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MOBILITY, ENERGY AND EMISSIONS IN CUBA AND FLORIDA

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Abstract

In many ways the island nation of Cuba and the State of Florida are remarkably similar. Both comprise similar area and similar sized populations, and until 45 years ago both were linked much more strongly than today. However despite being physically close, in economic and political terms the island nation of Cuba and the State of Florida are worlds apart. Overall, while Florida has grown ever stronger economically since this time, economic growth in Cuba has been far more constrained due to external pressures – most notably the economic blockade by the United States and the collapse of the Soviet Block. This paper devises a range of indicators for both territories to explore how mobility, energy use and emissions might be influenced by socio-economic conditions. Specifically, it compares and contrasts how transport policies have developed in an environment with virtually no economic constraints (Florida), and a situation where strong constraints were in place (Cuba).

Keywords: Cuba, Florida, mobility, emissions, energy use, transport policy, economic effects

Introduction

In broad geographic terms, the island nation of Cuba and the State of Florida are remarkably similar (see Table 1).

Insert Table 1 here

They have similar areas and have comparable populations, and until 45 years ago both were very strongly linked culturally, politically, economically and historically. Although they may be geographically close, in economic and political terms the island nation of Cuba and the State of Florida are 'worlds apart'. The United States and Cuba have existed with a minimum of interaction and while Florida has grown ever stronger economically since this time, economic growth in Cuba has been far more constrained due to severe external pressures. The economic blockade by the United States and the collapse of the Soviet Block during the early 1990s (see for example Jatar-Huasman (1999), Diaz-Briquets et. al. (1995) has led to severe curtailment of mobility for many Cubans.

The aim of this paper is to explore how contextual factors influence transport policies (and hence transport systems) over time. Therefore, two very different case studies were conducted: one of the Caribbean island nation of Cuba (Enoch et. al., 2004), and one of the State of Florida. There are two reasons why a comparison of Cuba and Florida may be of interest. First, is the fact that Cuba was so intrinsically linked to the United States (and Florida in particular) prior to the 1959 Revolution, and is likely to be so again, if Cuba should be free of economic restrictions. There is evidence for Cuba following a US-vehicle ownership growth curve from the early 1940's until the late 1950's (when data on car ownership ceased to be systematically collected). Specifically between 1943 and 1957, car ownership levels increased from 40,481 to 225,715 corresponding to ~ 9 to 33 vehicles/1000 people (Oficina Nacional de Estadísticas, 1952 and 1957). This amounts to nearly a 6-fold increase in ownership over a 14 year period during which population grew by approximately 40%. A similar growth profile was experienced across the United States from the year 1900 to 1915 (Davis et. al, 2003). Florida offers at least one transport scenario that Cuba may well have followed if circumstances had been different. Second, given the high price of oil at the time of writing due to a whole range of issues including supply problems and security concerns coupled with increased demand, it may well be that the Cuban experience has some relevance for the Floridian economy in the near future.

Transport in Cuba

Cuba is unique because for the past forty years it has been subjected to an economic blockade by its erstwhile dominant trading partner, the United States. This economic pressure was exacerbated in the early 1990s with the political and economic collapse of the Former Soviet Union, and the Eastern European Socialist countries which had replaced the United States from the 1950s as Cuba's principal trading partners. The impact of the post-Soviet State of Emergency meant that Cuban imports as a whole fell by 75%, from 8.1bn Cuban Pesos in 1989 to 2.0bn Cuban Pesos in 1993, while over the same period in the transport sector, fuel imports were cut by 76%, and imports of transport equipment fell by 86%. These events transformed how goods and people are moved, due to a huge reduction in the amount of hard currency available to pay for fuel, vehicles and spare parts. This resulted in a number of innovative behavioural and technological outcomes. Enoch et. al. (2004) and Jaffe and Soligo (2000) give examples of how the fuel crisis affected the industrial, residential and transport sectors, and in particular the previous transport review of Cuba illustrated–

- A strong shift towards walking, cycling and public buses
- A re-organisation of bus routes and bus systems in order to maximise efficiency of route and increase patronage (within the capital Havana)
- A conscious social effort to decrease any trips that were considered unnecessary or unwarranted as well as the proactive provision of collective taxis, organised 'hitch-hiking' and an acceptance of higher occupancy in all modes along with fuel rationing
- A re-emergence of the use of animal traction within both agricultural and local transport arenas especially in the regions outside of the capital
- Employers, in some cases, provide transport for their employees in the form of 'enterprise buses' accounting for ~10% of trips in Havana in 1998.

Capital expenditure towards infrastructure and repairs within the road, rail, and marine/port networks has been severely curtailed due to the blockade. Previous work (Enoch et. al., 2004) showed mobility (of all motorised trips for a typical citizen) had dropped from an average of nearly 3,000 km/year in the mid-1980's to less than 800 km/year in 2000-2001. These figures translate to a value in millions of passenger trips of 3.6 billion per annum at the peak in 1986 (or around 10m a trips a day for a population of 11.2m) dropping to 0.5m trips in 1995, but increasing again to 0.8m five years later. Despite the problems however, Cuba has continued to have mobility levels not dissimilar to other Latin American countries. Cuba continues to show positive growth in many areas including tourism, biotechnology, health care, literacy, and other fields which place the human development as key quality of life criteria (Jaffe and Soglio, 2000). The findings demonstrate that Cuba also uses more energy than most other countries to produce an increase in GDP, which may be due in part to the relatively high inefficiencies in industrial and transport equipment.

Transport in Florida

Given the strong US involvement in Cuba prior to 1959, if the revolution had not succeeded, then Cuban transport policy may well have developed as it did in Florida. Florida became a state in 1824, and grew steadily until the turn of the 20th Century, since when the population has taken off. For example, the population doubled from around 750,000 in 1910 to 1.47m twenty years later, while between 1950 and 1960 Florida grew from being the twentieth most populous state in 1950 (2.77m people), to tenth in 1960 with the fastest growing population in the country. Currently, Florida is soon to become the third most populous state, while its number of residents is projected to rise by a further 22% by 2015 to 18.5m people (Florida Department of Transportation, 2000; The Road Information Programme, 2000). When comparing Florida's population to that of the United States, Floridians have a higher median age (by 3.4 years) and the distribution of ages is skewed towards the older age distributions (Office of Policy Planning, Florida Department of Transportation and Center for Urban Transportation Research, 2003). Their study acknowledged that "Florida's age distribution today is similar to what the country's [USA] will be like in 20 to 30 years". Over the same period, the number of registered drivers is predicted to grow from 12.7m to 15.4m (The Road Information Programme, 2000). The State of Florida ranks fourth in total personal income, and has the fifth largest economy (in terms of Gross State Product) in the USA. Due to one-third of Florida's employment being in the relatively low-paid services sector, in terms of per capita income, the state ranks only twentieth nationally (Florida Department of Transportation, 2000).

In transport terms, as elsewhere in the United States, probably the key event occurred with the decision of the US Congress to fund the Interstate Highway System in 1956. In Florida, this contributed to fundamental changes in travel patterns – retail, residential and industrial development shifted to locations far from city centres. Public transport use and the rail sector declined, while road

freight, airline travel and car use rocketed. By the late 1960s, social and political changes resulted in the Florida Legislature declaring in 1967 that “pollution constitutes a menace to public health”, adding that “we must preserve, protect and improve the environment”. This led to the creation of a new multi-modal agency – the Florida Department of Transportation – from the State Road Board and seven other agencies. Further legislation followed throughout the 1970s dealing with a growing range of environmental issues, particularly relating to the 1973 energy crisis. This event led to a reduction in the speed limit to 55mph, the banning of petrol sales on the Florida Turnpike on Sundays, and more people sharing cars and using public transport. It also led to the adoption of an Action Plan by the FDOT, which effectively called for greater involvement of people and agencies in the decision making process and for an environmental impact assessment to be conducted for all transport projects.

Predictably, given the rapidly increasing population, there has been a significant increase in congestion problems as increased traffic levels have outstripped road capacity. Highway travel in Florida increased by 63% in the 15 years up to 2000, and is predicted to grow by another 35% by the year 2015. Rather more worryingly, three urban regions in Florida – Orlando, West Palm Beach and Jacksonville – rank 4th, 6th and 7th respectively in the US national rank of areas with the largest increase in vehicle travel during the years 1995-2000 (The Road Information Programme, 2000). As a result, there has been a renewed interest in transport alternatives – e.g. enhanced public transport, car pooling, and workplace transport demand management programmes – while planning functions have become more tightly regulated. For the future, investment in Florida’s transport system between 2001 and 2020 is planned to take up some \$US72bn (at 1998 prices), of which around half will be spent on increasing capacity (Florida Department of Transportation, 2000).

Cuban and Floridian Circumstances Compared

Altogether, Cuba boasts nearly 61,000km of roads compared with just over 194,000km in Florida. However, while 85% of public roads in the ‘Sunshine State’ are paved, about 40% of Cuban roads are not, and 54% are in urgent need of repair. It is noted that while there are roughly 19,500 km of in Florida’s road network, in Cuba only the 1,200 km Central Highway is similarly designated (Oficina Nacional de Estadísticas, 2001; Center for Urban Transportation Research, 2003).

The differences are still more noticeable when the number and type of vehicles are compared. In 2001 the Cuban vehicle fleet is estimated to comprise some 362,000 vehicles of which 173,000 are cars, 160,000 are trucks, and 29,000 are buses. In addition, there are 180,000 motorcycles and 115,000 tractors (Enoch et. al., 2004). The corresponding figures in Florida are 13,031,700 vehicles, made up of 12,452,200 cars, 513,200 trucks, and 66,300 buses; in addition there are almost 300,000 motorcycles, 217,000 recreational vehicles, and 559,300 mobile homes (Center for Urban Transportation Research, 2003). When translated into vehicles owned per resident, in 2001 there were 779 vehicles per 1000 population in Florida, while the Cuban figure of 31 vehicles per 1000 people is roughly the same as it was in 1957 (albeit for a population that has increased from 6.6m to 11.2m over the period). This is almost the vehicle ownership level experienced in the USA around the year 1915 (Davis et. al., 2003).

Insert Figure 1 here

Vehicle use figures are also substantially different. Perhaps the best way to illustrate this is to look at average total trip distances per person per year (see Figure 1). In Cuba in 2001 the average distance was only 750 km/yr, i.e. 23 times less than the 17,200 km/year figure for the ‘average Floridian’. This can be accounted for as follows. First, there are far less trips made by Cubans – 800 million in Cuba compared with 22.1 billion in Florida, which suggests that in Cuba there is a tendency by people to only make essential trips. It is likely there is considerable suppressed demand within Cuba. Second, trip lengths are only a third as long in Cuba as in Florida (5.7km compared to 15.1km). Third, average vehicle occupancy in Cuba is higher at 3.2 people per vehicle than Florida (1.2 people per vehicle). This data (in Figure 1) excludes the effects of tourists from outside of the region and residents who do not drive. One other mobility comparison is the share of public transport in the major urban areas in both territories (Havana, population 2.2m – public transport mode share 37.8% in 1998; Miami-Dade, population 2.3m – public transport share 2.7% in 1997). Moreover, walking and cycling trips made up 56.5% in Havana, while neither are noted in a range of publications for Miami-Dade or Florida as a whole (Alepez et. al., 2002; Center for Urban Transportation Research, 2003). There are significantly more road deaths and casualties in Florida than Cuba, though not as many as perhaps would be

expected given the discrepancy in vehicle miles travelled. More worrying, is that the number of Cuban road deaths is approximately one-third fewer than in Florida (1309 compared with 3013), an indication that these collisions are rather more serious than in Florida. The Cuban figure is taken from International Road Federation (2000) for the year 1997, while the Florida figure is for 2001 (from Center for Urban Transportation Research, 2003). In terms of deaths per distance travelled, in 1999 Florida had 1.3 deaths per 100 million vehicle km travelled whereas the value in Cuba was 155. In deaths per 100 million miles the values are 2.1 and 250 respectively.

Suggesting that such a disparity in mobility levels is entirely the result of economic restrictions is overly simplistic. Nevertheless GDP and mobility trends in both countries exhibit remarkably similar characteristics – the mobility ratio is approximately 23 times greater in Florida, whilst the GDP ratio is about 18 times greater (see Table 1 and Figure 1 for values). Care must be taken in which value is used for Cuba's GDP due the myriad of complex income values and the way GDP is calculated (figures for 2001 vary from \$1600 to \$2275 per capita) (Economist Intelligence Unit, 2002). This is due partly to the lack of internationally verified figures.

Given that transport energy use and emissions are strongly related to mobility levels, it is perhaps unsurprising that these indicators also illustrate large differences between the two territories. For example, the Cubans used 604,000 tonnes of transport fuel in 2001 (International Energy Agency, 2004), amounting to 45 litres per person which translates to roughly 0.5 tonnes of carbon dioxide generated per person from their transport activities. For Florida in 1999, the total tonnage of petrol used for transport for the same year was 23.6m, i.e. 1850 litres per person, or enough to produce around 5.1 tonnes of carbon dioxide per person (see Lindstrom, 2004; State Energy Data Report, 1999). The trends in Florida are similar to the trends at the national level, with similar increases in vehicle miles travelled for each vehicle type as the national US level. These total CO₂ and transport sector specific trends for both Cuba and Florida are depicted in Figure 2.

Insert Figure 2 here

It can be seen from Figure 2 that the amount of CO₂ generated per person in Florida is nearly six times greater than that of Cuba. The values for all sectors include carbon dioxide emitted from transport, industry and construction, and residential (electrical) in the case of Cuba, and for Florida are categorised as residential, commercial, industrial, transportation, and utilities. Data for bunker fuels was not available. When comparing the transport specific emissions Florida is some 31 times greater than that of Cuba. These values can also be expressed as percentage of total CO₂ derived from transport – for Cuba it is ~6% and for Florida it is ~33% - thus Florida is clearly spending more of its emissions budget towards transport. As with Florida's mobility values, this share of emissions is slightly higher than the national US average of 28% (Organisation for Economic Cooperation and Development and the International Energy Agency, 2001).

The difference in the levels of motorised mobility is reflected in fuel prices. The relatively high prices in Cuba are in part due to continued pressure on fuel supply systems there from all sectors, but also due to the fact that in most places fuel must be paid for in hard currency – this is a significant barrier for many Cubans (Jatar-Hausmann, 1999). This measure helps offset any inflation of the local currency to some extent and allows for further purchases to be backed by the foreign currency. Clearly, the availability and pricing of fuels make private transport out of reach for many Cubans but it also encourages high occupancy and a shift towards public transport modes. In the last two to five years the price of diesel and gasoline has risen considerably (Metschies, G P, 2003) with diesel sometimes being over \$2.00 per gallon and gasoline reaching nearly \$4/gallon. US prices have also recently risen with spot values of \$2.22/gallon (as a national average in November 2004) (Energy Information Agency, 2004).

Finally, Figure 2 shows the share of transport-generated carbon dioxide emissions as a proportion of total emissions for both Cuba and Florida over recent years, and illustrates the effect (Jaffe et. al., 2000) that the transport sector was squeezed more than any other as a result of the loss of subsidy by the Soviet Union combined with the effect of the US Economic Blockade. This implies that Cuba's transport supply is rather more elastic than other sectors, and that transport emissions (and by extension mobility and energy use) may well increase extremely quickly should the economic restrictions be removed. For the Florida case, carbon dioxide emissions from transport have been relatively flat for a number of years, due to the increases in vehicle miles travelled being balanced by fuel efficiency gains (Schipper et. al., 1999). In the future this trend will begin to decrease the overall

fuel economy in the short term due to the higher penetration of light trucks into the market with higher weights and higher power levels (Organisation for Economic Cooperation and Development and the International Energy Agency, 2001). Cuba has a strange mix of vehicles (Enoch et. al., 2004) and to date the current fuel consumption can only be estimated based on overall fuel use, annual mileage accrued and vehicle park numbers. As some of the older stock is scrapped there are likely to be major efficiency gains even if only second-hand vehicles with relatively high mileage are imported.

Future scenarios explored for Cuba and Florida

To explore the future transport paths of both Cuba and Florida a series of shaping factors (see Parsons, 1995) were used to construct two scenarios. The first of these envisaged that Cuba would experience a minor relaxation of its external economic restrictions coupled with very little change in the government structure with consequent, minimal secondary effects in Florida. The second scenario sees a step-change in the Cuban situation; under this, Cuba is freed of all economic restrictions and develops a close relationship once more with the US and with Florida in particular. The repercussions for Florida under this situation are much more pronounced and these in turn have further implications for transport policy and practice. The factors of each scenario are further detailed in Table 2 for the 'incremental change' and in Table 3 for the 'step-change' situations for both Cuba and Florida. The trends and conditions described in the tables are based on official projections as well as others (Alepez et. al., 2002, Jatar-Hausmann, 1999, Jaffe et. al., 2000).

Insert Tables 2 & 3 here

Scenario outcomes explored

It can be assumed that Cuba under the incremental change model would steadily begin to increase mobility, particularly through investment in public transport, over a number of years. In transport policy terms, the incremental change scenario in Cuba would likely see policy evolving in a controlled and managed way, largely as before. Thus, policy elements which one might visualise for this case can be summarised as follows:

- a) Strong land use policies to encourage higher density in established urban clusters which supports dedicated public transport corridor usage
- b) Relatively stringent controls (or disincentives) on private car usage including parking charges, appropriate purchase or annual taxation and high/increasing fuel prices
- c) Some planned replacement or refurbishment of major transport infrastructures in Havana and some other major cities using targeted investment
- d) Encouragement of 'slow modes' (bus, bike and walking) through campaigns and affordable public transport ticketing

Very little change could be expected in the Florida in this situation.

Under the step change scenario the pressures on the Cuban transport network would be intense, and would almost certainly result in a major shift in the transport policies adopted. In particular, the lifting of sanctions could be expected to lead to a dramatic increase in levels of tourism almost overnight – probably in the order of more than 100% - and a consequent increase in leisure traffic (e.g. hired/rental cars, taxis, and US-registered cars arriving by ferry). Secondly, and not unconnected, there would almost certainly be a strong surge in trade and thus freight transport would start to grow very quickly indeed. These two outcomes would mean that many of the constraints on the transport supply (i.e. fuel, vehicles, spare parts and government investment) would be removed, and this, coupled with the rise in economic activity, would cause an internal surge in the demand for travel. Without restrictions, it would be remarkable if the Cuban authorities could maintain (or would want to maintain) such restrictive mobility policies. More likely is that development would be accelerated to accommodate the increased demand as quickly as possible (as occurred in the former East Germany after the fall of the Berlin Wall in 1989).

Therefore the following policy decisions might ensue to support increased mobility:

- a) The capacity of sea ports and airports would be significantly expanded

- b) High levels of investment would be committed to increasing the quality and capacity of 'conventional' public transport systems (i.e. bus, LRT and rail)
- c) The capacity of the highway system would be significantly expanded
- d) High levels of investment would be directed at road maintenance programmes
- e) Road tolls (currently set up on two stretches of road) would become more widespread and fuel taxes would be increased (particularly for foreign-registered vehicles and hired cars)
- f) Increasing numbers of Cubans would have access to hard currency and therefore would be able to buy (and use) cars

Perhaps less positively:

- g) Planning rules may be relaxed as local authorities compete for investors, with corresponding knock on effects on transport (especially car) use
- h) Many of the innovative solutions – e.g. the organised car sharing schemes, the ciclo-bus etc. would disappear
- i) Government would be pressed to provide additional space for cars in Havana, with possible environmental implications

The transport situation in Florida could also be expected to be affected in light of the second, more radical, restructuring. In particular, mobility levels in Florida would be likely to increase at least a little in the short to medium term, as the state would become the main land-sea connection point between Cuba and the USA as a whole. Initially, a high proportion of this traffic would travel from the USA to Cuba, but over time this imbalance would correct itself as Cuban agricultural and industrial products, as well as labour, became more marketable in the USA. New developments too, could be expected, as new businesses (e.g. warehousing, freight, shipping, industrial and retail development) would take advantage of these opportunities. However, the impact of such a radical change in US foreign policy would be unlikely to dominate the Floridian economy and transport system to anywhere near the same extent.

Schafer and Victor (2000) developed a series of predictive mobility models for a number of nation groups. Moreover, the current predicted mobility level of Cuba – i.e. effectively the incremental change scenario - is following the forecast path of the Centrally Planned Asian countries (e.g. China, Mongolia and Vietnam). In Figure 3 the plot of historical series of mobility in Cuba and the lowest trend line depicts these trends. Other countries which have similar annual values to Cuba include El Salvador, Ecuador, Sri Lanka, Yemen, Argentina, and Lithuania (International Road Federation, 2000) based on 1998 figures. A second model (for North American countries) is depicted in Figure 3, derived from Landwehr and Marie-Lilliu (2002) labelled NAM 2. This shows the highest level of mobility partly due to the fact that automobile use in that model remains the dominant mode.

Insert Figure 3 here

Previous to the huge drop in mobility during the early 1990s, the Cuban mobility profile was actually following the Latin American countries (Argentina, Brazil, Chile, Mexico, and Venezuela) (LAM) trend line. Indeed it seems clear that Cuba would today have a mobility of approximately 5000 km/person if the support provided by the Former Soviet Union had continued. It is therefore highly possible, that should the economic restrictions be suddenly removed (as under the step-change scenario) then the Cubans could once again find themselves on that same trajectory when not limited. This 'kick-start' theory is supported by data (Enoch et. al., 2004), which estimated that Cuban mobility could be two to three times higher for rail while car use would be almost doubled if 'unconstrained' utilisation could occur based on historical trends.

Meanwhile Florida's mobility levels derived here are currently below the average for North America due to the fact that they are not corrected for non-drivers, but in terms of overall trends match well. The values are set to overtake the figure shown in NAM in the near future. The models assume a fixed time travel budget to predict that the peak travel distance of Canada and the USA as a whole will peak at 22,000km (Schafer and Victor, 2000) during the next five years, before slowly declining towards the future. Consequently, while projecting motorisation trends for more than 20 years ahead (particularly relating to developing countries) is "a very difficult task" (Gakenheimer, 1999), it is nevertheless fascinating to speculate that Cuban and Floridian levels of personal mobility will not converge until ~2070 (under the step-change model). The main differences between the NAM and NAM 2 result partly from the way air and high speed rail travel modes expand to become substituting modes for

personal automobile use. In NAM 2 the substitution is minimal and this is what is expected for Cuba under both scenarios, as this scenario is based on land-modes (Landwehr and Marie-Lilliu, 2002). In summary Cuban mobility growth rates extrapolated to 2020 range from 3% falling to ~2% (on a per-annum basis) under the lower growth assumptions, using the LAM model). Under the higher growth model a peak of ~8% is achieved, decreasing to ~4% (see the CPAM trend).

Given that energy utilised and thus emissions generated are derived from motorised mobility, it can be assumed that these two trends will develop in a similar direction. Obviously the higher growth outlined in Table 3 (for Cuba) results in higher CO₂ values approaching Florida's current CO₂ transport derived value when 2020 occurs. In summary, this paper has sought to examine how the future of transport in both cases may evolve, and the resultant issues that emerge when using scenarios. The transport futures of both territories currently lie at opposite extremes of the transport spectrum, but in the future there is every chance that their paths will begin to converge especially in terms of their transport trends depending on which scenario actually becomes reality.

References

- Alepuz M and Valdés Ríos H (2002) The urban transportation in time of crisis: The case of Havana, *Proceedings of CODATU X*, Lome, Togo, 12-15 November.
- Bureau of Transportation Statistics (2003), Florida Transportation Profile 2002, US Department of Transportation. Visit <http://www.bts.gov>. Last accessed 15 May 2004.
- Center for Urban Transportation Research (2003) 2003 Florida Transport Almanac, CUTR, College of Engineering, University of South Florida, Tampa, Florida, December.
- Davis S C and Diegel S W (2003) Transport Energy Data Book: Edition 23, Oak Ridge National Laboratory, National Transportation Research Center, Knoxville, Tennessee, October.
- Diaz-Briquets S and Perez-Lopez JF (1995) The Special Period and the Environment, Proceedings of the 5th Annual Meeting of the Association for the Study of the Cuban Economy, Miami, Florida, 10-12 August. Cuba in Transition, **5**, ASCE, Washington DC.
- Economist, The (2001) *Pocket World in Figures 2002*, The Economist Newspaper Ltd, London.
- Energy Information Agency (2004) World Petroleum Prices, EIA. Visit <http://www.eia.doe.gov/>. Last accessed 1 November 2004.
- Economist Intelligence Unit (2002) Cuba Country Profile 2002, EIU, London. Visit <http://www.eiu.com>. Last accessed 31 July 2002.
- Enoch M P, Warren J P, Rios H V, Menoyo E H (2004) The effect of economic restrictions on transport practices in Cuba, *Transport Policy*, **11**(1), 67-76.
- Florida Department of Transportation (2000) 2020 Florida Transportation Plan, Office of Policy Planning, Florida Department of Transportation, Tallahassee, Florida, December. Visit <http://www.fladot/planning/2020ftp>. Last accessed 31 August 2004.
- Florida Department of Transportation (2003), The 2002 Florida Highway Data Source Book, Chapter D, Historical Summaries of Mileage and Traffic Visit <http://www.dot.state.fl.us/planning/statistics/sourcebook/ChapD.pdf>. Last accessed 10 May, 2005.
- Gakenheimer R (1999) Urban mobility in the developing world, *Transportation Research A*, **33**, 671-689.
- International Energy Agency (2004) Country Energy Indicators – Cuba, IEA Energy Statistics, International Energy Agency, Paris. Visit <http://www.iea.org>. Last accessed 16 June 2004.
- International Road Federation (2000) *World Road Statistics 2000*, IRF, Geneva.
- Jaffe AM and Soligo R (2000) Energy in Cuba. Report to the J A Baker Institute for Public Policy, Rice University. Visit http://www.rice.edu/energy/publications/docs/SoliglioJaffe_EnergyCuba.pdf. Last accessed 15 May 2004.
- Jatar-Hausmann, A J (1999) *The Cuban Way – capitalism, communism and confrontation*, Kumarian Press, Connecticut, USA.
- Landwehr M and Marie-Lilliu C (2002) Transportation Projections in OECD Regions, International Energy Agency. Visit <http://www.iea.org/textbase/weo/papers/Transport.pdf>. Last accessed 18 May 2005.

Lindstrom P (2004) Environmental Protection Agency State Inventory Emissions Model, Module CO2FFC, version 1.30. Provided by the Energy Information Agency and the US Department of Energy, Washington, D.C.

Metschies G P (2003) International Fuel Prices Report. Visit <http://www.zietlow.com/docs/Fuel-prices-2003.pdf>. Last accessed 27 August 2004.

Organisation for Economic Cooperation and Development and the International Energy Agency (2001) Saving oil and reducing CO₂ emissions in transport – options and strategies, OECD and IEA, Paris. Visit <http://www.iea.org/dbtw-wpd/textbase/nppdf/free/2000/savingoil2001.pdf>. Last accessed 10 October 2004.

Oficina Nacional de Estadísticas (1952-2001) Anuario Estadístico de Cuba (1973-2001), Oficina Nacional de Estadísticas, Havana, Cuba. Editions for 2002, 2001, 1989, 1988, 1982, 1981, 1980, 1974, 1973, 1957, 1952.

OPP (Office of Policy Planning) Florida Department of Transportation and Center for Urban Transportation Research (University of South Florida) (2003), Trends and Conditions Report – 2003, Travel Demand: Population Growth and Characteristics (July 2003). Visit <http://www.dot.state.fl.us/planning/policy/trends/tc-report/population-7-31-03.pdf>. Last accessed 10 May 2005.

Parsons W (1995) *Public Policy*, Edward Elgar, London.

Shafer A and Victor DG (2000) The future mobility of the world population, *Transportation Research A*, **34**, 171-205.

Shipper L and Marie-Lilliu C (1999), Carbon dioxide emissions from travel and freight in IEA countries: indicators of the past and the long term future?, from International Energy Agency (working paper). Visit <http://www.iea.org/>. Last accessed 10 October 2004.

State Energy Data Report (1999) Energy Estimates for Florida, State Energy Data Report, EIA, US, Table 71 and Table 75. Visit <http://eia.doe.gov/>. Last accessed 15 May 2004.

The Road Information Programme (2000) Traffic congestion in Florida: Trends and solutions, Report for Floridians for Responsible Transportation Planning, Tallahassee, Florida, October.

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TABLE 1: Key demographics for Cuba and Florida

Characteristics	Cuba	Florida
Population	11,230,000 (2001)	17,071,400 (2003)
GDP (\$/capita)	1,670 (2001)	30,446 (2003)
Area of Country (km ²)	110,860	140,248
Population Density (people/km ²)	97.4	114.0
Population Growth Rate (% , 1990 -2000)	4.66	24.0
Percent Urban Population (%)	75.3	84.3
Road Density (km all road/km ²)	549	1338
Cars and light trucks (/1000 people)	32	688
Energy Spent on Transport (% of total)	11.0 %	34.9 %
Fuel Price: (\$/gallon) Diesel and Gasoline	\$1.70 and \$3.41	\$1.32 and \$1.23

Table 1 Sources: Oficina Nacional de Estadísticas 2001, Center for Urban Transport Research 2003, The Economist 2001, Bureau of Transport Statistics 2003, Metschies, 2003, Energy Information Agency 2004.

Table 2: Shaping factors and their effects on Cuba and Florida for the 'incremental scenario'

Shaping Factors	Cuba	Florida
Demographics	Continuation of historic population growth rates	Aging population, Continued

		immigration, Slowing population growth rate
Culture and Attitudes	Continued social cohesion (strong) and indigenous culture	Limited impact
Political Parties	Single party state	No change or no effects
Organisation of Interests and Power Distribution	Top down with strongly centralised, limited participation	No change
Past and Present Policies	Remain strong	No change
Local Economic Conditions	Controlled -medium growth with long term stability	No change
International Economy	Increased trade/contact with specific country partners	No change
Technology	Steady rate of infusion	No change
Institutions and Bureaucracy	Command and control – remains strongly regulated by central government and publicly owned, Hierarchical, well-planned	No change
Political Leadership	Remains autocratic	No effect

Table 3: Shaping factors and their effects on Cuba and Florida for the ‘step-change scenario’

Shaping Factors	Cuba	Florida
Demographics	Increased population due to higher birth rate, life expectancy improvements and immigration	Ageing population, Potential for immigration/emigration, Slow down in population growth (potential for reverse)
Culture and Attitudes	Erosion of social cohesion and indigenous culture with substitution by external culture	Step-change in all facets
Political Parties	Emergence of new political groupings	Limited effect
Organisation of Interests and Power Distribution	Top down with strong market influence with slowly devolving, increased participation	Limited or no effect
Past and Present Policies	Largely abandoned	Massive changes in land use, transport, economic and industrial policy outcomes likely
Local Economic Conditions	Large influx of capital – high growth – potential for cyclical episodes	Dramatic shift in labour, development, and investment patterns expected
International Economy	Significantly increased external trade - in particular increased dependence on US	Creation of new markets and supply chain systems
Technology	High rate of infusion	Limited or no effect
Institutions and Bureaucracy	Trends towards free market with reduced regulation and increased private sector involvement, Mix of structures, reduced planning	Limited effect
Political Leadership	Shifts to less autocratic system	No change

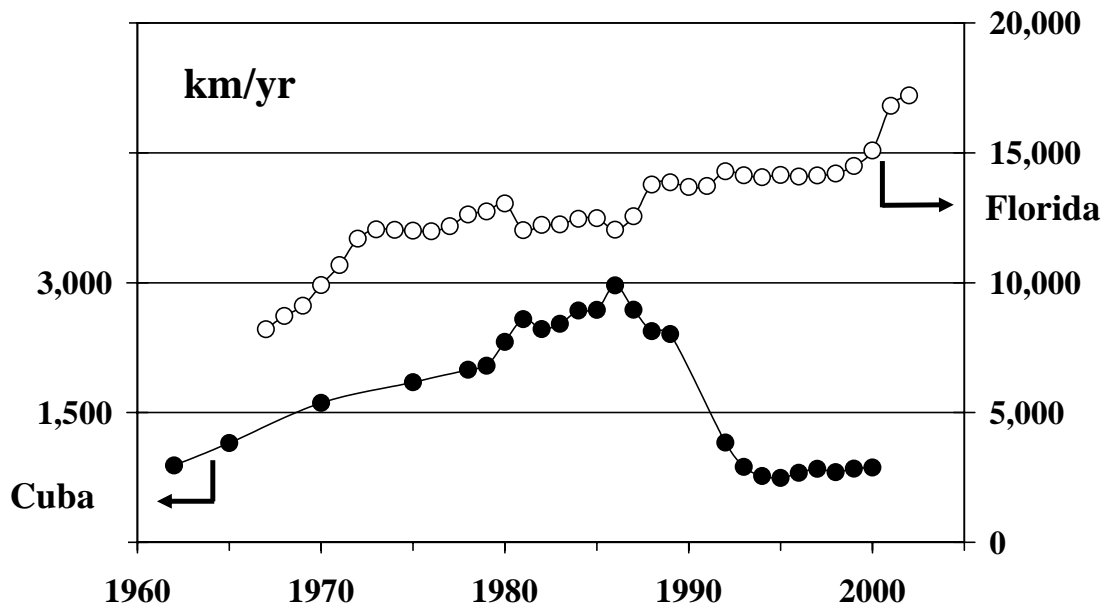


FIGURE 1: Per capita mobility trends for Cuba and Florida (km/year). Note difference in scale. Sources: Oficina Nacional de Estadísticas (1952-2001) and Florida Dept. of Transport (2003).

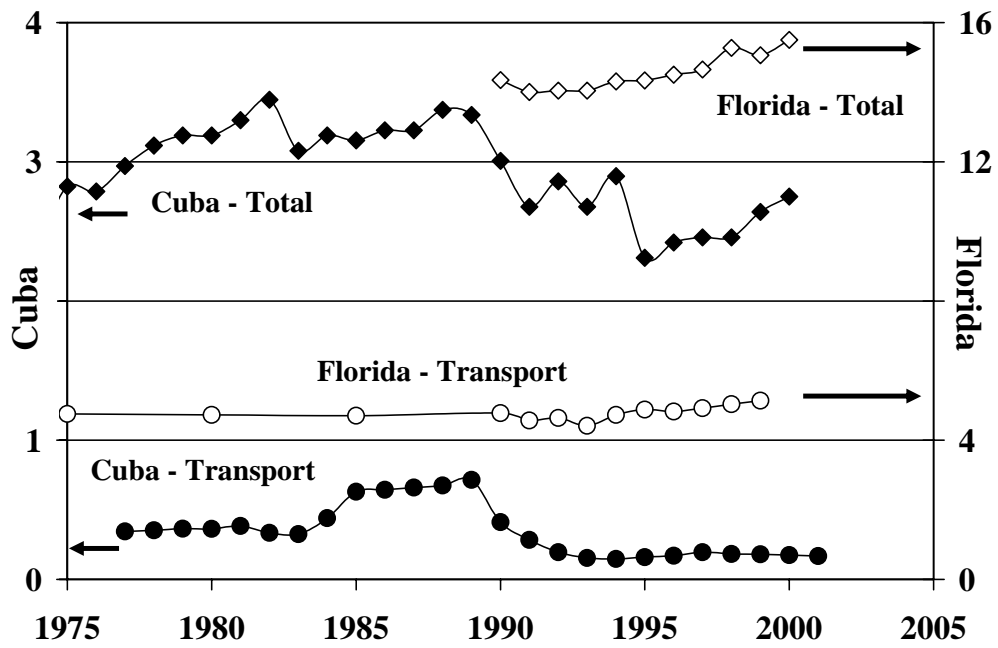


FIGURE 2: Per capita CO₂ emissions for transport and all sectors (tonnes/year). Note differences in scales. Sources described in text.

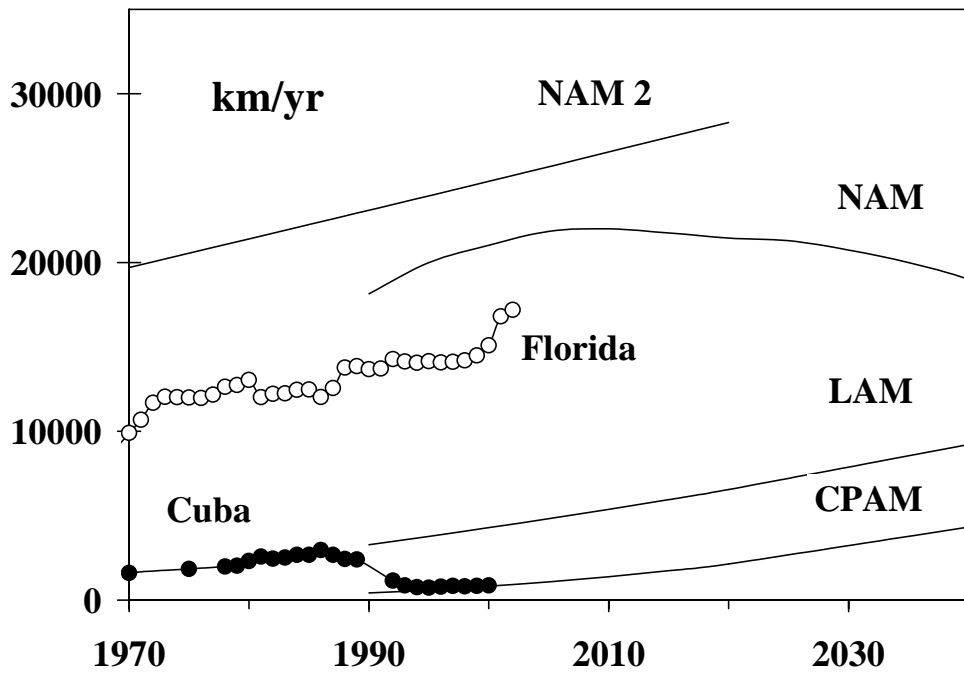


FIGURE 3: Per capita historical and predicted future mobility (km/year).