THE FUTURE OF THE AUTOMOBILE

ONE BILLION NEW CITY DWELLERS-
HOW WILL THEY TRAVEL?

by

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David Bayliss

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Draft Research Paper

#2359

International Policy Forum
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28 June - July 1, 1981

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PREFACE

This paper is an adaptation of the first Reuben Smeed Memorial Lecture given at University College London on 12 March. This series of lectures has been promoted by the late Reuben Smeed's former friends, colleagues and admirers as a tribute to him for his contributions to traffic science and engineering over a quarter of a century. Reuben Smeed's unique combination of imagination, rigorous objectivity and determination, coupled with his humour and warmth brought him rare distinction as a researcher and teacher. The subject of the paper is wide ranging and complex and it has not been possible to treat all parts of it with the thoroughness that Reuben Smeed would have sought. However there is little doubt that it would have appealed to him as one well worth tackling.

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1. INTRODUCTION

People have lived in complex settlements, with a range of activities that distinguishes them from simple hunting or farming communities, for perhaps up to ten thousand years. This phenomenon of urbanisation is relatively recent in man's history and arose through a subtle interplay of social, psychological, economic and technological changes of which improvements in transportation was one. The economic developments especially important to this process of urbanisation were improvements in agronomy and discovery of how to store cereals and other foods.

About seven thousand years ago the use of the wheel improved land transport technology and the development of stable boats transformed river transport. These developments meant that settlements in a number of the more fertile river valleys no longer had to depend on the immediate yield of the area within five or so kilometres. This new scale and stability allowed the growth of kingship, the priesthood, teachers, merchants and scholars thus providing the foundation for the growth of the first great civilisations.

Starting in the especially fertile valleys of the Euphrates and the Yellow River these civilisations flourished and died but the cities they occupied sometimes survived (e.g. Athens and Rome) to host later cultures. This process went on for several thousand years with the emergence of only very few cities with populations of over one million. However this started to change in the seventeenth and eighteenth centuries with mankind in the western world seeking to exert more control over the natural order of things and with the industrial revolution. One of the most important products of the industrial revolution was powered transport and this paved the way, amongst other things, for the growth of very large cities.

The steam railway, electric tramway, motor bus and, in some instances, steam ships along with the powered lift supported the increase in numbers of people living in cities with populations over 100,000 from 2% in 1800 AD to 5½% in 1900 AD. This has now risen to 28% and over 40% of all the world's population is currently classified as urban. Because the world's population grew from 900m in 1800 AD to 1600m in 1900 AD the number of people in 'cities' (using an urban population of 100,000 as meaning a city) increased sevenfold from 15m to 105m. During this period the first industrial 'million plus' cities emerged - London, New York, Paris, Chicago and Tokyo.

2. THE GROWTH OF CITIES TO 2000 AD

The twentieth century has seen a continuation and steady acceleration of the process of urbanisation. Of the 27% of people who are city dwellers more than half (15% of all people) live in cities with populations of one million or more and 6% live in the super cities with populations over five million (five of which now have populations over ten million - Tokyo, New York, Sao Paulo, Mexico City and Shanghai). These trends are projected (see Figure 1) to produce a situation in 2000 AD where there will be 57 cities with populations over five million in which 658m people live. The number of cities with populations over one million will have increased

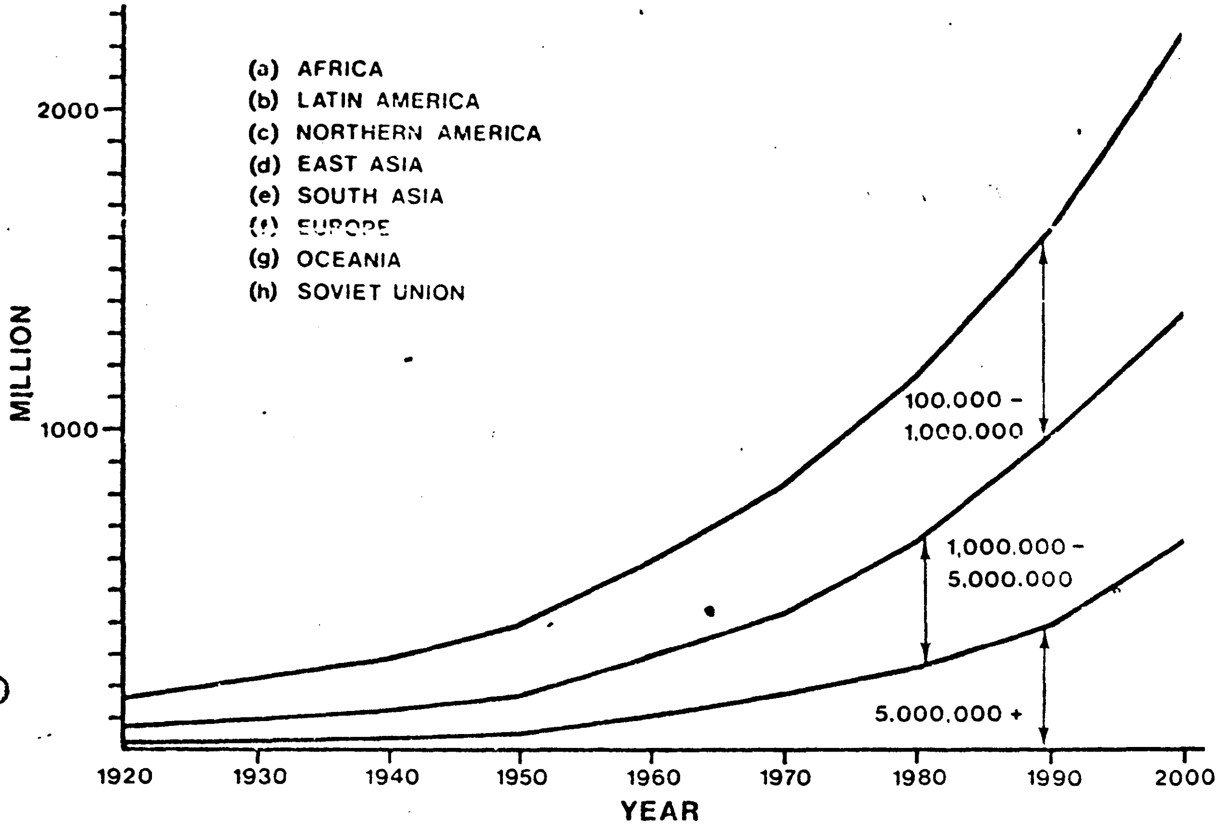


Figure 1. Growth of Urban Population by Size of Settlement 1920 - 2000

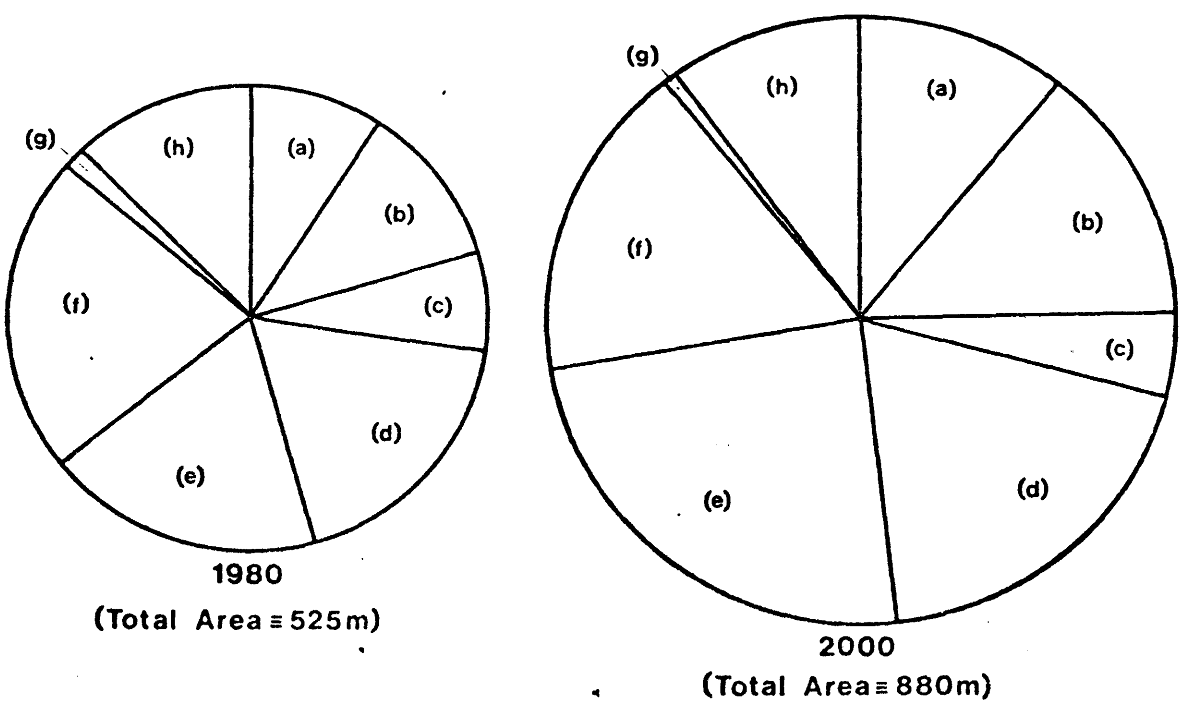


Figure 2. Growth in Population in Cities between 100,000 and 1,000,000 1980 - 2000

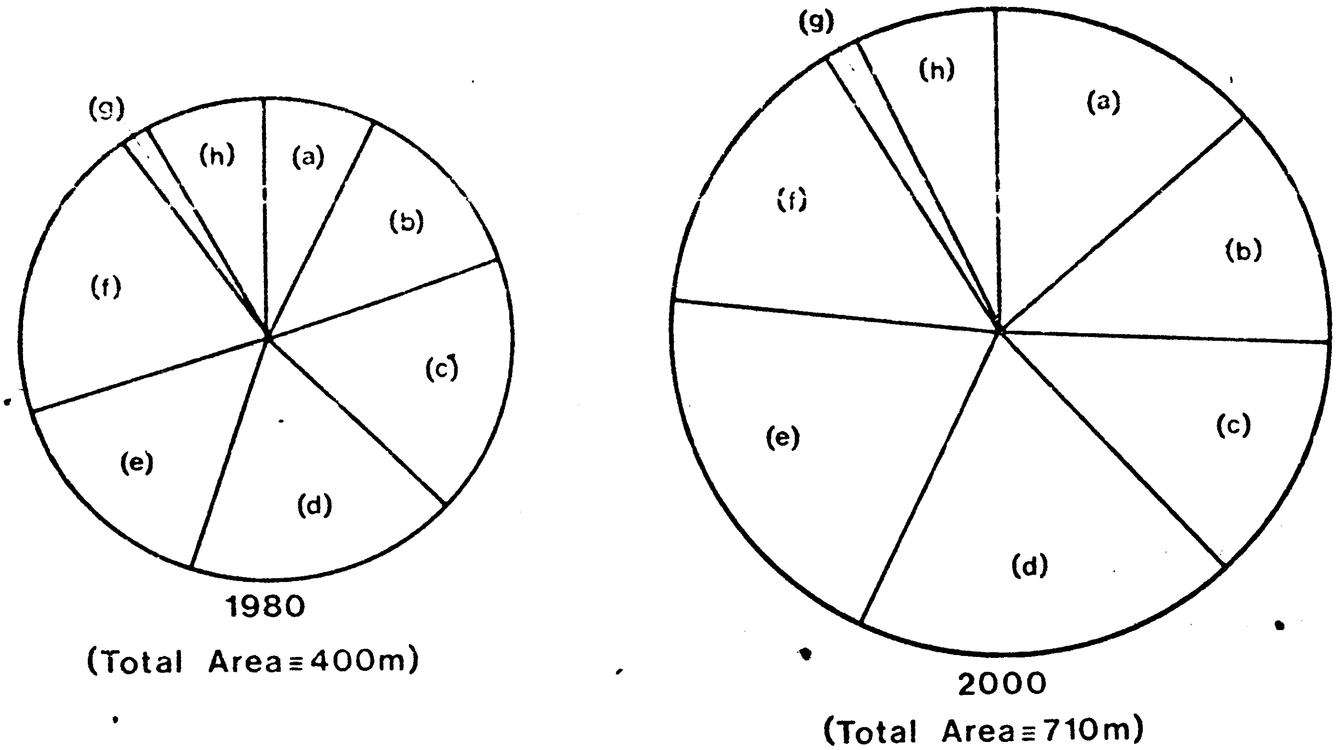


Figure 3. Growth in Population in Cities between 1,000,000 and 5,000,000 1980 – 2000

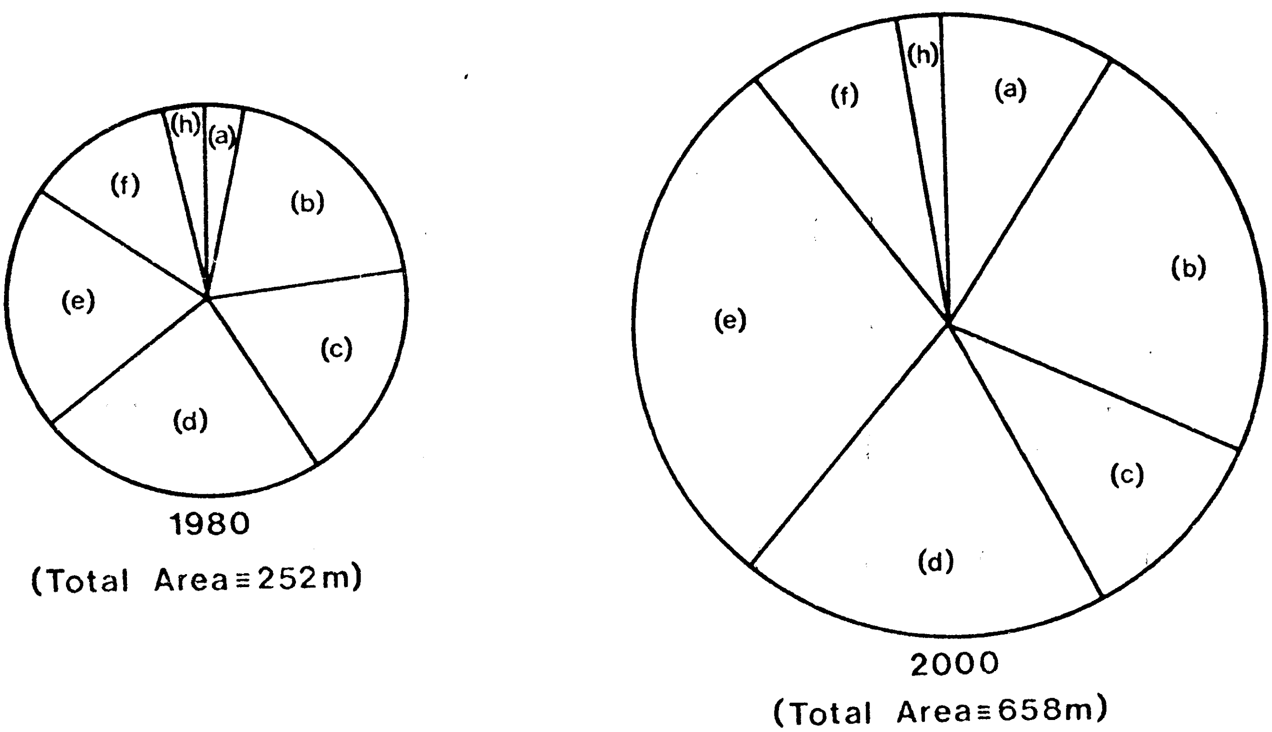


Figure 4. Growth in Population in Cities over 5,000,000 1980 – 2000

from 225 to over 400 and their population from 650m to 1370m. The total number of people living in cities (sticking to the definition of urban areas with populations over 100,000) will have grown from 1180m to 2250m i.e. an increase of 1070m or approximately one billion new city dwellers.

The general prospect is therefore of general population growth, increasing urbanisation and a relative increase in the importance of the very large cities; by 2000 AD over 10% of the world's population is expected to live in the 'super cities'. The growth in very large cities will not however be mainly through the traditional big cities getting bigger but largely as a result of growth in the newer cities of the Third World. Figures 2, 3 and 4 show the expected population growth in three city size ranges by world region, the letters representing these regions:-

(a)	Africa	(e)	South Asia
(b)	Latin America	(f)	Europe
(c)	North America	(g)	Oceania
(d)	East Asia	(h)	Soviet Union

The boundaries of these regions are shown on Figure 5. The picture these give is firstly one of most growth in the larger size ranges but especially the super cities. Secondly of much higher city growth rates in Third World countries. Most notable growth rates are expected in South Asian cities and the large Latin American cities.

At the end of the Second World War there were no super cities in the less developed countries. Today 18 of the 29 super cities are in less developed countries and by the end of the century the corresponding numbers are expected to be 41 out of 57. Put another way out of the 28 cities expected to join the super city league in the next twenty years 21 are forecast to be in less developed countries. This is illustrated in Figure 5. Many of these cities have basically poor transport infrastructures - hardly able to meet today's needs yet they face a rate of growth much higher than that in the maturer and richer cities in the developed world.

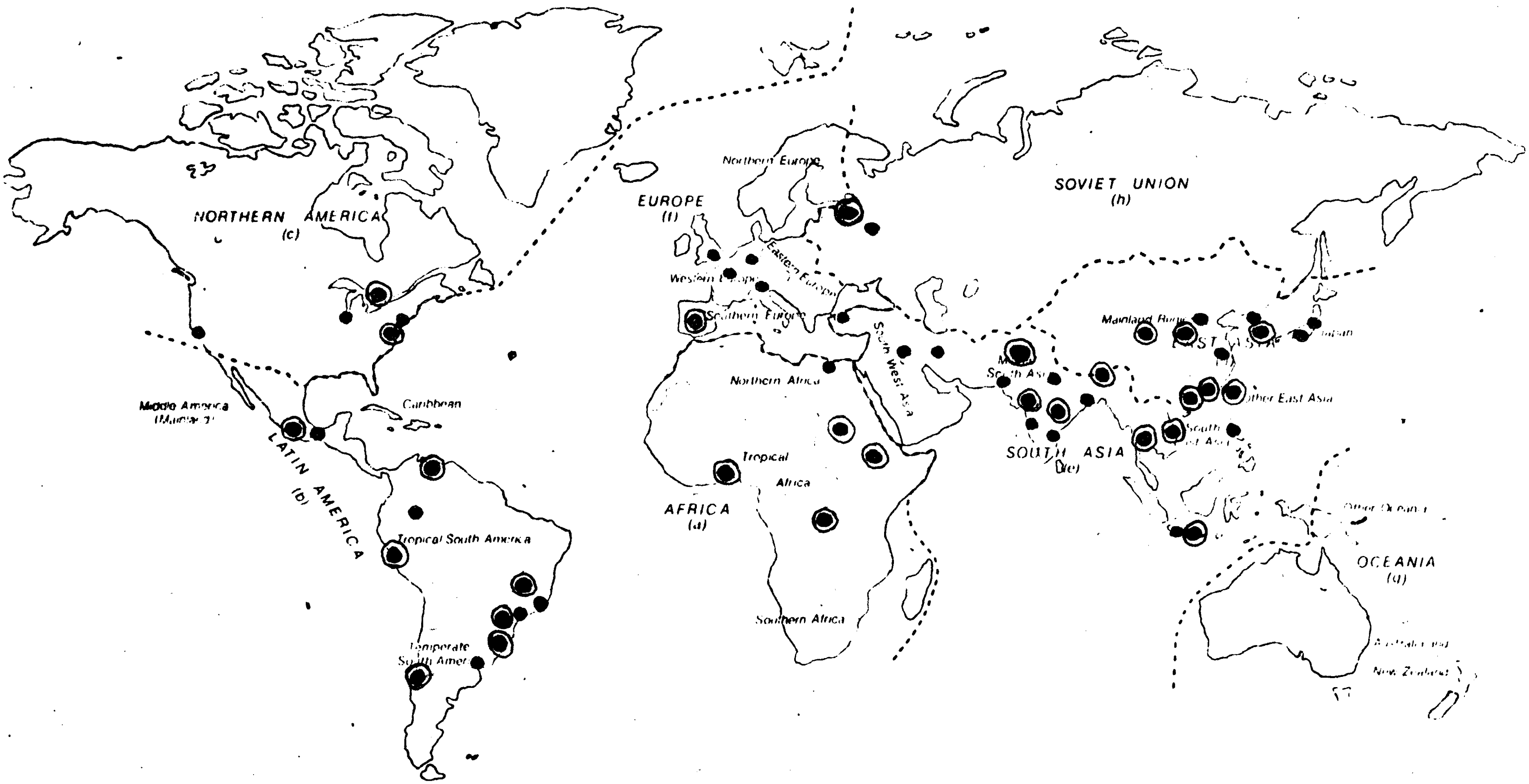
The main trends of continuing population growth, continuing urbanisation and a growing propensity to live in large cities are expected to apply most notably to less developed countries and give the broad picture of population change in cities over the next twenty years shown in Table 1.

<u>TABLE 1 - Growth in City Populations 1980-2000 AD</u>

City Size Range	Less Developed Countries (1)	More Developed Countries (1)	Whole World
100,000 to 1,000,000	279m (102%)	75m (31%)	354m (67%)
1,000,000 to 5,000,000	238m (114%)	70m (36%)	308m (77%)
5,000,000 +	355m (269%)	51m (43%)	406m (161%)
100,000+	872m (140%)	196m (35%)	1068m (91%)

(1) United Nations definitions used

Figure 5.



The World showing the eight major democratic regions and cities over 5m population

● Existing in 1980

◉ Reaching 5m between 1980 and 2000 AD

If these projections turn out to be reasonably correct there will be five cities (Tokyo/Yokohama, New York, Sao Paulo, Mexico City and Shanghai) with populations in excess of 20m.

3. THE CHANGING DEMAND FOR URBAN TRAVEL

The amount and nature of passenger travel in cities depends on their state of economic development, urban form, activity patterns and the transport facilities available. Unfortunately for the analyst these are not separate features and just as the level of economic development influences the availability and use of transport this, in turn, helps shape activity patterns and, through them, urban form. Again in its turn this effects the urban economy and travel patterns.

The relationship between economic development and urban travel exists at two levels. At the broadest level urbanisation itself has historically been a close correlate of economic growth. More immediately wealth and economic activity within cities creates the need for movement. The demographic projections outlined above, by their very nature, implicitly assume that the strong tie between economic development and urbanisation will continue. The problems of large scale urbanisation in the Third World are such that alternative forms of economic development, less dependent on progressive urbanisation, should be considered seriously both by Third World governments and those developed world agencies which exert influence on the way in which the Third World will develop.

Although the generality of the way in which urban systems work is well understood our ability to represent these workings precisely is still very limited. Moreover in looking at the future of travel in about three and a half thousand different cities in over one hundred and thirty different countries the enormous local variety is such that only broad generalisations are meaningful. For the purposes of this analysis city size and the state of economic development are taken as the two main descriptors. This is not because they are overwhelmingly important but because they are both important in their own right and, to some extent serve as proxies for other significant variables such as population density. Table 2 shows, for example, how density varies with city size and economic status and gives a clear picture of density increasing with size and falling with economic development.

TABLE 2 - Variation in Inner Area and Metropolitan Area Densities with City Size and Economic Status (thousands of persons/km^2 - sample of 180 cities)

City Size Range	Less Developed Countries		More Developed Countries	
	Inner Area	Metropolitan Area	Inner Area	Metropolitan Area
100,000 - 1,000,000	6.5	3.5	3.0	2.0
1m - 2m	10.0	5.8	3.9	1.4
2m - 3m	13.0	7.3	5.0	3.8
3m - 4m	17.0	6.5	7.5	2.0
4m - 5m	17.0	8.5	13.0	6.5
5m+	18.6	8.0	10.3	3.0

There are however major variations between cities which are not accounted for by differences in size, economic development, density and other macro variables. Any conclusions therefore can only be taken to apply generally to city classes. Moreover as tomorrow's cities grow and develop there must be doubt as to the extent to which they mature in cities like today's large developed cities which generally grew in a slower and more controlled fashion.

With these qualifications there can be little doubt that the amount of journey making, especially by motorised modes, increases with economic development. This phenomenon is illustrated in Figure 6, the scales indicating orders of magnitude rather than actual values. This shows a steady reduction in walking and cycling, which predominates at low income levels, with increasing personal income. The figure shows distance, if the number of journeys were shown this would demonstrate a greater importance of these modes at all income levels. The greatest proportion of growth in travel takes place by public transport as incomes rise towards $1000 p.a. As incomes rise beyond this point the use of cars and motor cycles start to account for a growing proportion of the growth until beyond $3,000 per year their use not only accounts for the growth but takes over part of the travel accommodated on public transport at lower income levels. Figure 6 does not indicate city size as a variable but it can be taken as a general rule that, at any income level, the larger the city the greater will be the use of motorised modes and public transport. The higher the density the lower will be the use of motorised modes but again the use of public transport will be a higher proportion of this use. Whilst the average GNP/capita is today about $2,000 US (1978) there are almost 2½ bn people living in countries with GNP/capita of $500 or less. Therefore whilst worldwide any growth in urban travel associated with economic development (as opposed to urban population growth and other factors) can be expected to be through the use of cars, in fifty countries at least this growth will be in the use of public transport for many years to come. World Bank GNP/capita growth rates up to 1990 if projected to 2000 give an average worldwide increase in GNP/capita of about 50% between 1980 and 2000.

4. FORMS OF URBAN TRANSPORT AND THEIR DEVELOPMENT AND USE

To get a clearer picture of the future of transport in cities it is useful to take the main modes of transport in turn, look at their availability and use and how this could change by the end of the century. This is done in this section and the scale of each of the modal groupings is indicated in Table 3.

Some of these estimates (e.g. bicycles, lifts and jitneys) are very approximate as reliable statistics about them do not exist on a worldwide basis. It is also important to note that the distribution of these modes is often uneven with 280m of the 310m cars in North America, Europe, Oceania and Japan; a high proportion of the pedal cycles in China and ferries being largely confined to bay and island cities (e.g. Sydney and Hong Kong). There are about thirty cities which make significant use of high volume vessels for local passenger transport.

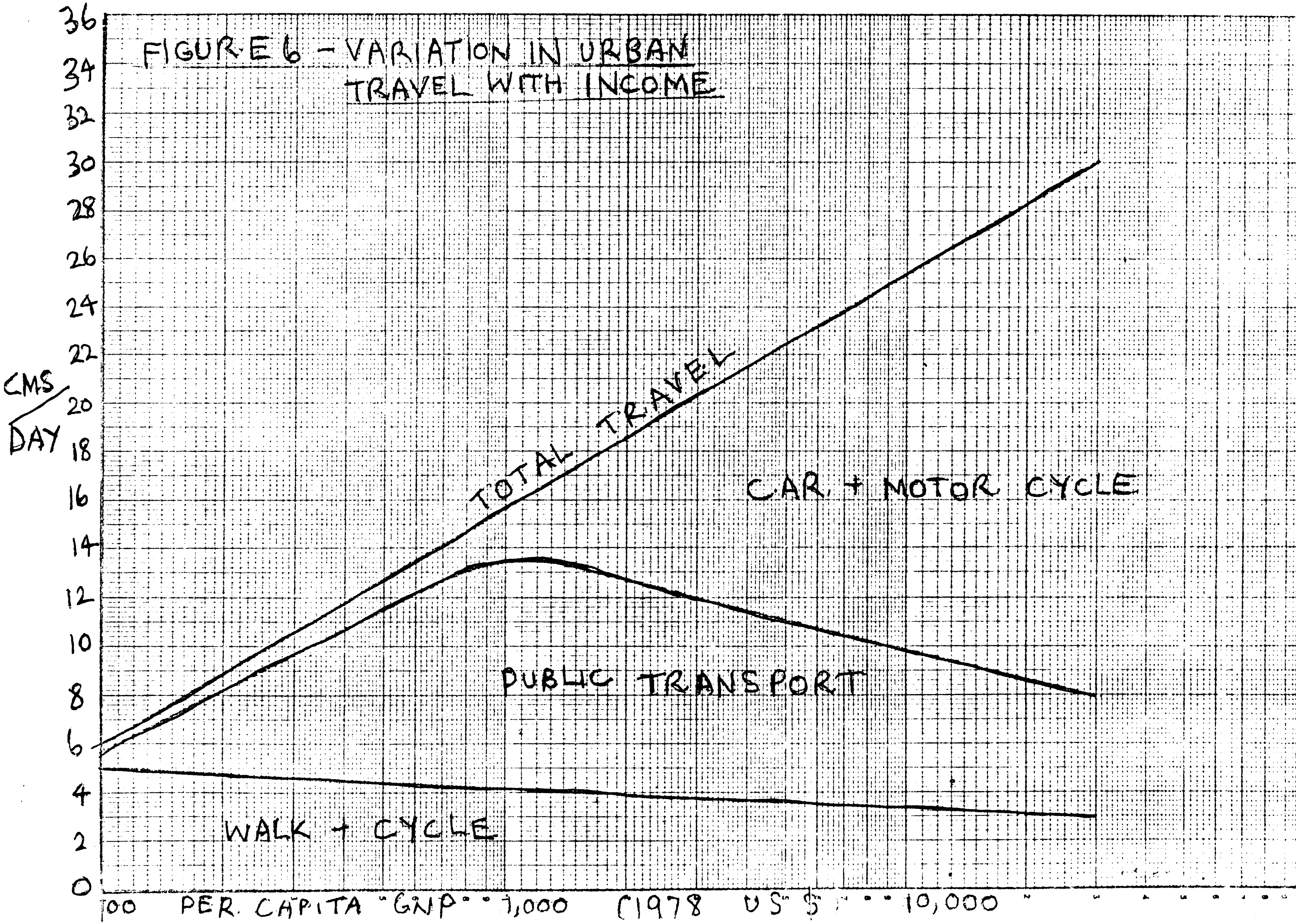


FIGURE 6 – VARIATION IN URBAN TRAVEL WITH INCOME
CMS / DAY
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
TOTAL TRAVEL
CAR + MOTOR CYCLE
PUBLIC TRANSPORT
WALK + CYCLE
100
PER CAPITA "GNP"
1,000
(1978 US $)
10,000

TABLE 3 - Scale of the Main Modes of Transport in Cities with Populations over 100,000

Mode of Transport	Scale
Walk	Almost universal
Pedal-cycle	100m + units
Motor-cycle	35m units
Motor-car	165m units
Motor-bus	0.85m units
Trolley-bus	0.02m units
Tramcars	0.05m units
Suburban railcars	0.1m units
Metro-cars	0.04m units
Ferry	less than 0.01m units
Taxi	about 1.0m units
Jitney	about 0.5m units
Lift/escalator	about 4.0m units

4.1 'Metros' and Suburban Rail

Perhaps the form of urban transport with the strongest 'city' image is the metro (called also by other names e.g. the Underground in London and the Subway in New York). The metro is also perhaps the most glamorous form of urban public transport and is looked to by many urban transport planners as a key element in dealing with the transport problems of the large and rapidly growing cities in less developed countries.

The special attributes of metros are their high capacity (up to 40 trains per hour each with a capacity of up to 1,000 people), high operating speeds (about 30 kph or twice that of buses), reliability and high cost. It is this last factor which is the main reason for their relative scarcity. There are now about 70 metro systems in operation with a total route length of about 3,600 kms. Of this less than 300 kms are in cities in less developed countries and 1,600 kms are in New York, London, Paris, Moscow, Tokyo and Chicago. The growth of the number of metros is shown in Figure 7. The possible range of numbers of systems at the end of the century is from 85 (currently committed) to 130 (currently committed plus three times the number in the firm planning stage).

Taking 120 as the probable figure for 2000 AD only one in four cities with populations over one million would have metro systems and many of these would be short (less than 30 kms in total route length). Taken with growth in existing systems there could be over 6,600 kms of metros in 2000 AD. The breakdown on which this figure is based in given in Table 4.

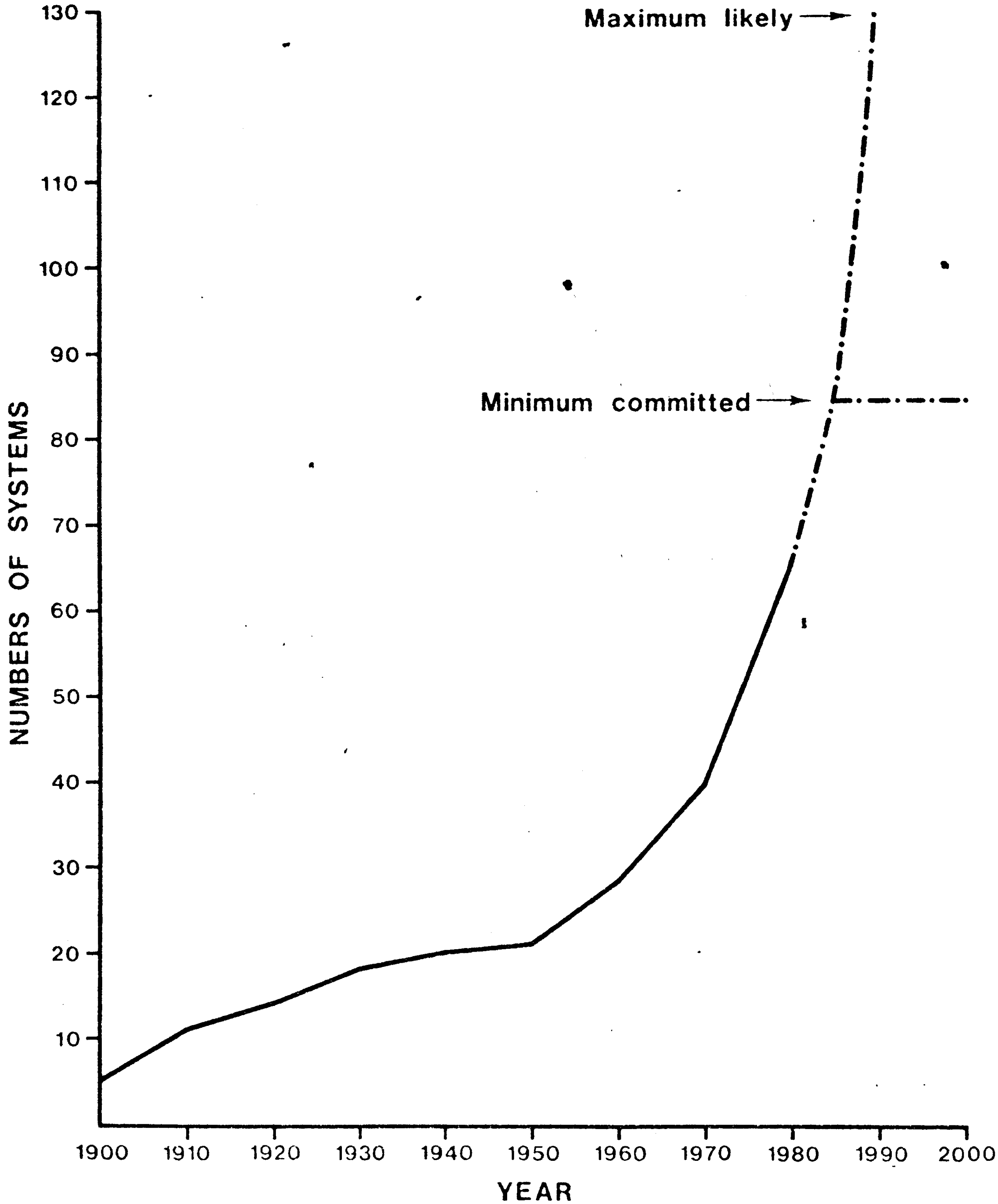


Figure 7. Growth of the Worlds Metros since 1900

TABLE 4 - Estimate of the Length of Metros in 2000 AD by City Type

City Size Range	DEVELOPED COUNTRIES (MDCs)			DEVELOPING COUNTRIES (LDCs)		
	Number of cities	Population	Length of systems (kms)	Number of systems	Population	Length of system (kms)
5m+	16	172m	2,500	41	486m	950
1m - 5m	150	265m	2,700	260	445m	200
less than 1m	1000 approx	315m	250	1700 approx	565m	0
All	1150 approx	752m	5,450	2000 approx	1496m	1,150

Whilst this would mean that the less developed countries share of the world's metros would increase from 7% to 17% most of the metro growth in these countries will be in the super cities which are forecast to grow by a factor of 3.7. Thus the level of provision will only rise from today's 1km per million population to about 2 kms per million which compares with a present day figure of 14.5 kms/million in developed cities with populations over 5m. This is expected to remain stable - metro growth and population growth keeping roughly in step.

In cities in the one to five million range the disparity is expected to be more marked with the developed city figure of 10 kms/million population being over twenty times that for less developed cities in this size range. In cities below 1m population the role of metros in developed countries will be very small and non-existent in developing countries.

Because of a number of factors, not the least significant being the concentration of metros in less developed cities in heavily trafficked central/inner corridors, the level of use of systems in these cities is very high compared with developed cities. Whereas metros in developed cities carry, on average, about 15,000 journeys/km/day in developing cities the figure is about three times this. On the assumption that these rates are maintained in LDC cities and fall slightly in MDC cities it is possible to estimate the number of metro journeys and trip rates; this is done in Table 5.

TABLE 5 - Estimate of Metro Journeys and Trip Rates (daily) in 2000 AD by City Type

City Size Range	MDC Cities		LDC Cities	
	No of Journeys	Trip Rate (per capita)	No of Journeys	Trip Rate (per capita)
5m+	35m	0.20	42m	0.09
1m - 5m	38m	0.14	9m	0.02
less than 1m	3m	0.01	0m	0.00
All	76m	0.10	51m	0.03

The totals of 76m and 51m journeys/day compare with current totals of 50m and 10m therefore the £25 bn worth of metro building that would be needed to double the number of journeys carried on metros would just keep metro ridership ahead of the growth of city populations. Given that economic growth will mean higher per capita trip rates it seems metros' share of the urban travel market will reduce by 2000 AD.

Many cities* have some suburban surface rail facilities although only about ten such systems carry more than one million journeys per day. In the 29 super cities about 45m suburban rail journeys are made each day although 30m of these are in three Japanese cities. These apart, this means daily trip rates in super cities by this mode are about 0.1 journey/capita. In the cities under 5m this falls to 0.03 journeys/capita/day and few cities in this size range, outside Europe, have significant suburban rail networks. The main exceptions to this are Melbourne, Vancouver, Cape Town, Toronto and Sydney which were important to the British Empire during the height of the Victorian rail building fervour.

The prospects for expansion of the suburban railway systems seem limited as to be effective good central area penetration is desirable and in the cities where there is the greatest need for new railways the capacities required are such that metro rather than suburban railways are needed. It seems therefore that suburban railways will cater for a declining share of the urban travel market. In MDC cities the upgrading of suburban railways typified at best by the S-Bahn in German cities could allow their role to be maintained or in some instances expanded (vide Tyne and Wear in England and Melbourne in Australia). However the cost of these projects is such that they are likely to be fairly few and far between. In LDC cities, with a few exceptions such as Calcutta and Bombay, the basic suburban railway infrastructure is too poor to make extensive upgrading a widespread probability. This must not be taken as dismissing the importance of suburban railways in certain circumstances. Although these often carry only a small proportion of total daily journeys they can be critical to the viability of central areas and containing traffic congestion on the radial roads.

Outside Japanese cities the number of suburban rail journeys in 2000 AD seems unlikely to exceed 25m daily and most of these will be in the large cities in MDC countries, middle sized (1m to 5m) cities in Europe and Oceania and a few exceptional LDC cities.

4.2 Trams and Trolley Buses

There are presently 290 tramway systems in the world's cities and this number has been steadily reducing since the Second World War. Generally these are small systems, the main exceptions being in the Soviet Bloc cities, and tend to predominate in the 1m to 5m city size range rather than in the super cities. With a total vehicle fleet of 45,000 the 'average' tramway system has between 100 and 200 vehicles.

Similarly there are only 20,000 trolley buses on the 200 operational systems and the number of these has been declining over the past quarter century. Whilst the growing cost and scarcity of oil will increase the appeal of electric traction the cost of maintaining and expanding the infrastructure of these systems are such as to militate against their large scale expansion.

* an estimated 130

Where opportunities exist to equip disused rights of way used formerly by canals, railroads or even former tramways for tram and trolley operation, there will be some new systems and some suburban railways can be expected to be converted to today's equivalent of tramway technology. However tramway and trolley systems are still being closed down and an upper estimate of the total fleet size in 2000 AD can realistically be no higher than today's figure of 65,000. This sets an upper limit to carryings by these modes of 50m journeys daily mainly in cities below 5m population in the Soviet Bloc and Europe.

During the 1970s there was much interest in the USA, UK, France, Germany, Japan and Canada in automated guided urban transport systems of various kinds. So far 25 systems have come into operation and these have a total route length of 70 kms. Most of these operate in special environments such as airports and only exceptionally do they have general urban applications (Morgantown in West Virginia being perhaps the best known). Whilst there may be a few more general purpose applications during the balance of this century their overall impact on the general city transport scene will be tiny.

This does not mean that these technological endeavours have not yielded benefits. These limited applications have been of value but more important is the spur these programmes have given to more conventional railway projects.

4.3 Urban Buses

The main form of public transport, indeed the main form of motorised transport for most city dwellers, is the petrol or diesel bus. The availability of city buses ranges from 1:500 people to 1:5000 people and operating speeds average 15 kph to 20 kph. In MDC cities the average provision is one to 1600 people whereas the figure for LDC cities is higher at one to 1250 people. However the proportion of the bus fleet which is operational in LDC cities is typically lower than in MDC cities and therefore the level of bus provision generally rises gradually as city size falls.

The number of bus transport journeys per person rarely rises above one per day. Exceptionally a few cities such as Moscow and Leningrad (which incidentally also have extensive non-bus public transport) with low car ownership, high service levels and low fares daily rates can be as high as two. In MDC cities bus trip rates average about 0.6/head per day; with little variation with size; the higher public transport usage in the large cities being accounted for by the use of metros, suburban rail and trams in the larger cities. In LDC cities bus usage does vary to some extent with city size. In the large cities (5m and larger) bus use averages about one journey/head per day except where there are extensive intermediate transport systems and this falls to about 0.6 journeys/head/day in cities with populations below one million.

The reason for lower trip rates by bus in MDC cities is due to higher car ownership as well as the existence of rail systems in the larger cities. It does not seem likely that developments of urban railways or growth in car ownership in LDC cities by the end of the century would reduce bus trip rates and the one and a half billion who live in LDC cities will be making a billion bus journeys each day. In MDC cities a further small fall in bus journey rates is to be expected and their three quarters of a billion occupants are unlikely to make more than four hundred million bus trips daily. To do these jobs will require a fleet of about one and a half million buses, probably with a larger proportion of high capacity vehicles (articulated and double decked).

4.4 Intermediate Public Transport and Taxis

Perhaps the most colourful and varied forms of public transport are the collection of modes ranging from the rickshaw to the lorry-bus which can be roughly classed as intermediate public transport but for the sake of brevity are referred to as 'jitney types' in this paper. These are to be found mainly in cities in southern Asia and South America. They are invariably operated by private enterprise, use small vehicles and do not operate in the fixed stop/ set route manner of conventional bus services. However they generally stop short of giving the quick personalised point to point service of taxis.

Inevitably the statistics on these non-institutionalised and sometimes illegal forms of transport are more incomplete and suspect that for conventional operations. It appears that there are presently between 50 and 100 such systems operating and these vary in technology from a small cart pulled by a man or a dray animal up to a comfortable saloon motor-vehicle with a capacity of twenty passengers or so. Their operating style ranges from individual hire hail stop, variable route with a negotiable fare through to multiple user, fixed route with fixed fares. The term 'jitney' is derived from a particular kind of fixed route shared taxi operation to be found in the mid-west of the United States in the late 1920s and early 1930s for which a fixed fare of five cents (or in the vernacular - a 'jitney') was charged.

Where cities have predominantly jitney type public transport (e.g. Chiang Mai and Manila) the provision of vehicles lies usually in a range of one for every 150 to 200 people in cities with populations below a million to one for every 250 to 300 people in larger cities. Where cities have mixed bus/jitney regimes the figures are correspondingly lower. The average carryings of these vehicles is of the order of one hundred passengers per day. Given that the city population primarily served by these systems is of the order of one hundred million there must be about half a million units carrying of the order of fifty million journeys daily.

The future of jitney type systems is a rather speculative matter. On the one hand growing traffic congestion, rising labour costs, protection of conventional bus revenues and a general trend towards regulation often associated with economic development will encourage decline. On the other the special quality of service they provide, their emplyment creation and the entrepreneurial environment of the cities in which they currently thrive are all forces for expansion. On balance it appears that the more primitive systems will go into decline and it does not seem likely that this will be more than offset by growth of the more modern end of the range and that fleet size will not be much greater than today's but carryings will grow somewhat.

Beyond the premium service end of the jitney range is the conventional taxi which is perhaps the most widespread form of public transport. Although taxi transportation is never to be found in quantity like the conventional public transport systems of large cities it exists in almost all kinds of urban area, rich or poor, small or large, laissez faire or authoritarian. In cities the level of provision ranges from about one per five hundred people in large cities to about one per two thousand people in small cities and does not appear to vary consistently between cities in more and less developed countries. This shows that there must be over a million taxis in the world's cities and that this is likely to double to two million by the end of the century. Good data on taxi carryings are hard to come by but typically individual hire taxis appear to carry of the order of 40 journeys per day. It seems therefore that the present level of city taxi use of 40m journeys/day could double by the end of the century.

Limousine and private hire car operations vary widely in scale between different cities, let alone different city types. In some (e.g. London) they are of a similar or even greater scale than conventional taxi operations whereas in others they are non-existent. The general scale of such operations does not appear to be reliably documented anywhere but is probably, overall, less than that of taxis.

4.5 Cars and Motorcycles

In many cities the most ubiquitous motor vehicle is the car; there are about 310m cars in the world today. The distribution of these however is very uneven ranging from one for every two people in the USA to one for every twenty thousand people in the People's Republic of China. Figure 8 shows the growth in the number of cars in different parts of the world since 1950 and where present trends, projected through to the end of the century would lead. This naive projection would give a total of 530m cars at the end of the century but it is not likely that present growth rates will continue to prevail over such a long period. In the United States for example, ownership rates have saturated in some areas and in other countries population and economic growth will mean faster increases in the number of cars than have been experienced over recent years. Figure 9 shows how motor vehicle ownership rates have fallen over the last sixty years and suggests a saturation level of about one vehicle (including commercial motor vehicles) for every ten people. This would give a total world vehicle fleet of 620m in 2000 AD of which 500m or so would be cars.

In order to obtain a less crude view of the likely car population in the year 2000 AD a simple relationship was constructed between ownership rates and GDP/capita. This was of the form

$$x = \frac{a}{y^b} \qquad \text{where } x = \text{people/car} \quad \text{and } y = \text{GDP/capita}$$

This relationship is shown in Figure 10 and is a plot of 1975 car ownership levels against 1978 income; a three year lag giving a better relationship than using car ownership and income data for the same year. Individual values of 'a' and 'b' were derived for each world region and used to forecast car ownership rates for each of the main 150 countries for 2000 AD. The forecast GNP/capita growth between 1980 and 2000 was then used to calculate the shift in car ownership rates by country over that twenty year period. A saturation value of 1.9 person/car was used and the elasticity to income reduced as the ownership rate approached this value. The process gave the regional totals which are set out in Table 6.

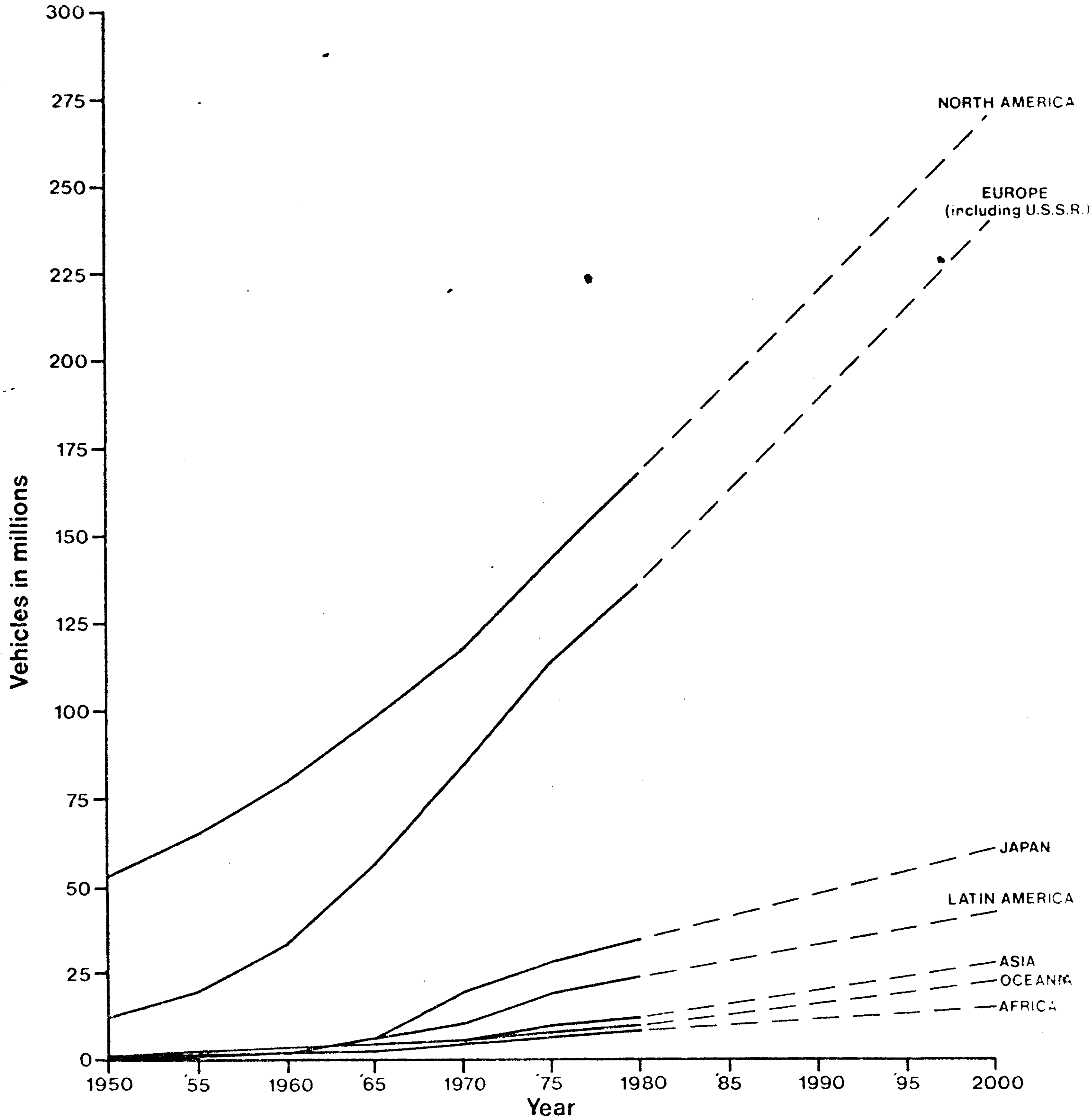


Figure 8 Vehicle Ownership Trends by Region 1950–1980

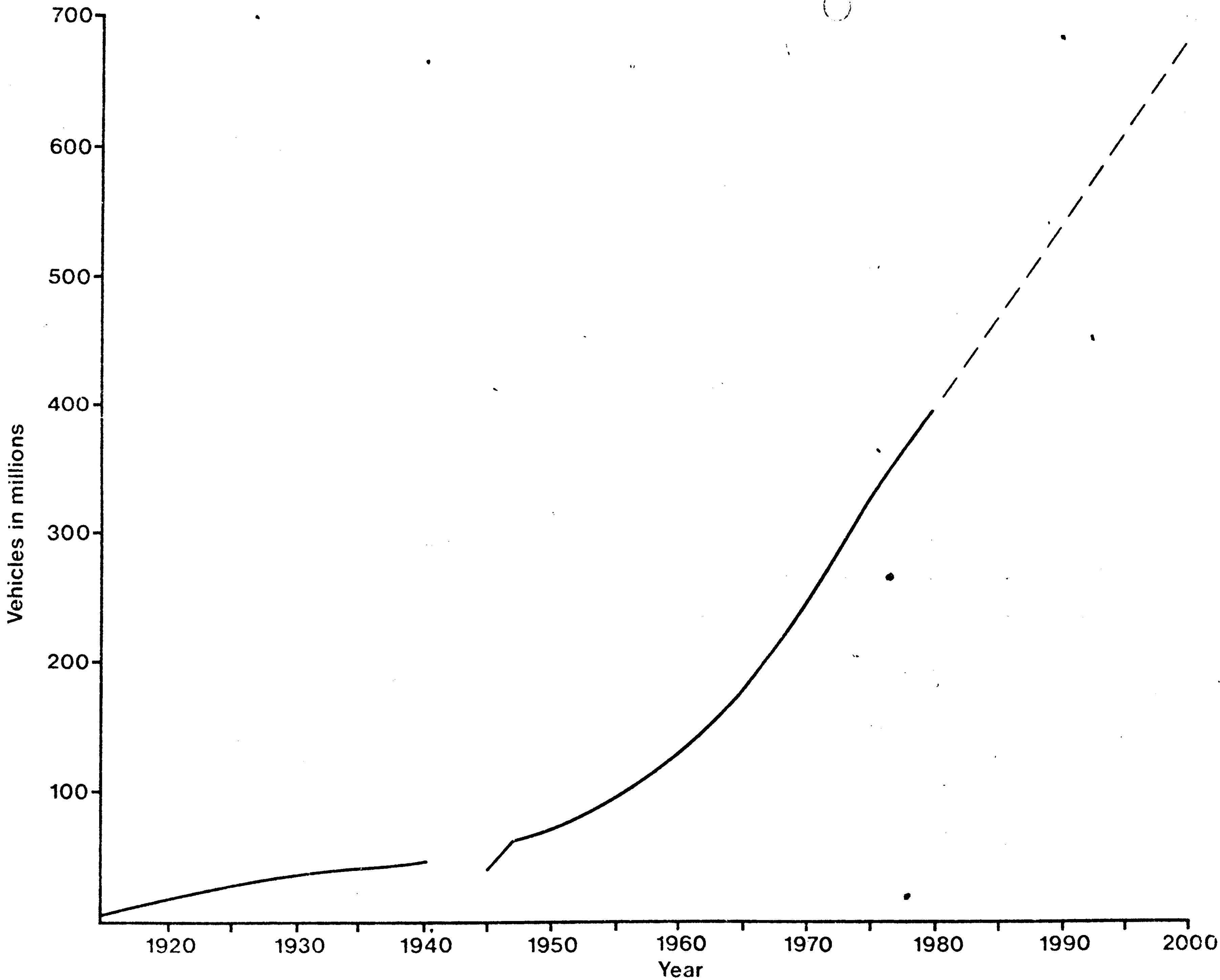


Figure World Vehicle Ownership Trends 1915 – 1980

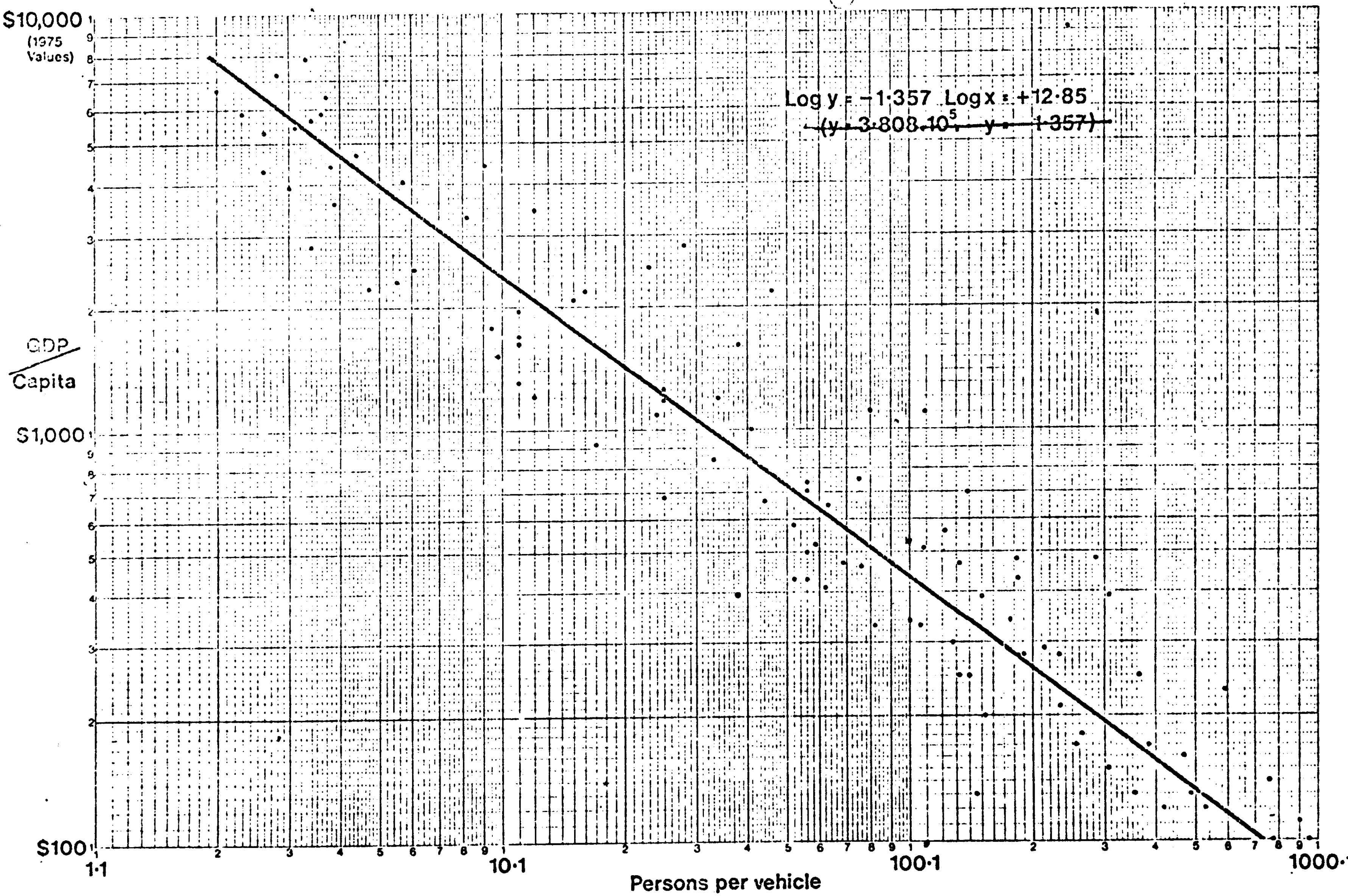


Figure 10 National Car Ownership Rates Related to Per Capita GDP

TABLE 6 - Regional Car Ownership Rates and Totals for 1980 and 2000

Region	Cars (1980)	People/Car (1980)	Cars (2000)	People/Car (2000)
Africa	5.5m	76.0	17.5m	47.0
Asia	29.0m	81.0	72.8m	49.0
Latin America	18.5m	19.0	58.5m	10.6
North America	133.0m	1.9	155.0m	1.9
Europe and S.U.	117.0m	6.3	202.0m	3.4
Oceania	7.0m	3.0	12.2m	2.0
World	310.0	13.8	518.0m	12.1

The economic growth assumed in making these forecasts is set out in Table 7. These are based on World Bank estimates up to 1990.

A comparison of the forecasts for individual countries and groups of countries with more authoritative estimates indicates that they are, on average, a little lower.

Within these regional totals there are wide national variations; generally the lower the average regional rate the wider the variation. Three particular national figures deserve special mention. The ownership rate for the People's Republic of China of one car to every eight thousand people gives a national car fleet total of 150,000. Whilst this is consistent with the assumed growth in the economy clearly a change in attitudes to cars could allow this figure to be larger. If the mixed economy ownership rate is applied to the forecast GNP there would be three and a quarter million cars. To a lesser extent the same applies to the USSR with a forecast of 26.3m cars against a mixed economy equivalent of twice this figure. Thirdly the Asian total includes a figure of 45.8m for Japan leaving 27m for the 2.3 bn people (excluding the People's Republic of China). Thus for most of Asia the car ownership rate averages one car to 85 people.

Cars, of course, are not the only form of personalised motor transport in cities. Indeed in some less developed countries motorcycles outnumber cars; notable examples being Taiwan, Malaysia and Thailand. These variations are reflected in the regional ratios given in Table 8.

If the motor cycle population were to grow at the same rate as the world's car fleet there would be 93m by 2000 AD. However as car ownership rises the relative size of the motor cycle fleet falls and accordingly a figure in the vicinity of 75m seems more realistic. Because of their lower carrying capacity it seems therefore that motor cycles will add about 10% to motor car carryings ranging from scarcely any addition in North America to about a third in Asian countries.

Region	Annual Rate	Growth (1980 - 2000)
OIL IMPORTING DEVELOPING COUNTRIES		
<u>Low Income</u>		
Africa (Sub Sahara)	0.4	5
Asia	1.5	39
<u>Middle Income</u>		
East Asia & Pacific	4.0	137
Latin America & Caribbean	2.5	72
North Africa	0.6	14
Middle East	0.6	14
Africa (Sub Sahara)	1.3	32
Southern Europe	2.2	61
OIL EXPORTING DEVELOPING COUNTRIES		
Capital Surplus	2.5	72
Others	3.0	92
INDUSTRIALISED COUNTRIES		
Mixed Economy	2.5	72
CENTRALLY PLANNED COUNTRIES		
All	3.3	104

<u>TABLE 7</u> - <u>Economic Growth Assumptions 1978-2000</u> (GNP/Capita)

TABLE 8 - Estimate of the Number of Motor Cycles (Based on a Sample of 60 Countries)

Region	Number of Cars (1980)	Ratio of Motorcycles/Cars (1975-1980)	Estimated number of Motorcycles
Africa	5.5m	0.15	0.83m
Asia	29.0m	0.63	18.27m
Latin America	18.5m	0.23	4.3m
North America	133.0m	0.04	5.32m
Europe	110.0m	0.21	23.1m
U.S.S.R.	7.0m	0.50	3.5m
Oceania	7.0m	0.06	0.42m
World	310.0m	0.18	55.74m

The projections of car ownership take no explicit account of such factors as energy costs, road congestion and government policies on car ownership and use. With current depletion rates world oil supplies are forecast to last from 20 to 100 years and whilst in reality a smooth transition from the oil energy era to its successor will mean complete exhaustion never takes place there will clearly be an increase in oil prices for both technological and market reasons. On the other hand there are likely to be improvements in vehicle fuel consumption and substitution of new fuels for oil in a growing number of applications. Overall the growth of the world's car fleet by two thirds by the end of the century does not seem implausible on energy grounds although what might happen in the subsequent quarter century unless there is substantial oil reduction of new fuel systems is much more worrying.

National policies towards the ownership and use of cars are often ambivalent recognising its unsocial features on the one hand and on the other its appeal, tax creation and, in car producing countries, the economic and employment aspects. There are no signs in most countries of central governments wishing to go further than making the best of growing car ownership. 'Best' in terms of reducing environmental safety and energy impacts and trying to cope with urban traffic congestion.

The growth of traffic congestion depends on the provision and management of road space, general transport and planning policies as well as the growth of car ownership and use. Almost by definition less developed countries have less developed road systems and it is important to consider whether these can be improved and extended to keep up with the growth of motorised road vehicles.

Good data on urban road provision are hard to come by. Some exist on a national basis and these point to wide disparities in the level of provision between different countries. Ignoring unpaved roads as being usually of little relevance to heavy traffic duty in urban areas this variation in the provision of road space is illustrated in Table 9.

TABLE 9 - Estimate of Current Paved Road Provision by Region

Region	Length of Paved Roads (000s of kilometres)	People/Kilometres
Africa	250	1,720
Asia	859	2,630
Japan	480	240
Latin America	350	940
North America	5,840	42
Europe	3,000	245
U.S.S.R.	600	433
Oceania	500	42
World	11,870	346

This suggests that economic growth is strongly associated with the development of the traffic road network. To test this more thoroughly a series of regressions were carried with paved road provision as the dependent variable and, country area, population, GNP/capita and urbanisation as the independent variable. Whilst it is not possible to draw hard conclusions from these they showed that:-

i) the length of paved roads correlates positively with population;

ii) the length of paved roads correlates positively with urbanisation;

iii) the length of paved roads correlates positively with economic development;

iv) land area correlates weakly and inconsistently with the length of paved roads;

v) urbanisation accounts for much of the effect of economic development and paved roads provision and also, in part, for the effects of population.

The analyses were carried out using data from 102 countries together and grouped in regional subsets to see the extent to which population and economic growth, on the basis of these relationships, suggested growth in the length of paved roads. In low income countries this gave a growth in paved roads of 1 km to every 15 additional cars (present worldwide ratio is one to every 26 cars). In middle income countries where population correlates most strongly with road provision it seems that road systems could grow slightly faster than the vehicle fleet. In industrialised countries GNP seems to determine road provision most strongly and this should mean that national road systems should grow roughly in step with vehicular growth.

This form of analysis does not, of course, prove that urban road systems will be expanded in line with traffic growth. What it does do is suggest that there is no obvious reason to expect a change in kind in the pattern of urban traffic growth and the congestion it causes if the sort of policies applied in the more highly motorised cities are applied in those with developing motorisation.

An important factor in this respect is the extent to which the growth in the car fleet will take place in cities. This will be determined by the extent to which city car ownership levels reflect national levels and the extent to which people will live in cities. The second of these two factors is dealt with in Section 2. The first needs further consideration. There is some evidence that city car ownership is higher than average in countries where car ownership levels are low and, to a lesser extent, that city car ownership levels are lower than average in high ownership countries. There is also some evidence to suggest that these effects are more marked the larger the city.

In order to test these hypothesis data on city size, city car ownership and national car ownership were analysed for 430 cities with populations over 100,000. This showed:-

i) Where national car ownership is low city car ownership is relatively high - where national ownership is less than 1 car to 10 people city car ownership is likely to be at least three times as high. Where the ratio is 1:5 or higher the rates are similar;

ii) Where national car ownership rates are high (i.e. 1 car to 10 people or higher) car ownership rates in large cities (i.e. over 3 million population) are lower; however

iii) The difference between national and city car ownership is not simply dependent on city size. It appears that urban density and the position of the city in the urban hierarchy are as important as population numbers in this respect.

The ratios of city to national car ownership rates for different city types are given in Table 10.

TABLE 10 - Ratio of City/National Car Ownership Ratios for Different Types of Cities

City Size \ Car Ownership Level	<10%	10% - 40%	40%+
0.1m to 0.5m	4.1	0.93	1.02
0.5m to 3.0m	3.7	0.86	0.98
3.0m +	5.1	0.54	0.89

In estimating the number of cars in cities this suggests that where car ownership exceeds 1 car to 10 people there is a weak but consistent effect of city size on relative ownership rates and that the disproportionately high city car ownership in low car owning countries disappears as ownership rates approach 10%.

Putting these factors together it is possible to produce an estimate of the numbers of cars in different city types. The results of this estimate are shown in Figure 11. Overall this gives a total of 310m cars in cities (i.e. 60% of the world figure) compared with today's city car population of 165m. Of the 145m additional cars in cities most growth is expected in Europe (50m), the second division is occupied by North America, Latin America and Asia (about 25m each). Growth in the Soviet Union and Africa will be about 10m and in Oceania 5m. Proportionate growth however is another matter with Africa heading the list with a factor of five; Asia, Latin America and the Soviet Union grouped around 3.5 and Europe and North America less than 2 (1.8 and 1.3 respectively). Looking more closely at individual city types the higher growth rates are likely in all three size ranges for African cities; the two largest for Soviet cities and the largest for Latin American cities.

These car ownership rates do not provide an accurate reflection of relative traffic levels as cars are used more intensively in less developed countries. On average cars cover about 25,000 kms per annum in developed countries but about 50,000 kms per annum in developing countries. The corollary of this is that as car ownership levels rise towards those of developed countries car usage is likely to fall and therefore traffic growth in developing countries will be less than car ownership growth at this stage.

5. THE OVERALL PICTURE

If the different estimates of the growth in the different forms of urban transport are put together what sort of pattern emerges? Other than by walking and on pedal cycles today's twelve hundred million city dwellers make about two billion journeys each day mostly by road. In developed

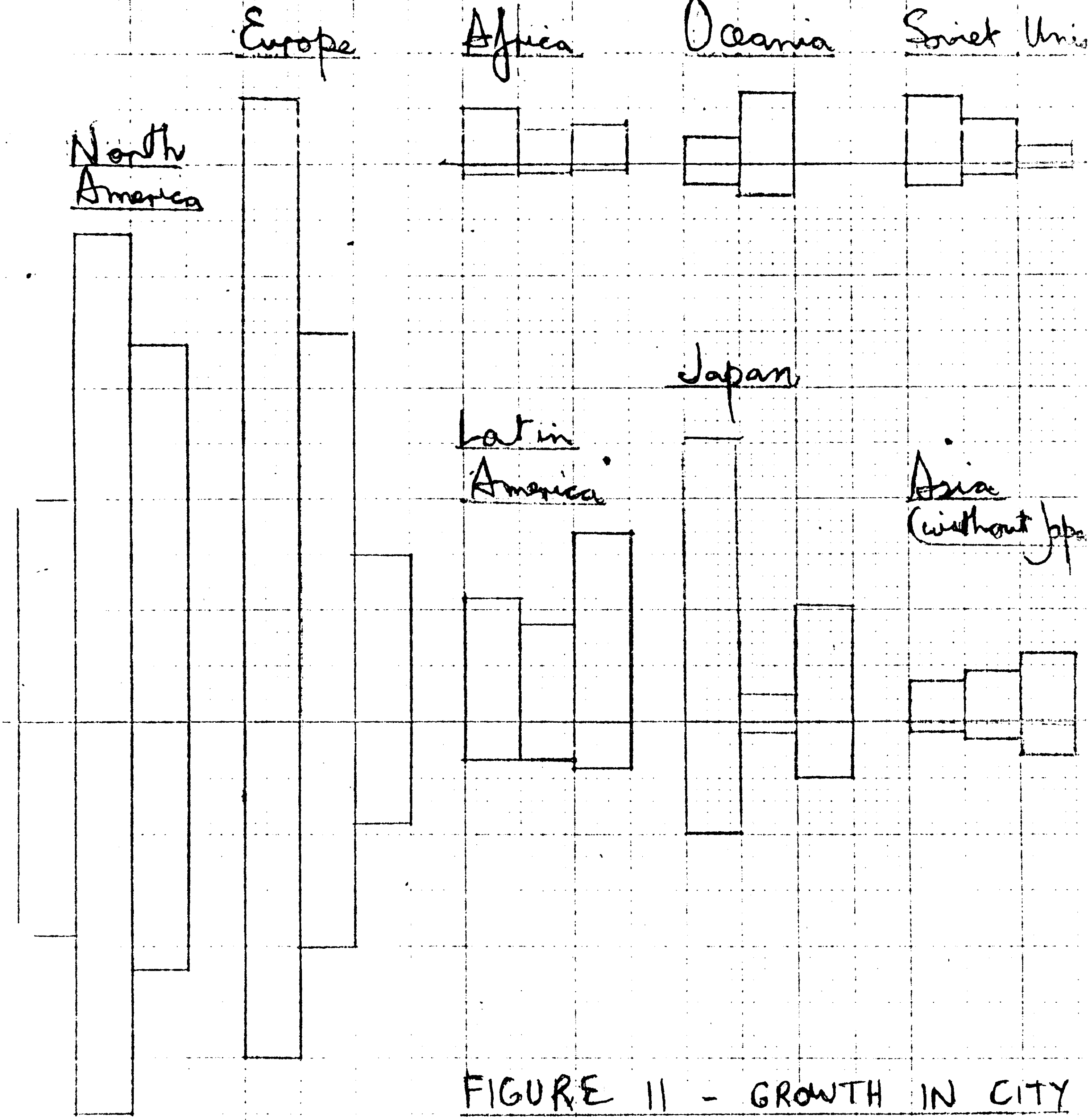
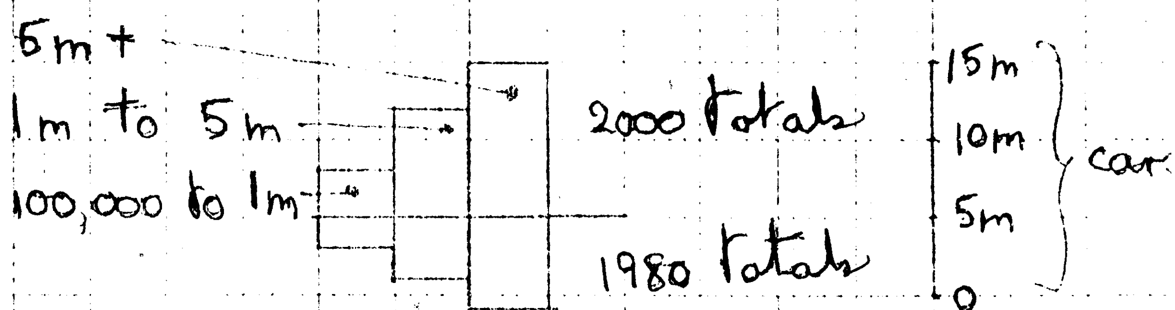


FIGURE 11 - GROWTH IN CITY CAR POPULATIONS 1980 - 2000



countries the private car is the dominant mode, in developing countries it is the bus. By the end of the century the number of city dwellers is expected to grow to twenty two hundred million and the number of motorised journeys to three point eight billion. Of the extra 1.8 bn city journeys about 1 bn will be by car and motorcycle and 0.6m by bus.

Although the bulk of the growth in the city and travel market will be by car and bus these will not have the highest growth rates. Metro carryings are expected to more than double making metro, taxi and car the fastest growing modes. The growth in modal usage for different city types is shown in Figure 12. Walking and cycling are not shown although in terms of numbers of journeys these will outnumber the most used motorised mode - the private car.

Whereas 60% of city travel is in MDC cities this is expected to fall to less than 50% by the end of the century although there will be an absolute growth of 45%. This is because growth in LDC cities will be by a factor of 2½; this figure being over 3 for LDC cities in the 5m+ size range. The large cities in Asia and South America are likely to be the most important factors in this aspect of the change in balance.

Rail though important in some cities and especially in busy radial corridors will continue to make a relatively small contribution, in volume terms, to meeting urban travel demand - about 5% in journeys and possibly double that in passenger mileage. The most dramatic change in the urban rail scene is likely to be the fivefold increase in metro usage in the very large LDC cities; typically by very intensive usage of relatively short networks of two or three inner lines.

The use of buses in more developed cities seems likely to be lower than population growth yet will still lead to a modest increase in usage in each of the three size ranges because of city growth. In LDC cities the picture is of very substantial growth with buses' market share falling from 56% to 50% despite increased car usage and metro building in the largest cities. Whereas usage in all LDC cities is expected to grow by a factor of 2.2 for the upper city size range a higher figure of 2.8 is more likely.

Quite how intermediate public transport operations will fare is much more speculative but urban traffic congestion and the progressive institutionalisation of public transport will probably limit the growth of these. The main features of change may well be the replacement of the more primitive forms of para-transit by more sophisticated systems. Taxi services on the other hand seem likely to continue to thrive as they are well used in almost all kinds of cities.

The use of cars is likely to be the most notable change in the city transport scene - that is mainly in cities in the developing countries with a 3½ fold increase in car traffic. Again the super-cities experience greatest growth. This sort of growth was seen in industrialised cities in the two decades following the Second World War and there are many lessons to be learnt from that experience for Third World cities.

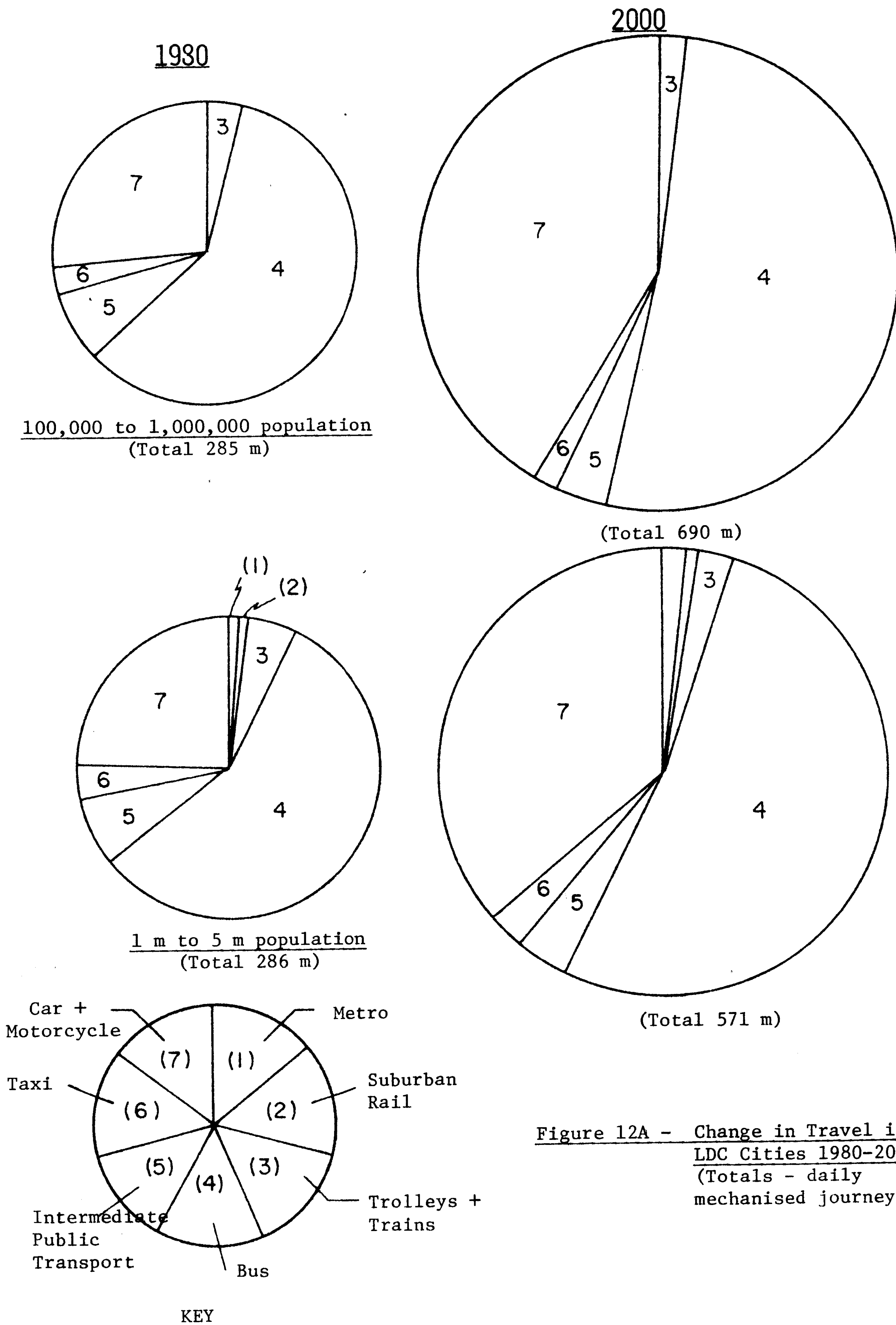
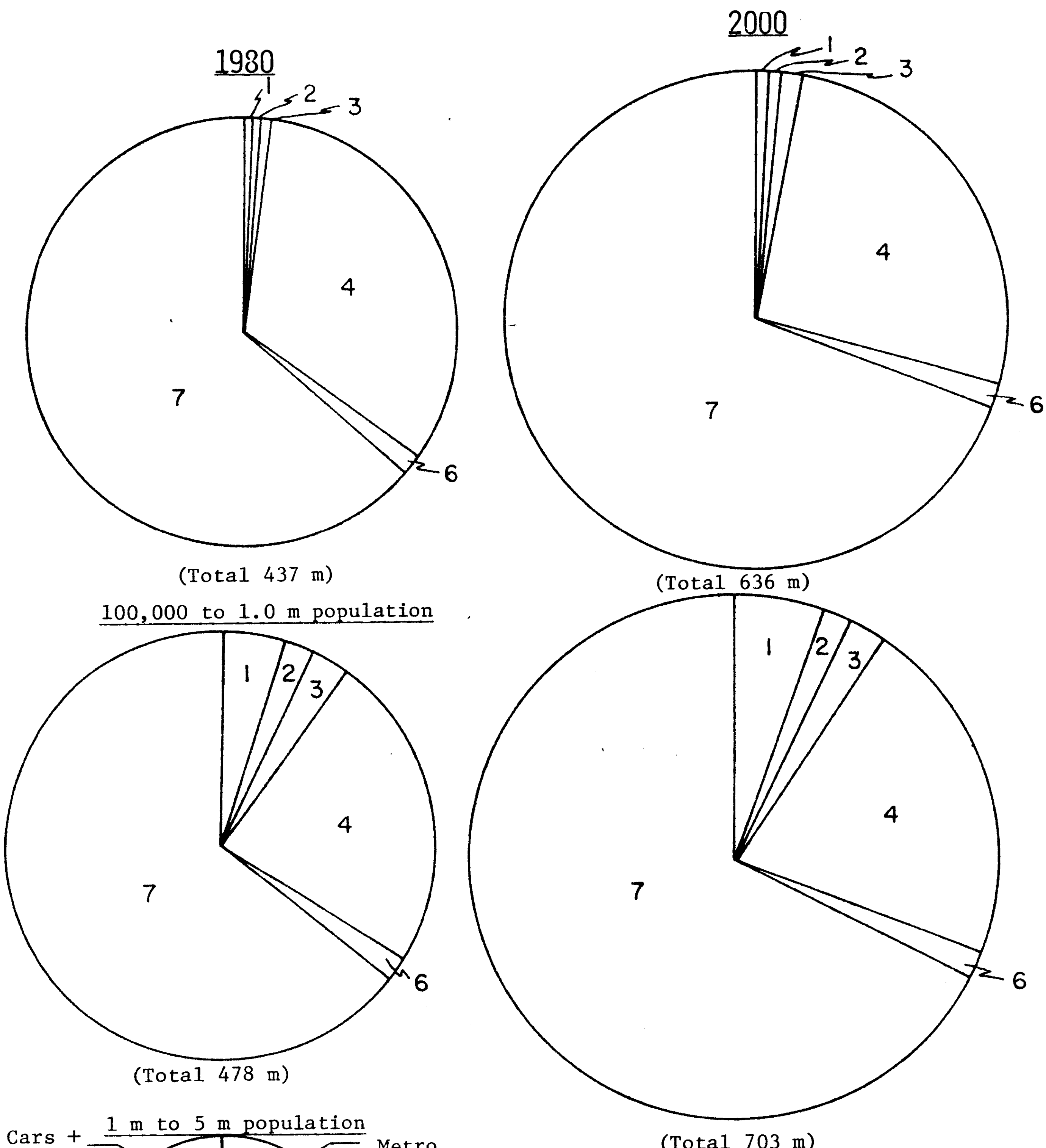


Figure 12A - Change in Travel in LDC Cities 1980-2000 A.D.
(Totals - daily mechanised journeys)



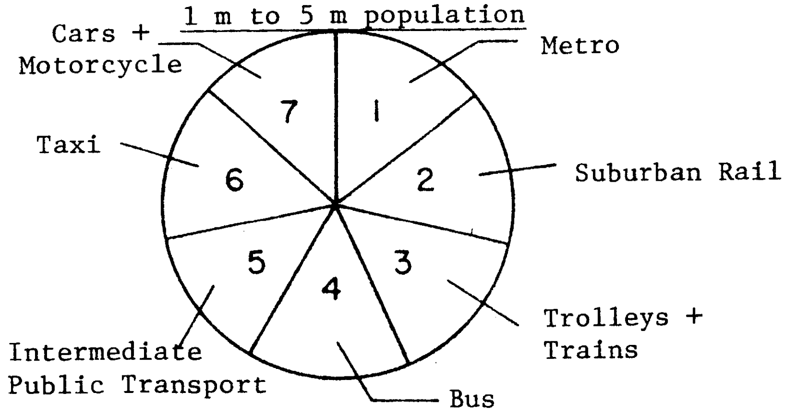


Figure 12B - Change in Travel in in MDC Cities 1980-2000 A.D.
(Totals - daily mechanised journeys)

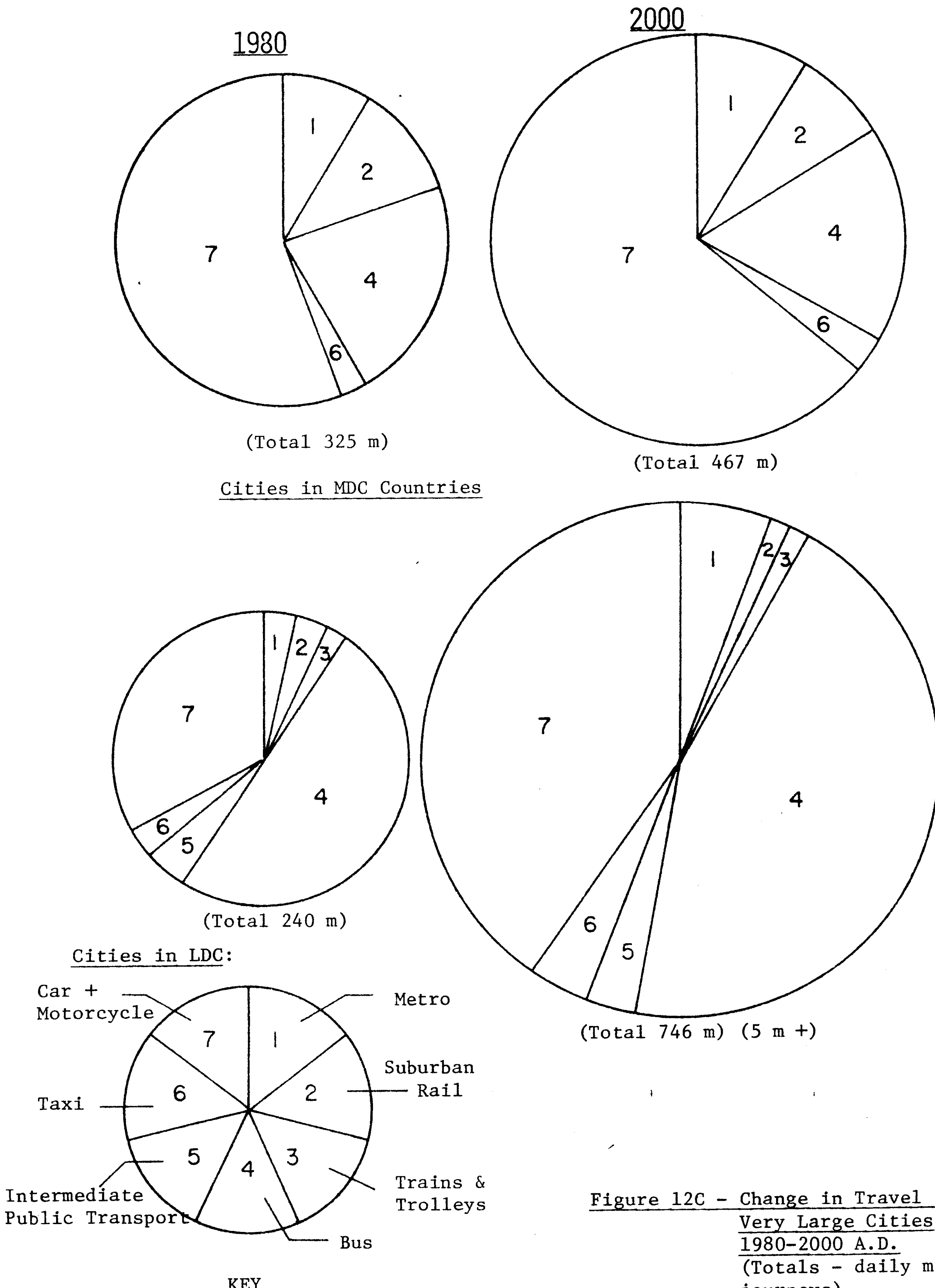


Figure 12C - Change in Travel in Very Large Cities 1980-2000 A.D.
(Totals - daily mechanised journeys)

6. SOME CONCLUSIONS AND ISSUES

It seems inevitable that there will be a large growth in the number and size of cities over the next twenty years. The trends are already well established and, it seems, could only be altered by a major event such as global or near global war. On the most authoratative forecasts in 2000 AD there will be a billion more people living in cities with populations greater than 100,000 than there are today. With over 80% of this growth expected to take place in Third World cities there will be urban growing pains of an order formerly only seen in the explosive urbanisation at the take-off of the industrial revolution. However the scale will be greater and the associated economic growth often less. This last feature is particularly disturbing as many Third World cities have poor infrastructures and massive injections of resources are needed if they are to cope reasonably with this growth. Growth will generally be much steadier in cities in the developed world and with their richer infrastructure and greater wealth the problems of urbanisation rather less.

The desirability of the expected urbanisation in the Third World must be seriously questioned. Is its close association with economic growth inevitable? Is there an economic growth option without rapid urbanisation? We have seen attempts, for example in the People's Republic of China, to industrialise smaller communities outside the cities. So far these have not been particularly successful but perhaps they could be. Even if there is an economic growth scenario for the Third World, with less rapid urbanisation is it politically feasible in those which are not authoritarian for either idealogical, administrative or other reasons? There seems little prospect of major control of the urbanisation process in most Third World countries over the rest of this century by which time the die may well be cast.

If this prospect of urbanisation does materialise there is going to be a large growth in travel in cities - the number of passenger journeys by motorised transport almost doubling by the end of the century. Expected modal growth factors are given in Table 11.

TABLE 11 - Growth in Modal Usage 1980-2000

Mode	LDC Cities	MDC Cities	All Cities
Car & Motorcycle	3.4	1.6	2.0
Metro	5.1	1.5	2.1
Taxi	2.5	1.4	2.0
Bus	2.2	1.2	1.8
Intermediate P.T.	1.2	N/A	1.2
Suburban Rail	1.2	1.1	1.1
Tram and Trolley	1.0	1.0	1.0
All	2.5	1.5	1.9

This table excludes non-motorised transport which will continue to be of major importance in all cities, especially in cities in developing countries where they are likely to make up about half total journeys at the end of the century. The relative growth of world usage is similar for both city types with the exception of metros. This is because of the currently very limited provision of metros in LDC cities today.

The doubling in the use of cars and motorcycles raises the question of fuel availability. It seems that the world's oil reserves are such that it would be possible to provide the 200m gallons of spirit needed each day for this level of car use if savings in other sectors are made. However whether urban car use should get this priority is another question. Moreover whereas this level of car use may be sustainable at the end of the century a further twenty years on the situation may be quite different. If oil availability started to contract sharply in the 21st Century it would make petrol based urban transport, especially in the Third World, very vulnerable. Because of the close association of urbanisation and economic growth the consequent economic damage could be very extensive. This risk points to the wisdom of controlling the next twenty years of growth of Third World cities to limit their dependence on car use. This means 'public transport plus walk' oriented urban structures. Whilst the advantages of increased private motor transport should be recognised usage strategies should be introduced, whilst cars are still in limited numbers in LDC cities, to avoid their use for journeys where public transport can do a reasonable job. One of the most important lessons from the industrialised world is that controlling car use in large cities is necessary but very difficult to achieve once 'free' car use is well established.

Both the energy and environmental problems of the use of cars in cities could be reduced if cars could be equipped with different motive systems (e.g. electric cars). Given present technology electric and hybrid vehicles suffer from range and performance disadvantages when compared with the modern internal combustion engined cars. However where high performance car use is low and the economic advantages of limiting oil consumption are very high, both of which conditions apply in many developing countries, the appropriateness of electric and hybrid cars is that much greater. Paradoxically the technological and manufacturing resources required to provide such vehicles lie in the industrialised world which seems very reluctant to give up the high performance long range petrol or diesel engined vehicle.

Success in controlling the growth in the use of cars will, in part, depend on the quality of public transport services. These vary widely in cities in developing countries but are often poor. Improved administrative frameworks and more resources are usually needed and will be needed in Third World cities even more. Lessons from industrialised cities show that free market conditions are unlikely to provide an adequate basis for urban public transport fulfilling its proper role in the face of rising car ownership. They also show that whereas some intervention is needed it is all too easy to go too far and thereby stifle enterprise and flexibility. The kind of entrepreneurial style seen in intermediate public transport operations in Asian and Latin American cities must be encouraged within broader policies for public transport. Whether this is capable of achievement in cities in the developed world is a moot point but the signs are not very encouraging.

Finally there is the matter of the quality of life in tomorrow's cities. Transport can affect this in many ways but perhaps most obviously in terms of accessibility and the direct impacts of transport operations and artifacts on the environment. With motorised trip rates expected to grow by about 10% in developed cities and 70% in cities in Third World countries over the next twenty years it seems that transport should contribute through increased mobility, to the quality of urban life provided the efficiency of the city structures is not allowed to markedly deteriorate.

It is not possible to be so sanguine about the impact of transport on the city environment; an environment which will be under pressure from other quarters. No large city has 'built' itself out of the traffic and environmental problem whether it has tried roads, railways or other means - even the world's richest cities. There is no prospect that the growing cities of the Third World could do so even if it were desirable. New infrastructure is essential if the world's cities are to prosper or, in some cases, just survive. However with half the world's population living on one tenth of one per cent of its surface area at the end of the century there must be clear codes and disciplines for behaviour in many activities and certainly in the transport sector.

The industrialised countries have learnt the hard way that the privilege of a few can become the burden of the many and this can be true in respect of cars in cities if proper control is not exercised over their use. The Third World countries should learn from this experience. The Brandt Report argued that the problems of urbanisation in the Third World would inevitably become desperate and could only be solved by massive aid from the industrialised world. With the industrialised world busy struggling with its own problems it seems unlikely that an increase in aid in step with the growth in Third World urban problems will occur. Even with massive resources developed cities have not 'solved' their transport problems and the one thing that can be forecast with confidence is that the cities of the Third World will not be able to 'solve' their transport problems in the next two decades. In coping with them however increased development resources will be of only so much help. Much improved institutional arrangements, a willingness to plan city growth and manage the urban transport systems have probably as much to offer as infrastructure development but all three approaches together have disproportionately more to offer than each or any of these individually.

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