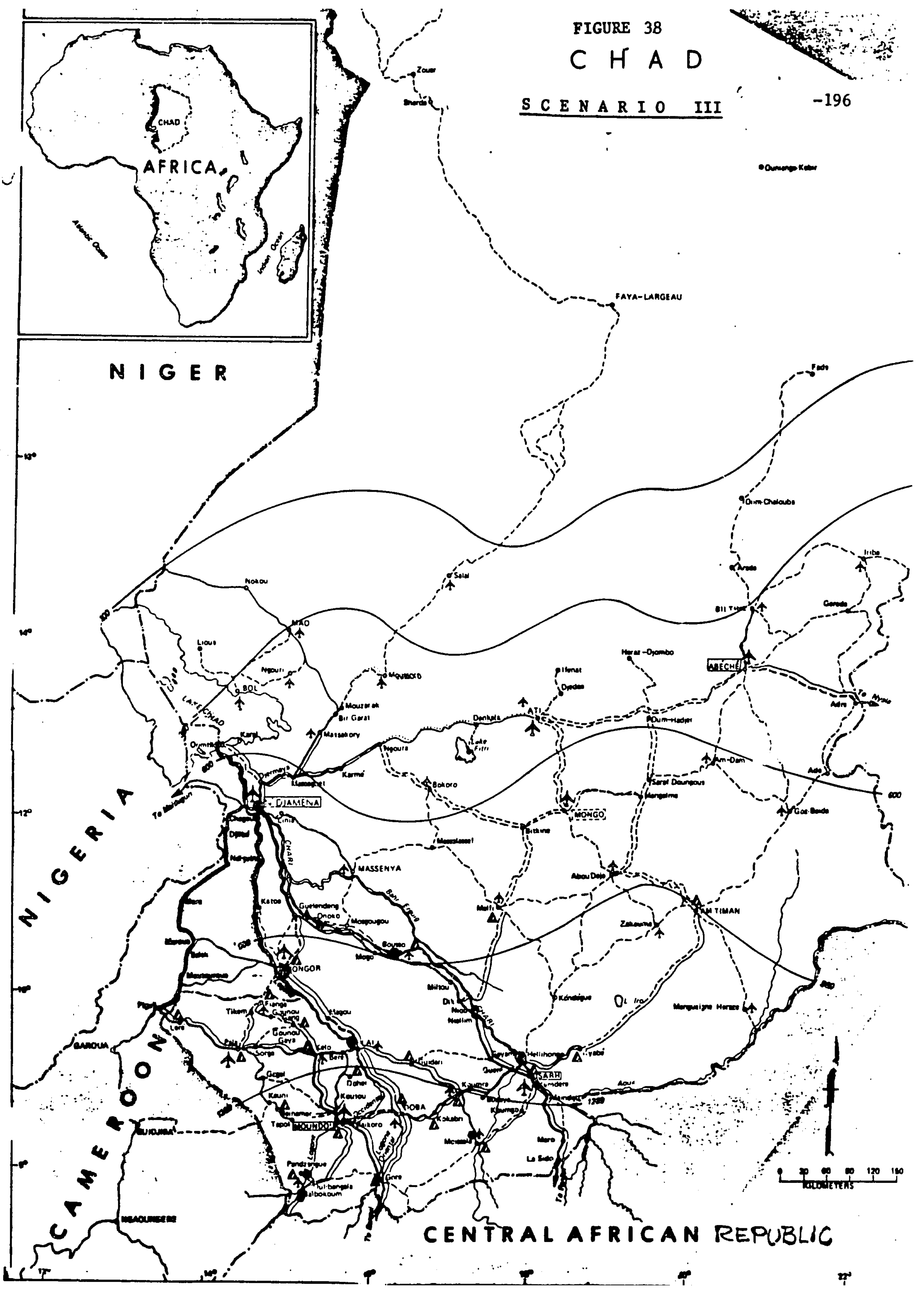
Present trade between Mali, Upper Volta and Niger is likely insufficient to warrant the proposed air service on the Bamako-Ouagdougou-Niamey leg of the itinerary.

Ivory Coast trade with Mali and Upper Volta and transit trade can be carried more economically on existing surface routes at a fraction of the tariff required for this air service.

Similarly, trade to and from Niamey is more economically transported via Cotonou and Lome on existing surface routes than on the proposed itinerary.

However, a further step in the analysis would be to assume alternative levels of high value cargo transport demand which would support a higher air cargo rate in view of the superior 1-day air service and determine the correspanding air transport costs. Through field work it could be determined whether demand for the air service at these prices would be adequate to warrant the service.

FIGURE 38
CHAD
SCENARIO III



Scenario 3 - Chad Domestic Operation

A domestic general utility airship service on a regular (or varied) itinerary is proposed, to provide all-weather service connecting N'Djamena with outlying areas of the country, and to provide a standby capability for diversion to emergency service.

Chad has a particularly difficult transportation problem because of its vast size, low population density, limited economic activity outside the southern corridor and extremely high road construction costs. One airship might provide a least-cost alternative to building and maintaining an expensive road system to support expected low traffic volumes.

The itinerary proposed would link N'Djamena and Abeche, Sarh and Moundou. (See Figure 38.)

The airship system would be capable of using airports and unprepared sites. A cleared space is essential. The aircraft would be useful as a combined cargo-passenger transport, an emergency relief vehicle, and for general administrative operations. A STOL or VTOL capability was deemed necessary.

Only presently available aircraft were considered, on the basis that this operation could be initiated immediately. Three aircraft were selected, with approximately similar payloads. The airplanes were the De Havilland Dash 7, and the Short Skyvan SD3-30. The airship was the Airship Industries Skyship 600, an improved version of the presently certificated Model 500.

The parameter of dollars per hour was used instead of dollars per ton-kilometer as in previous cases. The figure of twenty-eight hundred flight hours per year was taken as the utilization rate. The aiship's current sale price was used instead of allowing for lower production quantity prices. A hangar was also required for the airship and this cost was included. No maintenance facility cost was included for the airplanes, as their major maintenance could be obtained as purchased services. The relevant unit costs (based upon capital taken at 15 per cent) are shown in Tables 54 A-C, which follow:

TABLE 54 A

Operating Costs
($Millions)

TYPE	AIRCRAFT MODEL	PAYLOAD	DIRECT OPERATING COST	INDIRECT OPERATING COSTS			TOTAL OPERATING COST/YR.
				GROUND CREW	MAINTENANCE & OPERATIONS	ADMINISTRATION	
LTA	AI-600	2.25	0.776	.007	.086	.086	0.955
HTA	DASH-7	3.04	4.934	---	.043	.043	5.020
HTA	SD3-30	1.81	2.962	---	.043	.043	3.048

TABLE 54 B

Investment Costs
($Millions)

TYPE	AIRCRAFT MODEL	HANGAR & EQUPT.	AIRCRAFT	TOTAL	ANNUAL COST
LTA	AI-600	2.740	2.800	5.540	.886
HTA	DASH-7	.500	6.200	6.700	1.117
HTA	SD3-30	.500	2.700	3.200	.529

TABLE 54 C

Total Costs
($Millions)

TYPE OF A/C	AIRCRAFT MODEL	ANNUAL OPERATING COSTS	INVESTMENT COSTS	ANNUALIZED COST	TOTAL ANNUAL COST
LTA	AI-600	0.955	5.540	0.886	1.841
HTA	DASH-7	5.020	6.700	1.117	6.137
HTA	SD3-30	3.048	3.200	.529	3.577
Airplane	BN-2B	0.970	.563	.091	1.061
Helicopter	214-ST	5.417	4.150	.693	6.110

The last part of the total cost table shows two other comparative aircraft and their costs per annum. These are shown to illustrate the relative economy of the airship. The BN-28 is a light twin engine STOL airplane with a 1.0-ton payload. The 214-ST is a helicopter with a 1.81-ton payload. BN-2B annual costs are 60 per cent those of the airship, but the BN-2B has only 44 per cent of the airship's payload. If a one-ton payload capacity is adequate for this service, the BN-2B or a smaller airship would represent the least cost system. If a carrying capacity of at least two tons is required the airship AI-600 is the preferred system over all other aircraft types. And the airship with its larger cabin is capable of accommodating a greater variety of payloads than can either the BN-2B or the helicopter 214-ST. In this regard, the helicopter carries only 80 per cent of the airship's payload, while costing over 230 per cent more on an annual basis.

Alternative Surface Transport System

To link N'Djamena with Abeche, Sarh, and Moundou by all-weather surface transport would require the construction of roads in the following sections:

N'Djamena - Abeche	Estimated km	Cost in M S	Unit Cost $/km
Karme - Abeche	650	101.4	156,000[1/]
Abeche - Sarh	1,000	156.0	156,000
Sarh - Moundou			
Doba - Biakoro	84	13.1	156,000
Moundou - N'Djamena			
Bongor - Lai	198	80.0	404,000[2/]
TOTAL	1,932	350.5	

1/ Graveled surface.

2/ Paved surface.

Annual road maintenance including annualized periodic maintenance, calculated at $1,950/km for graveled roads and $3,900/km for paved sections.

The road life is assumed to be 20 years. The annual amortization cost of the road at 15 per cent interest for 20 years is $56.0 million; at 10 per cent it is $41.2 million; at 5 per cent, $28.1 million.

Equivalent Surface Vehicles

The airship logs 2,800 hrs/yr at 136 km/hr. This is equivalent to 380,800 km of travel per year on the circuit.

Trucks with a 2.25-ton payload will be equivalent in loading capacity, but their average speed will be 60 km/hr. Each truck is estimated to have a practical yearly service level of 90,000 km. This then will require four plus, or five truck to equal the service of the airship.

The capital cost of each truck is $15,000 and its operating cost per km on engineered gravel roads will be CFAF 160/km. The total annual vehicle operating cost, including depreciation, will be CFAF 60.9 million, or $184,630 for five vehicles.

Summary

Table 55 reflects these costs and indicates that the combined cost of facility amortization and road and vehicle maintenance will amount to $32.5 to $61 million per year, depending upon the rate of interest, as compared to $6.14 million for the highest cost air system.

TABLE 55

Chad; Surface Transport Alternative; Cost Analysis
(M$)

% Interest	Annual Amortiz. Payment	Annual Road Maint. Cost	Total Annual Facility Cost	Vehicle Operating Cost $/Vehicle-Km Cost	Vehicle Operating Cost Total Annual Cost	Total Annual Facility and Vehicle Optg. Cost
15.	56.0	4.2	60.2	0.485	0.185	60.385
10.	41.2	4.2	45.4		0.185	45.585
5.	28.1	4.2	32.3		0.185	32.485

Observations from Scenarios

These scenarios demonstrate that although some airships such as the 20 to 40-ton hypothetical size offer lower operating costs than airplanes, the capital investments required bring the total cost close to that of airplanes. Thus on the Bamako-Conakry route (Scenario 1), the system cost of a 40-ton airship is about the same as that of an L-100 airplane, while on the longer four-nation route (Scenario 2), the L-100 is the more expensive vehicle by 8 per cent.

It should be emphasized that these comparisons are based on equal ton-km per year; i.e., equal productivity. When equal productivity is the criterion, it takes more or larger airships to equal the total hauling capacity of faster airplanes. When this is not the index of merit, airships of equal payloads are the more economical, as is demonstrated in the case of Chad (Scenario 3).

In the Chad Scenario (and in the others) the use of existing aircraft, e.g., DC-3's and DC-4's, in comparison with modern turbo-prop airplanes and the airships was not brought into the equation. These aircraft are old and limited in cargo carrying capacity. If, however, they were to meet the requirements of the service vis-a-vis cargo configuration and weight, and passenger and cargo transport capacity, and if the airstrip lengths were adequate for their take-off and landing, they could represent the least-cost solution, since their capital costs, as sunk investments, would not enter into the calculations, though operating costs would be relatively high.

A case could be established for a single larger airship where its productivity was equal to that of faster airplanes, but it was decided to limit the maximum airship size to that readily achievable with non-rigids -namely about 40 tons payload. Faster airships are also another possibility, but the sensitivity of gaining productivity by speed vs. total cost would need more detailed study. The speeds chosen for the airships were selected from previous analyses.

Advertised cruise speeds were used instead of block speeds.[1/] These tend to favor the airplane slightly, particularly on short flights, but for this study it was not considered important to make this distinction.

[1/] Block speed is based upon time in flight plus time in landing and taking off, and taxiing.

Each scenario did not include the expense of building runways for airplanes, since airports exist at all the landing points chosen. If this were not the case, the capital costs of airstrip construction would have to be added to airplane system costs. The L-100 requires a 6,000-ft runway for a full gross weight take-off. Since airships are capable of VTOL operation, airports are not needed, although a cleared, level space, a mooring mast and truck accessibility are required.

VII. TRANSPORT OF SAHEL FOODGRAIN IMPORTS

TRANSPORT OF SAHEL FOODGRAIN IMPORTS

Domestic network surface routes, already in place to most Sahel population centers, will continue to carry most U.S. PL-480 foodgrain shipments and those of other donors, which are programmed in advance and shipped to meet anticipated foodgrain production deficits. In these circumstances, internal distribution does not require the speed of air transport nor warrant the higher costs.

To investigate how the airship might relate to emergency foodgrain shipments, data relative to the last great drought, 1972-75 were studied. Table 1 indicates U.S. grain shipments to each of six Sahel countries during the period 1973-75, while Table 2 provides estimates for all donors combined. It is estimated that in the peak year, 1974, tonnages distributed within each country varied from 45,500 mt in Chad to 186,200 mt in Mali. To move these quantities of supplemental cargo at that time it was necessary to consign shipments over a number of alternative routes not used in normal commerce. To illustrate, PL-480 sorghum was trucked from Algiers across the Sahara to Niger and cargo for Niger was landed in Abidjan.

TABLE 1

Sahel Region Drought, 1973-75
U.S. Shipments by Country by FY
(mt)

	FY	COUNTRY						REGIONAL (ALSO INCLUDES GUINEA, CAMEROON AND THE GAMBIA	TOTAL	(%)
		CHAD	MALI	MAURITANIA	NIGER	SENEGAL	UPPER VOLTA			
Grain deliveries	73	5,000	35,000	15,000	46,000	30,000	25,000	-----	156,000	26.2
and commitments	74	25,500	89,277	56,433	110,323	25,250	38,277	8,000	353,060	59.2
(Tentative)	75	349	28,178	4,408	32,197	4,359	3,779	13,910	87,180	14.6
		30,849	152,455	75,481	188,520	59,609	67,056	21,910	596,240	100.0

TABLE 2

Sahel Region Drought, 1973 - 75
Tonnages of Foodgrains Received, by Country
(mt)

	RECIPIENT COUNTRIES							
DONORS	CHAD	MALI	MAURITANIA	NIGER	SENEGAL	UPPER VOLTA	REGIONAL	TOTAL
OTHER DONOR NATIONS	45,878	162,127	95,560	116,718	74,358	75,080	69,500	639,221
INTERNATIONAL ORGANIZATIONS	82	----	402	----	----	----	----	484
U.S. GOVERNMENT	30,849	152,455	75,841	188,520	59,609	67,056	21,910	596,240
TOTAL	76,809	314,582	171,803	305,238	133,967	142,136	91,410	1,235,945
ESTIMATED TRANSPORT SCHEDULE 1/								
1973 (26.2%)	20,124	82,420	45,012	79,972	35,099	37,240	23,949	323,818
1974 (59.2%)	45,471	186,232	101,707	180,701	79,309	84,144	54,115	731,679
1975 (14.6%	11,214	45,930	25,084	44,565	19,559	20,752	13,346	180,448
TOTAL	76,809	314,582	171,803	305,238	133,967	142,136	91,410	1,235,945

1/ Based upon split reflected in Table 1.

U.S. disaster relief foodgrain assistance in Sahel countries since the great drought was also reviewed.

Information on U.S. tonnages and those of other donors is provided below.

1.0 Chad; Civil Strife/Food Shortage, 1978/1979

- U.S. provided 5,254 mt of Sorghum and Sorghum grits; Domestic transportation cost: $66.33/mt.
- Other donors contributed 12,333 mt foodgrains and other foodstuffs.
- Total tonnage of foods amounted to about 17,600 mt.

2.0 Chad; Famine Prevention; 1982

- U.S. contributed 392 mt of bagged wheat, sorghum, flour and lard.
- Britain and France flew in additional foodstuffs.
- An L-100 flown from Oakland, California for the purpose transported the U.S. donation from N'Djamena to the outlying villages of Amtiman, Abeche, Faya-Largeau and Mongo. There were three additional locations where the L-100 could not land.

3.0 Niger-Floods, August 1974

- Twenty tons of U.S. foodgrain were distributed.

4.0 Senegal; Drought/Famine, 1979/1980

- U.S. donated 8,000 mt of sorghum.
- Internal transport: Dakar to inland destinations: $75.00/mt.
- Other donors contributed funds for the domestic transport of 8,000 mt of millet.
- Total tonnage moved: 16,000 mt.

5.0 Senegal; Drought, 1977/1978

- GOS supplied 40,000 of sorghum, 30,000 mt of peanut cake, and 50,000 of wheat.
- U.S. contributed 43,000 mt of sorghum.
- Other donors furnished approximately 185,000 mt of foodstuffs and cattle feed.
- Total tonnage transported: about 300,000 mt.

6.0 Upper Volta Drought, 1977/1978

- U.S. contributed 18,000 mt of foodgrains and other foodstuffs.
- Other donors contributed 31,500 mt additional.
- Total furnished: 49,500 mt.

USE OF AIRSHIPS FOR EMERGENCY FOODGRAIN DISTRIBUTION

Lower system costs on existing networks suggest that trucks will continue to be the least cost transport solution to points which they can reach. To areas inaccessable to trucks, existing or chartered fixed wing STOL aircraft are likely to be the appropriate vehicle, if suitable landing areas exist. Airships would be highly appropriate for this service; however, because the emergencies are sporadic, intermittent and widely

dispersed in the Sahel, it would not be economically feasible to maintain an airship there solely for this purpose. The temporary assignment of an airship already operating in the region to emergency foodgrain shipments, however, would be an ideal application.

VII. LARGER BULK CARGO MOVEMENTS

LARGER BULK CARGO MOVEMENTS

Two railway extensions proposed in the Sahel have not received ready donor support. They are:

i) Extension of the Cotonou-Parakou railway to Niamey;

ii) Extension of the Abidjan-Ouagadougou railway to Tambao.

PARAKOU-NIAMEY EXTENSION

A feasibility study supporting this investment,[1/] though considered over-optimistic in terms of cargo generation and capture, provided data useful for modal comparisons.

The total cost of the extension in 1979 prices was $532 million, amounting to $779 in current 1983 prices at 10 per cent annual inflation.

Table 1 presents the 1990 projections of traffic upon which the investment was predicated. It indicates annual tonnages by 1990 of 1,161,000 mt inbound and 364,500 mt outbound. For the purpose of this exercise let us assume that these traffic volumes are reasonable. Would an airship system be a lesser cost and more attractive alternative? Based upon very preliminary estimates, this is not indicated. This opinion is reached proceeding as follows:

1) Inbound cargo, 1,161 million mt, and distance govern the fleet size.

2) Assuming a 300-day work year, average daily inbound cargo would amount to 3,870 mt.

3) A hypothetical 100-ton airship would make at most an average of one round-trip daily, carrying 100 mt of cargo inbound. (Total length of proposed railway extension = 640 km on a fairly direct route.)

1/ BCEOM study, 1979.

TABLE 1

Cotonou-Parakou-Niamey Rail Extension
Current and Projected Traffic
(mt)

	INBOUND	OUTBOUND
1978 TRAFFIC (COTONOU-PARAKOU)	363,000	27,000
1990 Estimated Traffic 1/		
Niger Mining	411,000	12,500
Other Niger Development and Mali Transit Cargo	529,000	155,000
N. Benin Development	221,000	197,000
TOTAL	1,161,000	364,500

1/ Ref: BCEOM Study, 1979.

4) Daily inbound traffic would require a minimum of 39 100-ton airships, whose estimated unit cost in 1982 was about $70.5 million. The capital cost of an equivalent airship system, not including ground support facilities, would therefore approach 4 times that of the rail system. Its operating costs likely would be higher and its expected lifespan less than that of the railroad.

It is therefore unlikely that the airship would offer a lower cost solution to this volume transport problem than rail.

OUAGADOUGOU-TAMBAO EXTENSION

A 340-km extension of the rail line from Ouagadougou to Tambao would facilitate a Tambao manganese mining project. While data on this proposed rail extension were not available, it is believed that roughly the same cost relationship would obtain in considering the annual movement of 600,000 mt of manganese ore from Tambao to Ouagadougou, but this should be studies with more accurate data and alternative airship sizes in Phase 2.

However, heavy-lift airships or conventional types with VTOL capability may be useful and efficient in transporting ore over short distances from inaccessible mine locations to the nearest railhead in place of constructing costly bridges, tunnels, and roads.

Further, while the airship is not the lowest cost solution to the movement of large volumes of bulk cargo it would be uniquely qualifid to transport heavy cargoes to otherwise inaccessable sites of operation such as new mine sites and oil fields.

VII. SPECIAL APPLICATIONS AND FURTHER OPPORTUNITIES

The airship will be most attractive as a Sahel transport vehicle in the special applications for which it is particularly suited.

The Airship as a Fuel Tanker

A situation perhaps unique to the Sahel is the need to maintain fuel supplies during the rains - conventional airships are likely well suited to cope with the problem in regions lacking other transport means because of weather conditions. During the rainy season, flooding often renders roads to outlying areas unusable and prevents any heavy transport to and from such areas. Air service in these cases is limited to light aircraft operating from short airstrips. These types have neither the payload capacity nor the cargo volume accommodation to permit them to be used. A 20-ton class airship actually carrying 24 tons at lower altitudes would be capable of delivering 7,300 gallons of gasoline or 6,000 gallons of diesel fuel. A 40-ton class would carry twice these quantities. The airship would operate in a VTOL mode using vectored thrust.

A typical example would be service to and from the Arlit uranium mine in northern Niger. An annual supply of 8,700,000 gallons of fuel is required by this operation. It is usually supplied from the railhead at Kano in Nigeria, roughly 800 air km away. An airship route might be slightly longer to avoid having to fly directly over the highest elevations. If a 15-hour round trip is assumed including loading and unloading, a total of 187 deliveries could be accomplished annually by one airship. For a 40-ton airship this accounts for 2.24 million gallons delivered or approximatley 25% of the total needed, which might be sufficient to cover the rainy season.

The new hybrid types of airships have substantially higher capital and operating costs than the conventional airships described herein. However, their higher lift capabilities and more precise control are attractive where VTOL heavy lift is the primary mission. In a NASA-sponsored study it was found that hybrids with payloads in the 50-260 ton range would offer substantial benefits in undeveloped and remote areas in the following missions:

1. Oil and gas exploration and drilling.
2. Development and servicing of mining sites.
3. Pipeline construction and servicing.
4. General heavy lift cargo transport.
5. Maritime cargo discharge.
6. Construction and transport of building.
7. Construction of power plants.
8. Erection of power transmission systems.
9. Construction of refineries and chemical plants.
10. Logging.
11. Offshore oil platform construction.

Investment in such a heavy-lift airship in the Sahel would be feasible only if the number of heavy lift requirements were adequate to generate benefits which would produce an adequate rate of return on the investment. Occasions for the use of this special airship in the Sahel might not be frequent enough to warrant its acquisition. This warrants further study. In the United States hybrids are currently under development as experimental aircraft.

Pipeline Construction

Figure 39 illustrates how the airship, used as a transport vehicle in pipeline construction, could double the work period, save road construction and maintenance costs, provide direct delivery service, bypass obstructions, and help repair pipeline breaks.

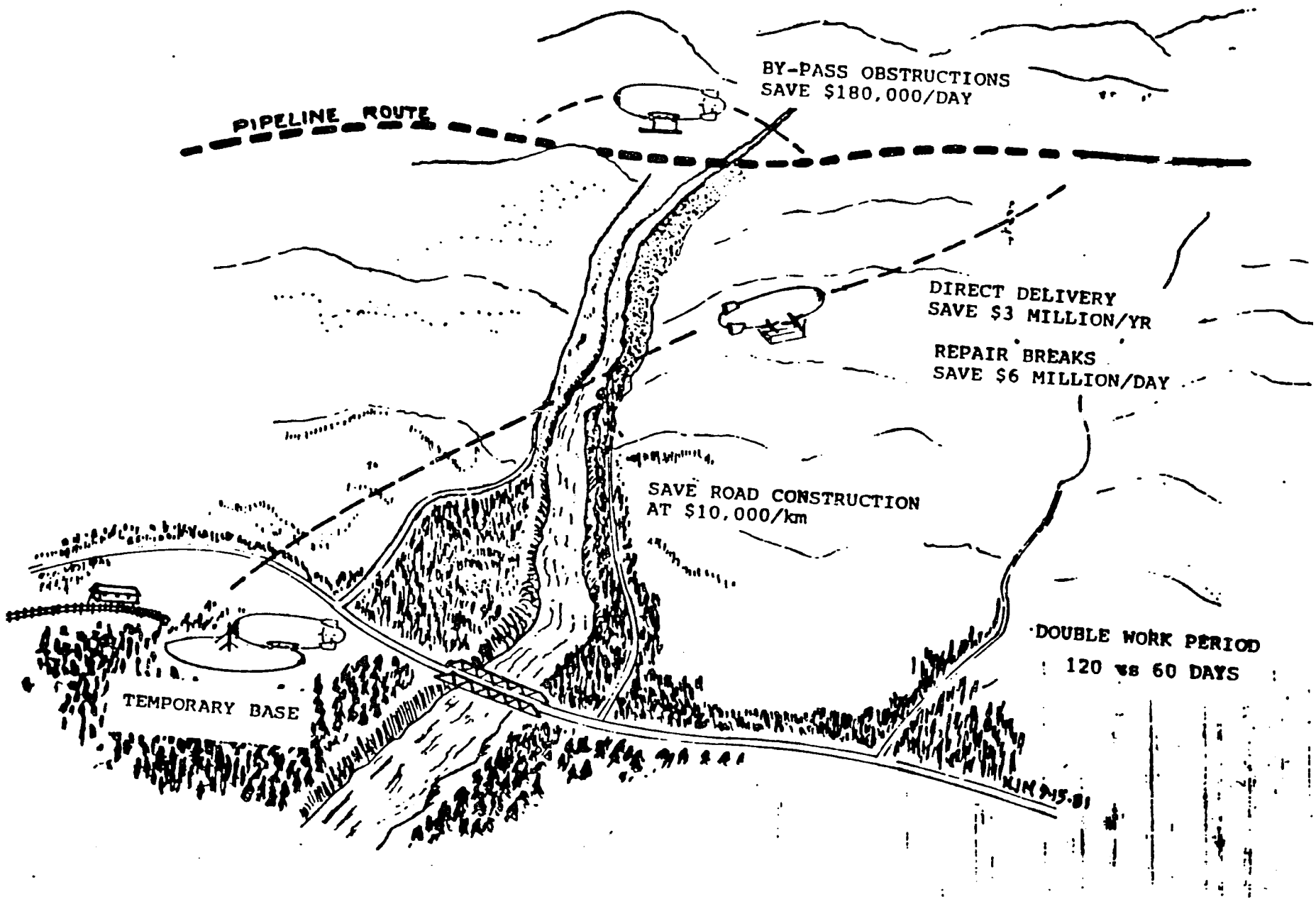
Logging

While lumbering is not a principal Sahelian activity, this description of the use of LTA craft in that undertaking may lead to ideas for adaptations in the Sahel or elsewhere.

Hybrid LTA vehicles offer potential for the harvesting of timber from inaccessible areas. The U.S. Forest Service estimates that a 26-ton vehicle could increase the number of acres from which such logging is feasible by a factor of 21.[1/]

[1/] Ref. 36.

FIGURE 39
PIPELINE CONSTRUCTION



At present, there are many forested areas around the world which are so difficult to reach that the cost of construction of roads and other necessary facilities renders the operation uneconomical. In the U.S., many of these areas are, in addition, under environmental protection such that nothing but aerial logging is permitted. Several systems are used now to avoid damage to soil or other trees as shown in Figure 40. The only system presently capable of significant transport distance is the helicopter.

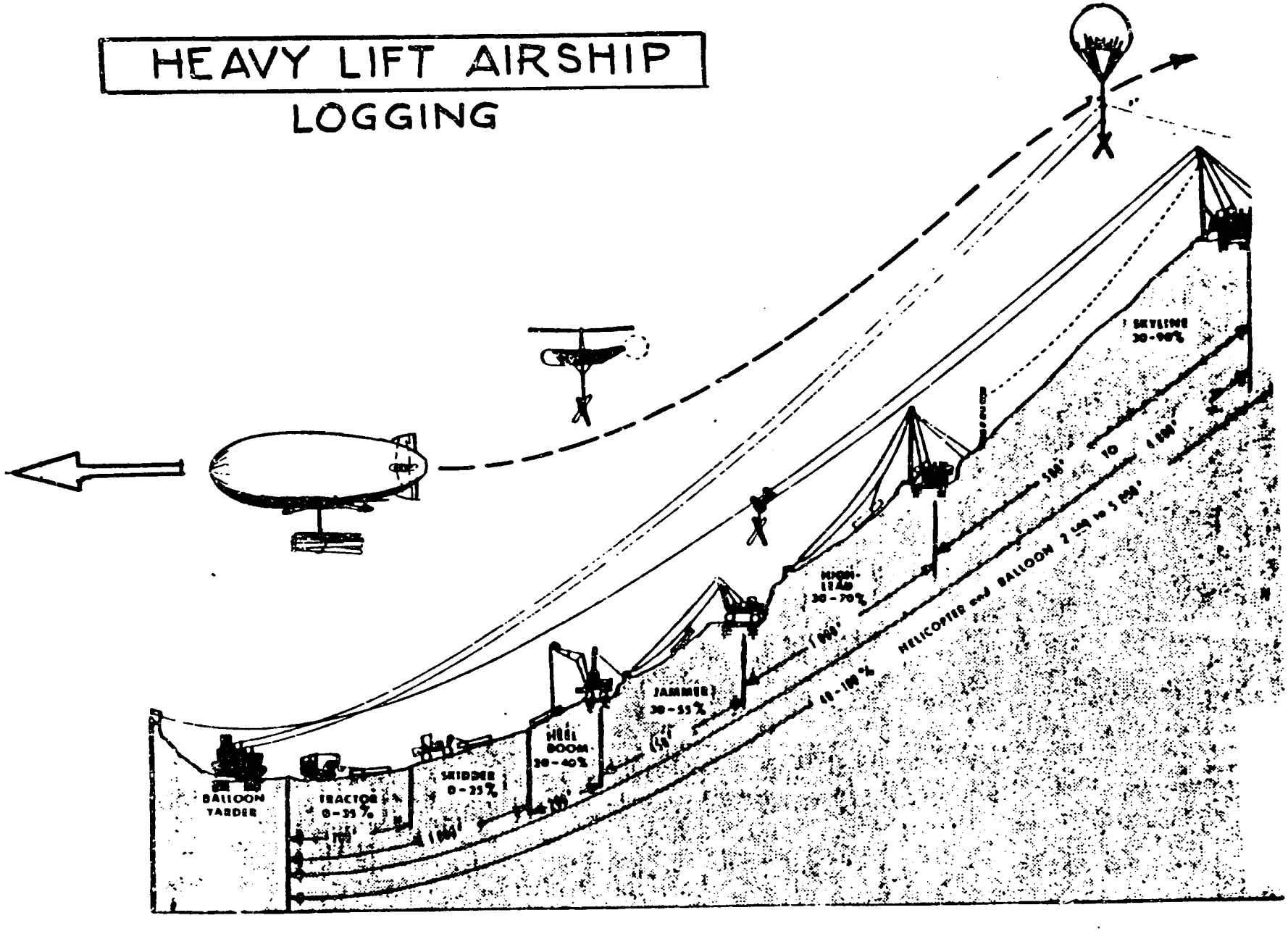
Helicopters are limited both by total lifting capacity and by operational costs. This reduces the economical range to about one mile. The use of airships could increase this to from 3-5 miles.

Estimates made in 1979 indicate that harvesting costs, using hybrid 16-ton airships, would be as low as $126/1,000 bd. ft. of timber compared with helicopter costs of $175.

Coastal Uses

Another attractive area for airship application is that of offshore operation. Countries with coastlines can have need for maritime and oceanographic surveillance, research, and exploration. The U.S. Coast Guard, NASA, and the U.S. Navy are currently engaged in evaluating the potential of airships for this purpose. In addition, the Government of Peru has proposed to implement its fisheries program through the use of airships to replace slower and more expensive surface exploration.

FIGURE 40


HEAVY LIFT AIRSHIP
LOGGING
BALLOON TARDER
TRACTOR 0-35%
SKIDDER 0-25%
HEEL BOOM 20-40%
JAMMER 30-55%
HIGH-LEAD 30-70%
SKYLINE 30-90%
HELICOPTER and BALLOON

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AIR TRANSPORT ALTERNATIVES
VS
SURFACE TRANSPORT IN THE SAHEL

PHASE I - PREFEASIBILITY STUDY
FOR

AID
WASHINGTON, D.C.

CILSS
OUAGADOUGOU, UPPER VOLTA

VOLUME III - ANNEXES

APRIL 1, 1983

224

AIR TRANSPORT ALTERNATIVES

VS

SURFACE TRANSPORT

IN THE SAHEL

A REPORT ON PHASE I

OF A

PRE - FEASIBILITY STUDY

for the

AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D. C.

and the

COMITE PERMANENT INTER-ETATS DE LUTTE
CONTRE LA SECHERESSE DANS LE SAHEL
Ouagadougou, Upper Volta

by

Norman J. Mayer, Aeronautical Engineer, NASA
and
Richard L. Braida, Transportation Economist, DOT

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AIR TRANSPORT ALTERNATIVES

VS

SURFACE TRANSPORT IN THE SAHEL

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ANNEX I

SAHEL REGIONAL OVERVIEW

THE SAHEL -GENERAL

One of the least developed regions of the world, the Sahel consists of eight states:

Senegal	Upper Volta
The Gambia	Niger
Mauritania	Chad
Mali	Cape Verde islands

The seven continental Sahel countries lie in a band stretching 2,600 miles across Western Africa between latitudes 10° and 25° N. They cover some 3.3 million square km, or about 60 per cent of the land area of the United States. Of this vast land over 50 per cent is desert; 20 per cent receives less than 20 inches of rainfall in a four-month wet season and is therefore highly marginal for crop production; less than 30 per cent has rainfall adequate to support rainfed crop production.

The topography is flat and soil variation is slight. The principal eco-climatic zones represented in the area are, from north to south: The Sahara Zone, the Sahel Zone, the Sudan Zone, and the Guinea Zone.

Sahara Zone:	Less than 10 inches of rainfall; accounts for about 50% of the area.
Sahel Zone:	Comprises about 20% of the area; 10 to 20 inches of rain.
Sudan Zone:	20 to 40 inches of precipitation.
Guinea Zone:	Over 40 inches of rainfall.

Climatic and socio-economic indicators for each of the Sahel countries are presented in Table 1.

TABLE 1

CLIMATIC AND SOCIO-ECONOMIC INDICATORS - SAHEL COUNTRIES

Indicator	Chad	Mali	Mauritania	Niger	Senegal	Upper Volta	The Gambia	Cape Verde
Total Area (millions of km^2)	1.28	1.24	1.08	1.27	.20	.27	.011	.004
Rainfall (% of area in region)								
Sahara (less than 250 mm)	51	44	71	60	-	-		
Sahel (250-500 mm)	10	27	15	30	21	8		
Sudan (500-1,000 mm.)	35	20	4	10	61	77		
Guinea (over 1,000 mm)	4	9	-	-	18	15		
Population in 1980 (millions)	4.0 1/	6.3 2/	1.5	5.5 4/	5.7	6.1	0.6	0.3
Population Average Growth Rate %	2.1	2.4	2.3	2.7	1.9	2.0	2.4	1.7
GNP per capita in 1980 (US $)	125 3/	159 1/	340	330	450	210	320 4/	300 4/

1/ 1978 estimate
2/ 1976 estimate
3/ 1975 estimate
4/ 1981 estimate

Transportation links inherited from the colonial past concentrated on penetration of the interior. The interior Sahelian states-Mali, Upper Volta, Niger and Chad-are, except for air service, linked to the rest of the world through the ports of Senegal, the Ivory Coast, Benin, Togo, Nigeria, Cameroon and the Congo.

Development and improvement of transport systems in the Sahelian countries should be programmed to take account of traffic growth emanating from economic development, and of future needs for extraordinary emergency movements. In each case the essential pattern of movement remains the same: each country must have an adequate internal collection and distribution system focused on one or more centers, with a seaport or with efficient links to a seaport. Without such a system to provide dependable low-cost access to foreign markets, there is little chance for any Sahelian country to develop its resources and improve its living standards. Similarly, in the event of a recurrence of the drought situation, the lack of such a system might mean a repetition of the hardships encountered in recent years. For the four landlocked countries in the region, provision of efficient outlets to the sea and hence to world markets depends upon the cooperation of neighboring coastal countries.

The primary inhibiting factor which must be overcome to facilitate Sahelian transport development is the pervasive lack in the Sahelian countries of the financial and technical resources required to achieve the desired objectives; these deficiencies relate not only to construction and improvement of transport links, but equally to adequate maintenance of the developed systems.

In considering possible transport investments in the Sahel, two salient facts must be recognized. First, while there is some scope for specific infrastructural improvements, the existing primary and secondary routes (including present expansion commitments) are basically adequate to the countries' needs, except, possibly, for new resource development. There is consequently much more to be gained from efficient utilization and maintenance of these facilities than from large-scale construction of new infrastructure elements. Secondly, the cost of maintaining the existing transport infrastructure, even at its present level of development, is a heavy and some time intolerable burden on the Sahelian economies in terms of availability of funds and/or technical expertise; further expansion of the network will only increase this burden and will tend to seriously diminish the value of the initial capital expenditure. The success of both of the above elements - efficient use of available transport facilities and adequate maintenance - are vitally dependent upon appropriate government policies and procedures.

There is little traffic between the Sahelian countries since most of them produce and consume the same commodities.

Because trading volumes between the Sahel countries are low, there is little justification on economic grounds for east-west international connections; however, such routes may serve an important domestic distribution or socio-political function, and may be supported for these reasons if constructured only to standards appropriate to traffic requirements, and if, as far as possible, they are directly linked to an increase in economic productivity of the areas served.

Past Performance of International Transport Systems

The transport systems of the Sahelian countries were sorely tested in the recent past by the need to import and distribute large quantities of food and supplies following the crop failures which resulted from prolonged and widespread drought conditions. These large-scale movements entailed the importation of various commodities of which a sizeable portion were transit movements through a foreign seaport; and distribution of grain and supplies from a central terminal in each country (usually the capital) to outlying areas. Shortcomings developed in the flows of traffic, arising as much from poor planning of shipment arrivals and inefficient operation of the transport system as from a lack of infrastructure and services, but on the whole, existing transport facilities were shown to have a surprising capacity to handle traffic volumes considerably above normal levels, albeit at the cost of some deterioration of the road network.

Air Transport

There appears to be some scope for the further development of domestic air services, particularly because of the long distances to remote areas in the Sahelian region, as well as the high cost of building and maintaining roads.

Aviation in the region is better coordinated than other modes because of the existence of an international infrastructure/navigational aid agency (ASECNA), which provides the necessary services at international airports,

and also trains personnel. International air transport services are provided mainly by the Air Afrique/UTA Group which enjoys a de facto monopoly position.

In addition to the Air Afrique services, domestic airlines of the countries provide local and some international services, mostly in West Africa. Better coordination or even integration of the existing domestic lines into a multi-national regional airline would most likely produce substantial economies in the form of standardized equipment, better utilization of such equipment with improved schedules, additional stopovers, and elimination of partially duplicated services.

Road Transport

As a consequence of the small, scattered populations in the Sahelian countries, the low level of economic activity, and the vast distances to be covered, road transport supplemented by air transport appears to offer the best modal system combination.

Domestic Road Networks

While the prime arteries of the Sahelian countries' transport systems are access routes to ports, an efficient network from farms to major collection centers within each country is of vital importance to its economic development. Without adequate facilities, (including provision for proper storage of foodgrain crops), there is little scope for the country's development from a subsistence to a market economy, for opening up new areas

for agricultural development, or for adequate distribution of food and supplies during emergency situations.

The weakness of the local distributive networks was particularly obvious during the most recent drought; this weakness stemmed not only from the actual lack of transport facilities, but equally from their poor condition from lack of maintenance of the existing infrastructure. Roads were badly damaged even with relatively few vehicle movements, and many were impassable during the rainy season. World Bank Group experience with road maintenance projects has revealed that most of the Sahelian countries lack the financial resources, expertise, and equipment to maintain their road networks to anywhere near the design standards; moreover, even when adequate technical assistance and maintenance equipment are supplied through foreign aid, provision of the recurrent local expenditures required often places a formidable strain on the country's budgetary resources. It is therefore clear that although the road systems in these countries are limited, there is nevertheless already the danger of overexpansion of the infrastructure in relation to the country's overall ability to maintain it to acceptable standards. It follows that great care should be exercised in assessing the justification for extensions or improvements to the existing infrastructure to ensure, first, that the proposed expenditure, whether met from local or foreign aid sources, represents an investment of top priority in the government's development plan; and second, that the proposed investment will result in, or directly contribute to, real economic growth. An appropriate example of an investment that meets these criteria would be a project for constructing roads vital to an integrated rural development scheme.

In light of all of the above, and in recognition of the fact that every additional kilometer of road constructed aggravates an already bad maintenance problem, it is clear that better economic returns would be realized from investments directed to proper maintenance of the existing system.

The major problem in improvement of the Sahel transport system is the lack of adequate maintenance (including limited upgrading) of existing roads. Donors financing projects in the region have long been aware that adequate maintenance was deficient due to the lack of proper equipment and technical expertise, and these elements have been provided. However, insufficient recognition has been given to the fact that the Sahelian countries are unable, because of limited resources and higher funding priorities, to provide a sufficiently high recurrent budget for maintenance purposes. As a result, roads deteriorate to the point where a major investment is necessary for either complete rehabilitation or expensive deferred maintenance programs to restore them to their original design standards.

Though there appears to be little scope for using specialized road transport vehicles in the Sahel in lieu of costly road construction, there seems to be a case for greater use of animal transport to and from road collection points in areas where traffic is too low to warrant road construction, and for the use of aircraft as least-cost extensions of the major arteries where distances are long, transport volume is low and road construction costs are high.

Rail Transport

The main railway systems used for the transport of goods and passengers within and outside the Sahel countries are the Dakar-Bamako line (ownership and operation divided between Senegal and Mali); the Abidjan-Ouagadougou (RAN)[1/] line (owned and operated jointly by the Ivory Coast and Upper Volta), and the Cotonou-Parakou line (Benin). The Nigerian Railway has been the traditional outlet for exports from eastern Niger, but its effectiveness has been seriously restricted by poor service on the railway and congestion at the Nigerian ports. The Ghana railway system is similarly inept. The Conakry-Kankan line in Guinea, which theoretically offers the shortest route to Bamako (920 km, supplemented by road connections), is in serious need of rehabilitation, and cannot be considered a competitor for Sahel traffic. The Cameroon railway, recently extended to N'Gaoundere, offers services into southern Chad with some road connections.

Chad and Niger have no railways; Mali and Upper Volta have a single line connection to the ports of Dakar and Abidjan respectively; Mauritania's railway is largely an enclave operation serving the iron ore industry; only Senegal has a railway system of significant national consequence. All the existing rail systems (except Mauritania's) were conceived and developed well before modern road transport services came into their own; today, largely as a result of the impact of road competition, the railways are all in a precarious financial position.

1/ Regie de Chemin de Fer Abidjan-Niger.

While there is considerable interest in constructing new railways or extending existing lines, there is little case for such proposals. Traffic is insufficient to warrant railway construction, unless substantial mineral deposits or other sources of high-volume bulk traffic materialize in the future.

As a general rule, railway construction is considered justified when annual traffic is forecasted to reach, at the very least, about 500,000 tons per kilometer of line. In comparison with this figure, the total volume of principal agricultural products carried by rail in the Sahelian countries amounted to only 8 million tons in 1970, the last year before the drought conditions began to take effect, and half of this consisted of millet and sorghum consumed within a short distance of the production areas. An additional 1.2 million tons of Senegalese phosphates, constituting 74 per cent of CFS traffic are moved to the port of Dakar.[1/] The only significant export crops were groundnuts and cotton, and of the one million tons transported, one-half originated in Senegal, relatively near the port of Dakar. With import traffic included, the volume of traffic available is still insufficient to warrant new railway construction in the foreseeable future, except in special cases where ore deposits might provide significant amounts of specialized bulk traffic. For low density movements, road transport costs are seen to be significantly lower than those for rail; however, where existing railways can be utilized over long distances, the marginal cost of rail transport should be lower than for road services. It

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1/ CFS: Regie des Chemins de Fer du Senegal.

should therefore be quite economical to improve and maintain railways which cater to such traffic, while avoiding investments in new line extensions and pursuing a policy of closing unprofitable branch-line services.

While there is no scope for additional railway extensions in the Sahel to handle normal traffic volumes, there is a considerable need to improve the operational and management efficiency of the existing systems. In varying degrees, all the railways which serve the Sahel are operating below capacity because of their inefficiencies and the resulting success of road competition even for comparatively long-haul traffic. Firm government policies should be adopted to permit the railways to operate as commercial entities, and a major effort should be made to improve financial, technical, and mangement standards.

The shortcomings of all the railways serving the Sahel were most apparent during the post-drought relief operations. Since most were unable to carry the volumes offered, and with difficulty carried the amounts actually handled, they had to relinquish other traffic to road services. This situation was generally due not to a lack of traffic or equipment capacity, but rather to operational inefficiencies, poor equipment maintenance, and an overall lack of management competence. Most of the railway systems are financially weak, and are increasingly threatened by competition from road transport.

Water Transport

Waterways

There is little physical scope for extension of river and lake transport beyond current levels, with the exception of the potential of the ongoing studies being carried out by the Senegal River Basin Commission to harness the river and develop its valley.

While this mode holds promise in terms of low operating costs (ranging from 2.5¢ to 4¢ per ton-km on annual volumes of 1 million to 50,000 tons), there is limited scope in the Sahelian region for such services.

The only organized river services of any consequence are the seasonal barge operations on the Senegal River between Saint Louis, Senegal and Kaedi, Mauritania, and long-distance haulage of bulk goods on the Niger River between Bamako and Gao. Both these services are gradually losing ground to road transport as routes are extended and improved.

Ports

Most of the ports serving the Sahel are reasonably efficient in loading and unloading operations, and many provide bonded areas and storage facilities for the landlocked countries. However, there are apparent shortages of storage and handling facilities at peak seasons, and these stem partly from a lack of coordination between private operators functioning in the port. Some inefficiencies also arise because many high-level port authority

personnel lack commercial expertise. Future investments in port installations should incorporate productivity targets for existing facilities and equipment, and emphasize recruitment of adequately qualified professional staff.

Mauritania, Senegal and The Gambia are the three mainland Sahelian countries with direct access to the sea. However, Mauritanian road and rail facilities do not provide port access for landlocked neighbors. The critical port situation during the emergency drought period (when traffic for the region increased by 50% at Dakar and 40% at Abidjan over two years) was attributed largely to the lack of adequate storage capacity both in the ports and in the recipient countries, as well as to congestion in the land transport services. Basically, the ports performed well in the loading and unloading of ships, and waiting time was held to a minimum.

Efforts have been made in the neighboring coastal countries of Cameroon, Benin, Ivory Coast, Senegal, and Togo to associate the enclave countries with their port administrations, and to provide special facilities such as bonded sheds and zones, or preferential tariffs. Nigeria and Ghana have not participated to any significant extent in this effort, which probably explains in part why the routes through these countries are underutilized, although they may actually be more economical than some routes through the French-speaking countries. This situation may improve with the recent establishment of a West African Ports Association (in which enclave countries are accepted as members) and of the Economic Community of West Africa.

In principle, long-term storage should be provided or encouraged in ports. Authorities have in the past been very lenient in accepting storage of transit goods, and this discouraged consignees of cargo from developing their own storage facilities outside the port customs area. Storage facilities must, however, be available to users in or near the port area, if only for a limited period. These facilities can either be provided by the port authority and leased to users at appropriate rates, or directly by the consignee or by the forwarding agent. All three alternative solutions are utilized in ports serving the Sahel. However, under normal traffic conditions, the total area available appears inadequate, and sheds or warehouses are congested during the peak produce trading period, although they remain half empty for the other six months of the year. All the storage operators, whether private as in Dakar and Abidjan, or public, as in Cotonou, are reluctant to invest in storage space or facilities that might be underutilized; on the other hand, they are not always willing to pool their equipment and facilities, an arrangement which would permit more efficient use of overall storage capacity.

Road Construction and Maintenance Costs and Expenditures

Representative construction and maintenance costs for Sahelian roads are indicated in Tables 3 and 4.

TABLE 3

Road Construction Costs[1/]

PROJECT ROAD	CONSTRUCTION TYPE OF WORK	LENGTH KM	COST CFAF BILLION=	COST U.S. $M	COST U.S. $/KM
UPPER VOLTA					
N1 Honde-Sakoinse	Paving	190	14.0	42.4	223,158
N4 Koupela-Fada N'Gourma	Paving	80	6.8	20.6	257,500
N4 Fada N'Gourma-Niger Border	Paving	169	12.8	38.7	228.994
N7 Banfora-Ivory Coast Border	Paving	70	4.4	13.3	190,000
N3 Ouagadougou-Kaya	Paving	98	12.0	36.3	370,408
R1 Barsalogo-Kaya-Tougan	Regravelling	335	9.2	27.8	82,985
R3 Djibo-Baraboule	Regravelling	27	0.4	1.2	44,444
D12 Ouhigouya-Djibo	Regravelling	109	2.0	6.0	55,046
D12 Dori-Djibo	Regravelling	188	8.0	24.2	128,723
Dori-Falagoutou	Regravelling	44	0.8	2.4	54,545
CHAD					
Moundou-Guidjiba, Cameroon;	Paving	304	43.9	132.9	437,170
NIGER					
Tahaoua-Agadez-Arlit	Paving	650	26.3	79.7	122,609
MALI					
Bamako-Bougouni	Paving	156	11.83	35.85	229,800
Bamako-Kangaba-Guinea Frontier	Engineered Gravel	118	5.80	17.56	148,810
Sevare-Gao	Paving	568	26.73	80.98	142,570
Bougouni-Yanfolila-Guinea Frontier	Engineered Gravel	125	9.98	30.24	241,920
Kayes-Nioro	Engineered Gravel	251	7.16	21.71	86,490

1/ Baseline year estimates were adjusted to equivalent 1983 prices; inflation rates; Chad: 15%, others: 10%.

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TABLE 4

Road Maintenance Costs in the Sahel[1/]
(CFAF/km/yr)

		Routine Maintenance	Periodic Maintenance	Total CFAF	Total, CFAF Adjusted To 1983 (000)	Equivalent U.S. $ 1983
PAVED ROADS						
Gambia	(1981)	n.a.	n.a.	533.4	645	1,955
Upper Volta	(1982)	331	621	952	1,047	3,173
Mali	(1982)	n.a.	n.a.	1,318.6	1,516	4,595
Mauritania	(1980)	963.6	1,485	2,448.6	3,259	9,876
Niger	(1981)	157	635.5	794.5	874	2,648
Senegal	(1981)	246	456	702	849	2,573
MPROVED EARTH ROADS						
Gambia	(1981)	n.a.	n.a.	448.8	543	1,645
Mali	(1982)	141.4	342.2	483.6	725	2,198
Mauritania	(1980)	528	594	1,122	1,493	4,525
Niger	(1981)	345	270	615	744	2,255
Senegal	(1981)	n.a.	n.a.	124	150	455

1/ Reference 15.

ANNEX II

ECONOMIC PROFILES

AND

TRANSPORT INFRASTRUCTURE

1. CAPE VERDE

A small archipelago consisting of fifteen islands some 650 km. off the coast of Senegal, Cape Verde has a population of about 296,000, half of which is located on Santiago Island, the largest island and the location of the capital, Praia. Figure 1, a map of the archipelago, indicates the geographic spread of the nine inhabited islands, while Table 1 gives the population and areas of the islands.

While the 1978 GDP per capita was only $170, remittances from Cape Verdeans living abroad almost double the GNP and contribute to a better living standard than is reflected by GNP alone. Cape Verde is subject to the typical Sahel development constraints, including the lack of natural resources, poor soils, low and unpredictable rainfall, and droughts. Maintaining adequate transport connections within the country and with the rest of the world are a further burden.

Fishing is the main economic activity, contributing one-third of Cape Verde's exports. Agriculture is limited to small holder subsistence farming, and industry is practically nonexistent.

FIGURE 1

REPUBLIC OF CAPE VERDE

REPUBLICA DE CABO VERDE

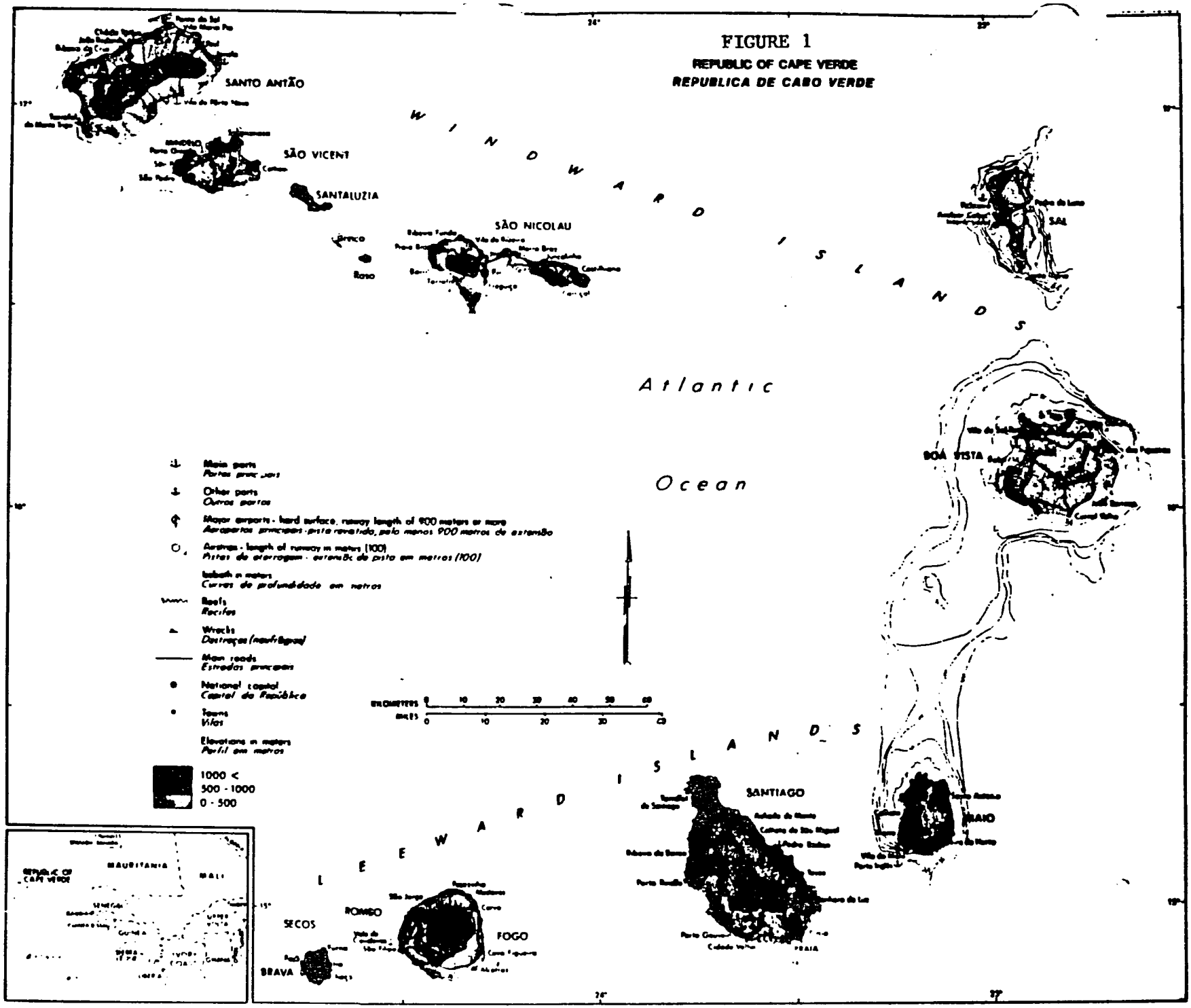

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TABLE 1

CAPE VERDE

Population and Area of Individual Islands (1960-80)

	Population				Annual Growth Rate (%)		Area	Population per Km^2
	1960	1970	1980	%	1960-70	1970-80	(km^2)	1980
Windward Islands								
Santo Antao	33,753	45,051	43,198	14.7	2.9	-0.4	779	55.5
Sao Vicente	20,883	31,586	41,792	14.1	4.2	2.8	227	184.1
(Mindelo)			(33,200)					
Sao Nicolau	13,772	16,320	13,575	4.6	1.7	-1.8	338	40.2
Sal	2,584	5,642	6,006	2.0	8.1	0.6	216	27.8
Boa Vista	3,218	3,463	3,397	1.1	0.7	-0.2	620	5.5
Subtotal	74,210	102,062	107,968	36.5	3.2	0.6	2,180	49.5
Leeward Islands								
Maio	2,632	3,451	4,103	1.4	2.7	1.7	269	15.3
Santiago	88,344	129,508	145,923	49.2	3.9	1.2	991	147.3
(Praia)			(55,318)					
Fogo	25,571	29,692	31,115	10.5	1.5	0.5	476	65.4
Brava	8,539	7,858	6,984	2.4	-0.8	-1.2	67	103.6
Subtotal	125,086	170,509	188,125	63.5	3.2	1.0	1,803	104.3
Total	199,296	272,571	296,093	100.0	3.2	0.8	3,983	74.3

Source: Direccao General de Estatistica, Population Censuses 1960, 1970 and 1980

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While in the past the combination of poor soils and poor rainfall has precipitated starvation and massive emigration, it now evolves that Cape Verde must import food and distribute it among the islands at relatively high cost. Government policy is to subsidize transport costs and distribute essential goods at the same price throughout the country, regardless of the location of islanders.

Table 2, Imports and Exports, shows that the value of exports amounted to only 5-6 percent that of imports in 1975 and 1976. Significantly, though Cape Verde is primarily an agrarian economy, only five percent of foodstuffs consumed are produced domestically. Table 3 indicates export and import tonnages of principal commodities traded in 1980.

In recent years, imports have amounted to about 150,000 mt annually, of which food represents half. Donor assistance has contributed a large part of the main staples (maize, rice, wheat, beans, sugar, and edible oils).

A former Portuguese colony, Cape Verde maintains its strongest trading ties with Portugal and with Guinea Bissau, another former dependancy of Portugal. A perspective of these and other trading partners is provided in Table 4.

TABLE 2
CAPE VERDE FOREIGN TRADE
IMPORTS AND EXPORTS
('ooo escudos)

IMPORTS	1975	1976	EXPORTS	1975	1976
Animal and animal products	53,445	30,232	Animals and animal products	10,989	14,165
			Fresh, frozen and chilled fish	6,612	6,185
Vegetable products	253,281	181,902	Crustaceans and molluscs	4,298	7,265
Beans	53,837	18,437			
Corn			Foodstuffs and beverages	5,882	4,921
Fat and oils	68,439	71,123	Prepared and preserved fish	3,546	977
Pork fats and lard	44,967	38,859	Water for ships stores	1,892	
Foodstuffs and beverages	185,541	161,978	Mineral products	1,642	4,380
Milk and cream	39,407	20,227	Salt	1,580	4,270
Wheat-flour	40,218	30,397			
Wines					
TOTAL (INCL. OTHERS)	1,010,855	910,877	TOTAL (INCL. OTHERS)	61,277	48,034

TABLE 3

CAPE VERDE IMPORTS AND EXPORTS [1/]
1980

COMMODITIES	IMPORTS (MT)	EXPORTS (MT)
Tuna (Frozen)		731
Tuna (Canned)		295
Bananas		950
Salt		11,455
Lobster (Live)		29
Petroleum Products	16,025	
Corn	41,911	
Rice	10,274	
Sugar	7,183	
Other	74,600	40
APPROX. TOTAL----------	150,000	13,500

1/ Ref. 22.

TABLE 4
MAIN TRADING PARTNERS
(Escudos ooo's)

IMPORTS	1975	1976	(%)	EXPORTS	1975	1976	(%)
Sahel Counties				Sahel Countries			
None				None			
Other Africa				Other Africa			
Angola	109,277	21,974	—	Angola	n.a.	6,920	—
Guinea Bissau	na.	na.		Central African Empire	602	1,320	—
				Guineau-Bissau	747	1,598	13
				Sao Tome e Pincipe	n.a.	1,794	—
				Zaire	n.a.	2,570	7
Rest of World				Rest of World			
Netherland	36,947	46,258	--	Portugal	54,397	30,147	62
Portugal	634,301	530,961	41	United Kingdom	2,301	2,168	--
United Kingdom	28,442	27,371	5				
U.S.A.	20,690	16,342	7				
W. Germany			8				
TOTAL (INCL. OTHERS)	1,010,853	910,877		TOTAL (INCL. OTHERS)	61,277	48,034	

Transport

For decades Cape Verde has derived important benefits from its strategic location as a transit facility, first as a bunkering port for coal and oil burning vessels, and more recently as a stopover and refueling stage for international air flights between the USA and South Africa, as well as between Central and South America and Western and Eastern Europe. The modern international airport at Sal Island - the only one capable of receiving jets - links Cape Verde with the rest of the world, as do the two main ports, Port Grande, at Mindelo, Sao Vicente; and Praia, Santiago.

Competition between transport modes, often a problem in other countries, is not an issue; it is limited to interisland service, where air and interisland shipping cater to significantly different segments of the market.

Road Transport

The road system, though miniscule (it totals only 750 km) is of good quality and is well maintained. About 50 percent is paved with waterbound macadam. See Table 5.

Road transport demand on the individual islands is limited to suburban road service.

TABLE 5

CAPE VERDE

Road Network
(kilometers)

Island	Bitumen and Cobblestone Roads		Improved Earth Roads		Unimproved Tracks	Total
	6m	3.5m	6m	3.5m		
Santiago	157	16	42	8	25	248
Sao Nicolau	--	18	--	11	38	67
Fogo	3	36	23	--	57	119
Sao Vicente	9	6	--	38	--	53
Santo Antao	54	14	--	22	163	253
Sal	--	--	18	--	--	18
Total	223	90	83	79	283	758

The small size of the road system does not seem to be an important development constraint, since the country's key means of communication - internally, and with the rest of the world - are water and air transport.

Water Transport

Ports and shipping are the most important elements of the transport sector.

Two deep water ports exist. Formerly, Mindelo on Sao Vicente Island in the northwest of the archipelago was the principal deep water port for the receipt and shipment of imports and exports, with subsequent transshipment in smaller vessels to the other islands. While relatively modern, having been completed in 1959, Mindelo (Porto Grande) was designed primarily as a bunkering facility for international shipping. As a consequence of changes in world trade patterns and vessel technology, demand for its refueling services declined from 700,000 mt in 1954 to 90,000 mt in 1978. Consequently, the Government is considering studies leading to the revitalization of Mindelo as a cargo port. Since the 1977/78 development of Praia on Santiago Island as a second deep water port, increasing amounts of imports are shipped via Praia, with transshipment as called for to the other islands. By 1979 Praia handled 55 percent of the total import tonnage, or over 84,000 mt, while Mindelo received the balance.

All seven other inhabited islands have port facilities - small harbors and piers - though some are limited to no more than primitive lighterage accommodations.

Passengers traveling by sea or air between islands and food and other imports transshipped from Mindelo and Praia to the other islands constitute the major element of transport demand. Cargo transshipped via the two ports to the other islands amounted to 65,000 mt in 1979 and about 74,000 mt in 1980.

Rehabilitation of the new deep water port at Praia, and upgrading of the interisland fleet are needed to improve international and domestic shipping service. In its Praia Port Project, Jan. 1983, the World Bank plans to rehabilitate 520 m of berthing facilities built in 1977, which have prematurely deteriorated as a consequence of faulty design and construction.

Shipping

Quite widely dispersed - the two major population centers of Mindelo and Praia are 160 nautical miles apart - the nine inhabited islands rely on shipping as the principal means of cargo and passenger transport, both interisland and foreign.

Interisland shipping, operated by the state-owned ARCAVERDE, moves passengers and cargo. Considered an essential lifeline between the islands for the bulk of their commerce, the company is operated efficiently.

We see in Table 6 that cargo loaded at Porto Grande (Mindelo) for interisland delivery totalled about 55,800 mt in 1980, while at Praia the amount was about 18,100 mt. These tonnages largely reflect imports via Porto Grande and Praia in transit to other island destinations. In contrast, the aggregate of loadings at all the other islands, constituting the balance of interisland trade, amounted to 6,500 mt, of which 50 percent originated at Porto Ingles. The flow of cargo is thus predominantly outward from Porto Grande and Praia to the lesser islands. The composition of cargo, with forecasts for Praia and Porto Grande ports, is indicated in Tables 7 and 8.

Air Transport

International

The international airport, located on Sal Island, accommodates intercontinental jet transports for refueling purposes, receiving about ten flights per day. TACV, the Government airline, serves Dakar and Guinea Bissau on the African mainland.

TABLE 6
CAPE VERDE

Traffic - All JAP Ports 1980
(excluding bunkering and water supply)

JAP Ports	Cargo (Tons)							Ships(a)		
	Foreign			Interisland				Foreign Trade	Interisland	Total
	Import	Export	Total	Unloaded	Loaded	Total	Total			
Santo Antao										
Paul				1,307	536	1,843	1,843	--	59	59
Ponta da Sol				3,604	--	3,604	3,604	--	25	25
Porto Novo				10,554	873	11,427	11,427	--	421	421
Tarrafal MT				5,808	--	5,808	5,808	--	33	33
Subtotal				21,273	1,409	22,682	22,682	--	538	538
Sao Vicente										
Porto Grande (Mindelo)	84,187	13,787	97,974	8,895	55,791	64,686	162,660	282	592	874
Sao Nicolau										
Priguica				6,693	73	6,766	6,766	--	76	76
Tarrafal				3,112	299	3,411	3,411	--	69	69
Subtotal				9,805	372	10,177	10,177			
Boa Vista										
Sal Rei				2,982	252	3,234	3,234	--	47	47
Maio										
Porto Ingles				5,184	3,281	8,465	8,465	--	97	97
Santiago										
Praia	89,536	855	90,391	22,120	18,079	40,199	130,590	158	158	316
Pedra Badejo				1,250	628	1,878	1,878	--	51	51
Subtotal				23,370	18,707	42,077	132,468	158	209	367
Fogo										
Vale dos Cavaleiros	--	--	--	12,927	413	13,340	13,340	--	287	287
Brava										
Furna	--	--	--	4,010	177	4,187	4,187	--	186	186
Total JAP Ports	173,723	14,642	188,365	88,446	80,402	168,848	357,213	440	3,452	3,892

(a) Includes passenger ferries, mostly between Porto Grande and Porto Novo.

Source: JAP

TABLE 7

CAPE VERDE

Traffic - Ports of Praia and Porto Grande (1976-1981)

(Excluding Overseas Ships' Bunkering, Oil and Water Supply)

	1976			1977			1978			1979			[illegible]			[illegible]		
	Overseas	Interisland	Total	Overseas	Interisland	Total	Overseas	Interisland	Total	Overseas	Interisland	Total	Overseas	Interisland	Total	Overseas	Interisland	Total
Port of Praia																		
Ship Movements																		
Alongside	-	-	-	-	-	-	-	-	-	93	107	200	102	122	224	102	173	275
G.R.T.	-	-	-	-	-	-	-	-	-	221,915	20,140	242,055	234,519	15,829	240,348	220,547	32,023	252,570
Lighterage	109	201	310	106	152	258	129	145	274	42	76	118	56	36	92	-	-	-
G.R.T.	327,522	42,159	369,651	232,215	28,137	260,352	265,806	24,901	290,707	184,783	7,884	192,667	181,798	10,090	191,888	-	-	-
Total																		
Ship Movements	109	201	310	106	152	258	129	145	274	135	183	318	158	158	316	102	173	275
G.R.T.	327,522	42,159	369,681	232,215	28,137	260,352	265,806	24,901	290,707	406,698	28,024	434,722	406,317	25,919	432,236	220,547	32,023	252,576
Cargo (Tons)																		
Unloaded	45,947	24,146	70,093	51,303	24,288	75,591	68,695	27,142	95,837	71,811	15,366	87,177	89,536	22,120	111,656	78,879	15,066	103,145
Loaded	1,796	8,008	9,804	1,438	10,626	12,064	1,042	12,237	13,279	687	14,364	15,051	855	18,079	18,934	5,423	27,850	23,272
Transit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	47,743	32,143	79,897	52,741	34,914	87,655	69,787	39,379	109,116	72,498	29,730	102,228	90,391	40,199	130,590	93,492	32,925	126,417
Passengers																		
Disembarked	1,778	4,174	5,952	118	3,325	3,443	15	2,029	2,044	67	2,849	2,916	3	3,304	3,307	121	4,064	4,185
Embarked	654	2,926	3,580	17	2,302	2,319	5	1,763	1,768	-	2,605	2,605	3	3,056	3,059	4	4,017	4,021
Transit	102	-	102	408	2	410	7	26	33	49	26	75	14	37	51	544	-	544
Total	2,534	7,100	9,634	543	5,629	6,172	27	3,818	3,845	116	5,480	5,596	20	6,397	6,417	669	8,081	8,750
Porto Grande																		
Ship Movements																		
Alongside	222	897	1,119	308	793	1,101	300	687	987	348	688	1,036	282	592	874	250	601	851
G.R.T.	913,123	127,174	1,040,297	1,186,011	111,174	1,297,185	1,007,736	119,337	1,127,073	1,017,142	106,978	1,124,120	860,663	123,356	984,019	847,833	151,528	999,411
Cargo (Tons)																		
Unloaded	75,383	7,736	83,119	96,169	6,983	103,152	82,375	8,553	90,928	61,620	10,076	71,696	84,187	8,895	93,082	81,188	8,830	90,018
Loaded	2,549	56,067	58,616	7,180	55,031	62,211	7,061	73,299	80,360	4,805	39,755	44,560	13,787	55,791	69,578	3,567	30,349	33,916
Transit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	77,932	63,803	141,735	103,349	62,014	165,363	89,436	81,852	171,288	66,225	49,831	116,056	97,974	64,686	162,660	84,755	39,179	123,934
Passengers																		
Disembarked	411	33,636	34,047	12	29,064	29,076	-	31,127	31,127	-	33,717	33,717	-	30,467	30,467	-	30,921	30,921
Embarked	250	26,738	26,988	-	26,738	26,738	-	27,512	27,512	-	29,819	29,819	-	29,212	29,212	-	39,277	39,277
Transit	1830	-	1,830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2,491	60,374	62,865	12	55,802	55,814	-	58,639	58,639	-	63,536	63,536	-	59,679	59,679	-	78,198	78,198
Summary - Cargo																		
Praia	47,743	38 % 32,154	34 % 79,897	36 % 52,741	34 % 34,914	36 % 87,655	35 % 69,737	44 % 39,379	32 % 109,116	39 % 72,498	52 % 29,730	37 % 102,228	47 % 90,391	48 % 40,199	38 % 130,590	45 % 93,492	32 % 32,925	46 % 126,417
Porto Grande	37,932	62 % 63,803	66 % 141,735	64 % 103,349	66 % 62,014	64 % 165,363	65 % 89,436	56 % 81,852	68 % 171,288	61 % 66,225	48 % 49,831	63 % 116,056	53 % 97,974	52 % 64,686	62 % 162,660	55 % 84,755	68 % 39,179	64 % 123,934
Total	125,675	100 % 95,957	100 % 221,632	100 % 156,090	100 % 96,928	100 % 253,018	100 % 159,173	100 % 121,231	100 % 280,404	100 % 138,723	100 % 79,561	100 % 218,284	100 % 188,365	100 % 104,885	100 % 291,250	100 % 178,247	100 % 72,104	100 % 250,351

Source: JAP

TABLE 8

CAPE VERDE

Cargo Traffic Forecasts for JAP Ports, 1982-86

('000 M. tons)

(Excluding Sal Island)

	Actual 1980	Actual 1981	Forecast 1982	Forecast 1983	Forecast 1984	Forecast 1985	Forecast 1986
PRAIA							
Foreign Trade							
Imports							
Corn	22.2	n.a.	23.2	24.8	25.4	26.0	26.3
Cement	23.3	n.a.	27.9	29.0	30.1	31.3	32.6
Fuel	7.0	n.a.	7.6	8.0	8.4	8.8	9.2
General Cargo	37.0	n.a.	35.3	37.0	38.9	40.8	42.9
Sub-total	89.5	88.1	94.0	98.8	102.8	106.9	111.0
Exports							
Fish and Fish Product	-	-	-	-	-	4.5	4.5
General Cargo	0.9	5.4	2.0	2.0	2.0	2.0	2.0
Sub-total	0.9	5.4	2.0	2.0	2.0	6.5	6.5
Total Foreign	90.4	93.5	96 0	100.8	104.8	112.4	117.5
Interisland Trade							
Unloaded - General	22.1	15.1	15.4	15.7	16.0	16.3	16.7
Fish	-	-	-	-	-	5.0	5.0
Loaded	18.1	17.9	18.4	19.0	19.6	25.1	20.8
Total Interisland	40.2	33.0	33.8	34.7	35.6	41.4	42.5
Total Praia	130.6	126.5	129.8	135.5	140.4	154.8	160.0
PORTO GRANDE							
Foreign Trade							
Imports							
Corn	25.9	n.c.	24.9	24.3	23.7	23.1	23.4
Wheat	15.0	n.a.	15.6	15.9	16.2	16.6	16.9
Cement	9.7	n.a.	10.7	11.2	11.8	12.4	13.0
Fuel	2.0	n.a.	2.2	2.3	2.4	2.5	2.7
General Cargo	31.6	n.a.	34.8	36.6	38.4	40.3	42.3
Sub-total	84.2	81.2	88.2	90.3	92.5	94.9	98.3
Exports	13.8	3.6	7.0	10.0	12.0	14.0	16.0
Total Foreign	98.0	84.8	95.2	100.3	104.5	108.9	114.3
Interisland Trade							
Unloaded - General	8.9	0.8	9.2	9.3	9.5	9.7	9.9
Fish	-	-	-	3.3	5.5	7.7	9.9
Loaded	55.8	30.3	30.9	31.5	32.2	32.8	33.5
Sub-total	64.7	39.1	40.1	44.1	47.2	50.2	53.3
Total Porto Grande	162.7	123.9	135.3	144.4	152.6	159.1	167.6
MINOR PORTS (JAP only)							
Interisland							
Unloaded	54.8	47.9	48.9	49.8	50.8	51.8	52.[illegible]
Loaded	4.4	5.3	5.4	5.5	5.6	5.7	5.9
Total Minor Ports	59.2	53.2	54.3	55.3	56.4	57.5	58.8

Domestic

Complementing the international airport are a principal domestic airport at Praia and lesser airfields on six of the seven other islands. Specifications on these airports and information on their capacity are contained in Table 9. Domestic air traffic during the period 1967-80 is indicated in Table 10. The data reveal that the airline is primarily a passenger carrying facility and that relatively little air cargo, normally less than 1000 mt per year, is carried.

The well run Government-owned airline, TACV (Transportes Aereos de Cabo Verde), provides frequent scheduled turbo-prop and propeller services. Based at the important domestic airport at Praia, it calls at all the inhabited islands but Brava.

While domestic air service is relatively well suited to current needs and is efficiently operated, limited airfield improvements would further increase efficiencies. Many flights are operating at or near capacity. Rather than by acquiring additional aircraft it should be possible to improve fleet performance by increasing operating hours. Installation of runway lights at Praia and a 300 m extension of its runway would permit landings after sunset and improve the productivity of existing aircraft.

TABLE 9

CAPE VERDE

Airport Facilities

Island	Airport	Length (meters)	Surface	Airport Capacity	Passengers 1980 1/
Sal	Amilcar Cabral	3270	Asphalt	International Service	284,300 2/
Santiago	Praia	1300	Asphalt	HS 748; no lighting 4/	65,460 3/
Sao Nicolau	Preguiça	1400	Asphalt	HS 748; no lighting	11,500
Sao Vicente	Sao Pedro	1200	Asphalt	HS 748; no lighting	37,850
Boa Vista	Rabil	1400	Hard soil	Twin Otter; no lighting 5/	4,700
Fogo	Mosteiros	500	Hard Soil	Twin Otter; no lighting	2,550
Fogo	Sao Filipe	500	Hard Soil	Twin Otter; no lighting	11,080
	Maio	550	Hard Soil	Twin Otter; No lighting	6,160

1/ Arrivals and Departures. All domestic unless otherwise indicated.

2/ Includes 243,000 international passengers of whom 210,000 were transit passengers.

3/ Includes 8,200 international passengers.

Source: Atree/Getram. Republique du Cap Vert: Preparation du Plan Quadriennal, Esquisse de Programmation dans le Secteur des Transports, Novembre 1981.

4/ Turbo-prop aircraft.

5/ Propeller-driven aircraft.

TABLE 10

CAPE VERDE

Domestic Air Traffic

(1967-80)

Year	Passengers	Freight (000 tons) Excess Baggage	Cargo	Mail	Passenger-km (million)	Ton-km (000)
1967	7,886	12	23	8	1.7	-
1968	11,535	19	64	9	2.2	202.8
1969	14,315	21	102	9	2.5	225.6
1970	17,596	31	130	14	3.2	286.3
1971	24,382	51	213	18	4.3	383.4
1972	34,636	77	232	26	5.1	456.1
1973	43,010	118	306	31	5.9	526.6
1974	57,787	87	620	28	8.9	797.9
1975	64,494	116	764	37	11.1	1,004.6
1976	69,629	137	883	78	11.4	1,126.9
1977	75,287	251	1,015	84	12.9	1,303.7
1978	76,396	282	832	108	13.7	1,395.5
1979	85,223	340	707	106	16.0	1,504.1
1980	93,750	368	697	118	n.a.	n.a.

Source: TACV, 1982

The TACV fleet consists of the following aircraft:

2 Hawker Siddeley HS-748s	(48 seats each)
1 DeHavilland Twin Otter	(20 seats)
3 BN-2A Sea Islanders	(8 seats each)

TACV passenger traffic increased at the average annual rate of nine percent during the period 1974-77. Domestic service is reported good, with high occupancy rates. There is a daily flight between Praia and Mindelo, Sao Vicente, and several flights weekly to the other islands. This frequency of service appears adequate.

The one foreign route is to Dakar and Guinea Bissau, and the Government hopes to eventually acquire a jet transport to expand the TACV network to Lisbon.

Applications for Airship Transportation

While Cape Verde as an insular country has unique distribution problems, the existing water and air transport systems seem to be responsive to those needs. The islands appear to be adequately served by an interisland shipping service which carries most of the cargo and by a domestic air passenger/cargo service which serves eight of the nine islands, Dakar,

and Guinea Bissau. There do not appear to be unique heavy lift or vertical take-off and landing requirements which favor the use of airships. Airfields and airplanes, ports and vessels are already in place, although new investments are in prospect. There does not appear to be a significant place for lighter-than-air craft, although this has not been studied in detail.

CHAD

(Appendix)

2. CHAD

The Economy

Some ninety percent of Chad consists of desert and Sahelian grasslands. The area is vast (1,264,000 km^2) and far removed from Atlantic ports. Principal areas of economic activity in the south are located at distances exceeding 1450 km from the sea. (See Figure 1.)

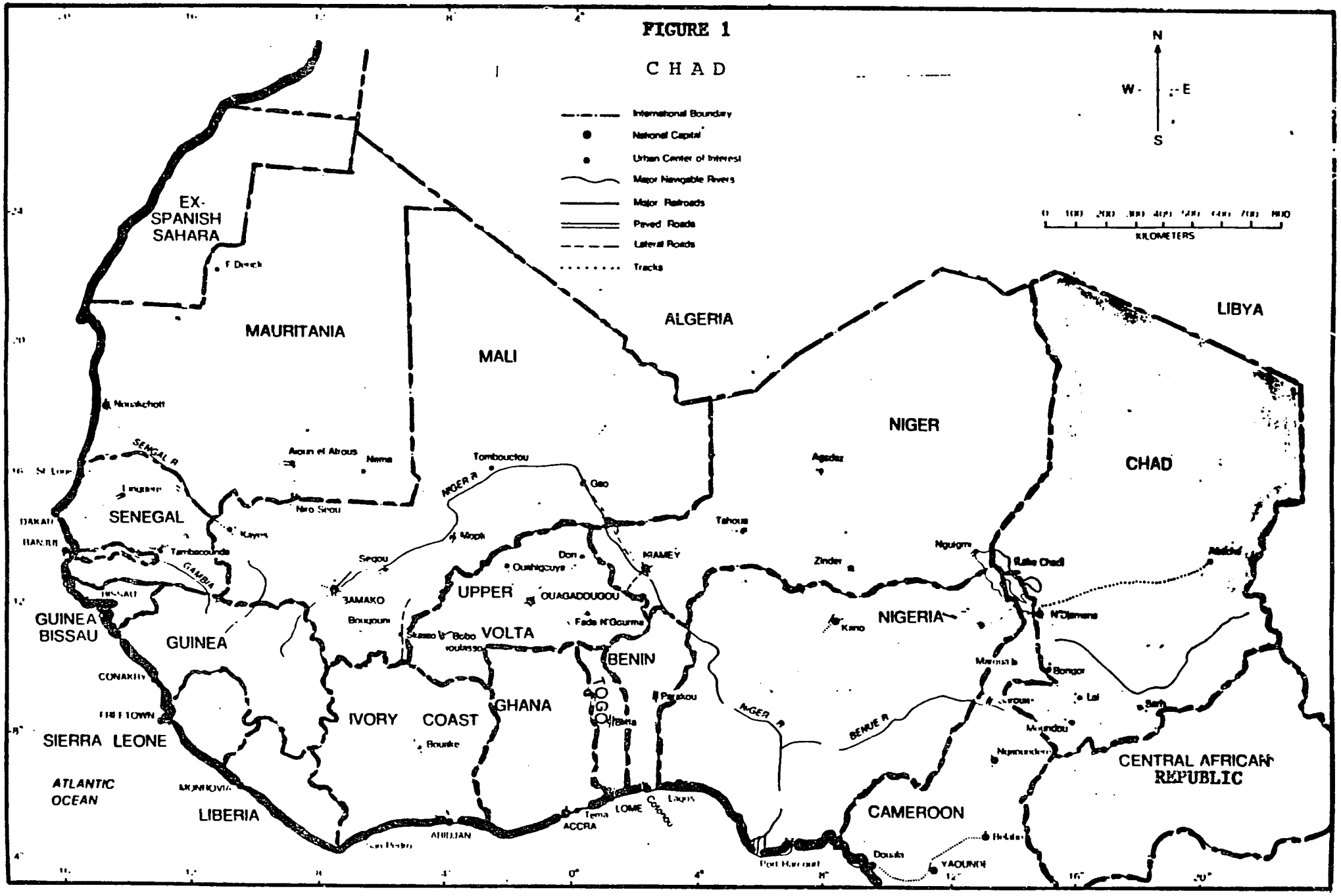
The population, estimated at 3.7 million in 1971, is growing at an annual rate of about 2.1 percent. Nearly one-half live in the southernmost ten percent of the land; most of the balance are in the central area, while fewer than 100,000 inhabit the northern desert.

Small-scale subsistence agriculture dominates the economy and accounts for 75 percent of annual crop production. Cultivation and herding occupy 90 percent of the population. The commercial production of cotton, livestock and meat for export is concentrated in the Chari River basin in the south.

Chad's development potential lies in agriculture, and improvement in the transport infrastructure is one of the key prerequisites to realizing this potential. Reduction of transport costs on export routes, construction and improvement of feeder access roads, and increased efficiency of the transport industry could together serve as a catalyst to increase agricultural production.

FIGURE 1

C H A D



The pace of Chad's development in the past decade has been slow due to the country's formidable growth problems which have been further aggravated by internal political unrest, severe drought, declining economic activity, extreme poverty, and stagnating exports. Until 1968, budget and fiscal performance was satisfactory but since then Chad experienced increasing political instability, rapid inflation, rising expenditures and declining revenues, coupled with rising military spending, increased demands for Government services and a limited capacity to mobilize savings.

Chad's precarious fiscal situation presents serious obstacles to transport development, since the Government can neither contribute to investments nor easily increase financing for recurrent costs (less than 2% of Government recurrent expenditures were allocated to highway maintenance, CFAF 200 million p.a., during 1972-75). While maintenance of the transport infrastructure has suffered and the level of traffic demand is such that major extensions of the transport network cannot be justified, the Government now appears to recognize that maintenance of transport infrastructure should be a higher priority objective than the construction of new facilities.

Commercial exploitation of Chad's oil reserves, estimated at about 400-1,000 million barrels, might help to improve the country's fiscal and economic situation. A study evaluated a petroleum project in Chad aimed at producing by 1980 about 1,500-2,000 barrels/day (75,000-100,000 tons/p.a.) of petroleum products for local consumption.

Production at this level compares with the country's petroleum imports in excess of 70,000 tons per annum, excluding unrecorded fuel purchases outside Chad. The proposed project would reduce the country's dependence on imported petroleum products, which comprised 13% of the total import bill of CFAF 23 billion in 1974 (compared to total exports of only CFAF 14.6 billion).

The use of aircraft in oil and gas exploration and development is discussed elsewhere in this paper.

Freight transport averaged about 175,000-225,000 tons p.a. during the period 1970-75; and estimates for 1980 indicated a 2.3% increase per annum. With construction costs for all-weather roads in Chad among the highest in West Africa, extensions or major improvements of the surface transport network are difficult to justify on economic grounds.

Imports and Exports

Imports amounted to 191,000 mt in 1976/77, and petroleum products imports equalled 70,000 mt or 37% of the total. Food products, building materials, and equipment constituted the bulk of the balance.

Exports totalled 61,450 mt in 1976/77, of which 54,000 mt in cotton was destined for France. Livestock stands second in value among exports. The cattle are mainly trekked; about 205,000 head of cattle are trekked to neighboring countries, principally Nigeria. New markets in Libya and the Middle East are being developed for refrigerated meat airfreighted from the abbatoir at N'Djamena. Other exports include smoked fish (in limited amounts), about 200 mt of gum arabic and locally assembled transitor radios. The commodity breakdown of imports and exports for 1976/77 is provided in Table 1; principal trading partners are shown in Table 2.

The Transportation Sector

Road Transport

The Road Network

The road network consists of about 7,270 km of classified roads - comprised of 4,560 km of national roads (of which only 253 km are paved) and 2,710 km of prefectural roads - and about 24,000 km of unclassified tracks (see Table 3). The road system has not been functionally classified; the current classification represents 7,270 km of roads that have been maintained from time to time by the Department of Public Works and by prefectural authorities. Of these, only about 1,128 km are all-weather engineered roads; most of the remaining roads (the majority of which are no

TABLE 1

Chad

Distribution of International Freight Transport Demand by Type of Commodity
1976 - 1977

	Metric Tons Transported
1. Imports	
Petroleum products	70,000
Agriculture-related products	
Sugar	25,000
Cement	15,000
Fertilizer and Insecticides	16,000
Timber	7,500
Wheat Flour	10,000
Food Products	20,000
Equipment	3,500
Miscellaneous	24,000
IMPORTS; SUB-TOTAL	191,000
2. Exports	
Cotton	54,000
Others	7,450
EXPORTS; SUB-TOTAL	61,450
TOTAL	252,450

Source: SEDES, 1977

TABLE 2
Principal Trading Partners of Chad
(CFAF millions)

IMPORTS	1972	1973	1974
Sahel			
Senegal	427.9	616.0	669.0
Other Africa			
Cameroon	404.7	725.7	932.8
Central African Republic	222.5	232.6	282.1
Gabon	446.6	489.4	229.4
Nigeria	1,690.5	2,194.3	2,562.4
Rest of World			
Belgium/Luxembourg	176.8	592.9	762.6
	204.5	254.8	218.7
China, People's Republic	567.2	774.5	474.9
France	7,472.4	7,728.8	7,642.6
Germany, Fed. Republic	466.6	410.9	651.0
Italy	282.3	224.7	386.0
Netherlands	535.1	232.9	827.9
Taiwan	313.2	418.7	281.6
United Kingom	266.9	255.4	373.4
U.S.A.	492.3	720.8	2,025.1
TOTAL (INCL. OTHERS)	13,958.5	15,872.4	18,319.5

EXPORTS	1972	1973	1974
Sahel			
None			
Other Africa			
Cameroon	300.4	197.1	128.2
Central African Republic	164.5	208.4	180.4
Congo People's Republic	351.6	397.9	316.9
Gabon	68.3	75.3	64.8
Libya	80.2	129.3	70.5
Nigeria	487.4	538.9	387.8
Zaire	562.6	121.9	496.5
Rest of World			
Denmark	4.6	44.2	10.9
France	145.4	215.0	297.6
Germany, Fed. Republic	22.5	92.1	10.9
Spain	17.8	54.6	68.2
United Kingdom	30.7	15.3	18.0
TOTAL (INCL. OTHERS)	2,236.0	2,090.0	2,050.7

TABLE 3

Chad Highway Network, 1970-76
(km)

	1970	1971	1972	1973	1974	1975	1976
A. Classified Network 1/							
National Roads (Primary)							
Paved	242	242	242	242	242	253	253
Gravel and Earth	1,738	1,838	2,438	4,320	4,320	4,309	4,309
Subtotal	1,980	2,080	2,680	4,562	4,562	4,562	4,562
Prefectural Roads (Secondary)							
Earth	4,150	4,050	3,500	2,630	2,630	2,710	2,710
Total	6.130	6,130	6,180	7,192	7,192	7,272	7,272
B. Unclassified Network 2/							
Tracks	24,000	24,000	24,000	24,000	24,000	24,000	24,000

Source: Directorate of Public Works, 1976

more than tracks) are passable only during 7-8 months of the dry season. The distribution of the classified road network is about 1.82 km/1,000 population, compared to 2.49 in Mali, and 5.92 in CAR. The road density is about 6 km/1,000 sq km in Chad, compared to 11.0 in Mali, and 17.0 in CAR. Most of the classified roads are located in the southwest cotton zone, which covers about 10% of the area of the country; the sparsely populated nothern part of the country is served mainly by desert tracks.

Inadequate maintenance of the road network has impaired its serviceability; there is a substantial backlog of periodic maintenance, while present maintenance activity is confined to urgent repairs and to one grading per year over approximately 1800 km. Over 90% of the feeder roads in the Cotton Zone, and most of the roads in the Sahel zone, are not even minimally maintained.

The internal direct road links between N'Djamena and the southern agricultural region are interdicted during the rainy season (June-October) by flooding. Road conditions generally are poor since primary roads have been only minimally maintained and feeder roads are all but neglected due to lack of funds and trained work force. In the 7-8 month dry season, internal road transport is concentrated on the road links making up the triangle between N'Djamena, Moundou, and Sarh.

Road Transport Industry

Protective tariffs and freight allocation measures favor the interests of small Chadian operators. In October, 1976 the Government granted exclusive rights to the Cooperative des Transporteurs Tchadiens (CTT) for both international and domestic road transport. CTT controls freight allocations for both domestic and external transport. Its large membership is predominantly comprised of small truckers.

CTT distributes freight, prepares accounts, does billings and packing for its members, and provides advances from its treasury. It acts as a trade association and prepares and discusses tariffs with the Government on behalf of its members. The transporters provide and maintain their own equipment, and arrange for their own insurance. The regulated transport tariffs presently appear reasonable, although they tend to be higher than warranted by costs. Passenger transport by road is not organized.

COTONCHAD has exclusive rights to the domestic transport of cotton; COTONCHAD, a semi-Government cotton processing and marketing agency, operates its own fleet of 300 tractor/trailer combinations with specially constructed frames, to transport seed cotton from about 2,100 purchase points to ginneries. Exclusivity of seed cotton transport was granted COTONCHAD on the basis that COTONCHAD could transport seed cotton, using its special trucks, at a cost 50% less than the rates charged by common

carriers. This arrangement permits COTONCHAD to efficiently coordinate the collection of seed cotton with some of its other functions, namely maintenance of cotton feeder roads, fertilizer and insecticide distribution, and ginning operations.

Other agencies operating their own truck fleets are: Societe Nationale de Commercialization du Tchad (SONACOT), for collection and transport of gum arabic, onions and hibiscus; Direction de la Lutte Contre les Calamites Naturelles (DLCCN) which is responsible for distribution of essential supplies to regions affected by drought and other calamaties (e.g., the regions of Ouadai, Guera, Salamat and Batha); and Fonds de Developpement et d'Assistance Rural (FDAR) for distribution of food aid.

The Chadian road transport industry encompasses the following functions:

i) International Freight Transport - comprising an annual export/import tonnage of about 253,000 tons, of which imports constitute nearly 75%. In accordance with freight transit agreements with neighboring countries, the portion of freight transport carried by Chadian carriers is estimated at 160,000 tons (63% of the total volume), corresponding to 130 million ton-km.

ii) Domestic Freight - totals about 226,000 mt, of which cotton, hauled by COTONCHAD, accounts for 146,000 mt (64%). The remaining domestic freight traffic consists of about 80,000 tons, equivalent to 45 million ton-kilometers, distributed among the principal commercial and administrative centers (N'Djamena, Sarh, Moundou and Abeche).

iii) Passenger Transport - there is no scheduled inter-city bus transport in Chad at present, although until 1972 Unitchadienne operated a regular bus services as part of its transport operations in Chad. Except for a few vans and covered pickup trucks, passenger transportation is mainly by truck; loaded vehicles carry 5-10 passengers in addition to their regular load. The administration does not take any action against this type of transport, although it is illegal and raises problems for insurance companies. Recent statistics on demand for inter-city passenger transport are not available. Studies carried out in 1963 estimated inter-city passenger transportation demand at 190,000 passengers per year, corresponding to about 74 million passenger-kilometers.

In 1967/77, Chadian transporters carried an estimated 130 million ton-km of dry goods and about 55 million ton-km of petroleum products. The present Chadian share of dry cargo transport is estimated at 150 million ton-km, excluding the farm-to-ginnery transport of seed cotton.

Inland Water Transport

The waterways systems comprises Lake Chad and the Chari and Logone rivers. In the rainy season the Chari is the only practical means of surface access between N'Djamena and the South and is navigable from mid-August to mid-December. The Logone River is navigable from September to late October between N'Djamena and Moundou; commercial transport operations, however, are hampered by erratic river behavior. Barge transport on the Chari between N'Djamena and Lake Chad constitutes the most important traffic activity on the internal waterways system.

Transport between N'Djamena and Lake Chad is estimated at about 12,000 tons, inclusive of barges and small craft. From the lake, the goods transported include natron (a sodium carbonate found on the shores of the lake), some fish, and agricultural products.

The traffic is heavily unbalanced; on the Chari the upstream traffic from N'Djamena is about 20% of that moving downstream. The major commodities transported are beer, wood, sugar, steel, and fuel. A round trip by a convoy of barges takes about one month.

The possibility of transporting cattle across Lake Chad from the area around Bol to Nigeria is being considered in the context of IDA's livestock

projects. Barge transport could also facilitate the evacuation of agricultural products from the Lake Chad polders to N'Djamena. The Government does not have any plans for improvement of barge transport on the Chari and Logone river south of N'Djamena. A breakdown of freight transport on the inland waterways is given in Table 4.

Industry Characteristics

Barge transport on the rivers and the lake is operated by three companies; of these, the two more important companies are Comouna (French owned) and Societe Tchadienne de Transport Fluvial (STTF), a Chadian concern. The operational characteristics of the three companies are:

i) Comouna: Operates a fleet with an aggregate capacity of 1,040 tons. The fleet consists of 13 barges, 4 pushers, and two petroleum tankers (40 m^3 and 20 m^3 capacity, respectively);

ii) STFF: Operates a fleet of two convoys (aggregate capacity of 650 tons), consisting of 8 barges and 4 pushers; and

iii) Souhaibou: (Chadian owned) operates a single convoy with a capacity of 150 tons.

TABLE 4
Chad

Freight Transport on Inland Waterways

I. Tonnage

1. Comouna

i) The Chari

Year	Upstream N'Djamena-Sarh	Downstream Sarh-N'Djamena	Total (tons)
1970	1,195	6,864	8,059
1971	1,333	3,529	4;826
1972	1,247	1,682	3,929
1973	872	2,064	2,936
1974	1,535	4,341	5,876
1975	1,613	3,030	4,643

ii) The Logone

500-1,000 tons per year.

2. STIF

i) The Chari

Upstream (N'Djamena-Sarh) - 400 tons/year
Downstream (Sarh-N'Djamena) - 2,400 tons/year

ii) The Logone

Upstream (N'Djamena-Moundou) - 320 tons/year.
Downstream (Moundou-N'Djamena) - 600 tons/year.

3. Barge Transport on Lake Chad is estimated at 5-6000 tons/year.

II. Goods Transported

Itinerary	Major Goods
N'Djamena-Sarh	Fuel
Sarh-N'Djamena	Wood, Sugar
N'Djamena-Moundou	Empty beer cases
Moundou-N'Djamena	Beer
N'Djamena-Lake Chad	Fuel, Flour Sugar
Lake Chad-N'Djamena	Natron, Fish

In addition, general merchandize items are carried on all itineraries. Some passenger transport, although illegal, is also effected.

Source: CONIOUNA, STIF, 1976.

Two-thirds of the river freight transport is allocated to Comouna, while the remaining third is shared between STTF and Souhaibou.

Development of River and Lake Transport

Prospects of river transport development are limited because of river regime constraints. The Chari, even during the rainy season, can only accommodate barges with a draft of less than 1.2 m. Dredging is ineffective because of shifting sand bars and frequent changes in the river regime. Besides these problems, navigation on the Logone becomes quite treacherous during the rainy season. In comparison, barge transport on Lake Chad holds more favorable prospects. An area that requires further investigation is the feasibility of barge transport of livestock from Chad (range developments north of Lake Chad) to Nigeria. This mode of livestock transport could replace the current practice of exporting cattle on the hoof. Other than project investments needed to facilitate the transport of cattle on Lake Chad, the only foreseeable project investment is the opening of navigation channels, and construction of finger-type jetties at N'Djamena, Sarh, Moundou, Djimtilo, Bagasola and Bol to improve loading and unloading operations.

International Transit Agreements

International agreements concerning the transit traffic of landlocked countries normally assign transport of 2/3 of the tonnage landed at the port of entry to the landlocked country and 1/3 to the transited country. Most of the agreements among "entente" countries (Ivory Coast, Niger, Togo and Upper Volta) have been fashioned on this principle. International arrangements governing Chad's transit trade area are as follows:

i) With Cameroon: a transit agreement resulting in the award of 65% of freight tonnage moved between N'Gaoundere and Chad to Chadian transporters and 35% to Cameroonian trucks.

ii) With Nigeria: a transit agreement, although already obsolete, governs the allocation of freight between Chadian and Nigerian transporters from Maiduguri to Chad as shown below:

(a) General Merchandise	-	85% of tonnage to Chadian transporters
	-	15% of tonnage to Nigerian transporters
(b) Fuel	-	15% of tonnage to Chadian transporters

85% of tonnage to Nigerian transporters

iii) With CAR: there is no formal agreement between Chad and CAR concerning goods transit, although transport of cotton exports to Bangui is handled exclusively by Chadian transporters who also account for about 85% of the remaining transport demand.

The agreement between Chad and Cameroon follows the freight allocation principle as far as the division of freight is concerned, but the agreement is only applicable to freight transport from N'Gaoundere, not from Douala. The agreement with Nigeria has lost its significance as Chadian transporters now carry 40% of fuel imports instead of their share of 15%, as stipulated in the agreements.

THE GAMBIA

- Appendix -

3. THE GAMBIA

An enclave within Senegal extending inland from the Atlantic coast along the Gambia River, Gambia has direct access to the sea. Its small size, geographic orientation and existing infrastructure largely mitigate against the use of airships. See Figs. 1 and 2.

The Economy

Economic activity consists mainly of traditional smallholder rural occupations; agriculture, livestock and fisheries account for 60 percent of the country's total GNP and employ about 85 per cent of the active population.

Groundnuts are the principal cash crop; they are the primary source of foreign exchange and are the basis for the country's principal industrial activity. Groundnut exports rose from an average of 70,000 mt/yr in the 1960's to 120,000 mt/yr in 1975/76. Part of this volume includes the re-export of tonnages from Senegal.

Groundnuts are grown throughout The Gambia on the highlands above river flood levels. The crop is harvested from mid-October through the dry season, with most of the crop being in by mid-December. The crop is purchased by GPMB, at one of 87 buying stations which are distributed throughout the country. The actual purchases are delegated via licensed buying agents to about 250 traders, who transport the crop from field to buying station,

FIGURE 1

GAMBIA

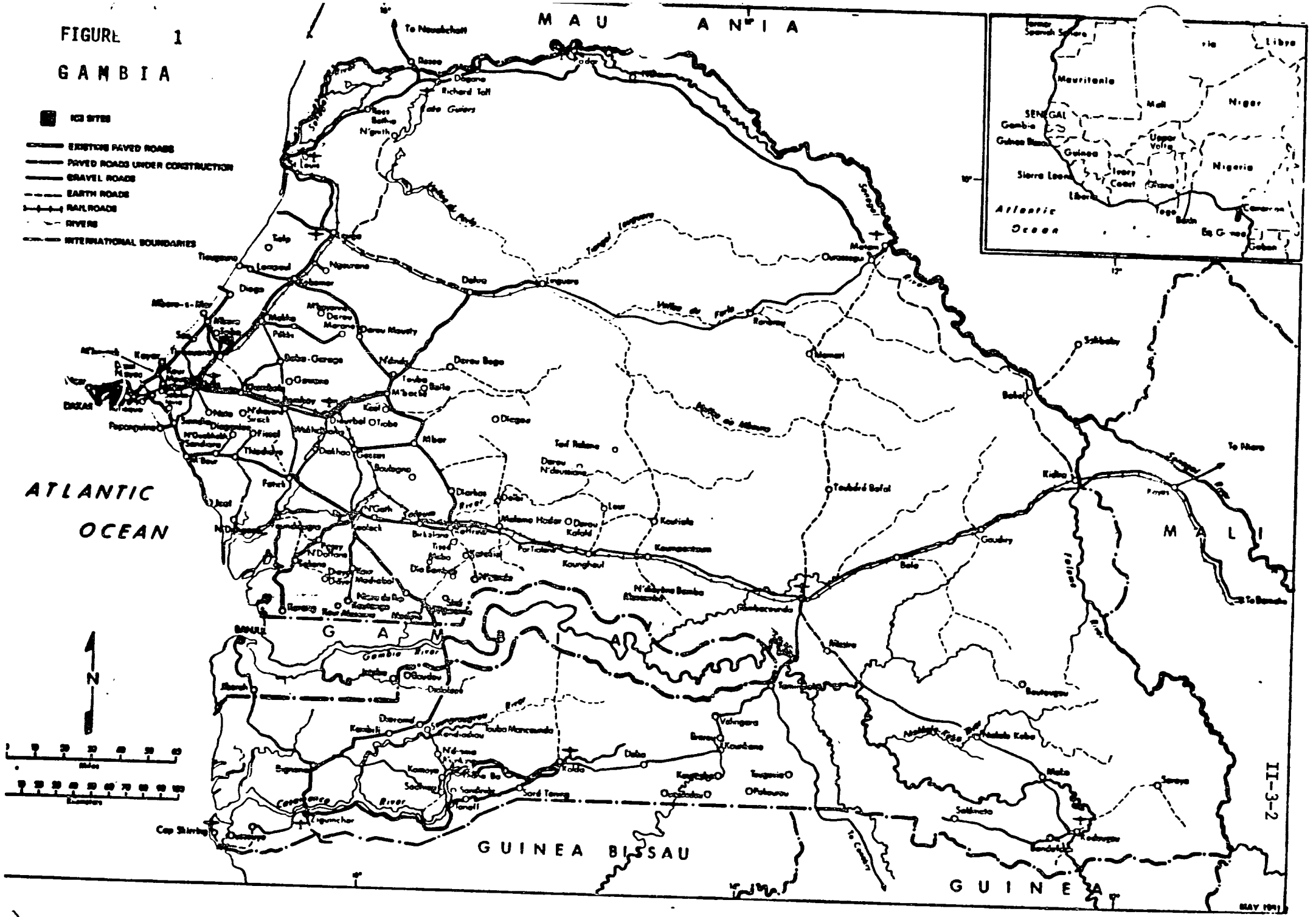


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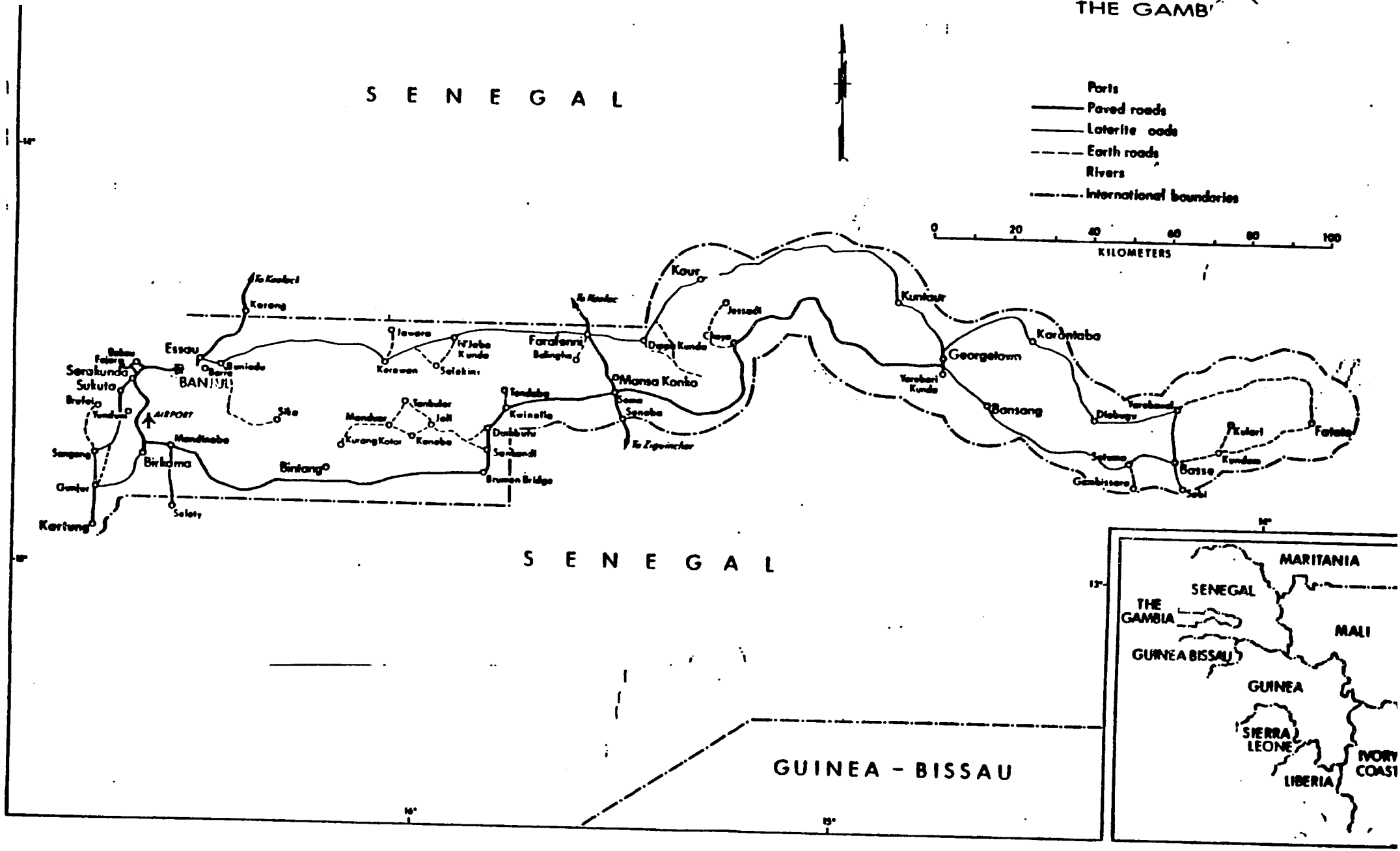
FIGURE 2
THE GAMB



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thence to one of ten storage depots under construction. The traders also deal in general merchandise and issue credit during the rainy season. As noted, one consequence of this system is that traders compete sharply and concentrate on buying during the early season rather than on transporting goods to the depots. This practice aggravates the peak demand for transport, a problem which could be resolved by paying a premium for early delivery. The system of up-country storage depots which GPMB has inaugurated has reduced the transport capacity required to handle a given production volume. GPMB has also located almost all of its depots on the river bank, thereby eliminating the extra handling which would otherwise be required to move the groundnuts down-country by river, retaining the natural competitive advantage of river transport.

Commerce

Exports and Imports

The magnitudes of Gambian exports and imports are shown in Table 1, while Table 2 indicates Gambian trading partners in Africa and elsewhere.

The Transportation Sector

The transport network comprises two oceanports, a river transport system, roads and complementary ferry links, and an airport. Only river and road transport are potentially competitive with each other.

TABLE 1

Gambian Imports and Exports
('000 dalasi)[1/]

IMPORTS	1972/73	1973/74	1974/75	1981
Food and Live Animals	8,119	14,436	17,100	
Beverages and Tobacco	3,039	3,810	4,130	
Crude Materials (inedible) except Fuels	2,512	2,117	2,459	
Mineral Fuels, Lubricants, etc.	2,490	3,380	7,887	54,000 (mt)
Animal and Vegetable Oils and Fats	98	81	159	
Chemicals	4,306	5,231	8,040	
Basic Manufactured Goods	19,500	20,469	25,977	
Texile Yarn, Fabrics, etc.	13,379	13,469	22,458	
Machinery and Transportation Equipment	8,405	8,031	17,486	
Miscellaneous Manufactured Articles	4,632	4,651	8,147	
Other Commodities	1,318	1,490	1,964	168,000 (mt)[3/]

EXPORTS	1971/72	1974/75	1974/75	
Groundnuts shelled	19,379		46,651	40,000 (mt)
Groundnut meal and cake	3,010		7,691	Groundnut products constitute virtually all export receipts.
Goundnut oil	11,061		26,126	
Palm kernels and palm nuts	455		667	
Fish and fish preparations	414		1,684[2/]	11,000 (mt)
Hides and skins	107		80	

1/ 1 $U.S. = 2.33 dalasi (April 1977); 1981 figures in mt.
2/ Representing 2,100 mt.
3/ General cargo.

GAMBIA

TABLE 2

Trading Partners
(Dalasi)

IMPORTS	1972/73	1973/74	1974/75
Sahel			
Senegal	2,434,635	2,939,594	3,488,802
Other Africa			
None			
Rest of World			
Burma	1,659,400	2,695,458	1,760,248
China (Taiwan)	7,278,193	6,406,216	10,148,085
France	2,341,133	3,201,260	3,296,537
Germany, Federal Republic	1,887,503	2,709,559	4,470,579
Japan	5,899,768	2,646,476	3,982,327
Netherlands	1,649,901	3,583,072	5,228,576
Poland	1,003,462	3,169,663	1,776,001
United Kingdom	15,411,324	15,440,924	21,263,242
U.S.A.	1,368,231	2,987,476	2,903,511
TOTAL (INCL. OTHERS)	54,418,533	63,494,509	88,348,975

EXPORTS	1972/73	1973/74	1974/75
Sahel			
None			
Other Africa			
Sierra Leone	190,092	313,331	365,423
Rest of World			
France	6,690,945	15,309,239	7,229,797
Germany, Federal Republic	2,974,734	4,648,234	2,783,546
Italy	2,424,434	3,725,473	9,886,706
Netherlands	735,465	11,402,720	16,803,296
Portugal	1,363,898	5,144,606	11,788,824
Switzerland	4,145,584	121,419	148,149
United Kingdom	13,262,980	28,847,503	32,849,431
TOTAL (INCL. OTHERS)	33,690,543	67,607,390	84,833,973

Ports

Banjul

The Port of Banjul is the most important facility between Dakar and Conakry (Table 3) and is well protected with a minimum channel depth of 8.0 m. The port could serve a hinterland larger than The Gambia, but would require a significant improvement in transiting arrangements with Senegal; this possibility may be reviewed in the framework of the new Sene-Gambia Federation. Banjul Port handles all of Gambia's seaborne import traffic (Table 4), all export traffic (except Kaur groundnuts), and commercial fishing taffic, and provides berth for the river steamer. In 1981, general cargo imports totalled 168,000 tons, petroleum 54,000 tons, groundnut and product exports 40,000 tons, and fish and other exports 11,000 tons. Total Banjul cargo traffic has grown since 1975 at 12% p.a., with exports remaining stable following an increase from 1974 to 1977 and a decrease after 1977 due to drought conditions and imports growing at 16% p.a. A Second World Bank Banjul Port Project is being implemented. It includes the emergency rehabilitation of the existing infrastructure and provides additional port capacity, including that needed for container traffic. This project will also try to meet the need for improving the port's productivity.

TABLE 3

The Gambia

Vessels Calling at Banjul Port, FY 1979

	Large Vessels		Small Vessels		Total	
	No.	Average grt.	No.	Average grt.	No.	grt. 000
A. By Type and Size						
Dry Cargo Ships	135	6,000	109	900	244	907
Mineral Oil Tankers	12	16,200	—	—	12	192
Vegetable Oil Tankers	—	—	8	2,600	8	21
Passenger Ships	10	10,900	—	—	10	109
Total	157		117		274	1,231

	Berth			
	Banjul Main	Banjul Inner	Government Wharf	Total
B. By Type and Berth				
General Cargo Ships	108	49	49	206
Fishing Vessels	3	6	14	23
Other	3	10	2	15
Mineral Oil Tankers	12	—	—	12
Vegetable Oil Tankers	—	—	8	8
Passenger Ships	9	—	1	10
Total	135	65	74	274

Source: Consultants and GPA.

TABLE 4

THE GAMBIA

Banjul Port Import and Export Traffic, FY1974-1980
('000s freight tons)

	1974	1975	1976	1977	1978	1979	1980	Increase in % p.a. /2 1974-1980
A. Imports								
a. Dry Cargo								
Cement	/1	/1	14	16	44	45	45	n.a.
Rice	/1	/1	24	36	32	32	29	n.a.
Fertilizers	/1	/1	3	4	12	7	12	n.a.
Sorghum	/1	/1	1	--	13	4	1	n.a.
General Cargo	92	92	75	94	114	135	150	n.a.
Subtotal	92	92	117	150	215	223	237	17.0
b. Petroleum Products	24	22	33	31	36	45	45	10.8
Total Imports	116	114	150	181	251	268	282	15.9
B. Exports								
a. Dry Cargo								
Groundnut Kernel	12	16	16	13	--	6	18	7.4
Groundnut Cake	22	28	26	26	21	16	17	(3.7)
Fish Products	2	7	7	15	18	16	10	26.8
Palm Kernels	2	1	1	2	2	--	1	(11.6)
Other	3	1	2	2	2	2	2	(5.6)
Subtotal	41	53	52	57	43	40	48	2.5
b. Groundnut Oil	16	17	18	18	12	12	10	(8.2)
Total Exports	57	70	70	75	55	52	58	0.2
Combined Total	173	184	220	256	306	320	340	11.9

/1 Included under General Cargo.
/2 Calculated on the basis of detailed not rounded figures.

Source: Consultants and GPA.

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Kaur

Located about 230 km upriver, the Port of Kaur has only one function, namely the evacuation of decorticated groundnuts for export by ocean-going vessels drawing up to six meters, equal to approximately 4,000 DWT. This traffic is concentrated into the six-month period from January through June, and in 1980/81 amounted to 40,000 tons compared with 25,000 tons in the preceding years. The port operates efficiently, handling about 500 tons daily during the season. Kaur is unlikely to require major investments or to present significant operational problems in the near future.

River Transport

The crop is evacuated to the Port of Banjul or Kaur by river and road transport, the GPMB designating the form of transport and destination of the nuts from each buying station, as well as the transport tariff (Table 5). The main form of river transport is a fleet of modern tugs and steel lighters owned by The Gambia River Transport Company (GRTC). GRTC carries about 65% of the total crop evacuated and appears to be efficiently managed. The other 25% of the crop is moved down river by locally owned cutters and canoes, which vary in size up to 80-100 tons in carrying capacity. The owners have formed a cooperative, The Gambia Cutter Owners Cooperative Society Ltd., (GCOCS), which in turn is largely financed by a growers cooperative which also acts as a

TABLE 5

The Gambia

Groundnuts Purchased by GPMB, 1975/76-1980/81
(thousands of tons)

	1975/76	1976/77	1978/79	1979/80	1980/81
Production	137.6	129.4	119.8	65.0	45.0
Percentage of which moved by river	70%	70%	76%	n.a.	n.a.

Source: Banjul Second Port Project Feasibility Study, Portconsult and Hoff & Overgaard.

licensed buying agent. There is therefore an incentive for this cooperative, in its role as licensed buying agent, to use the GCOCS to transport its own purchases, reducing the monopolistic position of GRTC. The river craft, including lighters, cutters, and canoes, carry cargo in bulk with deck cargo in bags.

A River Wharves Project, aimed at enhancing the use of the river instead of road for the transport of general bulk cargo, was scheduled for implementation during 1982, and includes the transformation of GRTC. GRTC, presently a subsidiary of GPMB, will become an inland water transport organization which will also take over from The Gambia Port Authority (GPA) operation of the ferries and the river steamer. The project is being financed by the Kuwait Fund and will cost about D 11.1 million. It stems from recommendations by consultants who expect that the creation or upgrading of river wharves will generate a reduction in transport costs for fertilizer and building materials, and result in improved profits to agriculture and decreased costs in construction and maintenance in the eastern part of the country when this traffic shifts from road to river transport. The wharf improvement program is also expected to improve the operational efficiency of the river cruiser by speeding up loading and unloading operations and improving accessibility to villages along the river, and to permit higher utilization of the vessel, "Lady Chilel" by both tourists and day passengers.

Road Transport

The existing highway system consists of about 471 km of paved roads, about 520 km of all-weather gravel roads, 135 km of unpaved earth roads, plus about 1,300 km of seasonal tracks (Table 6). The two main trunk roads extend along both sides of the Gambia River as far as Basse (400 km from Banjul) with an extension to Fatoto, another 40 km upstream. The Trans-Gambia Highway crosses the river, by ferry, at Farafenni, some 200 km from Banjul, and provides the primary north-south crossing of the country for Senegalese traffic. Except for the Trans-Gambia Highway, which has a rather thin stone-based bitumen surface, paved roads have a bitumen/seashell surface. This composition reflects the virtual non-existence of road quality stone in The Gambia and provides a surface which is generally adequate. The Soma-Basse Road (170 km) on the South Bank has a basalt surface treatment. The other main roads are of gravel or stabilized laterite (94% laterite, 6% cement) and the feeder road system is of unstabilized laterite, of which there is an abundance. Most of the secondary laterite roads, particularly in the upper reaches of the river basin, are impassable by normal vehicles during the rainy season. The major elements of the system are indicated in Table 6.

While the feeder road network in The Gambia is extensive, it consists mostly of seasonal tracks. Many links between villages, agricultural

TABLE 6

The Gambia

The Road Network in 1981/82
(km)

	Paved	Gravel	Unimproved	Total
Primary	421	277	135	833
Secondary	48	123	79	250
Tertiary	2	120	1,275	1,397
Total	471	520	1,489	2,480

Source: MWC.

areas, and administrative trade/river centers warrant upgrading. The Government has identified a priority program of 350 km, and the construction and maintenance of the first 174 km are being financed by CILSS and the Canadian International Development Agency (CIDA). The average daily traffic on principal roads is specified in Table 7

Road Transport Industry

Road transport is not highly developed since most of the groundnut crop is moved by river, and since the level of other economic activity is modest and is largely concentrated around Banjul. In 1979/80 the vehicle fleet totalled about 8,500 vehicles, of which less than ten percent are heavy trucks (Table 8). According to the latest available Public Works Department counts, growth appears to be less from Banjul to the Trans-Gambia Highway and greater in the eastern part. Fuel imports, which are also used to generate electricity, have been growing about 15% p.a. Traffic on the Trans-Gambia Ferry, of which about 75% is of Senegalese origin, has been growing about 13% p.a.

The relative absence of heavy vehicles has meant that proper road maintenance and the related question of vehicle taxes have been less important issues to date than in other countries. However, these questions will become more significant as the economy and the road network develop, particularly if part of the groundnut crop diverts to road transport.

TABLE 7

The Gambia

Average Daily Traffic; 1977 and 1980

North Bank	1977	1980	Annual Growth
Barra-Essau Road	690	802	5%
Essau-Kerewan Road	200	263	10%
Kerewan-Farafenni Raod	133	140	-
Farafenni to Senegal	340	811	35%
Farafenni to Georgetown	317	190	18%
South Bank			
Banjul to Bakau	8,800	11,285	8%
Birkana to Soma	420	577	12%
Soma to Basang	230	342	15%
Birkama to Mandinaba	640	1,098	20%
Mandinaba to Casamance	90	156	20%

Source: MWC Traffic counts (1980).

TABLE 8

The Gambia

Estimated Vehicle Fleet, 1976-1980

	1976	1977	1978	1979	1980
Private cars	2,200	2,650	2,920	3,143	4,011
Taxis	889	1,220	1,800	2,597	2,527
Buses	79	80	85	89	35
Trucks	1,092	1,020	980	1,000	1,061
G'vt. vehicles	na	na	na	1,181	920
Diplomatic vehicles	na	na	na	210	306
Private and commercial fleet	4,260	4,970	5,785	6,829	7,634
Total fleet	na	na	na	8,220	8,860

Source: MWC.

There is no trucking industry per se in The Gambia, since most larger vehicles are owned by PWD or GPMB. Smaller trucks, generally owned and operated by the private sector, are frequently in poor mechanical condition, having been bought secondhand; many are used only during the groundnut raising season. Individuals wishing to move goods throughout The Gambia must negotiate with vehicle owners to obtain quotations for specific weights and lengths of hauls. At present, no officially established tariff schedule is available. However, there is little variation in the charges made between the individual operators. In 1982 the GPMB paid the following rates for transport of groundnuts for class A road (paved and upgraded). D 0.31/ton-km; for all other roads, D 0.56/ ton km. There are no regulations on the entry of an owner or operator into the trucking business as a common carrier. A valid vehicle registration, minimal third-party insurance, and a current driver's license are sufficient to operate the vehicle. Usually, however, a driver and/or owner will be a member of the Motor Transport Association or of the Gambia Motor/Drivers and Mechanics Union. Vehicles owned by members of the former operate only in the Banjul/Kombos area, whereas owners and operators associated with longer distance trips are affiliated with the latter. No firm lines affecting areas of operation have been established.

Bus operations in The Gambia are provided by the Gambia Public Transport Corporation (GPTC) (Table 9) and by the private sector. GPTC provides scheduled local services in the Banjul and adjacent Kombos area and inter-city service between Banjul, Soma, Kaiaf, and Bausang. Private operators provide unscheduled local and inter-city service throughout The Gambia and into Senegal. Local service is provided by large buses and minibuses, but only the latter are used for service on inter-city routes.

GPTC is under the control of the Ministry of Works and Communications (MWC). In 1980, the company owned 50 Leyland 45-seat buses, 5 coaches and 4 Safari Minibuses. A report by the GPTC recommended that 65 new buses be processed between 1980 and 1983 to serve the large transport demand. At present monthly passenger volumes vary between 438,000 and 598,000 passengers and are growing rapidly. Tariffs are heavily subsidized, and at this time the company follows a policy of operating only on paved roads. The service appears to be efficiently managed and the Government should consider expanding the service into rural areas served by dirt roads.

Air Transport

During the 1940s and 1950s Banjul served as an important stopover for aircraft refueling between Europe, Africa and South America. More recently, particularly in the mid 1960s a steady growth in international

TABLE 9

The Gambia

Gambia Public Transport Corporation:
Routes and Passengers, 1977/78-1980/81

	1977/78	1978/79	1979/80	1980/81[1/]
Number of Routes	6	9	11	13
Number of passengers (in millions)	6.2	6.9	8.7	5.9
Revenue per km (in Butus)	45	74	76	78

1/ For 9 months only.

Source: GPTC Annual Accounting Report.

air traffic has continued, and since the early 1970s when tourism became a significant feature of The Gambia's economy, it has grown almost three times to present levels. To accommodate the actual and anticipated levels of activity, Yundum International Airport, located approximately 25 km south of Banjul, was reconstructed in 1978, and in 1980 its operating hours were increased to 24 hours per day. The single 2,850 m runway accommodates jet aircraft of the Boeing 747 and Tri-jet configurations anticipated in scheduled and tourist operations. An adjacent taxiway connects the runway with a concrete apron large enough to accommodate two large aircraft such as the B-747 plus two small-sized jets, such as the DC-9.

The most significant rise in passenger volumes has been in non-scheduled passenger movements, almost exclusively for tour purposes, as indicated in the table below.

Year	Passengers on Scheduled Flights	Passengers on Non-Scheduled Flights (Tourist Charters only)	Total Passenger Movements
1966/67	5,085	1,056	6,141
1978/79	40,000	45,000	85,000

Cargo traffic consists primarily of airmail and air freight. Since 1966, total airmail movement has increased from approximately 13 to 71 tons and air cargo has increased from 42 to 680 tons, with exports representing only 21% of total cargo movement. There appears to be no further need of major investment at Yundum Airport in the immediate future, or need to provide additional airports or air services due to the small size of the country.

Transportation Costs

Road Transport

On class A road (paved and upgraded): D 0.31/ton-km

On all other roads: D 0.56/ton-km

Passenger Fares: See Table 10.

River Freight Rates

See Table 11.

Transportation Sector Investment

See Table 12.

TABLE 10

The Gambia

Public Transport Fares, 1980
(in Dalasis)

		GPTC as of June 1980	Taxi as of Feb 1980
From Banjul to:	Denton Bridge	.25	n.a.
	Kanifing	.35	n.a.
	Serrekunda	.40	.56
	Sukuta	.60	.75
	Radio Gambia	.35	n.a.
	Bakau	.40	.56
	Fajara	.50	.93
	Latrikunda	.60	n.a.
	Churchillstown via Bakau	.80	n.a.
From Banjul to:	Talindingkunjang	.45	n.a.
	Lamin	.55	.93
	Yundum	.65	1.13
	Brikama	.85	1.13
	N'Demban	2.40	n.a.
	Sibanor	2.80	2.63
	Bwiam	3.20	3.00
	Kwinella	4.00	4.88
	Soma	4.50	4.88
From Bakau to:	Latrikunda	.20	n.a.
	Serrekunda (market)	.25	n.a.
	Churchillstown	.30	n.a.
From Yellitenda:	Mansakonko	.25	n.a.
	Soma	.30	n.a.
	Kaiaf	.65	n.a.
	Kwinella	1.45	n.a.

Source: GPTC.

TABLE 11

The Gambia

River Freight Rates, 1981/82
(Groundnut and Fertilizers)

Zone 1	(less than 40 km)	D 14.62 per ton
Zone 2	(from 80 to 142 km)	D 23.73 per ton
Zone 3	(from 142 to 208 km)	D 26.73 per ton
Zone 4	(from 208 km and over)	D 29.62 per ton

Source: Gambia Produce Marketing Board.

TABLE 12

The Gambia

Transport Development Expenditure,
Second Plan (1981/82 - 1985/86)

Projects	Total Cost Estimates (in million Dalasis)
Roads	
Buniadu-Albreda-Kuntair Road	4.7
Soma-Basse Road	61.0
Feeder Roads Phase III	4.7
Highway Maintenance Program	11.6
Highway Maintenance Workshop	8.9
Banjul/Serrekunda Highway & Bridge	37.0
Laminkoto-Passimassi Road	37.7
Sub-Total	165.6
Rivers	
Rural Wharves Project	11.1
Banjul Second Port Project	36.7
Banjul Port Hopper/Dredger	7.1
Sub-Total	54.9
Aviation	
Yundum Airport Improvement	2.0
Sub-Total	2.0
TOTAL	225.5

urce: Gambia Authorities.

MALI

(Appendix)

4. MALI

The Economy

Areas under cultivation are primarily in the Niger River Valley and in the southernmost part of the country; extensive regions in the north of landlocked Mali are desert, and during the rainy season, July - Sept., other large areas are inundated. Most of the 5.3 million population live in the southwest, where economic activity is concentrated, and along the Niger. Population densities are low, distances long, natural resources limited and traffic volumes light. (See Fig. 1.)

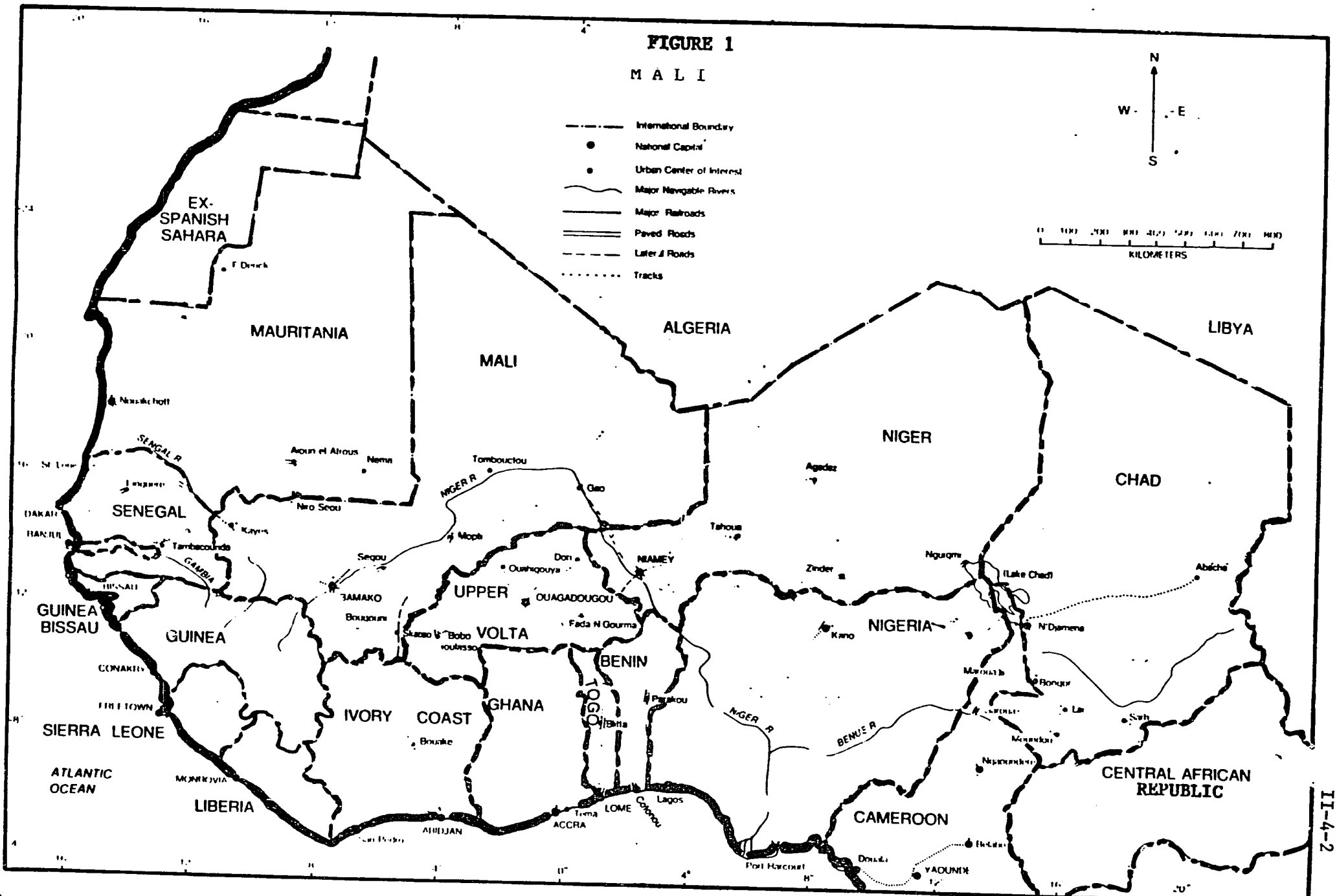
GDP in 1980 was only US $159 per capita; one of the Sahel's lowest. Agriculture accounts for about 25% of GDP; the two main export crops, groundnuts and cotton, provide half the country's foreign exchange earnings.

Among the several development constraints from which Mali suffers are: i) long distances to the sea; ii) lack of known mineral resources; iii) a weak agricultural base reflecting low and ill-distributed rainfall; iv) a shortage of skilled manpower; and v) communications problems stemming from the country's size and dispersed population.

Inflation has been averaging 15 per cent annually; higher than in other Sahelian countries.

FIGURE 1

M A L I



2/2

International Trade

Mali's main trading partners are Senegal, the Ivory Coast and Ghana, though exports to the latter have declined as a consequence of import and currency restrictions. (Table 1)

Tables 2 and 3 show recorded export and import flows from 1965 to 1978 by main commodities but do not include that significant part of Mali trade with neighboring countries which is not recorded. Import of petroleum products was the only regularly increasing item - to a total of 154,500 tons in 1978.

Carcass meat exports - 500 to 1000 mt/yr - are airfreighted to Liberia and Libya.

Domestic Transport System

The Malian transport system consists essentially of: (a) a road system comprising 13,000 km of roads, of which 1,650 km are paved and 4,284 km all-weather; (b) a 641-km railway linking Koulikouro and Bamako with the Senegal Railway and the Port of Dakar; (c) about 1,650 km of inland waterways, which are navigable less than seven months per year and which are not navigable beyond Gao; and (d) an airport network comprising an international airport at Bamako-Senou and 30 airfields for domestic commercial services. The road system is fairly well developed to the east of Bamako and its future improvement will likely focus on improving some of these

TABLE 1
Principal Malian Trading Partners
(Mali francs; millions)1/

IMPORTS	1969	1970	1971	EXPORTS	1969	1970	1971
Sahel Countries				**Sahel Countries**			
Senegal	1,705	1,445	2,069	Senegal	388	2,715	1,611
				Upper Volta	230	466	498
				Mauritania 2/			
Other Africa				**Other Africa**			
Ivory Coast	1,725	2,334	3,462	Ghana	1,876	1,733	1,575
				Ivory Coast	3,505	6,315	5,443
Rest of World				**Rest of World**			
Belgium/Luxembourg				France	1,431	3,370	4,030
Italy, Netherlands	1,129	1,088	1,563	Germany, Fed. Republic	9	262	204
China, People's Republic	1,770	1,356	2,030	Japan	22	94	360
France	7,770	6,925	14,620	U.S.S.R.	212	288	334
Germany, Fed. Republic	572	467	1,189	United Kingdom	94	510	320
Japan	131	332	518				
S.S.R.	1,976	2,531	1,986				
United Kingdom	239	169	799				
U.S.A.	539	195	1,804				
TOTAL (INCL. OTHERS)	20,099	26,200	34,870	TOTAL (INCL. OTHERS)	8,941	18,240	22,580

1/ 2 Mali Francs = CFAF 1.

2/ Sales of groundnuts to neighboring countries, mainly Mauritania, amount to up to 30,000 mt annually.

TABLE 2
MALI
Recorded Exports
(mt 000's)

	1965	1972	1974	1976	1977	1978
Cotton	9	51.7	26.5	68.5	72.2	42.5
Fibre		23.3	17.5	34.9	42.1	40.0
Seed		28.4	3.5	33.6	28.0	0.3
Cake		- 1/	5.5	0	2.1	2.2
Livestock	11	27.5	17.6	9.1	12.8	12.0
Cattle		20.5	11.8	4.3	6.2	5.3
Sheep & Goat		5.8	4.9	4.1	6.2	6.6
Other		1.2	.9	0.7	.4	0.1
Groundnut	30	34.8	18.8	47.2	42.0	30.7
Shelled		22.5	21.1	29.8	21.7	8.3
Oil		3.1	1.5	5.1	8.2	7.7
Oil cake		9.1	5.2	12.3	12.1	14.7
Fish	7	3.3	1.1	2.6	2.0	1.1
Karite		-	1.0	15.6	33.6	2.6
Sheanut		-	0.9	15.4	33.4	4.5
Butter & oil		2	0.1	0.2	0.2	0.1
Hides & Skins		0.8	0.8	0.6	0.4	0.5
Gum Arabic		2.3	5.6	1.1	2.3	1.2
Basketware		1.9	2.5	0.3	0.4	0.4
Other	9	13.4	19.5	42.5	43.1	14.0
Total Recorded exports	66	135.7	93.4	182.4	208.8	107.0

1/ Less than 50 tons.

2/ Exports of animals and animal products amounted to 29 per cent of export earnings in 1980.

TABLE 3
MALI
Recorded Imports
(mt 000's)

	1965	1972	1974	1976	1977	1978
Foodstuffs	56.0	128.6	331.5	82.5	65.7	148.2
Petroleum Products	73.0	87.5	96.3	107.6	131.0	154.5
Construction materials	11.0	23.5	19.3	51.7	61.0	80.6
Metal Products & Equipment	-	6.2	2.8	8.9	4.6	6.3
Motor vehicles & spare parts	3.0	5.0	8.9	13.9	10.0	11.6
Electrical Appliances	-	2.1	1.7	2.3	2.7	3.5
Chemicals & Pharmaceuticals	30.0	22.4	16.0	28.5	34.3	36.2
Textiles & Leather goods	-	4.1	5.5	6.3	6.0	4.9
Other Manufactures	27.0	6.1	5.5	4.8	10.5	8.5
Total Recorded imports	220.0	285.4	487.5	316.5	345.8	454.3

roads and constructing feeder roads to support the implementation of agricultural projects. The railways provide the main connection west of Bamako and extension of the system is not foreseen. Air transport presently reaches 10 destinations with limited frequencies, and there seems to be a need to improve some airports and air transport services to some areas where low traffic levels do not justify the heavy investment and maintenance costs of a road.

The Mali Government has full control of the major companies in the transport sector. The key elements of transport regulation are: (i) centralization of transport demand for imports, exports, and all domestic road haulage through Government-administered freight offices; and (ii) control of freight rates.

Road Transport

The Network

Mali's 13,000 km of roads are classified as national, regional, or local, according to the importance of traffic carried and the centers they serve (Table 4). About 5,900 km are all-weather roads of which about one quarter are paved and one quarter gravelled; the remainder of the network consists of unengineered earth roads or tracks which are often impassable during the rainy season.

TABLE 4
Mali Road Network, 1981
Administrative and Technical Classification
(km)

Administrative Classification	Paved Roads	Earth Road	Tracks All weather	Tracks Seasonal	Total
National Roads	1,475	1,292	763	2,166	5,696
Regional Roads	97	672	1,314	3,512	5,595
Local Roads	9	15	299	1,390	1,713
Non-classified Roads	75	20	396	632	1,123
Total	1,656	1,999	2,772	7,770	14,127
of which classified network	1,581	1,979	2,376	7,138	13,000

Source: Mali Transport Plan Study, SEDES, 1981

The national and regional network is fairly well developed, especially in the south where population density is highest. The main axes are Bamako-Faladie-Bougouni-Sikasso-Zegoua, the import-export route to Abidjan, and Faladie-Segou-Mopti, which serves the eastern part of the country.

Existing paved roads, constructed between 1955 and 1965, are rapidly deteriorating because of the increase in traffic and vehicle weights, and insufficient maintenance.

Vehicle Fleet

The vehicle fleet was estimated at 23,300 units in 1978, and was probably about 24,000 by 1980.

The Government-owned Compagnie Malienne des Transports Routiers carries an estimated 20% of road freight transport in terms of ton-km. The company has been plagued by operational inefficiency, inadequate management, lack of revenue due to low rates fixed by the Government, and liquidity problems resulting mainly from claims on the Government and on other state enterprises. The recent reorganization of the company has not resulted in increased efficiency, and its position is weak. Private transporters have also suffered from inadequate tariffs, which, although increased by 40% in 1974, are still too low; this situation has made it extremely difficult for even reasonably efficient carriers to generate funds for renewal or expansion of their vehicle fleets. Mali has suffered from a lack of freight transport capacity, and this has led to overloading and under-maintenance of vehicles.

Road Traffic Densities

Table 5 shows average traffic in 1976, the most recent year for which processed data are available. Based on the increase in the vehicle fleet and fuel consumption, road traffic is estimated to have increased about 8% per year between 1975 and 1978.

TABLE 5

Average Daily Traffic by Class of Road; 1976
(in number of vehicles)

Paved Roads	Major Unpaved Roads	Feeder Roads and Tracks	
		Improved	Seasonal
151	32	17	10

The 1978 traffic survey showed a traffic of 255 vehicles daily on paved roads during the survey period (between October and December, in the dry season).

The Road Transport Industry

The Government, through MTPW's Office Nationale des Transports, (ONT) administers the road transport industry by its control of tariffs and distribution of international and important local freight. Mali's road transport industry in 1977 was 70% private with all but the 20 largest truckers in Bamako belonging to regional cooperatives. The Union Nationale des Cooperatives de Transporteurs Routiers (UNCTR) is a loosely organized syndicate of the regional cooperatives whose members on average operate

between one and five trucks. The UNCTR's main activities are lobbying and mutual aid, and in 1979 it had begun to discuss a levy of 5% on revenue to organize vehicle maintenance facilities as proposed in a 1977 Transport Industry Study. In 1978, the UNCTR transported 45% of total goods and 70% of passenger traffic. The balance of goods and passenger traffic is handled by the Government-owned Compagnie Malienne des Transports Routiers (CMTR) and such state enterprises as the Office du Niger which operate their own truck fleets. The CMTR has presently become less important, with its fleet reduced from 250 vehicles in 1972 to about 53 in 1978.

The Vehicle Fleet

Passenger vehicles constitute a rising percentage (58% in 1971 and 62% in 1978) of the vehicle fleet. Vans, trucks and heavy road tractors decreased from 41% to 37% of the total fleet from 1971 to 1978, but transport capacity increased considerably due to a shift from relatively small trucks to large semi-trailers. The growth rate of the vehicle fleet, which averaged almost 10% per annum between 1965 and 1971 and 7% between 1971 and 1975, was only about 4% in 1976-78, but this rate may hide a substantial renewal, coupled with large write-offs, of the vehicle fleet. See Table 6.

TABLE 6

Estimated Vehicle Fleet at End of Years 1971 and 1973-78 1/
(in number of vehicles)

Type of Vehicle	1971	1973	1974	1975	1976	1977	1978
Passenger Cars	9,675	11,093	11,870	12,510	13,123	13,953	14,268
Vans, Pickups	3,672	3,720	3,968	4,560	5,073	4,999	5,804
Trucks	2,845	2,482	2,620	2,837	2,810	2,633	2,410
Road Tractors	256	396	406	532	527	481	504
Buses	89	117	113	170	184	258	171
Special Vehicles	100	81	98	90	90	126	148
Total	16,637	17,889	19,075	20,699	21,807	22,450	23,305
Trailers and Semi-Trailers	271	356	419	558	599	434	408

A new company, the Societe Africaine des Transports Routiers (51% Malian and 49% Algerian), with 50 heavy trucks, was established in early 1978 for international transport to and from Algeria, Niger and Abidjan.

Between 1976 and 1978, nearly 600 heavy trucks and semi-trailers were added to the private trucking fleet, partly to replace obsolete vehicles. Unused capacity developed but soon it was eliminated by ONT shifting freight from rail to road on the profitable Abidjan route.

1/ Military vehicles not included.
Source: World Bank Appraisal Mission (Fourth Highway Project) estimates, 1980.

The efficiency of the trucking industry is low because of poor organization and the seasonal work cycle based on agriculture, which results in a low average load factor. Rates are now fixed each year before the campaign.

Rail Transport

The Chemin de Fer du Mali (CFM) is owned by the Government and was established by an ordinance in 1960 as an autonomous public enterprise to be operated on a commerical basis. It is under the authority of the Minister of Transport and Public Works.

Evolution of Rail Freight Traffic

Freight traffic increased from 220,000 tons in 1965 to 310,000 tons in 1976 and then declined to 268,000 tons in 1981. In terms of ton-km the net increase and decrease were of the same order. International traffic constituted the bulk of the railway's freight between 1975-82. This traffic declined from 350,000 tons in 1975 to 210,000 tons in 1981. Between 1975 and 1978 the railway had to carry considerable amounts of famine relief food grains which kept the traffic level fairly high. When food aid dropped, railway freight traffic also dropped, but other factors also came into play.

Alternate drops in hauling capacity on both sides of the border largely caused the general traffic decline between 1975 and 1980, though 1981 was better, due to Senegalese locomotive assistance.

Evolution of Passenger Traffic

During the years 1965-75 the number of passengers declined from 561,000 to 492,000. However, the trend reversed itself and in the next three years the number of passengers was consistently above 630,000 per year. Passenger kilometers also increased from 103 million in 1975 to 157 million in 1980. These figures reflect an unprecedented growth in long distance passenger traffic on the international line because there is no competitive road service.

Domestic (national) and international traffic for freight and passengers for 1981 and prior years are indicated in Table 7.

River Transport

The Government fully controls the Compagnie Malienne de Navigation (CMN) which handles 70 percent of waterway traffic. The "traditional" carriers, private operators grouped in cooperatives, operate motorized pirogues. They concentrate on hauling dried and salted fish from the delta to Mopti and salt from Tombouctou. Only some large units (7-15 tons) compete with CMN between the main ports of the delta reach. On the whole, however,

TABLE 7
Mali
CFM Freight and Passenger Traffic
Selected Years 1972-1981

	1972		1975		1978		1979		1980/1		1981-Jan-Sept /1	
	ton (000)	ton-km (mil.)	ton (km)	ton-km (000)	ton (000)	ton-km (mil.)	ton (000)	ton-km (mil.)	ton (000)	ton-km (mil.)	ton	ton-km
National Traffic	73.0	26.2	96.3	34.1	77.7	24.8	70.4	23.9	53.0	15.6	35.6	9.8
Cement	39.5	16.7	46.4	19.4	30.6	12.2	28.8	11.0	16.7	7.0	8.8	3.7
Other carload	24.3	6.1	38.5	11.1	36.6	10.4	n.a.	n.a.	13.7	3.8	n.a.	n.a.
Miscellaneous	9.2	3.4	11.4	3.6	10.7	2.2	n.a.	n.a.	22.6	4.8	n.a.	n.a.
Exports	63.8	31.3	77.7	37.0	51.9	24.7	60.3	29.7	45.3	21.3	20.2	14.3
Cola nuts	7.7	4.5	17.5	10.1	12.1	7.1	12.5	7.5	8.2	4.8	4.9	2.9
Cotton seeds	3.3	2.1	6.1	3.8	-	-	-	-	-	-	-	-
Cotton fibers and textile	7.1	4.2	4.6	2.7	9.3	5.4	11.7	6.8	11.2	6.6	7.0	4.1
Groundnut	20.5	8.1	20.4	6.3	4.5	1.1	1.6	0.9	-	-	-	-
Groundnut oil	1.5	1.0	0.9	0.6	7.2	2.9	8.0	3.2	3.9	1.2	5.7	2.3
Groundnut cakes	10.9	6.8	8.1	3.9	10.8	4.7	9.5	3.8	10.1	3.0	5.9	2.6
Karite products	0.1	0.1	4.4	2.6	1.3	0.3	1.6	0.9	3.2	1.9	1.7	1.0
Cereals	-	-	-	-	-	-	-	-	-	-	-	-
Other carload	12.7	4.5	17.9	7.8	6.7	3.2	15.4	6.8	8.7	3.8	3.0	1.4
Imports	140.5	67.8	174.9	81.2	190.9	95.1	181.9	90.2	170.9	83.0	147.3	68.4
Cement	5.1	2.9	14.8	8.0	9.9	5.2	12.1	5.7	16.5	9.4	8.5	4.5
Machinery, vehicle, materials	8.6	4.9	11.8	6.0	14.1	7.6	16.8	8.8	15.2	7.7	6.0	3.7
Fertilizers	17.1	9.7	6.4	3.4	13.1	7.4	22.9	13.2	23.4	13.5	16.5	9.3
Foodstuff	46.0	20.4	65.4	27.8	57.3	22.9	30.6	13.2	20.9	13.1	36.3	14.5
Petroleum products	34.9	15.5	31.6	12.5	52.6	24.7	50.8	24.4	38.9	18.2	28.7	13.5
Salt	17.1	8.7	24.7	12.6	18.5	9.5	23.2	11.4	17.8	9.1	26.1	13.4
Other carload	10.7	5.1	20.2	10.5	32.0	17.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Miscellaneous	1.0	0.6	0.6	0.4	1.4	0.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
TOTAL FREIGHT TRAFFIC	277.5	125.4	349.5	153.3	328.5	144.6	312.6	143.8	277.2	119.9	211.2	92.5
Passengers	511.2	92.3	491.6	102.7	631.2	139.7	655.9	152.2	636.2	157.0	n.a.	n.a.
National	461.8	72.2	432.2	78.2	570.0	116.2	594.4	125.5	579.2	130.1	n.a.	n.a.
International	49.4	20.1	59.4	24.5	61.2	23.5	61.4	26.7	57.0	26.9	n.a.	n.a.

1/ Provisory figures
2/ Mali Railways and World Bank estimates.

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traditional carriers complement CMN services, by plying on tributaries that are not accessible to CMN vessels, and, more important, by operating throughout the year.

With the competition of road transport, traffic has been considerably reduced over the past 10 years and CMN operates now mostly between Gao and Mopti.

CMN is in an awkward situation since it is obligated to transport but does not have the monopoly and tariffs are fixed by the Government with no subsidies to CMN in case increases in tariffs are not approved. River is the only access to the 6th and 7th Regions and also the only means of evacuation of Bourem phosphates. In 1978 the CMN employed 636 staff and was equipped with: (a) 3 mail boats; (b) 3 boats with total loading capacity of 300 tons; (c) 9 tugboats with combined total horsepower of 2,380 HP; and (d) 35 barges with a total loading capacity of about 4,500 tons and a tanker of 270 tons. This fleet is now antiquated.

River transport volumes for 1967-70 are specified in Table 8.

Air Transport

The Government controls Air Mali, the principal domestic carrier. Mali Air Service (MAS) is a private charter company.

TABLE 8
River Transport Performance
(1967-1970)

	1967/68	1968/69	1969/70
Passengers (' 000)	71.9	70.1	60.8
Passenger-km (million)	22.0	18.7	19.8
Freight ('000 tons)	61.9	56.9	52.2
Freight ton-km (million)	36.3	26.8	29.2

Air traffic levels, presently low, would likely increase with more reliable and efficient service.

The fleet profile and performance of Air Mali are indicated in Tables 9 and 10.

TABLE 9

Air Mali Fleet in 1981

Aircraft	Average daily use (hours)
1 B-727	3.24
1 IL 18	(serves as a substitute to the 727)
1 Caravelle	1.34
2 Twin Otters	2.5
1 AN 24	2.0

The present average utilization rate of airplanes is low (see above) due to the diversity of types of aircraft, resulting in high maintenance costs and training of crews, and low availability. The staff, numbering 600, is considered excessive.

International Service

In 1982, Air Mali operated its B-727 on its international routes to Casablanca, Paris, Dakar, Abidjan, Accra, Douala and Brazzaville, and an IL 18 or AN 24 to Freetown, Banjul and Dakar. Air Algeria, Aeroflot, Air

Guinea, Royal Air Maroc, UTA and Air Afrique all provide services from Bamako once or twice a week. Air Mali has the highest load factor: 62%, and flew 43,100 passengers in 1977 on its international routes, but passengers are about 50% government employees. A good market should exist for fresh meat and vegetable produce at several destinations in West Africa and Western Europe (Paris) but the exports are relatively limited (4,320 tons in 1977 from Bamako).

Domestic Air Services

Air Mali

The domestic routes comprise two rather distinct regions; one to the west of Bamako and the other to the northeast, served by the 727, IL 18 and eventually the AN 24; primarily Mopti, Goudam, Tombouctou, and Gao, with connections to Niamey in Niger. Surface transport east of Bamako is limited, particularly when the Niger River is in flood and an incredible amount of land is under water. The region west of Bamako includes Nara, Nioro, Kayes and Kenieba, all within some 500 km from Bamako but not connected by roads. These towns are served with the AN 24 and the two DHC Twin Otters. Kayes is on the railway between Dakar and Bamako but the distance is sufficiently long to have some potential for air transport. This region is at present fairly isolated and may remain so for some time, though there is considerable potential for development in the area. Air Mali has 12 scheduled internal flights where the load factor is, on average, 65% and in 1977 the line flew 18,400 passengers. (See Table 10.)

TABLE 10
Air Mali Traffic

	Domestic		International	
	1968	1977	1968	1977
Total km flown	570,000	511,000	1,502,000	1,415,000
Departures	2,175	1,704	1,258	1,330
No. of passengers	18,858	18,380	14,621	43,063
Loading factor	49%	65%	28%	61%
Freight (mt)	82	6	711	284

Airport Conditions

In general, airport conditions are poor. The runways at Mopti and Gao were lengthened and strengthened by the Air Force with the help of the USSR in 1976-1977. They are, nevertheless, not completely safe for the present B727 operations. Mali has unofficially requested, through ASECNA, that the IBRD consider financing the other requirements at these airports, all necessary works at Tombouctou and other domestic airports.

At Mopti, the terminal building needs to be replaced but due to the low current level of activity at this airport it would be difficult to justify extensive works. The provision of navigational and communication aids could be justified.

The airport at Tombouctou suffered severely in the emergency airlift during the drought. Temporary repairs are underway but strengthening of the runway and lengthening would be required for B727 operations. The terminal building and other facilities are small and rather primitive but could be improved. Navigational communication facilities require upgrading. At Gao, the paved runway apron is in poor shape and needs rehabilitation, strengthening and lengthening for jet operations. The terminal building is an old hangar. The operations building could be rehabilitated and improved. Gasoline depots would be needed to rationalize the routing and provide service between cities without going through Bamako for refueling.

Air traffic at present is very low for the towns west of Bamako. Because of the short stage lengths involved, jet operations probably would not be advantageous here for a long time. However, to support development of the area, strips for Twin Otter operations could be provided with upgrading to accept aircraft of the AN-24 type as soon as possible, and navigation and communication aids should be provided consistent with operational requirements.

In 1981, Air Mali had a deficit of about CFAF 5 billion, mostly debt to other airlines and petroleum companies. Air Mali does not seem to be subsidized by the Government, but its tariffs are established by the Government. After ten years of operating with frozen domestic tariffs, the Government authorized an increase in 1980. Plagued by technical, managerial and financial problems, the company has not been able to start moving towards standardizing its aircraft fleet, today consisting of six aircraft of five different models. The quality of the domestic airport system is still a major constraint to domestic aviation, although some airports in the Niger route have been improved with USSR financing. The lack of runway lighting and appropriate refueling facilities are important factors behind Air Mali's very poor aircraft utilization rate.

Proper financial management needs to be established. The limited cost and traffic information from Air Mali unfortunately has prevented the preparation of any detailed comparative cost estimates to determine the

financial situation of Air Mali as well an appropriate scope of operations at individual airports. Nevertheless, it seems that national traffic is running with a large deficit somewhat compensated by international traffic. Until such costs are available it will be difficult to justify standardizing the fleet to reduce costs and increase availability of air transport.

Mali Air Service (MAS)

MAS is a private company, chartering by the hour three aircraft with a capacity of 17 passengers.

MAURITANIA

- Appendix -

5. MAURITANIA

With two ports on the Atlantic, Mauritania has direct access to world markets, but, by virtue of its location, it is not a transit area for trade of the 4 landlocked Sahelian countries. These factors, combined with a low level of economic activity suitable for air transport, mitigate against the use of extended commercial air transport in Mauritania. (See Fig. 1.)

The Economy

Agriculture and livestock herding, which sustain two-thirds of the population, are largely confined to the Senegal River Valley in the south. Prospects for increasing rainfed agriculture are limited, while irrigation expansion will be circumscribed and slow. One forecast estimates that there may be 26,000 tons of commercialized agricultural production by 1985. Livestock herding generates little transport demand because most animals are trekked to market.

Mauritania's principal commercial activity is iron ore mining, centered around Zouerate in the north. Annual production is expected to increase to 14 million tons by 1985. Iron ore exports and related imports move via a 651-km enclave railway to a specialized ore handling facility at Nouadhibou Port. Recommencement of copper ore mining at Akjorijit, discontinued in 1978, is not likely to occur. Fig. 2 reflects the geographic locations of these principal economic activities.

FIGURE 1
MAURITANIA
International Boundary
National Capital
Urban Center of Interest
Major Navigable Rivers
Major Railroads
Paved Roads
Lateral Roads
Tracks
N
W
E
S
KILOMETERS
EX-SPANISH SAHARA
MAURITANIA
MALI
ALGERIA
LIBYA
NIGER
CHAD
SENEGAL
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
GHANA
TOGO
BENIN
UPPER VOLTA
NIGERIA
CAMEROON
CENTRAL AFRICAN REPUBLIC
ATLANTIC OCEAN
BAMAKO
OUAGADOUGOU
NIAMEY
ABIDJAN
ACCRA
LOME
YAOUNDE
NIGER R.
BENUE R.
GAMBIA

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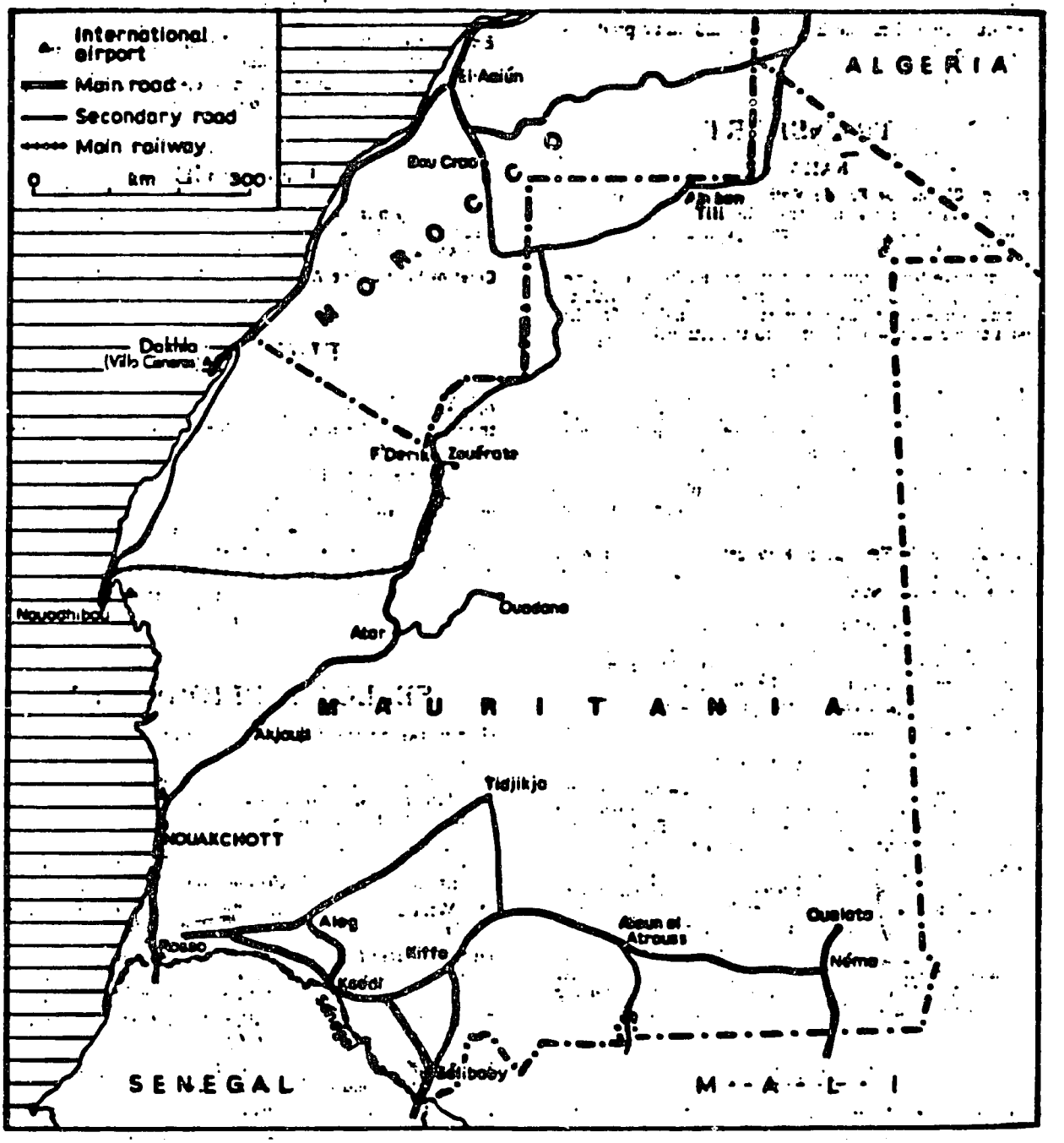
FIGURE 2

Mauritania

Principal Areas of Economic Activity



The balance of significant transport demand is attributable to imports of fuel, construction materials, food, and other materials, totalling about 500,000 mt per year. Thus the total demand for transport is low, apart from the iron ore mining operation.

Of the one million sq km land area, the northern two-thirds is desert, and of the small population of 1.6 million, 90 per cent are engaged in traditional agriculture in the south.

The most important occupation of the rural population, livestock, is still the main source of rural wealth. Related transport requirements are low; following traditional transhumance practices, a substantial part of the Mauritanian livestock population is trekked southward over the dry Senegal riverbed into Northern Mali. Unrecorded livestock sales are transacted there in the harder CFAF currency. These exports do not appear in official records; no transportation services are required.

In recent years internal flows of foodgrains from producing to consuming areas have declined. Guidimaka, in south central Mauritania, formerly a surplus producing area, was recently officially in deficit. A contributing cause is the illicit shipment of foodgrains across the Senegal River to Senegalese markets where prices are generally higher than those prevailing locally; it is not transported to the more distant markets in central and northern Mauritania.

In sum, there is relatively little domestic food production moving from rural production areas to Mauritanian market towns and urban centers. The populations of Nouakchott (250,000) and Nouadhibou (about 25,000) rely largely on food imports. These port cities require no long distance transport service for this purpose.

Commerce

Imports and Exports

Principal commodities moving in Mauritanian foreign trade are indicated in Tables 1 and 2, while Table 3 indicates Mauritania's principal trading partners.

Emergency Food Imports

Food relief imports provided by the U.S. and other donors totalled 66,500 MT in 1980 and 75,500 mt in 1981. Of the 75,000 mt of emergency foodgrains shipped by donors to Mauritania in 1981, only 5,000 mt was shipped overland from Dakar to Mauritania. The shipments were 95 percent cereals - wheat, sorghum and rice, in bulk and bagged. Butter, cooking oil and powdered milk in cases were furnished, in lot sizes of 100-1,000 mt. Grain lot sizes varied from 760 to 10,000 mt and deliveries were made throughout the year. Table 4 provides details of these shipments, some of which represented transshipments by coastal vessels from Dakar.

TABLE 1

Mauritanian Foreign Trade[1/]
(Ouguiya, millions)

IMPORTS	1970	1971	1972	1981
Groundnuts				30,000 mt
Fish and Preparations	1,060	n.a.	n.a.	
Cereals and Preparations	558	861	837	
Rice	309	511	378	
Sugar and Honey	897	1,342	n.a.	
Green Tea	255	258	345	
Petroleum Products	1,050	1,089	1,170	
Chemicals	1,002	n.a.	n.a.	
Iron and Steel	626	1,102	1,843	
Machinery (non-electric)	2,508	3,074	3,163	
Electrical Equipment	964	776	1,081	
Railway Vehicles	949	525	562	
Road Motor Vehicles	1,324	1,887	1,786	
Aircraft	17	149	460	
Ships and Boats	58	217	52	
TOTAL (INCL. OTHERS)	15,517	15,780	17,980	

EXPORTS	1970	1971	1972
Iron ore	20,924	20,847	18,475
Fish	2,029	2,137	2,842
(of which) Salted and dried	805	693	744
Fresh and Frozen	856	481	353
Natural Gums	492	434	700
Copper Concentrates[2/]	----	1,035	2,715
TOTAL (INCL. OTHERS)	24,680	25,129	26,959

Iron ore (million ouguiya): 5,720 in 1973; 5,864 in 1974; 6,153 in 1975.

1/ $1.00 U.S.= 44.73 Ouguiya (April 1977).
2/ Discontinued in 1978.

TABLE 2

Composition of Nouakchott Wharf Imports (Dry Cargo)
(metric tons)

PRODUCT IMPORTS	1973	1974	1979	1980
Rice	66,683.3	28,973.2	42,664	47,924
Flour	..	379.9	18,020	10,984
Sugar	26,989.7	18,120.7	46,979	23,575
Cement	..	..	29,553	36,887
Iron	..	..	3,807	..
Charcoal	5,700	13,927.8	..	..
Tobacco	56	624.9	..	..
Tea	1,642.4	805.7	1,815	2,986
Fabrics	323.4	418.1	0	0
Miscellaneous	..	24,565.2	76,575	49,859
Grain	..	29,972.1	20,140	33,026
Corn	..	11,144.8	..	..
Butter	..	1,085.0	..	..
Fish	..	61.2	..	..
Explosives	..	46.0	..	..
Milk	0	0	1,412	1,006
TOTAL	157,482	130,125	228,945	206,257

NOTE: .. Not Available

SOURCE: Republique Islamique de Mauritanie, Annuaire Statistique, 1981 IBRD Mauritania Transport Sector Memorandum (Unpublished), June 1976.

TABLE 3

Mauritania Trading Partners

(Ouguiya, millions)

IMPORTS	1970	1971	1972	EXPORTS	1970	1971	1972
Sahel				Sahel			
Senegal	976	909	1,260	Senegal	584	510	66
Other Africa				Other Africa			
None				Congo People's Republic	446	432	336
				Zaire	n.a.	14	405
Rest of World				Rest of World			
'um/Luxembourg	566	235	579	Beligum/Luxembourg	3,464	3,286	3,357
a, People's .public	308	278	921				
France	5,544	6,147	7,410	France	4,857	5,362	5,452
Germany, Federal Republic	459	811	981	Germany, Federal Republic	2,886	2,908	2,257
Italy	457	178	194	Italy	3,607	2,882	3,663
Japan	6	24	256	Japan	1,634	1,623	2,446
Spain	1,329	290	496	Spain	2,246	2,168	3,033
United Kingdom	1,369	1,131	1,298	United Kingdom	4,082	4,132	4,790
USA	2,189	1,664	2,013				
TOTAL (INCL. OTHERS)	15,517	15,780	17,980	TOTAL (INCL. OTHERS)	25,023	25,129	26,959

TABLE 4

Mauritania Food Relief Imports
(1981)

DONATEURS	DENREES	BATEAU	DATE	QUANTITIES (mt)	LIEU DE RECEPTION
FRANCE	BLE	SARDAIGNE	JAN 81	1,000	NOUADHIBOU
"	"	"	"	1,000	NOUAKCHOTT
"	"	SCHOUWENBANK	23-09-81	2,400	"
"	"	COELO	1-10-81	1,600	"
PAYS BAS	BLE	URSULA I	6-02-81	1,045	NOUAKCHOTT
"	"	STENHOLM	9-03-81	950	"
"	"	URSULA II	6-04-81	995	"
PAM	BLE	CAMION	Feb/Mar/81	2,540	ROSSO
"	"	HANNE THIGON I	19-06-81	3,500	NOUAKCHOTT
"	"	HANNE TRIGON II	27-06-81	900	"
"	"	VIOLA	25-06-81	2,419	"
"	"	CAMION	Juin-Jul/81	2,453	"
"	"	ERIK SIF	8-08-81	760	"
"	"	HERMAN SIF	9-08-81	768	"
TURQUIE/FINLANDE		BLE	11-06-81	1,613	NOUAKCHOTT
USAID	SORGHO	MARIA MONICA	14-05-81	900	NOUAKCHOTT
"	"	" "2	1-06-81	2,419	"
"	"	" "3	21-06-81	2,453	"
"	"	AFRO SRAR I	26-06-81	760	"
"	"	" "2	4-07-81	768	"
"	"	MARIA MONICA 4	18-07-71	1,613	"
RFA	BLE	ROUTE	Juin 81	2,000	NOUAKCHOTT
"	"	URSULA	28-06-81	1,100	NOUAKCHOTT
"	"	M. DE CAVADONGA	6-06-81	1,900	"
LYBIE	BLE	THEODORUS	10-05-81	4,000	"
CEE	BLE	MED JOY	21-11-81	3,000	NOUAKCHOTT
"	"	" "	5-12-81	2,000	"
"	"	TARA	17-12-81	5,000	"
"	LAIT	SUNNY MED	10-11-81	1,000	"
"	BEURRE	" "	10-11-81	500	"
ARABIE SAOUDITE	BEURRE	SUNNY MED	10-11-81	1,300	NOUAKCHOTT
	"	WESTG	29-11-81	700	"
"	BLE	DEMARG	29-11-81	10,000	"
ESPAGNE	FARINE	AMALINDA	25-12-81	1,500	NOUAKCHOTT
		TOTAL	WHEAT	63,278 Tonnes	
		TOTAL	SORGHUM	12,275	

In 1981 the U.S. provided 20,000 MT of relief foods under the PL 480 Title II program.

Principal Import Routes

Direct Discharge/Loading with Ocean Vessel at Nouakchott

Improvements to Nouakchott Port will stimulate the use of this Mauritanian port for imports and exports. Tonnages discharged in 1981 are indicated in Tables 5 and 6. New road construction will soon provide improved road access from Nouakchott to Kaedi via Aleg and Bougue. Traffic through the Port of Nouakchott rather than via Dakar is encouraged by these developments.

Dakar-Nouakchott

Considerable cargo is offloaded at Dakar for Mauritania; some 59,000 tons or 12% of Mauritanian imports presently follow this routing. No Mauritanian products are exported via Dakar. See Table 7.

TABLE 5

MAURITANIAN IMPORTS VIA DAKAR
1970 - 1981
('000 mt)

1970	53.5
1971	13.6
1972	19.8
1973	31.5
1974	26.0
1975	na
1976	na
1977	na
1978	na
1979	45.8
1980	41.3
1981	58.7

Three shipping alternatives are employed:

i) Dakar - Nouakchott overland by truck.

ii) Dakar - Nouakchott by coastal steamer or barge.

iii) Dakar - St. Louis by road or rail; St. Louis by truck, barge to Kaedi.

i) The Dakar - Nouakchott Overland Route

The landroute from Dakar to Nouakchott consists of a bituminous paved two-lane road extending about 400 km from Dakar to the border crossing at the Senegal River, and an additional 200 km from there to Nouakchott. The road is in fair condition but, especially on the Mauritanian side, would benefit from pavement strengthening. The IDA is financing these improvements under the Fourth Highway Credit to Mauritania. The one ferry at the Senegal River crossing is a weak link in the overland route.

ii) Dakar - Nouakchott by Water

In 1981 USAID Mauritania shipped grain from Dakar to Nouakchott by coastal vessel. Since it was known that the wharf at Nouakchott, (a simple unprotected pier of 330 meters length terminating in a working platform that can work two small vessels) was usually congested, assurances were obtained from the Government that ships carrying USAID grain would received top berthing priority. Since the line haul rates by coastal vessels were reported to be substantially lower than those of trucks, and since temporary storage of the grain in Dakar can be avoided, calculations by USAID indicated a potential for substantial savings by the coastal route, provided the coastal vessels received berthing priority.

While transporting grain from Dakar to Nouakchott by coastal vessel was a success, a cost comparison shows that there is little cost difference between the two modes; the final cost of grain (including all costs) delivered to the average inland destination is $459 per ton by the coastal vessel mode and $461 per ton overland. Though the coastal vessel mode appears $2 per ton cheaper, even this difference is questionable, given the degree of accuracy of comparative estimates.

iii) Dakar to St. Louis by Rail, to Rosso by Barge

A study team recently explored the possibility of shipping grain from Dakar to St. Louis, Senegal by rail, transferring the grain to barges at St. Louis, barging the grain to Rosso over the Senegal River, and then transferring the grain to trucks for the final leg from Rosso to Nouakchott. It was believed that the transport rates by barge and rail might be sufficiently competitive against road to offset the cost of the additional transfers that would be required.

The investigation revealed that the combined rate of rail (CFAF) 5,099 per ton) and barge (CFAF 8,300 per ton) equalled the rate for road transport to Rosso (CFAF 13,271 per ton). Additionally, the transfer cost from rail to barge at St. Louis is about CFAF 1,200 per ton. Because of the cost disadvantage of this alternative and the lack of adequate facilities, this alternative was not further explored.

A newly constructed fishing port at the mouth of the Senegal River contains a wharf of about 140 meters length with a depth of water of 3-4 meters, and could therefore accommodate small coastal vessels. In the future, when one could expect that the road improvement programs planned by the IBRD, USAID, and the OMVS program have improved the road system in the Senegal River Valley area, it may prove advantageous to ship grain by coastal vessel to the fishing port, and then barge it to distribution points along the Senegal River.

The Transport Sector

Road Transport

There is considerable economic exchange among the agricultural southwestern part of Mauritania, the western part of Mali, and the northeastern part of Senegal, which form an integrated economic unit.

The current transport system is intended to link popoulation centers with Nouakchott. Most of these centers, located in the flood plain of the Senegal River, historically were served either by river transport, or by the Senegal-Mali Railway which runs close to the Mauritanian frontier. The limited demand for onward transport from small river ports to more inaccessible areas was served by road transport and by traditional camel caravans. A main road running north from Rosso, Mauritania's principal Senegal River port, offered access to the sparsely settled semi-desert areas hundreds of kilometers away.

Since independence, paved roads were constructed to link the North and South to the capital, Nouakchott, and the Nouakchott-Kiffa-Nema road was constructed to tie the eastern region to the capital. These axes are intended to draw outward-oriented traffic crossing borders to Senegal, Morocco, Algeria and Mali, and redirect it toward Nouakchott. Long distances between towns and small settlements, a scarcity of good native road construction materials, difficult terrain and climatic conditions, a

lack of transport planning and coordination; and poor maintenance have all detracted from improvements to the road system in Mauritania which, except for a few heavily travelled paved roads, is in poor condition. As a result, truck transport in the interior is expensive, arduous, and sometimes hazardous.

The road network of about 7,000 km is comprised of 1,500 km of paved roads linking Nouakchott with earth and gravel roads, only a portion of which are passable the year round.

Road transport is by private carriers operating in competition. A National Public Transport Authority (ONPT) was established in the early sixties to set road transport rates and to allocate freight to individual carriers, thereby eliminating competition. This policy was reviewed in 1968, ONTP was abolished, and competition reintroduced. Now, maximum rates are prescribed and rate reductions apply where sufficient volume exists on a particular route. The system works satisfactorily.

Rail Transport

A privately owned and operated railway covers the 670 km between the iron ore deposit site near Bir-Moghrein and the export outlet at Nouadhibou, carrying almost exclusively iron ore, with some imported general cargo.

Water Transport

Organized waterway services on the seasonally navigable Senegal River consist of a few powered craft and barges; manual loading and unloading facilities for these vessels are provided at several small primitive ports.

Nouakchott Port

The Port of Nouakchott is congested, with a very limited capacity to directly unload ships alongside its wharf. Ships of over 5,000 tons carrying capacity must be unloaded via lighters, a timeconsuming and costly process. It is for this reason that coastal vessels are preferred by the grain importers.

Import/export traffic through Nouakchott Port is indicated in Tables 6 and 7. Current export tonnages amount to only 1.5% of import tonnages.

Nouakchott Deepwater Facility

Chinese construction of a new deepwater port at Nouakchott some 8 miles from the existing port will provide better docking facilities and lessen the country's dependence on Dakar.

TABLE 6

NOUAKCHOTT WHARF TRAFFIC, 1970-1981
(in '000 tons)

NOUAKCHOTT WHARF	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Imports (Dry)	53.5	68.0	99.0	157.5	130.1	..	..	..	..	228.9	206.3	293.7
Exports	.2	7.5	23.3	31.4	42.1	..	..	..	..	1.7	3.4	..
TOTAL	53.7	75.5	122.3	188.9	169.6	180.0	..	..	..	230.6	209.7	..
Ship Arrivals	..	..	..	131	..	..	..	..	..	213	216	..

NOTE: .. Not Available

SOURCE: Republique Islamique de Mauritanie, Annuaire Statistique, 1981.

TABLE 7

Metric Tons of Dry Cargo Unloaded at Nouakchott
(1981)

MONTH	GOOD WEATHER WORKING DAYS	CORRESPONDING TONNAGE UNLOADED	TONNAGE UNLOADED PER WORKING DAY
Juanuary	26	14,519	558
February	27	21,729	804
March	13	8,957	609
April	28	18,171	725
May	28	29,588	1,057
June	28	32,714	1,068
July	24	22,425	934
August	22	22,681	1,031
September	25	28,696	1,148
October	29	30,018	1,035
November	27	35,120	1,301
December	24	29,100	1,212
TOTAL		293,718	

SOURCE: Etablissment Maritime de Nouakchott

Nouadhibou Port

Nouadhibou is the port of exit for all iron ore and fisheries products, the two principal exports.

Nouadhibou Port is well protected and has wharves suitable for unloading the large grain vessels that load on the U.S. Gulf Coast. However, the land connection with Nouakchott is poor; the grain would have to be transported in railcars for about 300 km to Choum via the mining company railway. In Choum it would be transferred to trucks for the 450-km haul to Nouakchott. The cost of using the present land route is well above that of the Dakar - Nouakchott alternative.

The Government is considering, with Arab financial assistance, an investment in a new paved road from Nouadhibou direct to Nouakchott. These considerations are preliminary and, since the investment could not be justified on economic grounds, it may be difficult to obtain financing.

However, there is a possibility that the road will be supported on largely political and social grounds. If so, the import of grain through Nouadhibou could offer substantial cost advantages over other alternatives.

Air Transport

The air service network is relatively well-developed, with 12 airports capable of handling four-engined aircraft, and 10 other fields; domestic air services play an important role by compensating for the lack of adequate surface communication to remote or seasonally isolated areas. Nouakchott and Nouadhibou, immediately north, have international airports. These and feeder airport locations are indicated in Fig. 3. Air Traffic volumes are specified in Table 8.

TABLE 8

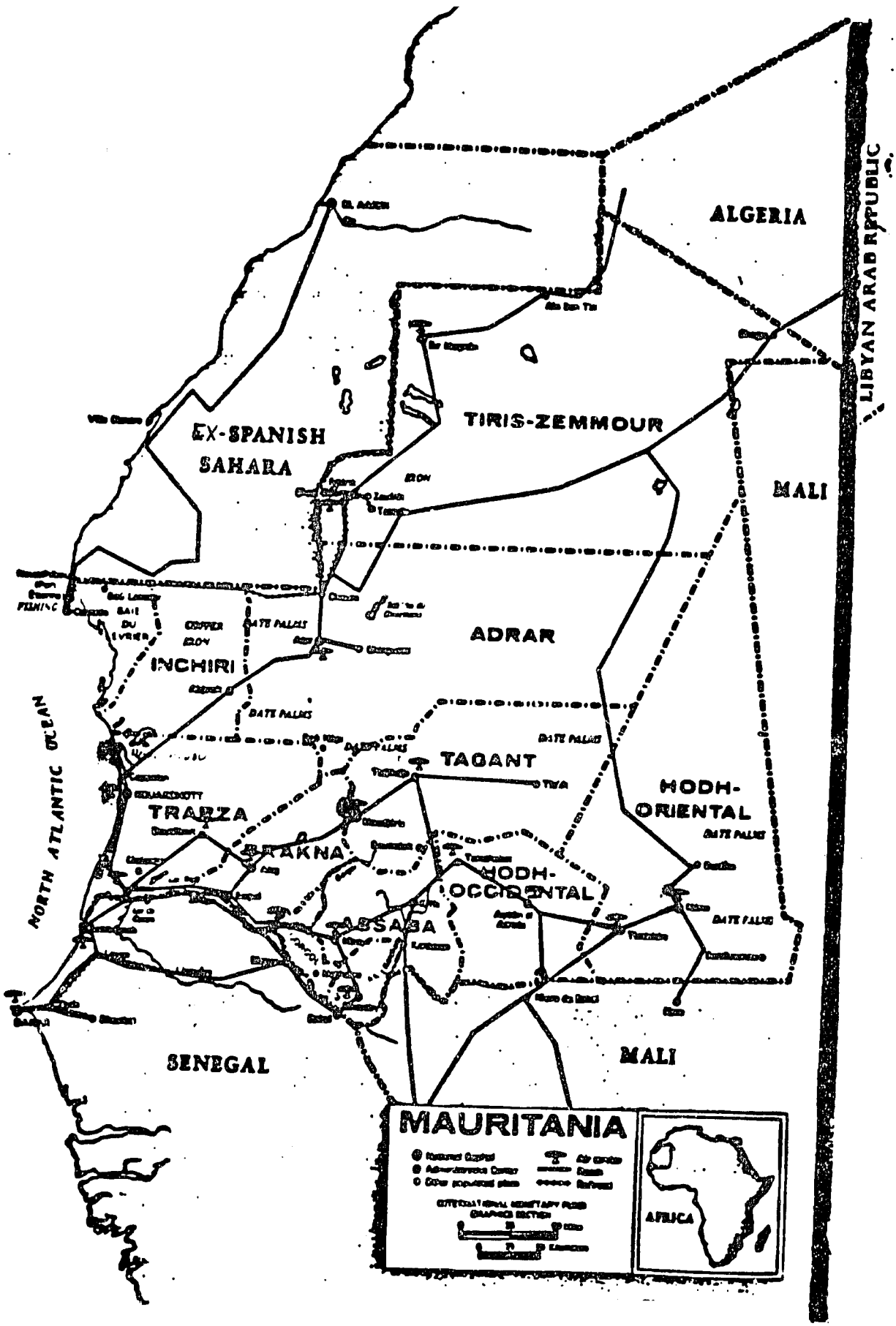
Civil Aviation: Scheduled Service

(000's)

	1975	1976	1977
Km Flown	2,600	2,800	2,900
Passengers Carried	85	94	105
Passenger-Km	127,000	148,000	165,000
Freight Ton-Km	1[illegible],000	13,700	13,600
Mail Ton-Km	600	700	700

FIGURE 3

Mauritanian Airport System



Transportation Costs

Road Transport

The poor road system adds substantially to the cost of transporting grain as well as other products needed by the population in the interior. There is a serious need to improve maintenance, for extension of the rural road network, especially in the Senegal Valley, and for developing a strategy for determining priorities.

Table 9 gives the transport prices charged by Mauritanian truckers in 1981 for the transport of grain from Nouakchott to distribution points in the interior. Transport is by heavy trucks capable of carrying about 10 tons of bagged grain. Prices are given for trucks engaged both by OMC and CRS. Also shown for purposes of comparison are the prices that were charged in 1975 for the transport of SONIMEX products. The 1981 transport rate over paved roads is shown to be between 4 and 5 UM per ton-km (8 to 10 U.S. cents per ton-km). This rate does not appear out of proportion with transport rates charged for similar service in other parts of Africa. Over the unpaved portion of the routes, and especially over those portions where road maintenance is extremely poor and where travel times increase to the point where trucks average only about 150 km of travel per day, the cost of transportation rises rapidly. It is estimated that over the unpaved roads the rates increase to about 12 UM per ton-km (24 U.S. cents). OMC rates paid are lower than those charged the CRS; the explanation appears to be that OMC

TABLE 9

Transport Rates Offered by Mauritania Truckers in 1981 for Transporting[1] Bagged Grain from Nouakchott to Various Inland Locations

FROM NOUAKCHOTT TO:	DISTANCE BY ROAD (KM)	TARRIFF IN UM/TON/KM CHARGED TO CRF	CHARGED TO OMC	CHARGED TO SONIMEX PROD 1975
Boutilimit	154	6.49[2]	6.17	---
Mederdra	160	13.75	---	---
Rosso (paved rd)	204	4.90	2.94[2]	4.0
Akjoujt (paved rd)	256	5.86	---	---
Age	258	5.62	4.76	---
Boghe	328	6.10	5.49	5.7
Magta-Larjar	363	---	5.51	---
Kaedi	438	6.62	5.84	5.7
Atar	454	6.39	7.33	3.4
M'Bout	563	8.88	---	---
Mgama	565	8.85	---	---
Kiffa (paved rd)	603	4.98	3.98	6.9
Tidjikja	628	9.55	---	7.7
Selibaby	683	7.32	6.59	6.4
Zouerate	791	6.95	---	---
Nema (paved 90%)	1,093	6.40	4.75	7.3
Aious (paved rd)	793	3.78	3.78	
AVERAGE PRICE		7.03	5.18	5.89

1. Bagged gain is generally transported in 45-Kg bags aboard trucks with a 30-ton payload capacity (truck-semitrailer combinations), except for routes that consist of mostly lesser roads and where smaller 10-ton payload capacity trucks are used.

2. These rates apparently were below cost and the truckers declined to continue offering this particular service.

3. Costs include loading and unloading the truck.

ships larger quantities of grain than CRS, and that OMC has its own small truck fleet that can be used over those routes where truckers attempt to charge inflated prices. Thus OMC is in a much better bargaining position than CRS and can somewhat control rates.

Though data are insufficient to draw firm conclusions, comparison of the SONIMEX transport rates for 1975 and those for OMC in 1970 indicate that, except for those routes that were improved, transport rates have remained relatively stable. For those routes that were improved, the drop in transport rates was pronounced. For example, the rate on the Nouakchott-Kiffa route in 1975 (before improvement) was UM 6.90 per ton-km. Over the improved road, the rate in 1981 was UM 3.98 per ton-km - a reduction of 42 per cent. Conversely, the rate increased significantly over the Nouakchott-Atar route, likely due to inadequate maintenance on that road since 1975.

Emergency Foodgrain Transport Costs

The cost of transport of foodgrains from the U.S.A. to the final inland destination in Mauritania more than doubles the cost of grain valued FAS vessel at Gulf Coast ports. Wheat costing $180 per metric ton delivered alongside a ship in one of the U. S. Gulf Coast ports will cost about $280 per ton delivered to Dakar, $100 representing ocean freight. Transport from Dakar to a point of entry in Mauritania adds about $110 per ton, and wheat stored in the warehouse in Nouakchott will have a value of about $390

per ton. Delivery to the final consumer over the remaining 400 km or so on the rudimentary inland road network in Mauritania will add about $80 per ton, bringing the final value of the wheat to about 470 per ton - about 2.5 times the value of the wheat in the U.S.A. Much of this cost increase is due to the inadequate, poorly maintained, and inefficiently administered transport infrastructure in Mauritania.

Until 1981 the U.S. shipped Mauritania relief foodgrains to Dakar on vessels of about 10,000 DWT. Trucks of about 30 tons carried the foodgrains to Nouakchott. The land distance from Dakar to Nouakchott is about 570 km over a fair paved road with a ferry crossing over the Senegal River. Though the single ferry is a weak link on the landroute, USAID experienced no significant technical problem with that route, though administrative problems at the border add to the costs and it appears that the long-haul trucking industry in both Senegal and Mauritania is somewhat monopolistic.

Though by previous agreement[1/] it is possible to transport the grain from Dakar across the border to Nouakchott on Senegalese trucks, there have

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1/ In 1977 the Government of Senegal and Mauritania agreed that for the carriage of food relief grain and perishable commodities, seventy trucks from each country would be authorized to cross the border without interference.

been numerous instances where the Mauritanian gendarmerie at the border crossing at Rosso forced Senegalese trucks to transfer the grain to Mauritanian trucks. Also border officials have delayed the trucks for several days before allowing them to proceed. Either type of delay adds considerably to transport costs, so USAID explored alternatives for transporting the grain.

In 1982 the cost of transport of bagged grain form Dakar to Nouakchott was CFAF 19,317/mt, including allowances for spoilage, losses, and border delays. This amounts to CFAF 33.9 per ton-km.1/

Transport Sector Development

Transport development policy has been appropriately directed largely to the maintenance and progressive improvement of existing roads. The Government is completing construction of a paved road from Nouakchott to Nema; the benefits of these projects will be in the long-term since traffic levels are generally low.

1/ Distance: 570 km; Truck size: 30 tons capacity.

NIGER

(Appendix)

NIGER

The Economy

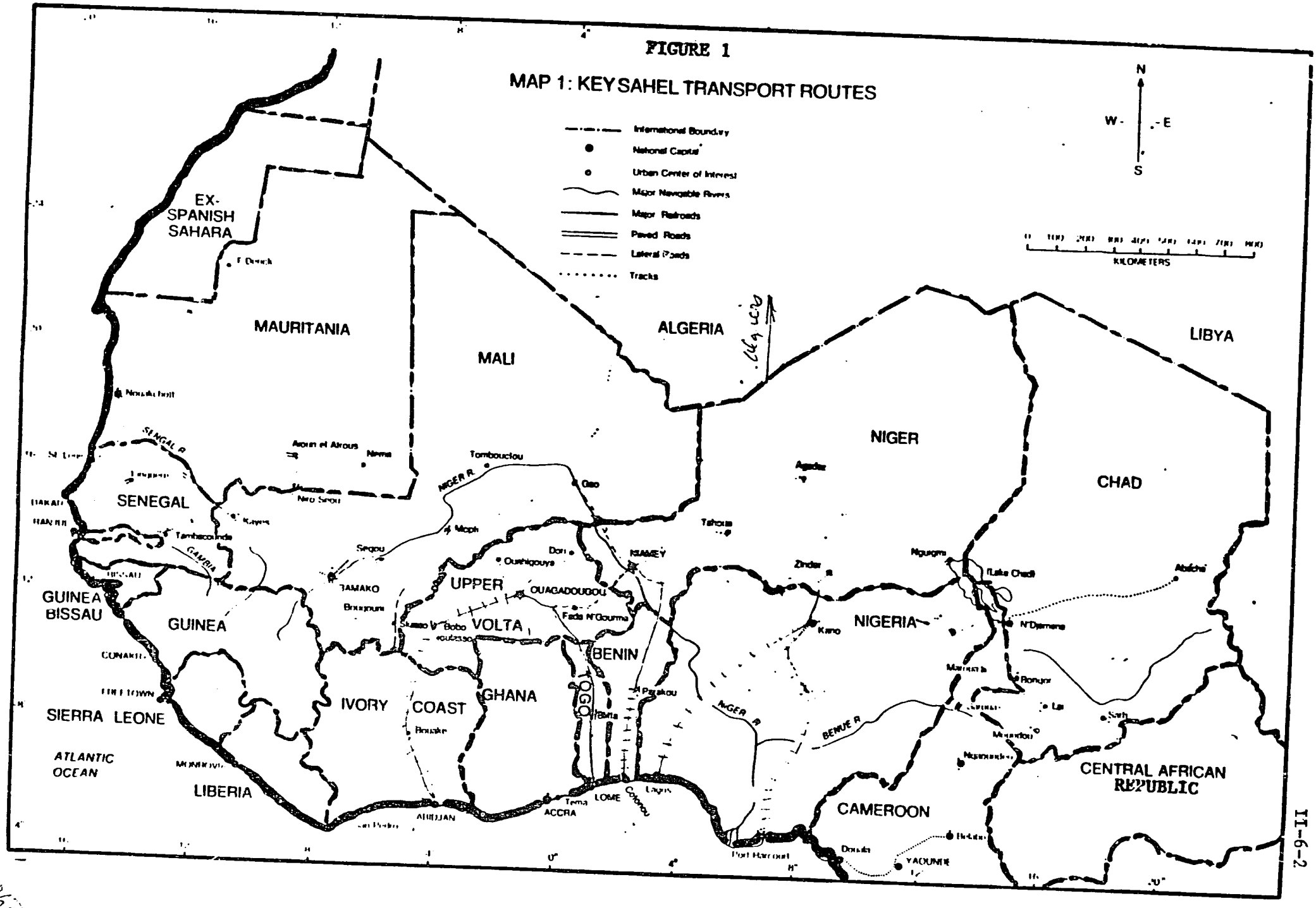
Niger is one of the largest landlocked countries in the Sahel, covering about 1.3 million km^2. It is bordered on the north by Algeria, on the south by Benin and Nigeria, on the east by Chad and on the west by Upper Volta and Mali. The arable land per capita is only one-fifth that of the Sahelian average, with about 60% of the country in the desert region of the Sahara. Only the Niger Valley and the extreme southern part of the country along the Nigerian border are moderately fertile, with rainfall sufficient for cultivation of basic food crops (millet, sorghum, niebe) 1/, cattle breeding and cash crops, mainly groundnuts and cotton. Therefore, the centers of population and of economic activity are located in the southern region. (See Fig. 1.)

The population was estimated to be 5.5 million in 1981 with a growth rate of about 2.7% p.a., giving Niger one of the youngest populations in West Africa (55% of the total population is less than 20 years old). About 85%

1/ Ninety per cent of the cultivated area is devoted to millet and sorghum production. Output is adequate for domestic needs; in some years small surpluses are exported. The small scale export of onions and other vegetables is being promoted.

FIGURE 1

MAP 1: KEY SAHEL TRANSPORT ROUTES



of the population lives in rural areas, of which approximately 80% are located in a 200-km wide zone along the southern border; north of this area the country becomes sub-saharan and saharan with infrequent and unreliable rainfall. Apart from the Air Mountains in the north and small areas of broken terrain in other regions, the topography is generally flat to rolling.

Despite the drought of the 1972-77 period, which probably hit Niger the hardest of the Sahelian countries, overall economic performance has been satisfactory. The per capita GNP rose from US$90 in 1972 to US$270 in 1979. This growth has been provided mainly by the rapid development of uranium production sustained by the fourfold increase of export prices during the 1970s as well as the development of activities associated with the mining sector such as construction and transport services. As a result, the rural sector which accounted for about 60% of GDP and 80% of exports in the early 1970s now represents only 45% of GDP and 25% of exports.

The economy remains agricultural; (30% of GDP) and livestock constitutes an additional 12% of GDP. Uranium mining contributes only about 4% of GDP but uranium concentrates account for more than 60% of the value of exports, and the mining operations contribute about 16% of Government revenues.

Niger's large size, widely dispersed population, rapidly increasing transport demand, and dependence on imports have led the Government to give high priority to investments in transportation. The availability of uranium

profits and donor aid greatly facilitated this objective, leading to imminent completion of an excellent, largely paved, trunk road system capable of satisfying most foreseeable needs for international and major inter-urban traffic. In consequence the capacity and funds needed for maintenance will need to increase two to threefold in real terms in the next ten years. With less favorable prospects for uranium production, exports and prices, important cutbacks are needed in Niger's ambitious plans for continuing its paving program. However, external aid will still be needed for some years to assure the financial requirements of developing a periodic maintenance program for paved roads.

Niger's Sahelian characteristics and the development of new mining centers contributed to a high rate of urbanization during the 1970s-some 9% per year with rapid growth in freight traffic, 13% per year, and passenger movements, 8% per year. This trend reinforced the need for secondary and feeder roads to facilitate the movement of domestic foodstuffs into towns and agricultural inputs into rural areas. This sector of highway development has not developed in line with population and traffic needs, and merits priority in the years ahead.

While uranium mining will continue to be an important industry, it is largely an enclave type industry with a very limited employment effect and few direct input/output linkages with the rest of the economy except in the transport, construction and energy sectors. The country's long-term development and the welfare of most of its people will continue to depend on

agriculture and the social sectors, perhaps supplemented by agro-industries. Therefore, the Government is directing its development policies toward these sectors.

Groundnuts, the most important cash crop, represent about half the value of marketed agricultural production (150,000 mt). Groundnuts are cultivated in the narrow strip of land in Southern Niger along the border with Nigeria. Groundnut oil exports in 1975 amounted to 27,000 mt.

Cotton cultivation has gained importance in recent years, although it accounted for only 3 percent of total export earnings in 1967/68. The area for the cultivation of cotton has reached 160,000 hectares, and in 1973/74 9,600 MT of cotton were exported.

Various minerals are found in Niger. Few, however, have been exploited and one of the principal obstacles has been the high transportation cost of moving the minerals from mining sites to processing locations; improved transport infrastructure will contribute to the exploitation of mineral resources. The only mineral so far developed on any significant scale is uranium, whose reserves are estimated at 70,000 tons of ore. A processing plant at the Arlit uranium mine reached 4,800 tons in 1981. Additional reserves have been located at Akoura near Arlit. Uranium became the major export in 1973.

Table 1 reflects the composition of Niger's foreign trade, while the country's trading partners are indicated in Table 2.

TABLE 1
Niger Foreign Trade; 1971-1973
(million francs CFA)

IMPORTS	1971	1972	1973	EXPORTS	1971	1972	1973
Cotton Fabrics	2,415	2,570	1,074	Live Cattle	1,703	2,209	1,873
Road vehicles	2,181	1,896	1,840	Live Sheep and Goats	270	302	423
Petroleum Products	1,120	1,467	1,533	Leather and Hides	397	435	N.A
Machinery 1/	1,377	1,408	N.A.	Raw Cotton	594	194	880
Sugar and Confectionery	448	836	596	Onions	192	181	112
Cerals	125	319	323	Groundnuts, Shelled	3,413	4,597	1,844
Pharmaceuticals	N.A.	301	166	Groundnuts Oil	967	1,221	833
Tobacco	228	247	178	Groundnuts, Cake	265	356	262
Electrical Equipment	624	232	353	Uranium 2/	1,737	2,369	5,428
Beverages	141	186	N.A.	Cotton Fabrics 3/			
Iron, Cast Iron, Steel	427	913	N.A.				
Metal Products	788	N.A.	N.A.				
TOTAL (INCL. OTHERS)	14,875	16,576	15,281	TOTAL (INCL. OTHERS)	16,670	13,712	12,690

1/ Largely, mining equipment and road construction units.

2/ Uranium exports (in mt metal equivalent) have been gradually increasing as indicated below:

Uranium Exported	1979	1980	1981 (est'd)
mt Metal Equivalent	3,740	4,129	4,847

3/ Manufactured cotton fabrics are exported; in 1975 Niger exported 7 million square meters of fabrics.

TABLE 2
NIGER TRADING PARTNERS
(million francs CFA; 1971-73)

IMPORTS	1971	1972	1973
Sahel Countries			
Senegal	295	312	100
Other Africa			
Ivory Coast	807	1,259	580
Nigeria	348	463	875
Rest of World			
China, People's Republic	391	293	344
France	6,466	7,721	6,585
Germany, Federal Republic	1,154	1,325	1,058
Italy	454	402	581
Netherlands	797	739	535
United Kingdom	565	423	454
USA	1,172	810	1,95
Venezuela	341	420	392

EXPORTS	1971	1972	1973
Sahel Countries			
None			
Other Africa			
Benin	478	145	274
Ivory Coast	264	300	145
Nigeria	2,726	3,772	2,931
Ghana	120	88	152
Rest of World			
France	5,509	5,260	6,775
Germany, Federal Republic	0.5	924	710
Italy	363	710	727
United Kingdom	199	147	343

France buys most of Niger's uranium and in 1980 supplied 75 per cent of Niger's nonpetroleum imports.

Nigeria and the Ivory Coast are the principal markets for Niger's cattle, the second most important export.

The Transport Sector

General

Niger's transport system consists of 18,400 km of roads and tracks, an international airport at Niamey, five domestic airports, and to a very limited extent the River Niger. Niger also has an important interest in the Benin-railway operated by the Organization Commune Benin-Niger des Chemins de Fer et des Transports (OCBN) which is one of its main outlets to the sea. The extent and density of the road system is generally adequate. Because of the long transit time between Niger's important production centers to the nearest ocean ports and the scarcity of natural resources causing heavy dependence on imports, the flow of trade is very sensitive to transport costs. Consequently, past and present road programs in Niger have concentrated on the upgrading and improvement of the main and secondary roads.

External transport costs could be reduced if transport infrastructure and transit services in neighboring countries were improved, reducing the high transport costs for exports and imports which Niger has to bear.

Transport by camel is still very significant in large areas of the country. This is especially so in the sparsely populated north where transport requirements are limited, and where the volume of freight carried is

too low to justify the infrastructure costs of modern highways, even though the operating cost per ton-km by camel transport is estimated to be two to three times higher than trucking.

Road Transport

Today, Niger has 2,700 km of paved roads and 3,000 km of good engineered laterite roads out of a total classified network of 8,200 km (See Fig. 1 and Table 3). About 2,000 km of roads were paved between 1976 and 1981. This exceptional performance was made possible because of the availability of important windfall revenues provided by the uranium boom.

Since 1975, most of the Government's efforts have been to upgrade the east-west axis to paved standards to serve the major economic centers of the country, and to upgrade and extend the north-south axis which links the uranium mine sites in the Arlit area to Gaya at the Benin border.

The non-classified secondary road network -- about 12,000 km -- includes mainly elementary tracks and rural feeder roads that are relatively well developed but of low standard. There is a backlog in the periodic maintenance of non-classified secondary earth roads. Further extension of the feeder road network to the remote agricultural areas is needed in the south. The Government recognizes the importance of feeder roads in rural development, and extension of the network is planned within the framework of future integrated rural development projects.

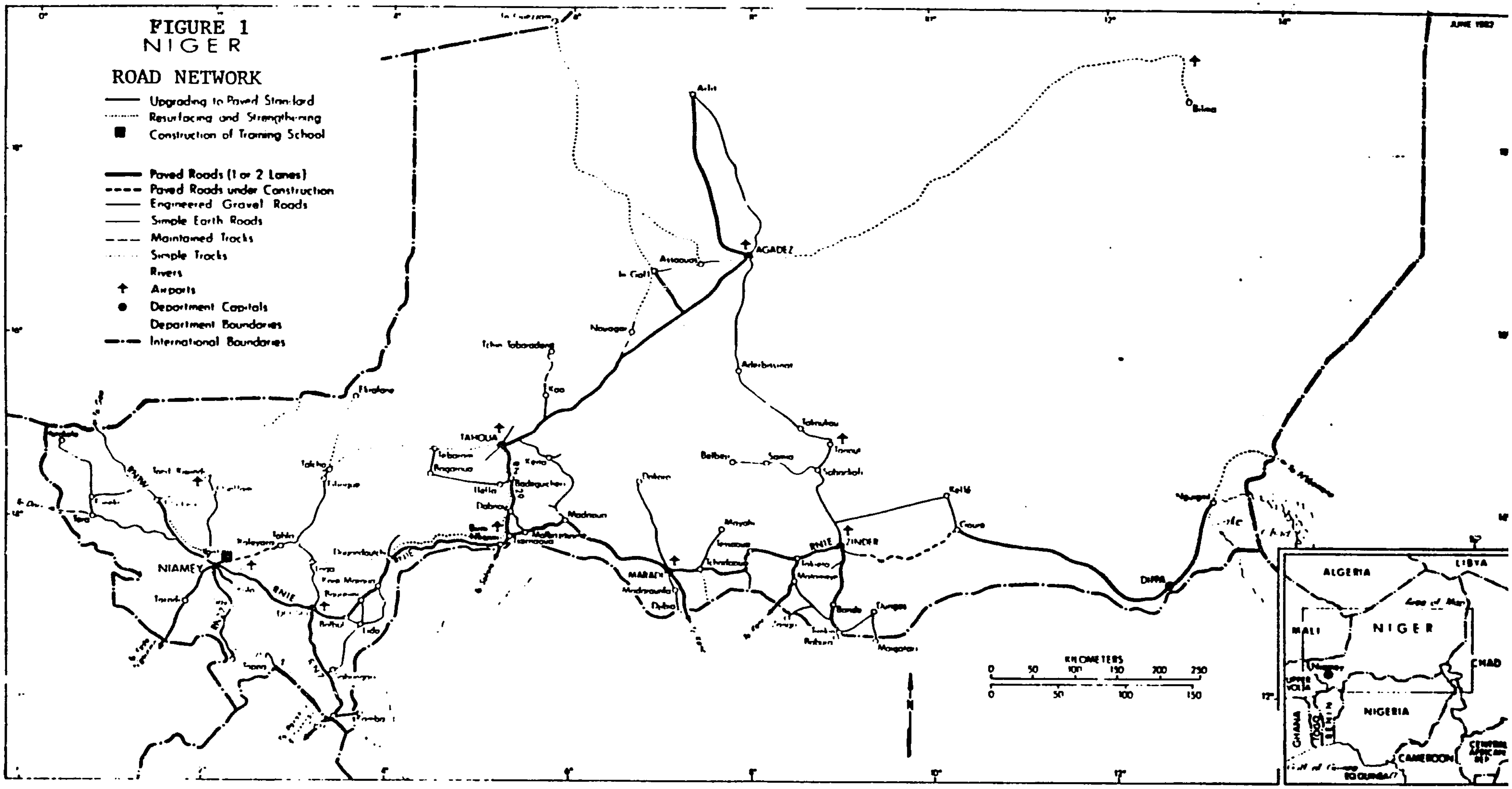


FIGURE 1
NIGER
ROAD NETWORK
Upgrading to Paved Standard
Resurfacing and Strengthening
Construction of Training School
Paved Roads (1 or 2 Lanes)
Paved Roads under Construction
Engineered Gravel Roads
Simple Earth Roads
Maintained Tracks
Simple Tracks
Rivers
Airports
Department Capitals
Department Boundaries
International Boundaries
JUNE 1982
AGADEZ
TAHOUA
NIAMEY
MARADI
ZINDER
DIFFA
KILOMETERS
0 50 100 150 200 250
0 50 100 150
ALGERIA
LIBYA
MALI
NIGER
CHAD
NIGERIA
CAMEROON

TABLE 3

Republic of Niger
Development of the Highway Network 1970-1980

(km)

	1970	1973	1975	1976	1977	1978	1979	1980
A. Classified Network 1/								
Paved roads	488	933	1,530	1,729	1,765	1,835	2,020	2,673
Gravel roads	2,979	2,637	2,525	2,529	2,791	2,720	2,799	3,086
Earth roads	996	1,186	637	639	874	874	835	360
Tracks	2,481	2,715	2,260	2,016	2,158	2,158	1,951	2,104
Total	6,944	7,471	6,951	6,913	7,587	7,587	7,605	8,219
B. Unclassified Network								
Tracks			---------- 11,000 to 12,000 ----------					

1/ Road network under responsibility of DPW, excluding the new Tahoua-Arlit Road.

Source: Ministry of Public Works, Transport and Housing, 1981.

03/82

Most paved road network extension was accomplished with the windfall revenue provided by the uranium boom. This is reflected in the very ambitious ongoing 1979-83 Investment Plan which allocated about CFAF 60 billion (US$200 million) for highway investments including: (a) about CFAF 22 billion for the construction of the Tahoua-Arlit "uranium road"; (b) CFAF 26 billion for the improvement and extension of the primary road network (mainly paved roads); and (c) CFAF 12 billion for the extension of the secondary road network. By mid-1981, the Tahoua-Arlit road and 60% of the investment program of secondary roads were completed. However, only 19% of the total allocated for the improvement and extension of the paved network was effectively spent by mid-1981. Following the fall in uranium prices in 1980 and 1981, the possibility of having to curtail the 1979-83 Investment Plan was foreseen. The Ministry of Public Works, Transport and housing (MTPTU) gave priority to the strengthening and upgrading of the high traffic road sections such as: (a) the Sabongari-Gaya Road (in the south on the Beninese route); (b) the Guidam-Romji-Tchadaoua Road (Maradi area); and (c) the paving of the Niamey-Upper Volta border road.

The Government is planning to pave a number of low-volume roads (less than 100 vehicles per day) in the highway investment program, which includes the reconstruction and upgrading of the Zinder-Lake Chad road (CFAF 8 billion), the paving of the Niamey-Fillingue-Tahoua road (CFAF 3 billion), and the Tillabery-Gao road to the Malian border (CFAF 2.2 billion). In Niger, as in neighboring Sahelian countries such as Upper Volta and Mali,

traffic volumes outside the major paved trunk roads are very low and it is becoming more difficult to economically justify extension of the paved road network. Construction of new roads should be tied to the traffic needs of economic development programs in other sectors which are served by such roads. One example is the paving of the Niamey-Say road along the potentially rich left bank of the Niger River where several development projects are now implemented.

The Government could best cope with the critical problem of high domestic transport costs by preserving the existing network from deterioration, and plan for progressive improvements.

Road Traffic

Traffic density patterns follow the economic activity in the south and southwest. The highest density has been observed on the Niamey-Dasso road section (200 vehicles/day). Traffic on the north-south uranium road averages 90 vehicles/day, mostly heavy trucks. Only about 5% of the feeder roads and tracks carry more than 10 vehicles per day. The low level of rural development and low standard of roads contribute to this low traffic flow. Over the last decade domestic freight transport increased about 13% per annun in terms of ton-km (Table 4). This high rate reflects an increase both in volume of traffic (about 10% p.a.) and in travel distances following

TABLE 4
Republic of Niger
Traffic Growth
(million ton-km)

	1965	1977	Growth p.a. %
Total domestic transport;	72.7	320.6	13
of which international traffic	39.5	174.3	13
Niger domestic operators;	57.5	260.6	13
of which international operators	28.7	89.7	10
Total Foreign Operators	41.0	176.7	13

Source: Five Year Economic Plan, 1979-83

the opening of uranium mines in the center of the country. The growth of passenger traffic is estimated to be 8% p.a. Since traffic data collection is almost non-existent, up-to-date statistics are not available on the network as a whole. A recent BCEOM Highway Maintenance Study contains the latest available information.

Road Transport Industry

The motor vehicle fleet has been increasing over recent years at about 13.5% p.a., and in 1980 it was estimated at about 12,000 units, of which about 75% were light vehicles (Table 5). The existing truck fleet is considered more than adequate to serve present requirements. The consumption of gasoline and diesel oil increased over 1975-80 at an average of 11% and 14% p.a. respectively.

Of the 250 transporters who handle public freight transport, about half are located in Niamey. The largest is the Societe Nationale des Transporteurs Nigeriens (SNTN), with 49 per cent Government equity. In 1980, the company's fleet comprised about 807 units, as opposed to only 295 units in 1976, and when necessary, it rents trucks. It handles about 75% of fuel transport, and about 40% of all general freight carried. It also has the monopoly for transport of uranium ore from the mines at Arlit to Parakou (Benin). Another important component of the road transport fleet is owned and operated by NITRA, a publicly owned enterprise, with a monopoly for sharing with OCBN the carriage of Niger's trade using the Port of Cotonou.

TABLE 5

Republic of Niger
Estimates of Existing Vehicle Fleet

	1972	1973	1974	1975	1976	1979	1980
Cars	4,499	4,897	5,295	4,672	4,477	4,040	4,856
Vans	2,242	2,394	2,594	2,389	2,574	2,401	3,012
Trucks	770	907	1,012	1,112	1,109	1,185	1,392
Tractors	341	362	364	433	450	777	1,030
Trailers	275	279	266	269	286	594	720
Buses	131	176	249	279	273	567	800
Total	8,258	9,020	9,780	9,154	9,169	9,564	11,810

Source: BCEOM Plan de Transport and World Bank estimates.

Other transport needs are met by the mining and petroleum importing companies and private owner/operators.

Public freight transport is a flourishing activity in Niger. Although there is officially no monopoly in road transport the well-managed and efficient Societe Nationale des Transports Nigerien (SNTN) has benefitted more than any other trucking company from the growth of transport demand in the late 1970s. Its fleet increased from 295 units in 1976 to more than 1,000 in 1981 and the total haulage distance of the fleet increased more than 30% p.a. SNTN now owns about 20% of the national trucking fleet and has its own well-managed workshop and training center.

Aviation

Air service in Niger is centered at Niamey Airport, the country's only international airport (202,000 passengers in 1980; growth averaging about 11% p.a.), which is the closest to Europe among the major airports in Sub-Sahara West Africa, and an important transit stop (79,000 transit passengers in 1980). The Agence International pour la Securite de la Navigation Aerienne (ASECNA) operates the airport at Niamey, which is capable of handling B-747 aircraft.

Domestic air transport (25,000 passenger departures in 1980) is served by Air Niger, the national airline; by TRANSNIGER, an air-taxi service, and by a number of small privately-owned planes. Scheduled service is

provided to five feeder airports, located at Agadez, Arlit, Maradi, Tahoua, and Zinder. In addition, there are about fourteen public airstrips and about 50 very small private airstrips, mainly serving mining and oil exploration companies in outlying regions of the country. Air-Niger's fleet is comprised of two recently acquired Hawker Siddeley 748s, which carry 48 and 52 passengers, respectively.

Air traffic demand, mainly to and from the Arlit mines, is expected to grow and the Government recently authorized Air-Niger to modernize its fleet and requested ASECNA to undertake a feasibility study for the construction of a new airport facility at Arlit suitable for medium-sized aircraft of the B737 type. Although the quality of land transport is improving, given the long distances involved, air services will remain important to the economy; especially for passenger transport and emergency operations. See Table 6.

The MTPTU is responsible for aviation, whose functions in the Department of Civil Aviation are performed almost entirely by the local ASECNA representatives. ASECNA generates additional employment for Niger through its Flight Information Center (FIC) which is located at Niamey Airport. In addition, ASECNA's main regional school for technical training of all ASECNA staff (air traffic controllers, meteorological personnel, etc.) is also established in Niamey.

TABLE 6

Republic of Niger

Air Traffic
(Passengers, Freight and Mail Movements)
(1970-1980)

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Passengers	(T)	43944	49929	56608	65217	71731	73353	n.a.	n.a.	138945	153495	147187
Niamey	(T)1/	37954	40021	50721	58917	61087	67178	73493	85766	112853	125641	123293
	(TB)	(n.a.)	(74522)	(89817)	(101165)	(113380)	(120108)	(127609)	(146568)	(177009)	(194707)	(202045)
Agadez	(T)	1043	1003	1800	2506	4247	2892	n.a.	n.a.	12459	13411	10994
	(TB)	(n.a.)	(1998)	(3524)	(4520)	(6300)	(5076)	(n.a.)	(n.a.)	(16894)	(19252)	(16124)
Zinder	(T)	2387	2720	3071	3342	3718	2988	n.a.	n.a.	9095	6973	6322
	(TB)	(n.a.)	(2736)	(3253)	(3734)	(4621)	(4340)	(n.a.)	(n.a.)	(8216)	(10705)	(8910)
Maradi	(T)	2260	2180	2936	2372	2679	2595	n.a.	n.a.	4970	4486	4123
	(TB)	(n.a.)	(4091)	(5162)	(5928)	(5991)	(5227)	(n.a.)	(n.a.)	(7879)	(8918)	(7315)
Tahoua	(T)	n.a.	n.a.	n.a.	n.a.	n.a	n.a.	809	n.a.	3268	3746	2455
	(TB)	(n.a.)	(n.a.)	(n.a.)	(n.a.)	(n.a.)	(n.a.)	(5453)	(n.a.)	(5241)	(6820)	(6019)
Freight (tons)		4159	4091	5036	6822	7439	6171	n.a.	n.a.	14176	15356	14327
Niamey	(T)	3958	4261	4783	6574	7003	6024	7088	9195	13809	15075	13902
Agadez	(T)	66	87	105	134	196	71	n.a.	n.a.	282	207	330
Zinder	(T)	84	95	104	84	143	93	n.a.	n.a.	99	57	61
Maradi	(T)	98	48	44	40	39	25	n.a.	n.a.	9	24	25
Tahoua	(T)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a	18	13	9
Mail (tons)		203	210	233	253	257	272	n.a.	n.a.	391	401	453
Niamey	(T)	185	174	198	196	198	236	272	282	384	364	416
Agadez	(T)	14	11	9	8	12	4	n.a.	n.a.	7	7	9
Zinder	(T)	19	19	19	16	17	14	n.a.	n.a.	10	14	16
Maradi	(T)	9	10	11	13	10	11	n.a.	n.a.	13	12	7
Tahoua	(T)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	4	5

T = Arrivals and Departures
TB = Arrivals, Departures and Transit

1/ Includes 9,122 domestic passengers in 1972, 10,352 in 1976 and 12,200 in 1977. No data are available for other years. All other airports have domestic passengers only.

Source: ASECNA, 1980

River Transport

Efforts to develop modern river transport on the Niger River have recently been abandoned. The Societe Nationale des Transports Fluviaux (SNTF) established in 1972 with the assistance of the Canadian International Development Agency (CIDA) to operate river transport between Gaya and Warri (Nigeria) has been recently dissolved. At present there is no serious hope for the company to resume its activities unless Nigeria moves ahead in developing its inland waterway system, involving major investments in construction of dams and canals. The improvements required include river regulation, major investments in construction of dams and canals, dredging, creation of river ports with supplying and bunkering facilities, river signalization, and provision of terminal storage facilities.

SENEGAL

(Appendix)

7. SENEGAL

A coastal country, Senegal enjoys ready access to world markets via its modern port facilities at Dakar. Past transit flows to Mali and Upper Volta via Dakar were substantial, but with inefficiencies on the CFS railway and development of other alternatives for those countries, volumes have declined. In view of the relatively adequate internal transportation system in Senegal and the increasing use of other alternatives for transit cargoes, the introduction of airship transportation in Senegal does not appear economically feasible, although this case was not studied specifically.

The Economy

Senegal is the most economically advanced of the eight Sahel countries. Its population and economic activity are concentrated in the west, and a considerably larger proportion of the people live in urban areas (30%) than do the populations of other Sahelian countries (5-10%). This affects traffic patterns; the transport networks radiate from Dakar and there are greater flows of foodstuffs from rural areas to urban centers.

Dominant features of the economy are its limited natural resources and its small size (5.0 million population in 1975 in an area of 197,000 km^2). Conditions which have favored Senegal's growth since independence have been: i) a high level of human skills and development in the coastal area; ii) political stability; and iii) adequate sector prioritization.

Senegal's transport system is relatively well developed, and transportation does not pose a constraint on economic development, although railroad operations are inefficient and roads are not adequately maintained. Figure 1 indicates the transportation network and its links with Mali and Upper Volta.

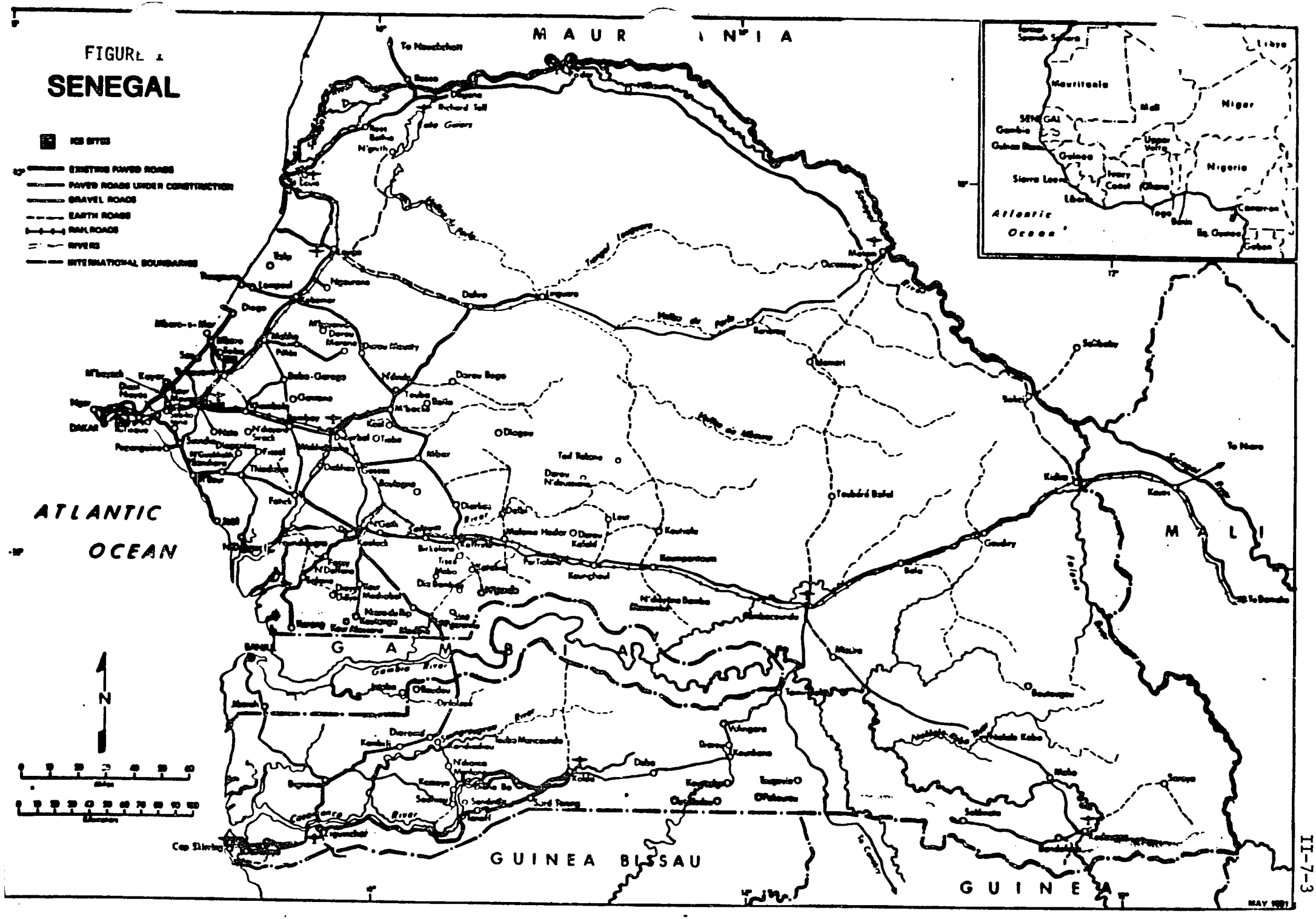
Population - Population growth is estimated at about 1.9% per year. Rural densities are much greater in the western quarter of the country, where most major towns are located; 15% of the population lives in Dakar, which has a population of over 600,000. Population densities are very low in the subdesert eastern and northwestern areas.

Topography - Senegal is situated on a flat savannah plain extending inland from the westernmost point of Africa. Elevations of over 100 m above sea level exist only in the southeast.

Climate - A tropical subdesert regime prevails, with distinct wet and dry seasons. Rainfall varies from moderately heavy in the south to light and erratic in the north. Temperatures range from warm to hot throughout the year.

FIGURE 1

SENEGAL



Commerce

Exports and Imports

Groundnuts and phosphates, the principal export products, constituted 57 percent of total exports in 1975. In that year 1.7 million mt of phosphates were exported. Table 1 is a profile of exports and imports, by value. Trading partners of Senegal are indicated in Table 2.

Transportation Sector

The domestic transport system consists of a 13,000-km road network carrying about three-quarters of commercial inter-urban freight and passenger traffic, excluding phosphates; and a 1,032-km railway carrying primarily phosphates and international traffic to Mali. The port of Dakar is a major protected deep-water port. Three secondary seaports handle a small additional volume of traffic. Dakar airport serves as a strategic stopover on routes from Europe to South America, and from New York to East and West Africa. Domestic air and river transport and coastal shipping are not significant. Apart from the location of Gambia (see Fig. 1), there are no major physical barriers to the development of transport within Senegal.[1/] Population and economic activity are concentrated in the Cap Vert peninsula and the adjacent groundnut basin, resulting in short travel distances for most domestic traffic, and a substantial flow of commodities between Cap Vert and adjoining rural areas.

1/ The continued integration of the two countries' activities may mitigate whatever problems this presents.

TABLE 1

Senegal Foreign Trade

(million francs CFA)

EXPORTS	1973	1974	1975	IMPORTS	1973	1974	1975
Groundnuts	419	1,404	1,324	Dairy Products, Eggs and Honey	1,781	1,986	2,411
Groundnut Oil	8,324	25,655	31,123	Fruit and Vegetables	2,638	3,002	2,319
Oilseed Cake	6,532	6,918	7,871	Wheat	2,619	2,858	4,023
Fresh Vegetables	547	578	771	Rice	9,519	18,012	6,050
Fresh Fish	1,265	2,440	2,321	Sugar	5,223	9,082	7,998
Preserved Fish	2,519	3,428	3,644	Petroleum Products	4,833	15,476	14,782
Crustaceans and molluscs	851	1,304	1,297	Parachemicals	1,737	2,638	2,987
Cement	501	840	1,194	Paper	2,248	3,466	3,495
Phosphates	4,943	24,946	22,226	Textiles	3,266	3,714	4,732
Petroleum products	2,537	5,309	6,948	Base Metals	2,869	5,344	3,481
Sea Salt	493	793	810	Machinery	7,484	9,866	17,827
Phosphatic Fertilizers	831	2,549	1,508	Electric Apparatus	3,227	4,843	4,877
Cotton Fabrics	1,545	1,459	1,641	Vehicles and Spares	4,961	6,129	9,367
Footwear	859	977	1,235				
TOTAL (incl. others)	43,237	93,973	99,101	TOTALS (incl. others)	79,766	119,376	124,616

TABLE 2

Senegal Trading Partners
(million francs CFA)

IMPORTS.	1973	1974	1975
Sahel Countries			
None			
Other Africa			
Ivory Coast	3,321	3,731	5,258
Nigeria	1,913	6,592	5,118
Rest of World			
Belgium/Luxembourg	1,160	1,921	3,001
Brazil	1,119	9,018	2,213
China, People's Republic	4,269	3,461	1,854
France	37,140	44,306	51,647
Germany, Federal Republic	3,781	6,711	6,726
Iraq	1,500	5,012	4,392
Italy	3,175	2,653	3,617
Netherlands	1,956	2,324	3,514
Pakistan	417	2,958	2,388
Thailand	2,871	3,530	1,880
U.S.S.R.	551	6,025	1,725
United Kingdom	989	1,643	2,364
U.S.A.	5,962	7,542	9,215
TOTAL (INCL. OTHERS)	79,766	119,376	124,616

EXPORTS	1973	1974	1975
Sahel Countries			
Mali	1,639	1,927	2,808
Mauritania	3.083	4,211	5,220
Other Africa			
Ivory Coast	3,598	1,411	4,471
Rest of World			
Belgium	190	767	1,059
Finland	n.a.	621	1,406
France	20,556	51,915	47,857
Germany, Federal Republic	293	746	1,238
Greece	488	2,381	2,846
Italy	1,733	1,365	2,873
Japan	554	1,707	1,313
Lebanon	183	1,064	855
Netherlands	1,600	4,857	3,614
Spain	1,147	1,235	793
United Kingdom	1,107	4,673	5,981
TOTAL (INCL. OTHERS)	43,237	93,973	99,101

Roads

Senegal has over 9,000 km of roads, of which 3,500 km are paved, plus about 4,000 km of tracks. (See Table 3.) The network is well developed relative to the size and growth of the national economy. For example, Senegal has about 72% more paved roads than Cameroon with a similar GNP, and about 25% more paved roads than either of the larger countries of Ivory Coast or Zaire, each having GNPs about double Senegal's. The network is concentrated in the coastal regions and the groundnut areas, peripheral to Dakar, and a number of main roads parallel the railway line.

Traffic growth on selected principal routes is indicated in Table 4.

The Road Transport Industry

The road transport industry comprises three major segments: a modern private sector; a traditional private sector; and public/semi-public agencies. The modern sector is made up of a few large companies which carry the products of trading companies. The traditional sector is made up of owner-drivers grouped in a federation, who carry groundnuts, food, cattle or small loads. ONCAD, the groundnut state monopoly which formerly organized groundnut transport, was abolished in 1980. After a year of disorder, the groundnut oil companies have taken over that task. There seems to be sufficient transport capacity for the existing demand.

TABLE 3

Senegal

Road Network, Selected Years 1972-1982

	kms			
	1972	1974	1978	1982
Paved roads	2,256	2,586	2,836	3,500
Engineered gravel and earth roads	645	456	448	450
Other all-weather gravel and earth roads	1,640	2,794	5,108	5,100
Tracks	4,480	7,435	5,350	4,950
Total	9,021	13,271	13,742	14,000

Source: General Directorate of Public Works, 1982.

TABLE 4

Senegal

Traffic on Main Road Sections, Selected Years 1954-1981

(ADT)

Section	Road	1954	1964	1969	1975	1979	1981
- Dakar - Diam Niayes	RN 1	-	3 800	2 075	9 400	11 300	16 000
- Diam Niayes - MBour	RN 1	400	1 250	-	2 260	2 450	2 595
- Mbour - Kaolack	RN 1	650	590	-	850	1 590	1 500
- Kaolack - Malem Hodar	RN 1	-	444	360		820	1 000
- Malem Hodar - Tambacoun.	RN 1	-	122	200	100	285	430/286
- Tambacounda-Goudiny	RN 1	-	-	20	58	68	80
- Diam Niayes - Thiès	RN 2	400	2 450	2 075	3 800	4 300	3 718
- Thiès - Saint Louis	RN 2	-	500	720	760	1 290	1 473
- Saint Louis - Rosso	RN 2	-	390	235	940	735	721
- Rosso - Podor	RN 2	-	120	-	330	360	350/122
- Podor - Matam	RN 2	-	-	45	90	140	160
- Matam - Bakel	RN 2	-	-	10	12	47	56
- Thiès - Bambey	RN 3	200	660	390	1 500	1 900	1 420
- Bambey - Diourbel	RN 3	-	270	360	985	1 350	
- Diourbel - Touba	RN 3	-	370	225	530	1 930	555
- Touba - Dahra	RN 3	-	-	190	290	610	681
- Diourbel - Kaolack	RN 4	-	-	20	135	730	772
- Kaolack - Keur Ayip	RN 4	350	450	-	410	900	1 017
- Sénoba - Ziguinchor	RN 4	40	-	-	300	560	
- Kaolack - Karang	RN 5	-	-	-	340	500	649/400
- Bignona - Séléti	RN 5	-	-	-	140	310	543
- Ziguinchor - Kolda	RN 6	-	-	40	290	490	663/458
- Kolda - Vélingara	RN 6	-	-	-	420	310	163
- Vélingara - Tambacounda	RN 6	-	-	30	150	180	112/229
- Tambacounda-Dialakoto	RN 7	-	-	50	-	170	110
- Dialakoto - Kédougou	RN 7	-	-	15	30	50	50
- Cayar - Feut	D 700	80	280	-	-	810	

Source: Ministry of Equipment, 1981.

Passenger transport in Dakar has grown considerably, as most people commute between the southern end of Cap Vert and Grand Dakar, Medina and Pikine where they live. In 1971 SOTRAC was awarded a 15-year convention for the monopoly of this passenger traffic; SOTRAC, a joint Government-Renault venture, was scheduled to displace the "cars rapides" (minibuses) services but in fact was unable to despite the fact that the importation of minibuses was banned. Now SOTRAC has twice the market share of the minibuses, charging more or less similar tariffs; however, while SOTRAC is running a considerable deficit -- about 1/3 of its revenues, which is fully absorbed by Government -- the small-private operators are making a profit and paying taxes.

Trans-Gambia Transport

A reason for paving the road around Gambia was the avoidance of delays at the Gambian ferries at Banjul and Farafenni. At Farafenni, where the heavy vehicles are ferried, one boat operates from 0815 to 1915 and another operates for half the day; waiting time is about two hours for cars and six hours for trucks, which, generally arrive in the evening and wait until morning. The full-time ferry manages about eight round trips per day, and can handle on each trip two 20-ton trucks and nine cars or the equivalent; in 1981 the two ferries handled a total of 59,000 vehicles, which corresponds to the full capacity; about 75% of these vehicles were Senegalese. The fare, CFAF 6,000 (D 35) for a 10-ton truck or CFAF 16,200 (D 90) for a 20-ton unit, is about equivalent to the operating cost for some additional 80 km.

The ferry at Banjul is less used by Senegalese trucks.
The ferry is in a dilapidated condition but as the Gambians want to build a bridge/dam -- at an estimated $300 million -- they have not given priority to better ferry service. Studies are available for both a bridge and a bridge/dam; but even if the Gambians were to proceed with the bridge/dam, it would take until the late 1980s to be completed and a new ferry has been acquired.

Railway

The 660-km meter gauge main line railroad of the Regis des Chemins de Fer du Senegal handles most freight traffic, including the transit traffic of landlocked Mali and a part of Mauritanian imports and exports. The rail network, which includes an additional 370 km of branch lines, is well developed in western Senegal, while a single line serves the sparsely populated east. The main line from Dakar to Bamako carries 35 percent of Mali's exports and 47 percent of its imports; Mali traffic accounts for 50 percent of the Senegal Railway's gross revenues.

Although the railway has been the dominant freight carrier for some time, it has been losing this position through its inability to provide the necessary capacity. Railway traffic has decreased: after carrying 3.8 million passengers (295 million pass-km) in 1966/67, it lost most shortdistance customers to the competitive road transport and carried only 873,000 passengers (113 million pass-km) in 1981. Freight traffic decreased

less and for the last five years was stable at around 1.7 million tons, or 302-346 million ton-km. Almost 50% (some 145 million ton-km) is phosphate traffic and another almost 50% is Malian traffic, which fluctuated between 215,000 and 243,000 tons in recent years, or some 144 million ton-km. Only slightly over 10 million ton-km were due to other goods. The reduced traffic is in part a consequence of the railway's chronic inability to handle available demand. Despite many efforts, CFS continues to be characterized by low operational performance, low productivity, and considerable deficits, stemming largely from management problems, a strong union, lack of staff discipline, continued operation of uneconomic lines, lack of autonomy, and poor infrastructure. Freight and passenger traffic levels from FY 1972 to FY 1981 are indicated in Table 5.

Maritime Transport

The port of Dakar, accounting for some 90% of the imports and exports to and through Senegal, is the western terminal of Senegal's railway. Of the few inland waterways, the Senegal River is the most important, but navigation is seasonably restricted to two months on the river as far as Kayes, Mali, and three months as far as Kaedi, Mauritania.

International seaborne shipping volumes for the period 1965 and 1971-1981 are indicated in Table 6.

TABLE 5

Senegal

Senegal Railways
Freight and Passenger Traffic FY1972 - FY1981
(ton/pass 000; tkm/pkm mill)

	FY72		FY73		FY74		FY75		FY76		FY77		FY78		FY79		FY80		FY81 1/	
	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm	ton/pass	tkm/pkm
FREIGHT																				
INTERNATIONAL TRAFFIC	295	129	238	119	303	190	251	154	263	144.6	239	147	267	171	227	138	215	131	243	144
Exports (Mali imports)	242	89	163	101	231	158	205	128	166	102.7	153	94	194	124	187	114	169	105	202	120
Imports (Mali exports)	53	41	67	18	72	32	46	28	97	63.9	86	53	73	47	40	24	46	28	41	24
NATIONAL TRAFFIC	1,792	212	1,676	214	1,994	193	2,633	203	2,343	163.9	2224	161	2,460	172	2,422	182	2,664	174	2,363	158
Phosphates - Taiba	1,277	343	1,331	169	1,291	144	1,283	133	1,066	121.4	1159	139	1,335	150	1,321	148	1,364	153	1,239	138
Phosphates - Thies	143	12	128	11	130	12	66	7	116	10.0	47	4	23	2	22	2	16	1	62	7
Groundnuts	107	24	71	10	90	12	76	20	101	21.5	72	16	64	15	28	8	41	10	-	-
Other	178	33	146	34	184	33	90	21	42	10.1	47	11	38	8	51	24	43	10	71	13
TOTAL FREIGHT TRAFFIC	2,910	341	2,906	293	2,897	293	2,884	322	2,606	292.6	2543	308	2,727	346	2,649	320	2,681	307	2,606	302
PASSENGERS																				
National	2,715	220	2,398	202	2,217	184	2,689	166	2,791	[illegible]	1692	159	2,250	123	1,828	113	608	77	834	92
International	44	21	51	25	67	33	53	27	51	28	46	23	46	23	50	25	44	23	39	21
TOTAL PASSENGER TRAFFIC	2,759	241	2,449	227	2,284	217	2,842	193	2,842	184	1738	182	2,296	146	1,878	138	732	100	873	113

1/ Provisory results.

December 1981

Source: CFS.

TABLE 6

Senegal

Traffic at Port of Dakar, 1965 and 1971-1981

	1965	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Imports (I)					('000 tons)							
Oil, at M'Bao					672	653	697	766	758	842	747	675
Petroleum products	1351	967	961	1009	856	635	473	742	1373	460	430	431
General cargo	931	1023	1054	1369	1157	927	1163	1165	1387	1275	1274	1446
Total	2282	1990	2015	2378	2685	2215	2333	2673	3518	2577	2451	2552
Exports (X)												
Phosphates	1020	1321	1599	1736	1879	1527	1513	1818	1739	1775	1521	1387
Other	1316	536	790	649	723	661	832	862	1400	690	566	622
Total	2336	1858	2389	2386	2602	2188	2345	2680	3139	2465	2087	2009
(I) + (X)	4618	3849	4405	4763	5287	4403	4678	5352	6757	5042	4538	4559
of which for Mali		127	91	163	191	123	85	112				
Number of ships (arrivals & departures)	4236	5541	5677	5372	5221	5066	5214	5472	4879	8133	7536	6595
Oil tankers			345	286	258	210	147	168	247	86		

Number of Containers

In			1621	1797	1997	3433	5131	5999			
Out			1190	3040	2809	4923	5799	6305			
Total			2811	4837	4806	8356	10930	12304		28609	31887

Source: Port Autonome de Dakar, 1981.

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International Transit Role

Senegal is still an important transit route for Mali, but decreasingly so; from handling most foreign Mali traffic, it now handles less than half, or some 220,000 tons/year. This represents virtually all the traffic on the rail line to Mali but only some 10% of the Dakar Port throughput. The remainder of Malian external traffic goes via the Ivory Coast at a higher transport cost, which is insignificant compared to the products' value and to other considerations, principally the following:

a) an expanded Malian trucking fleet, which lets Malians retain transport benefits and value added; allows greater service flexibility, dependability and speed;

b) the roads to Mali in the Ivory Coast are better than in Senegal, and are being further paved to the San Pedro Port, nearer than Abidjan for Malian traffic;

c) the Senegal railway services have deteriorated while tariffs have increased considerably, to cover an excessive number of staff and frequent salary increases. Wages are much lower in Mali; and

d) the Abidjan Port may be faster in handling freight than Dakar.

Air Transport

Senegal has the main international airport at Dakar-Yoff, two airports that can handle jets, at Ziguinchor and Cap Skirring, and 13 smaller airfields of low standards. The country has a domestic line, SONATRA (Air Senegal) and is a shareholder in the international Air Afrique.

The Dakar airport has a main runway of 3,500 m x 45 m, two additional runways of 2,410 and 2,030 m respectively and terminal, technical and commercial buildings. It is the center of aviation activity and headquarters for ASECNA. During the 1970s, its traffic growth was impressive: until 1977, 15% for passengers, 13% for freight and 8% for aircraft movements (due to increased aircraft size), and more slowly from 1977 to 1980: 4% for passengers, stagnant freight volumes and a decline in aircraft movements of 1.4% p.a. In 1980, it handled 570,000 passengers plus some 250,000 in transit only, 16,500 tons of freight and 13,900 aircraft movements by some 20 airlines. See Table 7. However, air traffic is expected to grow very little in the 1980s for several reasons: (a) the overall stagnation in Senegal's economy; (b) fewer transit stops between Europe and Latin America with increased use of long-haul aircraft; (c) little potential for general air freight, as Dakar is only 6-10 days from Europe by sea (the single largest air freight exporter of agricultural produce -- BUD -- went bankrupt in 1979); and (d) after more than doubling in the 70s, little further growth potential for tourism. Therefore, Dakar's present airport capacity should suffice for the next 20 years.

TABLE 7

Senegal

Air traffic at Dakar Airport, 1971-1980

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 /6
Passengers (thousand)										
International /1	198.2	226.0	289.1	332.0	379.8	413.4	474.2	500.0	528.1	
Domestic /1	8.7	10.4	16.8	24.7	27.8	27.7	32.0	35.0	39.0	
Total Dakar	206.9	236.4	305.9	356.7	407.6	441.1	506.2	535.0	567.1	570.0
Transit /2	137.6	151.8	177.0	203.2	218.2	195.5	250.9	267.3	288.1	
Freight /3 (tons)										
In cargo planes	71	330	2,893	2,353	2,944	3,994	5,870	7,981	n.a.	
In other planes	6,338	6,564	7,913	8,368	8,828	9,156	10,380	10,987	n.a.	
Total freight	6,409	6,894	10,806	10,721	11,772	13,150	16,250	18,968	17,181	16,500
Mail	827	895	867	805	942	925	871	856	825	
Aircraft Movements /4 (thousand)										
International scheduled	6.3	7.0	7.3	7.8	9.3	9.7	10.6	11.0	n.a.	
International non-scheduled	1.1	1.0	1.9	1.7	2.1	1.7	2.0	1.8	n.a.	
Domestic	1.7	1.6	1.9	2.4	2.2	2.2	1.9	2.0	2.8	
Total commercial	9.1	9.6	11.1	11.9	13.6	13.6	14.5	14.8	14.7	13.9
Other /5	27.4	34.0	31.5	26.5	24.9	23.0	29.0	37.7	30.9	

/1 Passengers boarding and disembarking at Dakar.
/2 Passengers aboard aircraft transiting via Dakar.
/3 Inbound and outbound.
/4 Landings and take-offs.
/5 Includes private, military and any other non-commercial.
/6 Estimate based on 11 months.

Source: ASECNA.

The national airline, Air Senegal, provides scheduled flights to 13 domestic airports and to Mauritania, Cape Verde and Guinea-Bissau. The two busiest routes are Dakar-Cap Skirring, a tourist resort, and Dakar-Ziguinchor (Senegal's third largest city), each carrying some 10,000 passengers (20,000 arrivals and departures). Only two other routes have more than 1,000 passengers: to St. Louis and to Tambacounda, while the remainder are mainly used by the Government. Services to Kolda and Kaolack were suppressed, and flight frequency has been reduced on low demand lines. Total domestic air traffic grew some 3% p.a. in recent years, and numbered some 89,000 passengers in 1979/80 (Table 8). Overall domestic services do not cover the airline's costs, the deficit being satisfied by a Government subsidy. Given competitive land transport services, the regional airports would not warrant much upgrading.

The Air Senegal aircraft fleet is comprised of 10 aircraft:

2	HS 748
1	DC-3
2	Twin Otter
1	Aztec
1	Cherokkee 6
3	Pawnees

TABLE 8

Senegal

Scheduled Air Senegal Traffic, 1976/77 - 1979/80 1/

No. of Passengers Boarding

Air Fields	1976/77	1977/78	1978/79	1979/80
Domestic				
Dakar	18,441	21,929	23,812	24,253
Ziguinchor	7,684	7,175	8,940	8,661
Tambacounda	1,274	1,231	1,149	754
St. Louis	187	317	274	258
Kedougou	732	446	462	420
Matam	401	627	413	363
Podor	45	99	41	37
Simenti	324	167	253	205
Cap-Skirring	9,794	9,500	9,637	8,347
Kolda	57	39	50	-
Bakel	412	385	379	373
Rd. Toll	350	274	228	235
Kaedi	1,033	697	666	529
Kaolack	23	-	-	-
Total Domestic	39,757	42,886	46,304	44,435
International				
Bissau	1,447	1,438	1,797	1,561
Nouakchott	1,634	3,113	3,021	2,403
Praia	834	900	1,065	1,383
Conakry	-	-	-	474
Total International	3,915	5,451	5,883	5,821
Total Air Senegal	43,672	48,337	52,187	50,256

1/ Includes domestic, international, charters and taxi flights.

Transport Costs

Road

Tariffs for passengers, fuels, and basic foodstuffs, are established by the Directorate of Land Transport, after consultation with other agencies; it would appear that they cover costs and are updated periodically. However, some of the small truckers charge less in order to secure loads in a competitive market, and subsequently cannot cover the cost of replacing their worn-out vehicles.

On paved roads, the average ton-km cost is about CFAF 12 - 16.6 and the pass-km cost, CFAF 3 to 7, depending on the type of vehicle (Table 9). For short freight transport by road or rail, costs are about the same, contrary to the common belief that rail transport is cheaper.

Rail

While the average rail pass-km economic cost is some CFAF 10.8, and the average ton-km cost is CFAF 16.5, they can be as much as five times higher on low density lines. See Table 10. The comparison becomes even more unfavorable to rail when new rail investments or replacement values rather than book depreciation values are considered. All passenger transport is provided more economically by road; whether in fact some specific rail service should be continued, such as high density lines to help reduce road

TABLE 9

Senegal

Road Transport Economic Costs and Tariffs, 1980 (CFAF)

	Costs 1/		Tariffs
	Paved	Earth	
Freight:			
20-ton truck, per km	200	260	
Cost per ton-km, at 60% load	16.6	21.7	
at 80% load	12.5	16.2	
Interregional, small truckers			10-13
other transporters			16-20
Some actual costs per ton-km 2/	with taxes	w/o taxes	
Groundnuts	21.3	15.6	16 (paved) 3/
Fuels	13.2	9.3	27-32
Cereals	25.0	18.3	10-14
Sugar	11.1	8.1	
Cement	19.9	14.5	
Cotton	18.1	13.2	
Non-alcoholic beverages	49.9	36.5	
Phosphates			10
Passengers:			
Cost per pass-km in taxi, 7/8 pl.	7.0		3.7-7.0
pick-up, 15 pl.	4.4		3.4-6.0
in bus, 29 pl.	3.3		3.2-5.6

1/ Including taxes as proxy for road investment and maintenance costs; 100% of truck taxes and 25% of passenger vehicle taxes. The costs are thus comparable to rail economic costs.

2/ Based on size of truck used, and actual load factor and road type.

3/ Plus CFAF 1,100/ton, loading and unloading charge.

Source: National Transport Plan, Ministry of Equipment, 1981.

TABLE 10

Senegal

Rail Transport Economic Costs and Tariffs, 1980 1/

(CFAF)

Costs	Cost per Pass-km	Cost per Ton-km 2/			
		Phosphates	Groundnuts	Intern'l	National
Dakar - Thies	11.9	8.5	12.9)		
Thies - Diourbel	8.9		16.2)		
Diourbel - Guinguineo	8.4		17.8)	12.5	
Guinguineo - Tamba	6.7		16.8)		
Tamba - Kidira	8.3		16.4)		
Diourbel - Touba	51.1		100.1		
Guinguineo - Kaolack	21.0		28.0		
Thies - Lam Lam	7.9	7.8	11.4		
Lam Lam - Tivaouane	7.9	7.9	11.4		
Tivaouane - Louga	10.2		52.6		
Louga - St. Louis	17.2		58.0		
Louga - Dahra	14.6		74.5		
Average Cost	10.8	8.0	16.5	12.5	15.8
Tariffs	10/6.6 3/	5.6	17	11-21	
fuels (full tankers/others)					10-12/22-2

1/ Without financial charges; depreciation at book value; no new investment foreseen
2/ Transfer costs to be added.
3/ First and second classes.

Source: National Transport Plan, Ministry of Equipment, 1981.

congestion or on long distance trips, should be analyzed in detail. The Cap Vert Transport Plan includes the study of suburban rail commuter services; and the accounting system being set up in CFS should help refine unit cost estimates.

Rail vs. Road: Tariffs and Fiscal Effects

Financial costs and tariffs, and their fiscal incidence are compared in this section.

For passenger services, while rail tariffs produce a deficit that requires a state subsidy, competitive road fares enable transporters to derive a net benefit and provide the Government a considerable tax contribution of some 30% of the fares. Concerning freight, tariff revenues allow both the railway and road transporters to cover all their costs; however, each tariff does not cover its related cost; further, the rail tariffs cover only book value depreciation, and when new investments are required, they will have to be covered with a Government subsidy as the tariffs could not be much increased without the rail losing the traffic to the road transporters whose tariffs are very competitive. Unless the railway can become more efficient, it seems that its "economic role" is limited to groundnut transport and phosphates; 1/ even fuels for which in principle it would have an advantage are mostly carried by road.

1/ In 1980 the phosphate tariff did not cover costs, according to estimates.

The following table, derived from the National Transport Plan completed in 1981, summarizes the fiscal incidence of road and rail transport in 1980:

		million CFAF		
		Passenger	Freight	Total
Road:	Tax receipts from users	23,400	5,500	28,900
	Av yearly road cost (inv & maint)	4,700	5,300	10,000
	Net Government income	18,700	200	18,900
Rail:	Income from tariffs	648	2,908	3,556
	Cost - a) at book value	1,207	2,695	3,902
	b) at renewal value	1,809	3,729	5,538
	Net Government loss (subsidy) a)	559	-213	346
	b)	1,161	821	1,982

Transport Development

The National Transport Plan identified the priority projects for Senegal in all modes and made policy recommendations. This Plan was the basis for the ongoing development plan's transport section.

Investments in transport have been substantial. They absorbed 21% of total public investment during the Fifth Plan period. Road projects, for which suppliers' credits were available, accounted for more than 70% of transport sector investments and increased the paved network by some 800 km. Senegal has one of the best transport networks in West Africa. Still, the Sixth Plan foresees a 16% allocation of total investment to transport, implying growth in absolute amounts for modes other than roads. Projects and their estimated costs are listed in Tables 11a, b, and c. These investments would require foreign financing for practically the full amount; the Government has no funds and only 25% has been secured (mostly for carry-over projects). Consequently, many projects will have to be delayed.

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TABLE 11 a

1981/86 Sixth Development Plan (million CFAF) ROAD PROGRAM

Project	Total Cost	Total Cost VI Plan	Financing Negotiated	Financing not Acquired	Execution by 6/30/81	Annual Program 81/82	82/83	83/84	84/85	Balance
I. ROAD TRANSPORT										
1. Registration and driving permits	200	138	62	76	62	39	33	33	33	
2. Axle load control	50	50	-	50	-	-	50	-	-	
II. SOTRAC										
3. Bus purchase	3,000	2,000		2,000	-	-	-	1,000	1,000	1,000
4. Training center	214	214	-	214	-	214	-	-	-	-
5. Equipment for Ouakam workshop	500	500	-	500	-	150	200	150		-
III. STUDIES										
6. Coastal protection	500	500	-	500	-	250	250	-	-	-
7. Strengthening No.4	230	190	190	-	40	190	-	-	-	-
8. Tambo-Labé Road	120	120	-	120	-	-	100	20	-	-
9. Topographic and geotechnical studies	150	150	(50)	100	-	101	49	-	-	-
10. Feasibility study of transport	80	80	(80)	-	-		80	-	-	-
11. Navigability of the Saloum River	50	50	(50)	-	-	50	-	-	-	-
12. Price index study	50	50	-	50	-	50	-	-	-	-
IV. WORKS										
13. Strengthening No.3	6,550	4,585	4,585	-	1,965	3,585	1,000	-	-	-
14. Strengthening No.4	6,000	2,000	-	2,000	-	-	-	-	2,000	4,000
15. Longa-Dahra	2,500	2,000	2,000	-	500	1,500	500	-	-	-
16. Ourossogui-Bakel	2,000	300	-	300	-	-	-	-	300	1,700
17. Tambacounda - Diamé-Makan	5,500	4,500	(4,500)	-	-	-	1,000	2,500	1,000	1,000
18. Dehar - Ranjul - Rissem	2,300	1,000	-	1,000	-	-	500	500	-	1,300
19. Upgrading of Faidherbe Bridge	1,000	1,000	-	1,000	-	-	1,000	-	-	-
20. Widening of Gouloumbo Bridge	720	200	-	200	-	-	-	-	200	520
21. Upgrading of Point Noirot	300	300	-	300	-	300	-	-	-	
22. 2nd Cap-Vert Exit	8,000	500	-	500	-	-	500	-	-	7,500
23. Rocade Fann- Bel-Air	680	680	-	680	-	-	680	-	-	-
24. Access to Stade de l'Amitié	650	650	-	650	-	300	200	150	-	-
25. Works following the traffic plan of Cap-Vert	2,000	2,000	-	2,000	-	300	500	600	600	-
26. Feeder roads	3,000	2,200	(2,200)	-	-	1,000	400	380	380	800
27. Cotton feeder roads	1,200	600	(600)	-	-	-	-	300	300	600
28. Kavil-Kaur-Madiabel	700	200	-	200	-	-	-	-	200	500
29. Diouloulou - Kafountine	700	300	-	300	-	-	-	-	300	400
30. Access road to Oringindo	400	400	-	400	-	-	-	400	-	-
31. Pasny - Foundiougne - Fatick	1,600	600	-	600	-	-	-	-	600	1,000
32. Kédougou - Saraya - Diamé-Makan	2,800	2,800	1,800 (1,000)	-	-	500	1,300	1,000	-	-
TOTAL	53,744	30,857	8,637 (8,480)	13,740	2,367	8,229	8,482	7,083	7,063	20,320

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Senegal
1981/86 Sixth Development Plan
(million CFAF)

TABLE 11 b

Port & Shipping Program

Project	Total Cost	Cost of the VI Plan	Financing Secured	Financing not Secured	Status of Execution as of 6/30/81	Multiannual Programming				
						81/82	82/83	83/84	84/85	Balance
Ship for COSENAM	6,000	3,000		3,000					3,000	3,000
Container Terminal phase I	5,460	5,460		5,460			2,045	2,855	560	
Dredger for Saloum River	650	650		650		325	325			
Crane for Kaolack Port	45	45		45		45				
TOTAL	12,155	9,155		9,155		370	2,370	2,855	3,560	3,000

TABLE 11 c

Civil Aviation Program

Project	Total Cost	Cost of the VI Plan	Financing Secured	Financing not Secured	Status of Execution as of 6/30/81	Multiannual Programming				
						81/82	82/83	83/84	84/85	Balance
Maintenance plant for large transport planes	10,000	10,000		10,000		4,000	6,000			
Reinforcement of Cap-Skirring air-strip	600	600		600		600				
Purchase of handling material	100	100		100		100				
Improvement of Ziguinchor air-strip	200	200		200			100	100		
Improvement of regional airports	300	300		300		100	100	100		
New extension of terminal at Yoff	1,000	1,000		1,000				500	500	
Study of airport relocation	200	200		200		50	50	50	50	
Energy/telecommunications of regional airfields	160	160		160		40	40	40	40	
Outfitting of gendarmerie at Yoff	500	500		500					500	
Radar control for air traffic	3,000	3,000		3,000					1,500	1,500
TOTAL	16,060	16,060		16,060		4,890	6,290	790	2,590	1,500

8. UPPER VOLTA

The Economy

Upper Volta, landlocked, has an area of 274,000 square km. The surface is a plain, lying between 250m and 350m above sea level, of which about 89,000 sq. km,-or 33%-is considered arable. With a population of about 6.1 million and a per-capita gross domestic product of about US $210 in 1980, Upper Volta is one of the ten poorest countries in the world. The country's geography is dominated by its poor soils, lack of exploitable mineral resources and an arid climate. Two-thirds of the population are concentrated on the central plateau and in the eastern part of the country and it is growing at about 2% p.a. Some 50% live in rural areas, engaged in subsistence agriculture and livestock raising. The most important cash crops are cotton and sugar. Seven percent of the population reside outside the country, mostly in neighboring Ivory Coast, and their salary remittances provided in 1978 an amount equivalent to 8% of GDP. Real GDP has been declining steadily, down 27% since 1970 in spite of a short-lived recovery in 1974-75. This is due to a combination of factors, the most important of which are the long-lasting effects of the drought and the decline in productivity following the emigration of young male farmers to the Ivory Coast.

Upper Volta has suffered heavy trade deficits because of stagnating exports and increasing imports. During the past few years, growth in cotton exports has helped diversify the country's export structure which has been

Upper

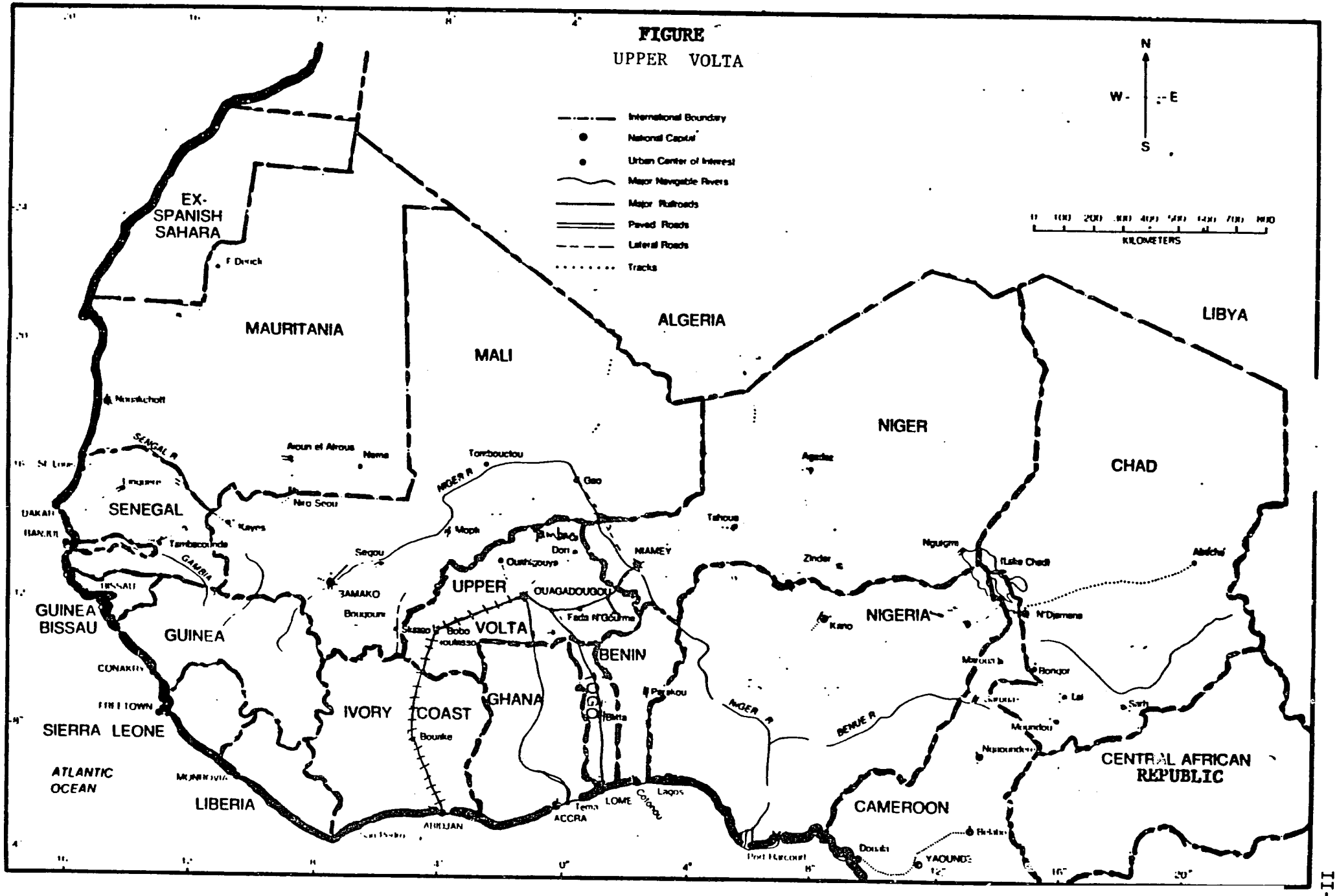
FIGURE
UPPER VOLTA
International Boundary
National Capital
Urban Center of Interest
Major Navigable Rivers
Major Railroads
Paved Roads
Lateral Roads
Tracks
N
W
E
S
KILOMETERS
EX-SPANISH SAHARA
MAURITANIA
MALI
ALGERIA
NIGER
LIBYA
CHAD
SENEGAL
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
GHANA
UPPER VOLTA
BENIN
NIGERIA
CAMEROON
CENTRAL AFRICAN REPUBLIC
ATLANTIC OCEAN
SENEGAL R
GAMBIA
NIGER R
BENUE R
DAKAR
BANJUL
BISSAU
CONAKRY
FREETOWN
MONROVIA
BAMAKO
Segou
Mopti
Tombouctou
Gao
Niamey
Ouagadougou
Bobo Dioulasso
Bouake
ABIDJAN
ACCRA
Tema
LOME
Cotonou
Lagos
Port Harcourt
Douala
YAOUNDE
Maiduguri
Kano
Zinder
Agadez
Tahoua
Nouakchott
Aioun el Atrous
Nema
Nioro Sepou
Kayes
Tambacounda
Dori
Ouahigouya
Fada N'Gourma
Parakou
Ibadan
Ronjor
Lai
Sarh
Moundou
Ndjamena
Abéché
Lake Chad

traditionally dominated by livestock products; but at the same time livestock exports declined significantly because of adverse weather and animal health conditions, as well as for lack of investment and operational funds.

Imports, on the other hand, have increased as a consequence of small industry's demand for raw materials, and the rising cost of petroleum products.

Figure 1 illustrates the nature and geographic distribution of agricultural production.

Commerce

Exports and Imports

Exports and imports for 1973-75 are indicated by value in Table 1. Livestock exports represented about one-third of export earnings in 1977. Part are trekked to the Ivory Coast, Togo and Nigeria and the balance are shipped live by rail from Ouagadougou and Bobo Dioulasso to the abbatoir at Abidjan. Animal products, cotton and groundnuts are the other principal exports.

Trading partners, of which the Ivory Coast and France are the most significant, are identified in Table 2.

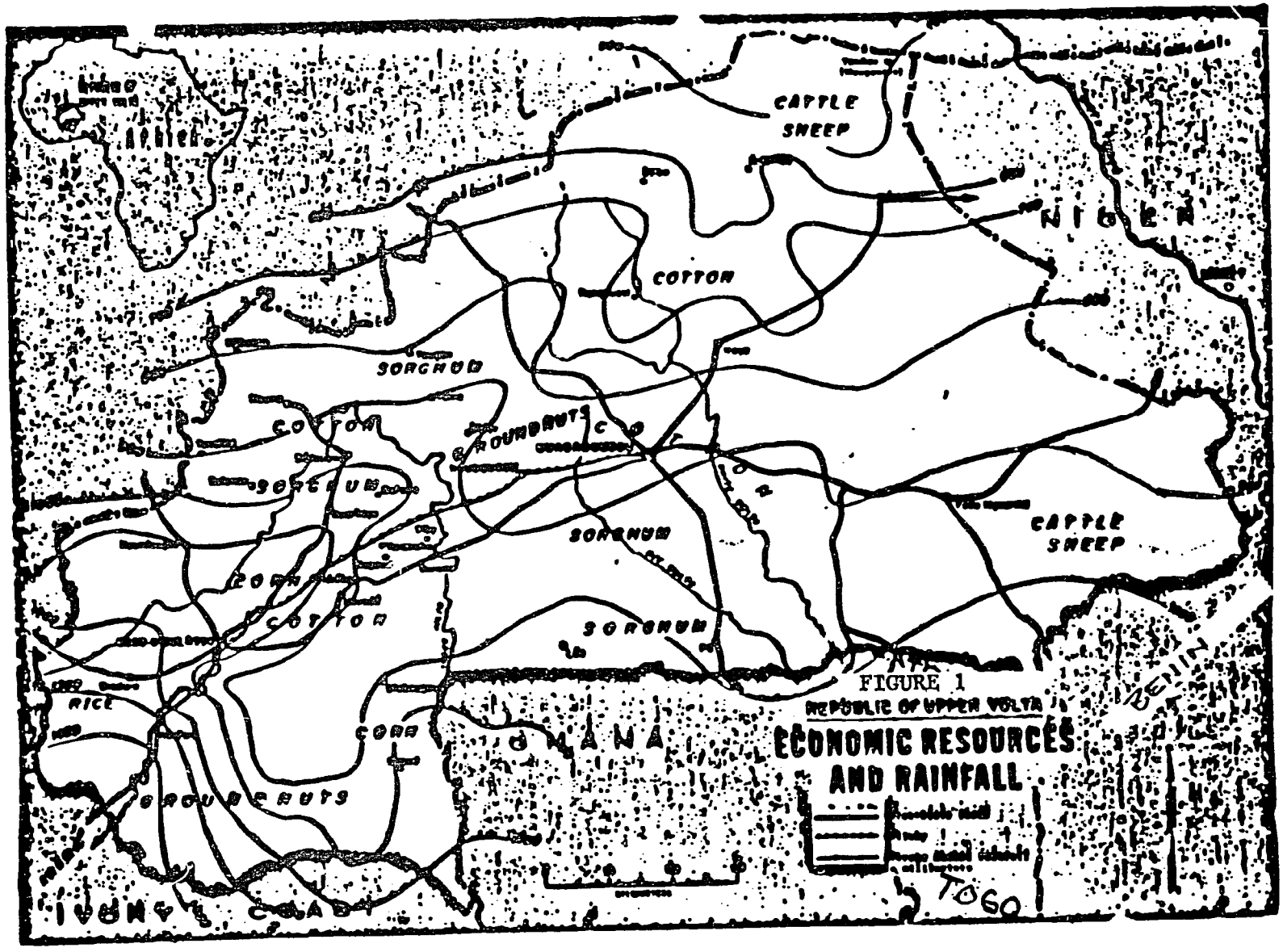

FIGURE 1
REPUBLIC OF UPPER VOLTA
ECONOMIC RESOURCES
AND RAINFALL

TABLE 1

Voltaic Imports and Exports

(million francs CFA)

IMPORTS	1973	1974	1975	EXPORTS	1973	1974	1975
Food, beverages and tobacco	4,035.7	11,073.3	6,111.1	Live animals	2,286.6	3,061.0	3,380.9
Petrol and oil	1,219.1	2,220.1	2,828.4	Hides and skins	1,310.7	1,632.5	1,724.7
Cotton, textiles and clothing	1,142.0	1,863.0	1,923.2	Meat	154.8	162.4	116.8
Electrical equipment	752.0	1,268.8	1,096.8	Cotton fibre	1,205.6	1,545.6	1,524.5
				Cotton seed	54.8	46.3	n.a.
				Groundnuts (shelled)	655.0	1,698.0	1,440.1
				Karite nuts and butter	72.6	357.7	637.7
				Seasame seed	229.9	318.2	533.5
				Fruit and vegetables	152.8	268.1	329.2

TABLE 2

Voltaic Trading Partners

(million francs CFA)

IMPORTS	1971	1972	1973	EXPORTS	1971	1972	1973
Sahel Countries				Sahel Countries			
Mali	520.4	888.5	205.6	Mali	126.9	381.0	3.3
Senegal	277.8	302.5	368.4				
Other Africa				Other Africa			
Congo People's Republic	67.1	22.6	4.9	Ghana	389.0	593.2	244.7
Ivory Coast	2,254.8	3,010.3	3,829.0	Ivory Coast	2,268.1	2,962.6	4,507.7
Rest of World				Rest of World			
France	8,407.3	13,876.1	13,988.4	France	1,469.4	3,095.4	1,761.1
Germany, Fed. Republic	863.4	4,244.7	1,345.7	Italy	425.4	374.8	244.7
Netherlands	510.7	302.5	368.4	Japan	75.4	181.3	152.2
				United Kingdom	147.6	137.6	602.7

The Transportation Sector

Rail Transport

The Railway, Regie Abidjan-Niger (RAN), a semi-autonomous agency jointly owned and operated by the governments of Ivory Coast and Upper Volta, is one of the largest (1,159 km of single meter gauge track) and better functioning railways in West Africa. It services from 80 to 90% of Upper Volta's export and import transport needs as well as domestic freight and passenger movements.

The RAN is particularly important for Upper Volta, which continued to generate about 81% of the freight traffic in ton-km carried by the railway. Purely internal traffic utilizing the 519 km of track within Upper Volta is presently low (60,000 tons in 1973), but steadily increasing.

The main problems of RAN vis-a-vis Upper Volta center around five factors: (a) competition from an alternative highway route through Lome carrying 100,000 tons in 1980; (b) over-investment in passenger traffic infrastructure and rolling stock,primarily to meet Ivory Coast's domestic needs at the expense of freight traffic requirements; (c) a continuing imbalance in tariff levels resulting from Upper Volta's insistence on retaining sub-economic tariff levels for strategic bulk commodities; (d) the adverse financial impact of these factors on RAN's debt servicing capacity and the modal distribution of traffic between road and rail; and (e) a

continuing inability to exert an effective influence on RAN's management and decision making, despite the dependence of RAN's financial viability on Upper Volta's long distance freight traffic.

These factors are reflected in the serious financial difficulties which RAN faces: (i) management deficiencies; (ii) high operating costs due in part to inadequate cost and productivity control; (iii) tariff levels which in some cases do not reflect short-run marginal costs; and (iv) a heavy and rapid increase in debt service.

Appropriate measures to remove unfavorable marketing factors, risk of long delays and pilferage, high cost of break-bulk and transfer charges at rail terminals, and poor quality of individual service, and to increase Upper Volta's influence in key investment and operating decisions, are reported to be under consideration.

Efficiency and Traffic

RAN Freight Traffic[1/]

In terms of ton-kilometers RAN's total freight traffic[1/] increased by about 5.8% per annum during the decade 1966-76, but stabilized to about 550 million ton-kilometers since 1976. The discrepancy between traffic trends

1/ Includes Ivory Coast traffic.

expressed in tons v.s. ton-kilometers reflects the fact that the railway is progressively losing traffic on short and medium distances (under 400 km) but has been successful in developing and retaining its long distance traffic to northern Ivory Coast and Upper Volta.

The efficiency of RAN's operations has not significantly improved in recent years. This is due to accelerated breakdowns of old, inadequately maintained locomotives and delays in implementing technical assistance. With new locomotives and technical assistance, there is potential for a rapid increase of railway freight traffic. It is not clear, however, how much potential rail traffic has been permanently lost to trucking.

Presently, six commodities dominate the RAN freight traffic: cotton, oil seeds, sugar, petroleum products, cement and fertilizers.

RAN Passenger Traffic[1/]

Between 1960 and 1975 the total number of RAN passengers doubled from 1.5 to 3.0 million annually. As average distance travelled more than doubled during this period, travel demand expressed in passenger kilometers increased rapidly, with a growth rate of 8.5% between 1970 and 1975. Inter-state travel generates two-thirds of all passenger-kilometers. Passenger traffic now generates more than 50% of RAN's general revenue from operations.

1/ Includes Ivory Coast traffic.

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RAN's passenger traffic seems to be both lucrative and in high demand, and RAN may very well remain predominantly a passenger carrier, thus giving some ex post justification to RAN's preference for investment in passenger equipment. RAN's customers, ranging from migrant workers to better-off Ivorians, feel, obviously, that the railway's passenger service is beneficial and are willing to pay fairly high fares. The economies of RAN's passenger traffic have never been analyzed in great detail.

Upper Volta's Interests

Upper Volta's main interest in RAN is the provision of cheap and reliable freight transport, whereas the Ivory Coast seems, in addition, strongly interested in good passenger services, even at relatively high cost. RAN's investment policy over the last five years has been biased in favor of improving passenger services at the expense of freight transport.

The Port of Abidjan, Ivory Coast

Abidjan is the conventional port of entry for Voltaic cargoes. It is served by RAN. The annual throughput of conventional berths for break-bulk cargo only, i.e. after excluding all small bulk cargoes (cereals, wine, vegetable oil and container traffic) was estimated in 1977 at about 130,000 tons/year. This is satisfactory[1/] considering that operations might be affected by unfavorable factors over which the port operators have limited

1/ For pure break-bulk traffic a throughput of 120,000 tons/year is considered good, by UNCTAD European Standards.

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or no control such as: the present shortage of stacking areas, the small size of cargoes for break-bulk traffic (1150 tons) or the slowdown of operations during the rainy season. In addition, some stevedores complain that complications recently introduced in documentary procedures contribute to limit the possibility of increasing the productivity of handling operations and serve to increase costs. Shippers have to allocate cargo between the various flags in order to comply with the rules of the new code of conduct of the maritime conferences (Rule of the 40/40/20 1/). The average rate of handling containers is about 14 boxes/hour which is satisfactory considering that all operations are done by ships' gear. This satisfactory operational performance has reduced ships' waiting time to an average of 12 hours per ship call in 1977 despite a high rate of occupancy averaging 75% at the break-bulk cargo berths and 90% at container berths. The high rate of berth occupancy, combined with the fact that no significant increase of productivity can be expected in the short run, indicates that the port is operating at the limit of its capacity. Ship waiting time is expected to increase significantly until two container berths now under construction are completed. These factors explain the increase of ships' waiting time to 36 hours/ship/call by the end of 1978.

The port operates 18 hours per day, plus overtime when needed, about 300 days per year. There is no limit on the number of gangs that can be deployed during each shift. A major characteristic of the port of Abidjan

1/ Forty per cent of maritime traffic under national flag, 40% for foreign partner in trade and 20% allocated to other countries.

is that operations are largely entrusted to well-equipped private firms who are also the users. Handling, stacking and transiting operators are grouped into a union, Syndicat des Enterprises de Manutention du Port d'Abidjan (SEMPA), which also controls the use of port labor. There is no shorehandling equipment except for specialized berths.

Road Transport

Transport within the country is primarily by road. The system consists of almost 9,000 km of classified roads, and about 8,000 km of rural tracks. The network of primary roads (4,450 km, of which about 500 km paved) radiates from two centers - from the capital, Ouagadougou, and from the main commercial center, Bobo Dioulasso. For lack of resources, maintenance has been carried out only on the primary network; other roads have therefore deteriorated over the past decade and are passable only by trucks and fourwheel drive vehicles during the dry season; rural tracks are used largely by light pickups, donkey carts, bicycles, pack animals, and head loading.

Road transport is mainly by private transporters in a free market but international traffic is distributed by international agreement on a percentage basis between domestic and foreign carriers.

Road Transport Industry

In 1978-79 the Government inventoried the fleet dedicated to the public transport of goods. The average age of this fleet was 3.5 years, while the average age of the vehicles for passenger transport was about 4.5 years. The analysis detected in the transport of goods a shift toward tractor-trailers which increased by 8% and away from medium trucks which dropped in number by 26%. The tractor-trailers are profitable on long distance international traffic and among them the number of tanker trailers for the transport of carburants increased six times in one year. There is no information on the tonnages actually carried.

The industry is dominated by one mixed public/private firm, Societe Voltaique des Transport Routiers (SVTR) and another relative large private company, Societe Voltaique des Transports Fret et Personnes (SVTFP). These two have their own repair facilities and keep spare parts inventories for vehicle maintenance. Otherwise, 46% of the vehicles belong to individuals engaged in transport services and owning only one vehicle. In the transport of passengers 71% of the vehicles are in the category of one per owner. Thirty-one percent of the trucks and 77% of the tractor-trailers are engaged in the international public transport of goods.

Waterways

There have been a number of studies of the Niger river for navigation purposes. However, the uncertainty of the water levels, the priority requirements of the agricultural sector for what water is available, lack of suitable bulk commodities within the catchment area, as well as its tortuousness and narrowness, make it unlikely that it will ever serve other than its immediate basin area, outside the Voltaic borders. The Volta rivers which cross the Central Mossi plateau are not navigable.

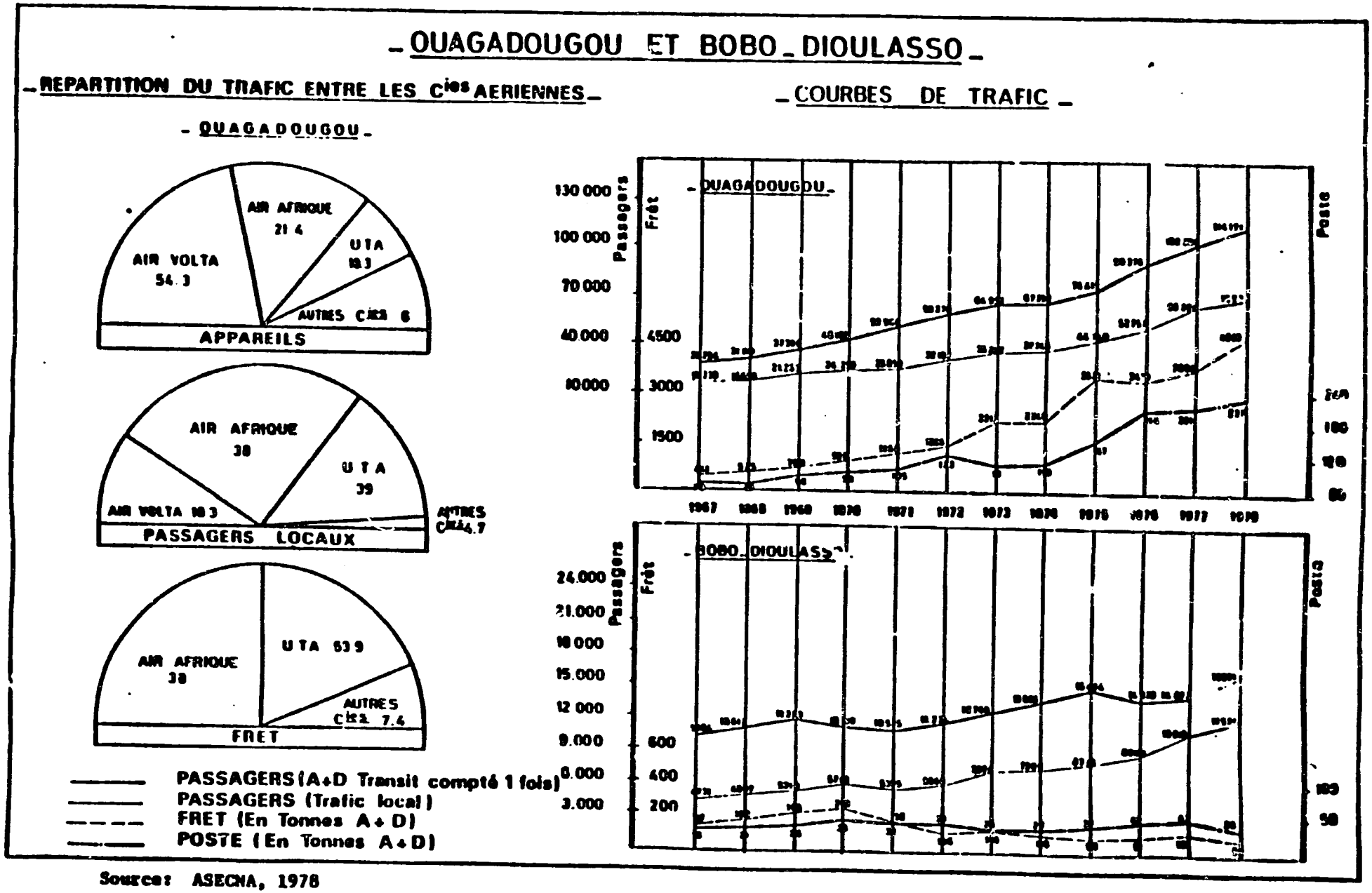
Air Transport

Air transport is not a major freight or passenger mode. The country has two international airports (Ouagadougou and Bobo Dioulasso) and six local airports (Gorom-Gorom, Kantchari, Pama, Diebougou, Nouna and Sebba). Air Volta, the national carrier, operates no international flights and loses on all routes except that between Bobo Dioulasso and Ouagadougou where, however, it shares rights with international carriers.

Internal air transport is negligible; Air Volta was created in 1967 by the Government and private interests, but its operations are not yet profitable, due mainly to inadequate demand for service.

Passenger and freight volumes registered by the two principal airports, during the period 1967-78, including domestic passenger traffic, are shown in Figure 2.

Up. Volta
Figure 2
Air Traffic - Passenger and Freight
(1967-78)



Source: ASECNA, 1978

Development of Routes

The Government has been giving priority in transport investments, which depend on external sources, to the improvement of international road links with Mali, Ghana and Togo. The roads between Bobo Dioulasso and the Mali border and between Ouagadougou and the Ghana border were recently paved, and work on the Ouagadougou-Togo border road is planned. FED is considering paving the primary route from Fada N'Gourma to the Niger border. The Government's decision to upgrade the road links with Ghana and Togo has been based mainly on a desire to create alternative outlets to the sea, and to reduce the country's dependence on the railway connection to Abidjan.

ANNEX III

PORT DATA

TABLE 1

West African
Port Capacities

PORT	BERTHS NO.	BERTHS DEPTH (m)	ANCHORAGES	CHANNEL DEPTH (m)	PORT CRANES NO.; CAPAC.	CARGO HANDLING RATE CARGO TYPE	CARGO HANDLING RATE mt/GANG-hr	COMMENT
Abidjan, Ivory Coast								
	5	10		10	15 ; 25 mt			
	3	11			1 ; 60 mt			
					1 ;150 mt			Annual tonnage throughput: Export and Imports Combined: 8.0 million mt
Conakry, Guinea								
	4	8.5	Outer: 36'			Gen. Cargo	12-15	Max. Draft: 9.8 mt; (20,000 DWT)
	1	11	Inner: 28'	7	8 ; 50 mt	Bagged Cargo	20	
	Also bulk ore and banana quais.					Bulk	10-12	

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TABLE 1

Port Capacities

PORT	BERTHS NO.	BERTHS DEPTH (m)	ANCHORAGES	CHANNEL DEPTH (m)	PORT CRANES NO.	PORT CRANES CAPAC. (mt)	CARGO HANDLING RATE CARGO TYPE	CARGO HANDLING RATE mt/GANG-hr	COMMENT
Dakar, Senegal									
	1	6.5			4	5			
	1	8			7	6			
	6	8.5			1	60			Max. Draft: 11/m
	10	10			1	125			Container Terminal planned for 1983/84. Annual Tonnage Export 2.5 million mt Import 2.0 million mt
	1	11							
Douala, Cameroon									
	11	7.5							Max. Draft: 7.9 m
	2	13							
	2	8.5			20 boxes/hr.				Container Berths Annual Tonnage: Exports 893,200 mt Imports 2,218,000 mt

TABLE

Port Capacities

PORT	BERTHS NO.	BERTHS DEPTH (m)	ANCHORAGES	CHANNEL DEPTH (m)	PORT CRANES NO.	PORT CRANES CAPAC.	CARGO TYPE	mt/gang/hr	COMMENTS
NIGERIAN PORTS									
PORT HARCOURT									
	10	6.9-8.2	7.6 m; in River Bonny	7.6 m in River Bonny	14 1	5 mt 15 mt			Max. Draft: 7.6 m
BURUTU	2	4.9	4.3 m depth;	Load and discharge by ships' gear					Max. Draft: 4.9 m Deeper draft vessels discharge to lighter Covered storage for 32,000 mt of cargo.
LAGOS/APAPA									
	14 5	8.2 7.9	5 Anchorages 7.3-8.5 m	9.1	Adequate				Max. Draft: 8.2 m
	1	7.6							
	3	7.3							
	1	13.5							

TABLE

Port Capacities

PORT	BERTHS NO.	BERTHS DEPTH (m)	ANCHORAGES	CHANNEL DEPTH (m)	PORT CRANES NO.	PORT CRANES CAPAC.	CARGO HANDLING RATE CARGO TYPE	CARGO HANDLING RATE mt/GANG-hr	COMMENT
Pointe Noire, Congo									
	1	7.3							Max. Draft: 10.5 m
	1	7.9							Annual Tonnages:
	1	8.5							Exports: 2.2 million mt;
	2	8.8							Imports: 6 million mt
	1	9.5							Containership berth
									Also:
									1 Timber berth
									Lighter berths

ANNEX IV

CURRENT AND PROJECTED INTERNATIONAL R&D EFFORTS IN LIGHTER THAN AIR TECHNOLOGY

CURRENT LTA TECHNOLOGY DEVELOPMENTS

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Abstract

Lighter-than-air aircraft (LTA) developments and research in the United States and other countries are reviewed. The emphasis in the U.S. is on VTOL airships capable of heavy lift, and on long endurance types for coastal maritime patrol. Design concepts include hybrids which combine heavier-than-air and LTA components and characteristics. Research programs are concentrated on aerodynamics, flight dynamics, and control of hybrid types.

Introduction

In the interval between the termination of U.S. Navy airship operations in 1962, to about the middle of the 1970 decade, the field of lighter-than-air aircraft (LTA) engineering and development was in a dormant state. The only continuity during that period was provided by flight operations with modified World War II type training airships by private firms in the U.S. and West Germany. A renaissance of sorts is now occurring in which there is world-wide interest in LTA, evidenced by several government and privately sponsored studies and some actual aircraft development.

Several stimuli have served to create this new attention to an old subject. One of the most important is the potential for new transport capability in a world of changing requirements, particularly for heavy vertical lift caused by development of energy related resources in remote areas, harvesting of timber from relatively inaccesible locations, and certain industrial construction.

A second stimulus is the need for greater transport efficiency through elimination of intermodal operations, reduced terminal time, and higher fuel economy. Such demands in the past led to the development of containerized cargoes and new surface ship development -- pointing the way to aerial systems to handle larger sized payloads.

Transportation in nations of the third world constitutes another incentive for advanced aircraft development which could provide capability to bypass some of the evolutionary development of surface infrastructure which is often non-existent and difficult and expensive to develop.

Of equal interest, is the increased awareness of all nations to conserve marine resources with the consequent establishment of extensive off-shore zones of protection which require new surveillance capability.

These new applications have created requirements for airships with characteristics considerably changed as compared to past designs. These include VTOL capability under a variety of conditions, long period hovering, and in some cases higher speeds. Such capabilities may not be available without the combining of LTA and HTA (heavier-than-air) aircraft features. These hybrid concepts will require the development of basic aerodynamic data, better understanding of their flight dynamics, and other new technology.

In the following descriptions of current developments, the various aspects of this relationship between new technology and aircraft design will be emphasized. In this review, various airship types will be described using an established method of referring to their structural systems. This method has been used with classical airships, as shown on the left side of Figure 10, but it can also be applied to the newer configurations shown on the right.

Current Developments

Aircraft Developments

United States - Two major programs, are focused on the development of heavy-lift hybrid airships. Lesser but significant activity exists in the evaluation of airships for maritime surveillance.

Interest in the heavy-lift application was generated around a concept by Frank Piasecki of the Piasecki Aircraft Corp. for combining helicopters and aerostat hulls to obtain up to an order of magnitude increase in vertical lift capability beyond present helicopter capacities. This hybrid offered the further advantage of reduced development cost by combining existing technologies. The concept appeared to be a fortuitous solution to a current military problem of off-loading cargo vessels in ports where facilities do not exist or have been destroyed. Although an operational requirement was written by the Navy for a heavy-lift hybrid (Ref. 1), no program for development was authorized.

Various heavy-lift airship (HLA) types were studied by Piasecki and the Goodyear Aerospace Corp. under NASA sponsorship (Ref. 2) (and later independently). A recent proposed Goodyear configuration included rotors and drive components modified from current helicopters, forward and reverse propellers for horizontal propulsion and a 2,650,000 cu. ft. envelope with a payload of 75 tons. (Fig. 11) In 1980, the U.S. Forest Service awarded a contract, to be administered by the Navy, to Piasecki for the development and operation of a Heli-stat for a demonstration of aerial logging of Federal forests in the U.S. Northwest. This vehicle is shown in Fig. 12. It utilizes a large number of surplus components from Navy aircraft. The major components are four H-34 helicopters and a 975,000 cu. ft. ZPG-2 Navy airship envelope. The helicopters are mounted on four "wings" of a large open truss interconnecting structure which mates which the existing suspension system of the airship envelope. The additional loads and moments

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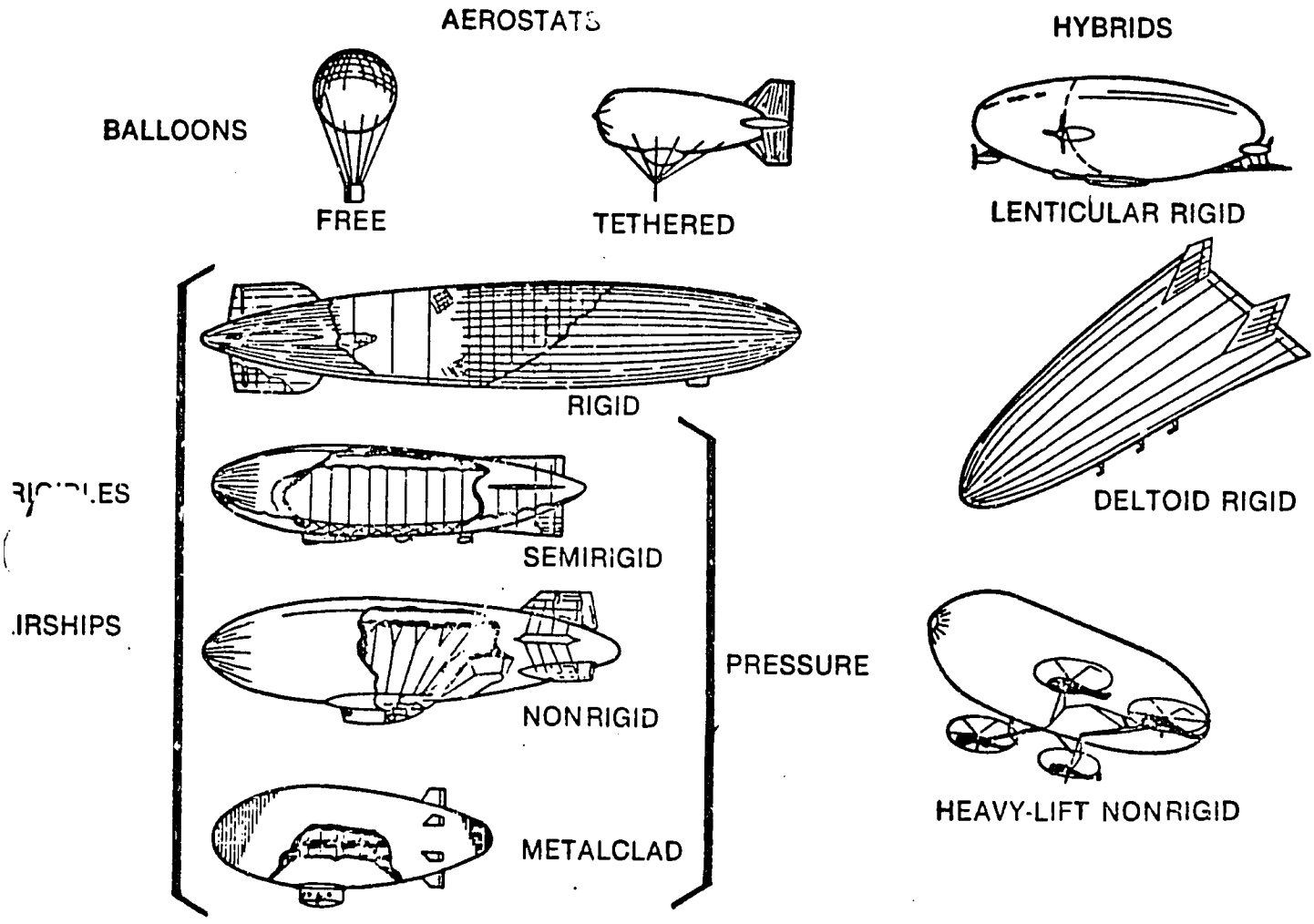
TYPES OF LIGHTER-THAN-AIR AIRCRAFT



imposed by this arrangement are partially supported by auxiliary external suspension cables attached to the envelope. The interconnecting structure supports the slung payload (logs) and a four wheel landing gear. The control system is designed for one pilot operation located at the master control station in one helicopter. During the flight evaluation, a copilot will be carried plus three standby pilots in the other helicopters. Cross shafting of diagonally opposite helicopters will be used to compensate for loss of an engine. The helicopters are modified to accomodate forward and reverse thrust propellers. This hybrid will lift a nominal 25 tons of payload at sea level. It is being constructed at the Naval Air Engineering Center at Lakehurst, N.J., and is scheduled for delivery in June, 1983.

Another type of hybrid airship has been developed by AeroLift, Inc. (formerly D.C. Associates) at Tillamook, Oregon. This unique concept, called Cyclocrane, aims to achieve positive low-speed control or hovering flight by rotating its gas filled lifting envelope about the major axis, Thereby causing four wing-vane combinations, located approximately midship to act as rotors and propulsion devices. Rotation is produced by the thrust of 4 engine-driven propellers mounted at the juncture of the wing-vane systems. As forward speed increases, the rotational rate is reduced so that a constant velocity is experienced by the rotor system. At cruise speed, the system will function without hull rotation.

A forward control station is mounted on bearing supports on the axis at the bow. A second station is slung below the hull-rotor assembly. This station is also the support point for carrying payloads. Static lift is used to support the empty weight of the vehicle and half of the useful load. A fixed trefoil empennage is used at the stern for directional stability.

The Cyclocrane combines a nonrigid envelope with an internal rigid structure used to support the wing-vane assemblies and the forward pilot's station. This structure consists of a jointed axial keel and four transverse beams to the root ends of the wings. Structural stability is achieved using internal and external suspension cables. A single axial ballonet surrounds the keel structure. Volumetric changes and air surges are controlled by a system of elastic cords and reel take-up devices. During development, a small scale model was fabricated to establish construction techniques and ballonet performance. (Shown in Figure 14).

A 2 ton payload demonstration model was developed to begin flight tests in the latter part of 1982. Unfortunately, the vehicle was severely damaged while moored in high winds before any flight testing was accomplished. Rebuilding and initial testing is now scheduled to be completed in the latter part of 1983.

NASA has continued to explore the dynamics and control characteristics of hybrids, (described under technology development), and a study was sponsored to explore the potential market for the type which included several concepts and configurations (Ref. 3). This study indicated that a substantial number of applications do exist for heavy vertical lift vehicles of various sizes. These results are summarized in Table 4. It can be seen that a leading application is in aerial logging.

Since 1976, the U.S. Coast Guard has been engaged in an investigation of various methods of implementing their requirements and responsibilities resulting from the Fishery Conservation and Management Act which established a 200 mile zone outward from most U.S. coasts covering an area of 2.2 million square miles. Added to these needs were problems caused by illegal maritime traffic. The U.S. Navy has been assisting in studies of a number of types and sizes of airships which might be suitable for Coast Guard missions (Ref. 4). These studies indicated that airships could be compatible with Coast Guard operations and would show improved capability over certain air and surface units now in use. A comparative plot is shown in Fig. 13. For the cases selected, it was determined that airships could complete from 80-100 percent of the missions at costs equal to the HC-130 airplane and at 50-60 percent of the cost of ship operations. In 1980, NASA entered into a joint agreement with the Coast Guard to also assist in the assessment of airships and to develop necessary related technology.

Simultaneously, the U.S. Navy was requested to assist in the development of a program to evaluate airship capabilities via a scaled-down demonstrator (using airships smaller than would be required for full mission capability). As a preliminary to this, Coast Guard operational commands engaged in a series of surveillance flights using a radar equipped GZ-20 blimp furnished by Goodyear in 1982.

The Coast Guard, Navy, and NASA are cooperating in an evaluation of the British Airship Industries Skyship 500 (described later). The flight characteristics will be represented in the NASA computer simulation program HYBRDS (see technology developments) and the results correlated with flight data. This simulation and the experimental data will allow projections of larger scale capability and help to identify design characteristics needed for improved control and flight dynamics in later airships.

Canada - Several events in Canada have resulted from recent growth and development of the Northwest territories and some of the Western provinces. Studies sponsored by the Ministry of Transportation of Alberta, identified several types of modern airships which might be suitable for transport systems in this area (Ref. 5). Economic analyses in this study indicated that enormous savings in transport expense were possible through the use of some kind of heavy-lift VTOL aircraft. These savings would accrue from the elimination of road construction -- and reconstruction due to weather effects, elimination of time delays by by-passing obstructions (rivers, canyons) direct delivery of men and equipment, and extension of the working season.

Development of the 2 ton Cyclocrane, previously described, was sponsored by the Canadian Forest Engineering Research Inst. (FERIC), as a demonstrator for logging in the Northwestern provinces, and with the intention of developing a full scale operational vehicle. The U.S. Forest Service supported flight testing however.

Fig. 11

Production Configuration - Heavy-Lift Airship

WORLD MARKETS FOR HEAVY-LIFT AIRSHIPS

APPLICATION	NUMBER OF AIRSHIPS*				
PAYLOAD	30	75	150	300	600
LOGGING	1082	600			
MARITIME LOGISTICS	27	10			
PETROLEUM DRILLING & TRANSPORT	3	4			
POWER PLANT & POWER LINE CONSTRUCTION	9		1	5	1
TRANSPORTATION					4
TOTAL	1121	614	1	5	5

*ASSUMES 2000 HR./YR. UTILIZATION

Table 4

HELISTAT
GENERAL ARRANGEMENT

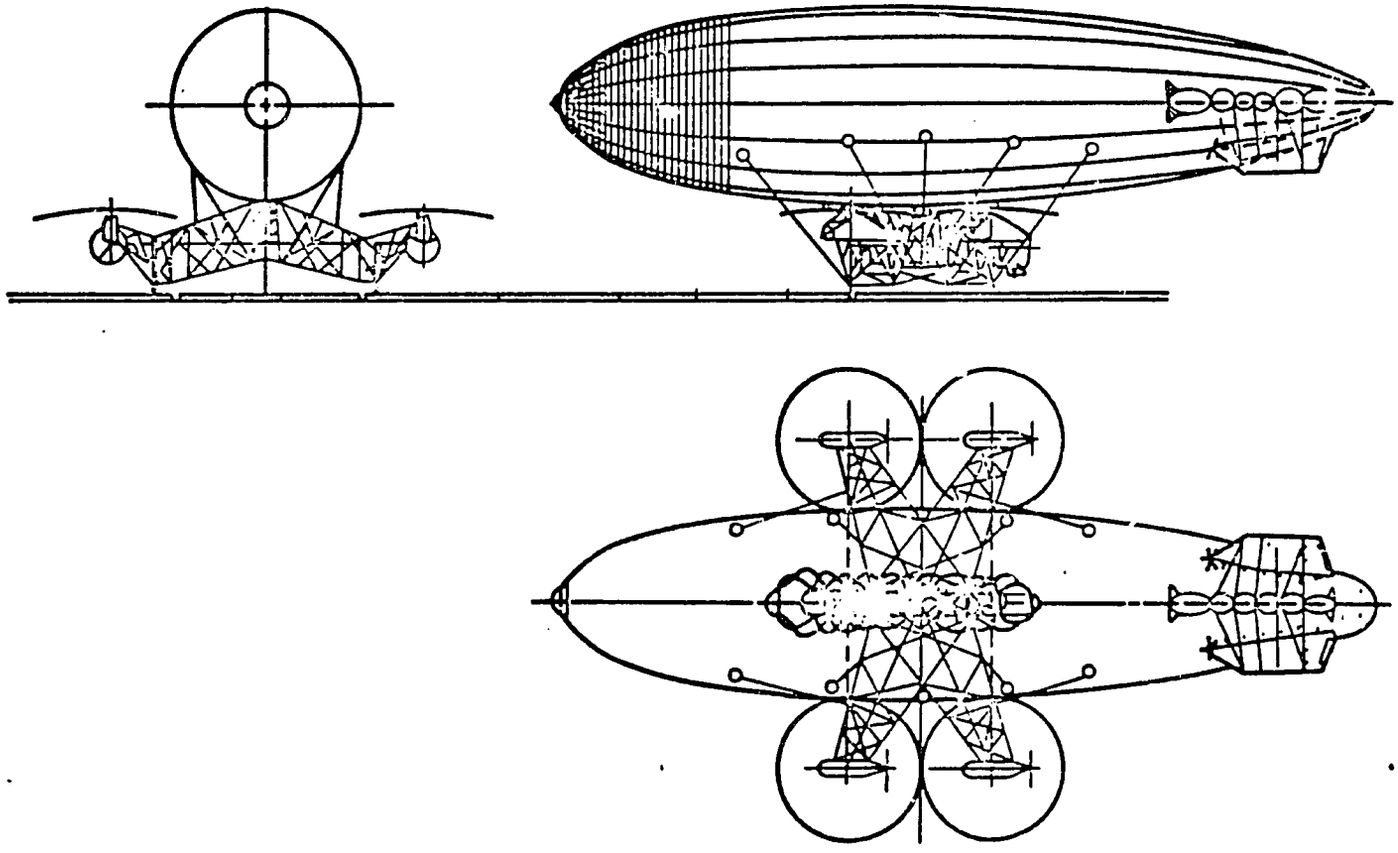


Fig. 12

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Other interest has led to the establishment of companies in Canada to build and operate airships. Two groups at present include the Aerostat Corp. in Montreal, proposing to build conventional (classical) airships, and the Van Dusen Development Corp. in Ottawa. This latter firm's concept involves a rotating spherical hull which utilizes the Magnus effect for propulsion and control.

Great Britain - Interest in LTA in Great Britain has never ceased, although Government sponsorship of any work has. As a consequence, limited private interests have been confined largely to studies of various concepts or to small experimental airship projects. In recent years, one firm, Aerospace Developments (later called Airship Developments), combined their own design engineering capabilities with those available from specialized contractors to produce a 181,200 cu. ft. nonrigid with several advanced features, designated the AD-500 (Fig. 15). The low drag car and parts of the mooring system of this airship were molded in single piece assemblies using Kevlar-epoxy composite, a high-strength non-metallic all synthetic material. A unique method of assembly was also used for the tail surfaces. The ribs and spars were constructed of fiberglass-epoxy composite face sheets sandwiching a Nomex core. These stiff subassemblies allowed a self jigging final assembly method to be used with considerable cost saving over conventional hand fabricated metal structures.

A major item of weight saving was in the single ply polyester envelope. The normal 2-ply construction was eliminated through the use of a 4 curtain internal suspension system designed to carry all of the car weight without causing shear distortion.

The most advanced feature of this airship was in its use of vectored thrust. This was accomplished by mounting the two 200 H.P. Porsche engines in the aft end of the car and driving the propellers through extended shafts. The propellers were 5 bladed ducted fans which could be reversed and vectored through a vertical range of +90 to -120 degrees. This arrangement allowed greater flexibility for VTOL operation and for vertical control in hovering flight. Control of the vectoring system was by means of an electrical pushbutton arrangement on the pilot's column. One pilot operation was standard. All components were fabricated by separate manufacturers in England, France, and Germany, with final assembly of the airship provided by Aerospace Developments. This airship was wrecked during ground handling following its second flight.

The company was later reorganized as Airship Industries, Ltd. Their plans included the building of several sizes of nonrigid airships beginning with an improved version of the AD-500 now known as Skyship 500. This second airship has a redesigned control system, mooring system, and envelope. The mooring system has been strengthened to withstand higher forces, and the envelope is designed for improved gas retention. The new 500 made its first flight during the summer of 1981 and is now fully certified for commercial operations.

An enlarged version of the 500 is also under development, designated Skyship 600. It will provide an additional ton of lift. The car will also be stretched 2.5 meters and will be equipped with 2 supercharged Porsche 250 H.P. engines driving two tilting ducted fans (as in the 500). This power will allow a top speed of 65 knots with a vertical lift-off capability of over 1700 lbs.

The company is also contemplating a larger nonrigid, designated Skyship 5,000 with a 1,700,000 cu. ft. envelope Airship Industries has tentative orders for 500 and 600 series airships for training, patrol, and advertising.

Another company, previously associated with Airship Industries and now known as Wren Skyships, is designing metalclad airships to be used as transports for both short and long range operation. Two major stockholders in the company are freight transport companies and they are interested in the potential which such airships offer for fast lower cost service.

West Germany - As in Great Britain, activities in Germany are privately sponsored. The most active company, West Deutsche Luftwerbung GmbH (WDL), has been operating two nonrigid airships in Germany and Japan for aerial advertising. These aircraft are modified versions of World War II Goodyear-Navy "L" types. However, several new features have been incorporated in the WDL modifications These include fuel tanks suspended by the internal car suspension cables within a center ballonet, improved air pressure systems, slightly larger envelopes (6,000 m^3), and tractor propellers. The two airships have been in service since May, 1981.

WDL has also completed a preliminary design study of a larger nonrigid, the WDL III (60,000 m^3), which would feature diesel engines located within the envelope, vectoring turbines for maneuvering control, and removable cargo and passenger modules. Specific development plans have not been made for this airship.

France - Various government and private organizations in France have sponsored studies of airship applications and airship concepts. Two agencies in particular, ONERA and SNIAS Aerospatiale have investigated hybrid aircraft some of which are similar to concepts proposed in the U.S. involving helicopter-aerostat combinations. One of these, called the HELICOSTAT, featured a tri-lobed nonrigid envelope and 2 Turbomeca Arriel turbines driving AS350 Ecureil rotors and propellers for horizontal thrust. If the aircraft had been built, it was to have been used to demonstrate aerial logging, however, no construction is planned at present. (Ref. 6).

The same envelope concept was used in an experimental RPV designated DINOSAURE. In this 40 cubic meter mini-airship, 2 envelopes were joined to form a lifting body shape. Other features included blown controls and an air cushion landing system. The model shown in Fig. 16 was used for atmospheric research and completed 70 flights (Ref. 6).

A French engineer, M. Balascovic, has been experimenting with lenticular shaped hulls and has proposed several versions named Pegase, Titan, and Vespa. A single place flight vehicle, "Flipper", was constructed in 1978 to provide early data (Ref. 6). Unfortunately, the aircraft

EFFECTIVENESS OF AIRSHIPS
COMPARED WITH OTHER COAST GUARD CRAFT

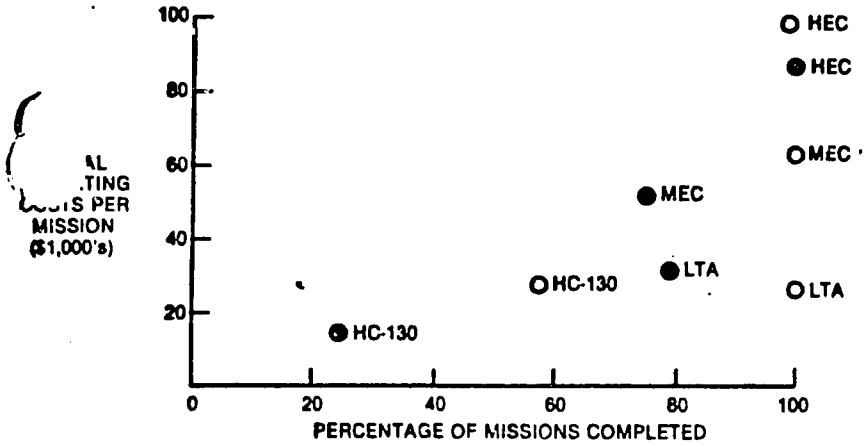

Fig. 13

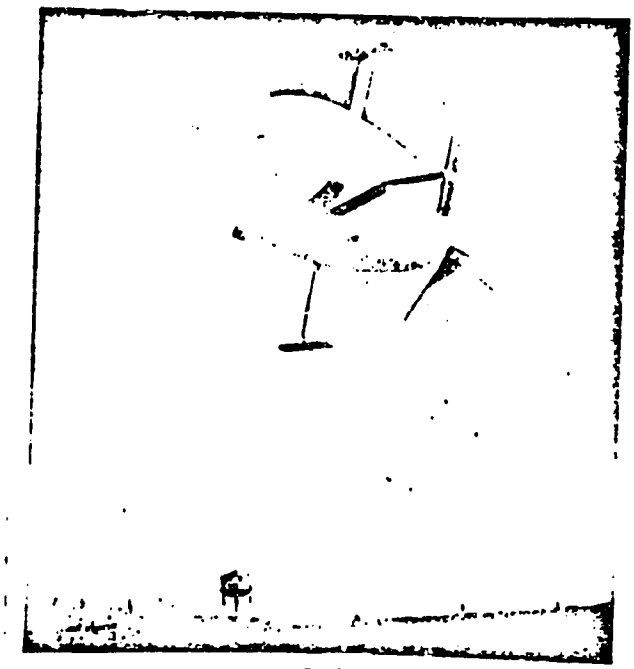

Fig. 14

CYCLOCRANE MODEL

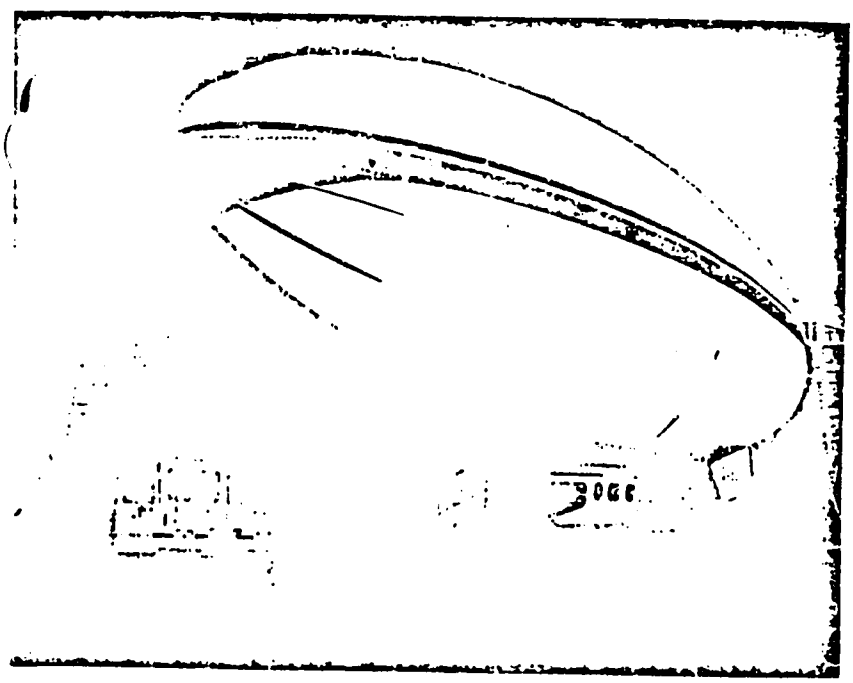

Fig. 15
AD-500 Airship

was damaged beyond repair prior to its first flight. Present plans by Balascovic and his company S.E.A.B. include development of a 6,200 cubic meter airship called ALCYON. A model of this aircraft is shown in Fig. 17. It is intended as a low altitude VTOL vehicle. Vertical thrust is obtained from 3 rotor systems located at 120° points on the hull perimeter. Forward thrust is provided by 3 propulsive units mounted on the tail support structure of the aircraft. Although the vehicle has a large horizontal tail, it was judged to be inherently stable (in pitch) without this appendage on the basis of an analysis provided by CERT (the Toulouse branch of ONERA). Wind tunnel tests to measure drag were also run by ONERA. A full scale vehicle was planned, but no further progress has been reported.

Japan - The Japanese Ministry of International Trade and Industry (MITI) sponsored studies to identify missions in which modern airships may be useful. Many of these included the transport of electric power generating equipment to various relatively unaccessible locations in Japan. Others included supplying populations located on the many small islands of the Japanese nation. Favorable results were shown in terms of the indirect costs which would be eliminated through the use of airships such as road construction, airport runways, bridges, etc. The studies also identified a heavy-lift type of hybrid carrying between 20-100 tons of payload. Following the study, a program of development was recommended, but it has not been implemented to date (Ref. 7).

Airship operations have been conducted in Japan on several occasions by German firms, such as WDL, for advertising and radio communications. These are likely to resume through the planned acquisition of two airships from Airship Industries.

Enthusiasm for the subject has also been demonstrated by the activities of the Japan Buoyant Flight Society. This group has constructed flying scale models of hybrid and conventional airships.

South America - There has been sporadic interest on the part of several countries in South America. The most serious effort was undertaken by a Venezuelan firm in financing the development of the Aerospace Developments Ltd. AD500 airship in the U.K. as a public relations and advertising project. The late completion and later accident of the airship forced discontinuation of this connection.

In Peru, studies sponsored by the Ministry of Transportation and Communication showed conventional airships to have advantages over other aircraft as cargo transports in the development of forest regions (Ref. 19). Airships are also being studied for coastal surveys and oceanographic research by the Ministry of Fisheries. The results of these latter investigations could lead to the acquisition of a small airship.

Africa - A limited demonstration of airship operations was carried out by the German firm, WDL, under government sponsorship, in Ghana and Upper Volta, using a WDL-I nonrigid. The airship was shipped to Ghana and erected (in the open) at the airport. Conclusions on the results of these experiments were not publicized. It is understood, however, that interest in developing an air transport system suitable to the requirements of terrain and traffic is continuing in several W. African nations.

Soviet Union - The Soviets have shown an interest in heavy-lift airships as well as other types of advanced designs. One recently publicized enterprize shows a type of nonrigid with a vertically oriented helium-filled airfoil shaped envelope designated "Ural 3". This is apparently a scaled down version of a later 15 ton vehicle.

Other Developments - In October, 1981, a conference was sponsored by the United Nations Industrial Development Organization (UNIDO) to determine the implications of advances in LTA systems technology for developing countries. This was attended by representatives from 14 nations. It concluded that LTA technology had the potential for meeting certain transport needs in third world countries, but lack of experience and high development costs were barriers to its application. As a beginning, it was recommended that other countries be invited to observe the fisheries project in Peru and that data from the program be disseminated by UNIDO.

II - Technology Developments

Configurations - In several countries, departures from the normal hull forms of ellipsoids and cylinders continue to be studied. These concepts have been considered for a number of reasons such as a desire for increased dynamic lift in flight, reduced resistance to ground winds while moored, or the need for a special hull form because of payload or mission requirements. Configurations include delta planforms, lenticular shapes, and ellipsoidal cross sections.

Objective evaluations of these concepts in comparison with conventional types is difficult because of the lack of an adequate data base (for the new concepts) and also because requirements for each type may not allow direct comparisons. One such evaluation (Ref. 8) was made recently on the basis of specific productivity for deltoid hybrids and conventional equilibrium types. (Spec. Productivity = Productivity/Airframe Weight & Propulsive Weight). The results show that hull forms of very low aspect ratio (~ 0.5) have slightly higher values (of specific productivity) than conventional shapes. These hulls would actually combine ellipsoidal fore bodies with flattened (delta shaped) afterbodies. These results seem to have been confirmed in an independent study (Ref. 9) which compared very large VTOL hybrids and equilibrium types for military airlift missions involving very long range flight. Fig. 18 illustrates the results of these investigations.

It should be noted that the productivity values are low compared to airplanes at their best ranges, but possible features such as VTOL capability, large single payload and volume capacity, and the potential for extreme range flight could make some hybrids attractive for future development.

Dynamics and Control - Conventional equilibrium airships are usually designed to be controllable by aerodynamic means through the use of hull and empennage forces above some minimum flight speed.

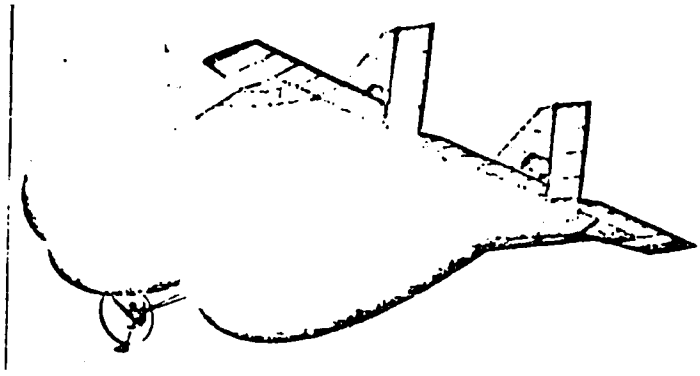

Fig. 16
DINOSAURE Mini RPV

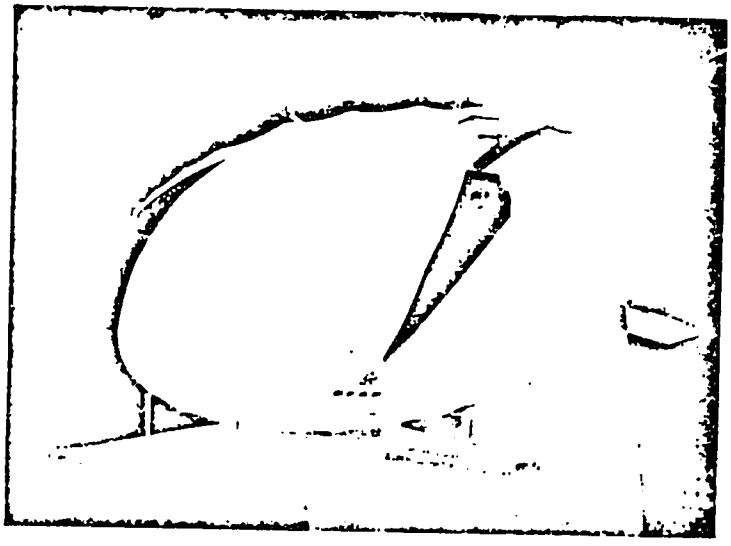

Fig. 17.
ALCYON Model

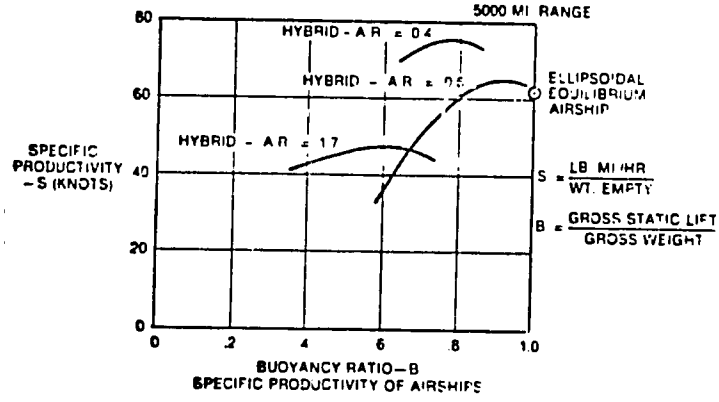

Fig. 18
Productivity Comparisons

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Below this point, static forces are the predominant means of control. The new hybrid concepts which combine large rotors with aerostat hulls are, by design, intended to circumvent this problem through the availability of large thrust forces at all airspeeds, and to achieve near helicopter-like hover capability. It also appears that many future airships will require improved controllability at or near zero airspeeds. These new flight characteristics will vary with mission applications but in general they establish needs for design criteria beyond the present data base. For this reason, the bulk of research effort in recent years has been devoted to the development of suitable dynamics and control analysis and simulation of flight characteristics.

One example of such effort is an analytical program developed by Goodyear (Ref. 10) for nonrigid heavy lift hybrids which models flight path simulation, dynamic stability, and control concepts for various flight mission profiles. The vehicle motions, velocity changes, power requirements, fuel consumption, and suspended payload dynamics are recorded via strip charts and can also be displayed.

A more comprehensive effort was undertaken by Systems Technology, Inc. under NASA contract. This program is known as HYBRDS (Hybrid Buoyant Rotorcraft Dynamic Simulation). It was developed to be a generic, but comprehensive mathematical model and computer simulation of airship flight dynamics over the entire flight envelope. Its major purpose is to serve as a synthesis and analysis tool for evaluation of design concepts. Although originally intended for simulation of hybrids similar to the Helistat concept, it can also be used to analyze balloons, classical airships and non-buoyant multi-rotor helicopters by selectively altering the input data.

The HYBRDS program contains 3 main parts:

HLASIM - models the powered vehicle in flight.

HLAPAY - models the powered vehicle with a slung payload.

HLAMOR - models the unpowered vehicle when moored.

Each of these calculates operating point or trim and stability and response derivatives about selected points for use in linearized vehicle dynamic response models. It also performs a forward integration in time for vehicle state variables in response to control commands and aerodynamics disturbances (gusts and turbulence) for selected trim conditions. The program operates on a CDC 7600 computer.

The program was used during 1982 to simulate the flight characteristics of the 25 ton payload Heli-stat. Figure 19 shows the results of analysis of Yaw/Sway instability. This indicates that a 4 fin empennage may be required to achieve satisfactory flight above 20 knots forward airspeed. HYBRDS is also being utilized to simulate the flight characteristics of the AI Skyship 500. Both results will be compared with data from instrumented flight tests, and used to indicate desirable design improvements. The piloted simulator facilities at the NASA Ames Research Center have also been utilized to provide opportunities for piloted simulation of airship flight.

Another approach to the study of flight characteristics is being employed by the Naval Air Development Center. This consists of a remote control flying model 32 ft. long and 865 cu. ft. in volume. It will approximate a 1/10 scale version of a potential Coast Guard patrol vehicle concept, and will incorporate a tilting bi-rotor propulsion and control system.

Dynamics and control studies of conventional airships have also been conducted in Canada by DeLaurier (Ref. 12), and in France by CERT. This latter work includes analysis of slingload dynamics in connection with heavy-lift airship certification (Ref. 13).

A number of other analyses for specific concept developments have also been made in France, Great Britain, and the U.S.

A fundamental problem with most of these new programs is the lack of a suitable data base. Some of these new configurations have strained theoretical knowledge to limits without correlation with either wind tunnel or flight data. An early indication of some of these problems was revealed in discrepancies between small scale wind tunnel tests and analyses of hybrid concepts with large rotor systems (Ref.14). Force vectors did not agree in magnitude or direction. Larger scale and higher Reynold's number tests are needed to provide reliable data.

Structure and Materials - Two developments in recent years which have major impact on airship structures are new methods of analysis, and new materials.

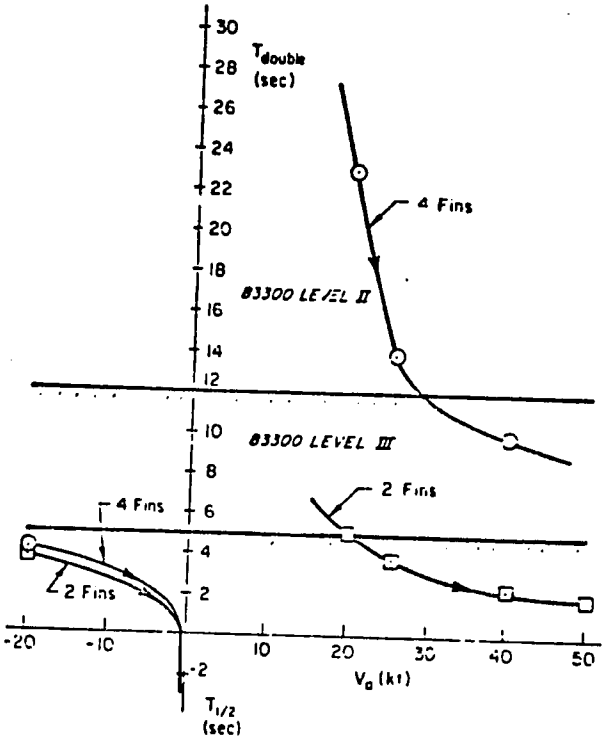
Past efforts in this area were extremely limited by the complexities of the structures. In rigid airships, for example, simplications and approximations were required which only by experience provided reasonable results. In nonrigids, the envelopes and suspension system were treated by assuming that strength and elastic characteristics in major portions would exhibit relatively uniform behavior.

Finite element methods using digital computing equipment now provide a basis for more exact and more detailed computations. A particular advantage results from the ability to model (analytically) the dynamic behavior of structural systems taking into account nonlinear characteristics and coupling effects. Fig. 20 illustrates the envelope and suspension system of a small nonrigid airship using a specifically developed program (Ref. 15).

Structural weight continues to be one of the most important elements in sizing airships, and hence determining their efficiencies. Weight reductions can be accomplished through the use of composite materials, and new synthetic filaments and films (for inflated components).

The envelope assembly is the largest single weight component in a nonrigid. A saving of half of this weight would result in a net reduction of 15 percent in envelope volume and 13 percent in propulsive power if a complete re-design is

EFFECT OF AXIAL AIRSPEED ON YAW/SWAY INSTABILITY



(Fig. 19)

COMPUTER DRAWING OF NON-RIGID AIRSHIP STRUCTURAL ELEMENTS

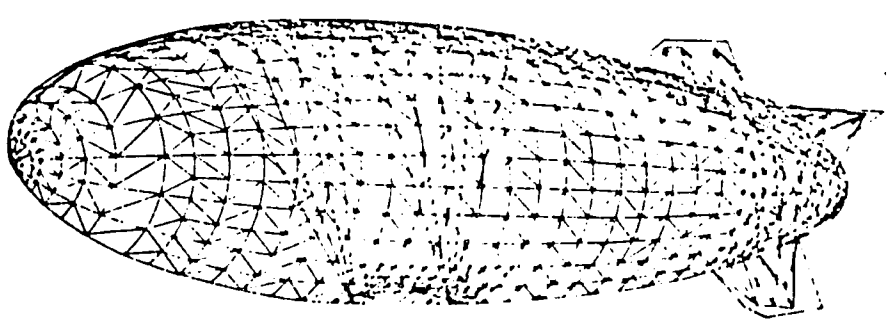


Fig. 20

considered. Such savings may be possible using a combination of composites for the hard structural components with newer synthetic filaments such as Kevlar, and graphite.

An example of the actual application of new materials can be found in the British Airship Industries Skyship 500 which is described elsewhere in this paper.

Another possibility for weight reduction in envelopes could result from a decrease in factors of safety. Current practice is to use a value between 4 and 5 for fabric structures. This is based on creep-rupture criteria largely developed by experiment on natural staple fiber fabrics. Continuous filament synthetics have improved failure characteristics which should allow for less conservative design. Accurate criteria for these new values must be established by further analysis and testing. Currently, there is little or no research on the subject. Part of this determination needs to be based on better correlation between design criteria and actual service experience, similar to that reported in (Ref. 16) for Navy airships.

Some exploration of structural design criteria was undertaken as part of the heavy-lift hybrid airship studies sponsored by NASA (Ref. 1), but a considerable greater amount needs to be done if realistic requirements are to be established for new airship designs. Among these is the subject of gusts and turbulence. Criteria used for past airships may not be very applicable particularly for determining loads from maneuvering with much higher thrust and carrying suspended loads such as possible with some of the heavy-lift hybrids.

Propulsion - It is not likely that engines specifically designed for airships will ever be available considering the small market such aircraft represent. In the past, engines designed for other uses have been adapted for airships using special gear boxes and components, and it is probable that future vehicle designers will be forced to continue this practice. A significant difference between the past and present, however, is the emphasis now on low speed control. This establishes requirements for higher thrust in some cases and for thrust vectoring through the use of tilting propellers and cyclic and collective pitch variation.

Response time for counteracting disturbances is crucial if any thrust system is to be effective. Even though inertial characteristics of airships favor longer periods, these would be shorter than the time required for tilting thrust axes. Thrust units already located in the proper direction seem to be one practical approach as was demonstrated by the side thruster shown on the model in Fig. 21. This experimental model, designated HX-1, incorporated tilting propellers and a tail thruster as well. A French experiment, designated ROBIX, conducted by ONERA, used two intermeshing propellers with axes at 90° to each other, and demonstrated that both thrust and efficiency were enhanced as a result. Many of these systems have been incorporated in airships before, but a reexamination of these in the light of new technology seems worthwhile.

Operations - The actual operation of airships in the past 21 years has been limited to those involved with private U.S. public relations activities (Goodyear) and German aerial advertising as previously noted. Both these groups have employed methods similar to each other and basically not different from past operations. These include assembly and major maintenance from a fixed base with hangar facilities and flight operations using portable equipment at various locations without hangaring. Current British flights are adding to this experience.

An examination of the possibilities for ground handling heavy-lift hybrids was made by Goodyear and sponsored by NASA (Ref. 17). These indicated that nose mooring to a fixed or mobil mast continues to be the method by which weight penalties to the airship from structural loads are minimized for hybrid and conventional types. Fig. 22 shows the effects of total restraint (no weathervaining) on suspension system and envelope weight for heavy-lift airships. It can be seen that component weight could exceed total lift.

Certification - In the U.S., the only civil activity (Goodyear operations) is certified on the basis of similarity of the airships to Navy "L" type airships flown during WWII. For this reason, a detailed certification for airships of any type has never been developed. In contrast, the British Civil Aviation Authority had to develop a complete requirement (Ref. 18) during design and development of Airship Industries Skyship 500. It is anticipated that a similar requirement will be written by the FAA if new U.S. designs are developed for civil application.

Comment and Summary

Table 5 is a list of the several LTA vehicles and their characteristics under development in various countries. The largest project is the HELI-STAT program for the U.S. Forest Service. It is possible that the programs in the U.K., if successful, could surpass theinvestment levels now indicated for the U.S. projects. It is interesting to note that enterprizes in the U.K. are privately supported even though the efforts involve novel departures from past types. It is likewise noteworthy that the German operation which is devoted to advertising and which also involved some risk venture capitalization is reported to be self supporting. These operations should offer evidence that government financing is not necessarily a prerequisite to the initiation of a new LTA venture.

The new types under study and development in most cases are a compromise between slow flying equilibrium airships with low energy consumption and faster more maneuverable concepts. But the total cost of flight vehicles is not fuel cost alone, although this factor will rise in importance as costs increase. As shown in the productivity studies of deltoid hybrids, such vehicles may be uniquely suited to certain mission applications provided that β^* values near 1.0 are not required. This is reasonable since no single type of vehicle of any kind has ever been found to satisfy all requirements.

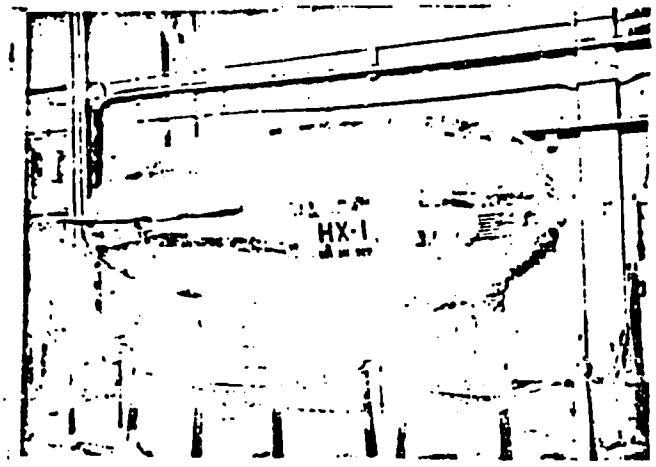


Fig. 21
Vectored Thrust Test Model

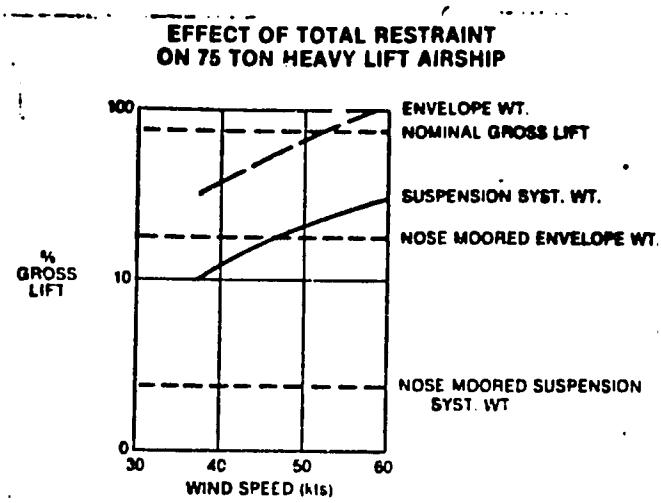


Fig. 22

CURRENT AIRSHIP DEVELOPMENTS

NAME/CO.	VOLUME CU. FT.	LENGTH FT.	MAX. DIA. FT.	GROSS WT. LBS.	GROSS LIFT LBS	MAX. SPEED KNOTS	USEFUL LOAD	H.P.	COMMENT
	CHARACTERISTICS								
HEAVY-LIFT AIRSHIP GOODYEAR	2,600,000	453	107	290,807	140,807[1]	80	150,000	8760	UNDER STUDY
HELI-STAT PIASECKI	975,000	343	75	11,265	59,582[2]	60 70	56,380	5100	UNDER CONSTRUCTION
CYCLO CRANE D.C. ASSOC.	330,000	180	65	24,000	20,000[2]	60	4000	360	UNDER CONSTRUCTION
SKYSHIP 500 AIRSHIP INDUS.	131,200	164	46	12,575	11,175[3]	62	4152	300	UNDER CONSTRUCTION
SKYSHIP 600 AIRSHIP INDUS.	252,080	194	50	14,781	14,781[3]	65	6395	500	UNDER CONSTRUCTION
WDL I W. DEUTSCHE LUFTWERBUNG	211,860	197	48	13,860	13,860[4]	61	3300	500	OPERATIONAL
WDL III W. DEUTSCHE LUFTWERBUNG	2,118,600	400	98	137,236	129,468[2]	76	88,000	2600	UNDER STUDY
HELI-COSTAT AEROSPATIALE	120,054	123	48	14,420	7600[2]	49	7600	1200	UNDER STUDY
DINOSAURE	1660	25	2	101	101[4]	—	—	7	RPV OPERATIONAL
ALCYON	218,922	146	315	—	12,540[2]	60	2200	885	UNDER DEVELOPMENT
GZ-20A GOODYEAR	202,700	192	46	12,320	12,320[2]	43	3281	420	OPERATIONAL
XZV-1 NAVY	865	32	8	55	55[4]	67	10	0.75	RPV OPERATIONAL
R 30 WREN	1,000 000	336	75	—	59,000	107[6] 134[7]	32,284[6] 28 600[7]	3300[6] 6600[7]	UNDER DEVELOPMENT

1. @ 5000' ALT'
2. @ 1000' ALT.
3. @ 3000' ALT.
4. @ S.L.
5. HEIGHT
6. CARGO VERSION
7. PASSENGER VERSION

c.443

LTA technology and development today appears to stand on the threshold of an era of new applications. Compared with other aeronautical types, these developments are miniscule and extremely vulnerable. Their viability is conditioned by the critical need for a true industrial base and continuing funding. The particular design effort involved in the various projects described in this paper is somewhat akin to the kind of fragmented aeronautical endeavor that existed in the U.S. following World War I, where there was much enthusiasum, limited financing, and inadequate engineering in many cases.

Basic technology development should include all the subdisciplines involved in design, construction, and operation. It is generally true, however, that most research today is only in connection with particular concepts and only on subjects which appear to be obstacles to predictable deisgr. Few, if any of the incremental refinements normally associated with aeronautical research are part of current investigations. Whether these will be, remains to be seen. Without a continuing research effort, there is little hope for true advancement in the field.

Among the many elements needing investigation, perhaps the most important are:

1. Large Reynold's number aerodynamic data and the effects of various configuration changes.

2. Design and location of propulsion units for maximum efficiency.

3. Development of structural design criteria including particular definition of realistic requirements for flight in turbulence and gusts for various airship concepts.

4. Envelope materials research to improve long term permeability, durability, and achieve lower weight fractions.

5. Improved methods of ground handling, maintenance, and determination of all-weather flight capabilities.

6. Realistic assessment of design, construction, and operational costs particularly related to specific missions and types.

The area of flight dynamics and control appears to be sufficiently emphasized in current programs and should continue to be an important aspect of future research as well.

In summary, current developments include continuing efforts in the U.S. in research on the dynamics and control of hybrid airships, structural analysis, and scaled experiments. Vehicle programs include the construction of heavy-lift BELL-STAT and Cyclocrane hybrids for logging demonstrations. Activities in foreign nations include building airships for demonstration of aerial advertising, passenger and freight transport, coastal surveillance, and general utility. The successful achievement of these and future efforts will contribute to an improved industrial base and broadened R&D effort.

* β = Static Lift/Gross Weight

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