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Chapter 11

Road transport, motorisation and pollution

Introduction

In everyday life, people and goods have to be transported, often over long distances. Children have to go to school, the employed need to go to work, stock at shops has to be replenished, and businesses have to be looked after. All these activities require transportation and transportation requires roads and vehicles, especially in the absence of other modes of transport such as rail, air or waterways.

Whereas the benefits of the use of roads and vehicles cannot be denied, the fact is that such uses also impact upon the environment. Many of the negative impacts of road transport on the environment have been experienced in the urban areas of the highly developed countries. A 2005 World Bank publication stated that:

> 'Urban air pollution from road transport is a growing concern in a large number of developing country cities. With rising income, the use of motorized transport is expected to continue to increase in the coming years, potentially worsening air quality. Poor air quality in turn has been shown to have seriously adverse effects on public health. The World Health Organization estimated that 650,000 people died prematurely from urban air pollution in developing countries in 2000.'

Small Island Developing States (SIDS) may not be immune to these negative impacts. However, they may learn from the experiences of the developed as well as developing world to mitigate the impact and adapt to the risks.

This chapter begins with a discussion on the links between road transport density and vehicular expansion. The next section analyses the trend in motorisation and pollution, and considers some of the environmental impacts of road transport with particular reference to air quality. The fourth section examines some public policy responses to pollution from road transport. The final section offers some conclusions.

Road density and vehicular expansion

Rodrigue (2006) argues that the transport sector is an important component of the economy, impacting on development and the welfare of populations. When transport systems are efficient, they provide economic and social opportunities and benefits that result in positive multiplier effects such as better accessibility to markets and additional investments. When transport systems are deficient in terms of capacity or reliability, they can have an economic cost such as reduced or missed opportunities. Transport also carries an

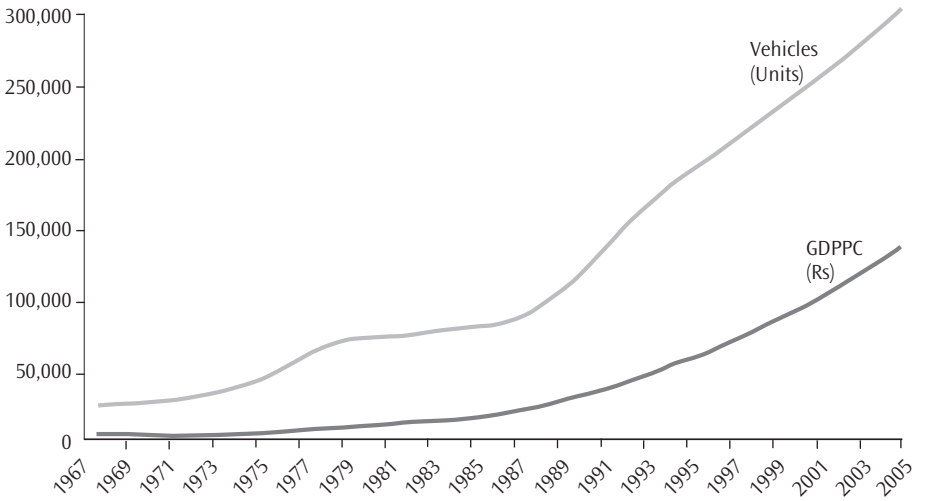
important social and environmental load, which cannot be neglected. It has commonly been the role of the government to promote and re-distribute wealth and, to that end, possessing the means of transport is a fundamental requirement that facilitates, intensifies and contributes to international trade. The necessity of international trade for economic development to take place has been illustrated by Barro and Sala-I-Martin (1992), and Collier and Gunning (1999), amongst others.

While it is established that higher growth levels are generally associated with greater availability of road infrastructure, there is considerable variation with significant outliers in both dimensions. Table 11.1 shows the road density in km of road/square km of land area and the GDP per capita in SIDS in 2008. Singapore, which is the most developed of the SIDS with a GDP per capita of US$52,000, has a road density of 4.72 km of road/square km of land area, followed by Bahrain at US$37,200 per capita/to 5.26; The Bahamas and Cyprus, both at US$28,600 per capita, against 0.27 and 1.58 respectively. Malta, with a GDP per capita of US$24,200, has the highest road density at 7.05 km of road/square km of land area.

The case of The Bahamas is striking. Among the SIDS with a road density of less than 1 km of road per square km of land area, it assumes the median position in terms of road density but the highest position in terms of GDP per capita and the third highest position overall along with Cyprus. With about the same road density (1.01 km of road per square km of land area against 1.00), the GDP per capita of Seychelles is 40 per cent higher than that of Mauritius.

Vehicular expansion in Mauritius has been significant. Figure 11.1 plots the rise in the number of vehicles registered since 1979 as well as GDP per capita. The relation between increase in GDP per capita and increase in the number of vehicles is clearly demonstrated. In fact, the rate of change in the number of vehicles is greater than the rate of change in GDP per capita as from 1987. The rapid economic growth (termed the Economic Miracle due to FDI-led light industrialisation) witnessed since 1983 was also manifested in transportation growth, thereby causing accelerated vehicular expansion.

Figure 11.1. Vehicles registered in Mauritius and GDPPC (1979–2005)



Source: Adapted by the authors using data from the National Transport Authority, Mauritius

Table 11.1. Road density and gross domestic product per capita (2009)

Small island state	Road density km/square km	GDPPC (US$) Estimates 2008
Antigua and Barbuda	2.64	19,000
The Bahamas	0.27	28,600
Bahrain	5.26	37,200
Barbados	3.71	19,300
Belize	0.13	8,600
Cape Verde	0.33	3,800
Comoros	0.41	1,000
Cook Islands	1.36	9,100 (2005)
Cuba	0.55	9,500
Cyprus	1.58	28,600
Dominica	1.03	9,900
Dominican Republic	0.41	8,100
Fiji	0.19	3,900
Grenada	3.28	13,400
Guinea-Bissau	0.12	600
Guyana	0.04	3,900
Haiti	0.15	1,300
Jamaica	1.99	7,400
Kiribati	0.83	3,200
Maldives	0.29	5,000
Malta	7.05	24,200
Marshall Islands	0.36	2,500
Mauritius	1.00	12,100
Micronesia, Federated States of	0.34	2,200
Nauru	1.14	5,000 (2005)
Palau	0.13	8,100
Papua New Guinea	0.04	2,200
Saint Kitts and Nevis	1.23	19,700
Saint Lucia	2.00	11,300
Saint Vincent and the Grenadines	2.13	10,500
Sao Tome and Principe	0.32	1,300
Seychelles	1.01	17,000
Singapore	4.78	52,000
Solomon Islands	0.05	1,900
Suriname	0.03	8,900
Trinidad and Tobago	1.62	18,600
Tuvalu	0.31	1,600 (2002)
Vanuatu	0.09	4,600

Source: The CIA World Factbook 2009: Central Intelligence Agency

Trends in motorisation and pollution

Mauritius is not endowed with mineral resources. Its sugar industry, light-machine-based garment industry, international tourism, financial and information technology services are its major economic activities. The growth of these sectors has been facilitated by the expansion of infrastructure of which road transport is an important segment. While all economic and human activities are sources of pollution, Mauritius's sugar industry, international tourism and road transport accompanied by motorisation can be identified as the principal pollution-generating activities. In this section, the focus is on trends in vehicular growth and motorisation-induced pollution. Pollution due to motorisation and traffic congestion in peak hours is the concern.

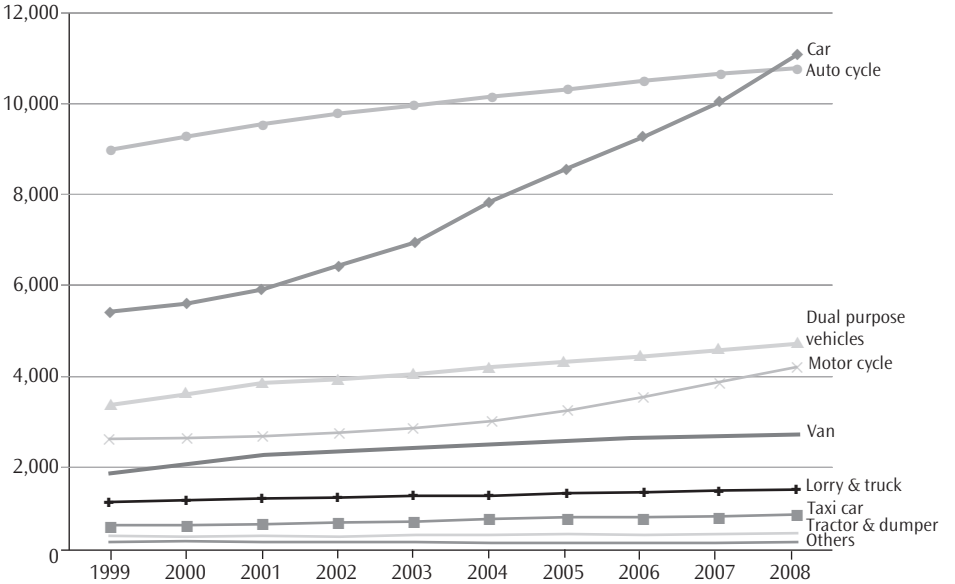
The urban and rural areas in Mauritius are well interconnected and every part of the island is accessible through tarred roads. The principal north–south link is through the capital city with, at present, no effective by-pass, giving rise to a serious problem of traffic congestion and air pollution. Traffic congestion in Mauritius has been a subject of concern for some time. The construction of a ring road in the central-government-cum-business district of Port Louis has been on the agenda since 1975. However, the proposed Terre Rouge – Verdun – Trianon Link Road, which will connect Terre Rouge and Rose Hill, will not greatly ameliorate the situation since it will bypass Port Louis by some distance.

Mauritius uses a system of evaluation of northbound and southbound vehicular movements, at strategic points along the highway (M1) to measure the level of traffic congestion having implications for air pollution. However, information regarding a measure of the air quality at different points on the highway or elsewhere was not accessible. It is now commonly observed that at peak times in 2009 the congestion on the M1, the principal main road from south to north in Mauritius extended over some 8 kilometres in three lanes to Port Louis and over 7 kilometres in two lanes from Phoenix towards Port Louis. The situation on lateral roads leading to the M1 is similar; journey times on the 17 m-long M1 can be one hour or more.

Several proposals to alleviate traffic congestion in Mauritius are under consideration. The 2007/08 budget *inter alia* provides for the Terre Rouge – Verdun – Trianon Link Road. The theory of induced traffic suggests that new roads bring their own users, and that an increase in vehicular traffic brings in its wake traffic congestion, which in turn gives rise to a number of environmental problems, such as oil spills on the roads washed onto adjacent land, thereby damaging the ecological system, litter from used tyres and spare parts, and air pollution. Thus new roads may not solve the problems of traffic congestion and related environmental issues in the country and it may make them worse. Further, SIDS that rely heavily on the tourist sector, such as Mauritius, would have a high proportion of their coastal areas serviced by roads. This will generate all the negative impacts that the use of these roads by vehicular traffic produces.

The number of private cars in Mauritius increased from 47,987 in 1999 to 102,556 in 2008, registering an average annual increase of 11.37 per cent. The trend of the number of vehicles registered according to vehicle categories over the past twenty years is shown in Figure 11.2.

Figure 11.2. Trend of the number of vehicles registered in Mauritius according to vehicle categories

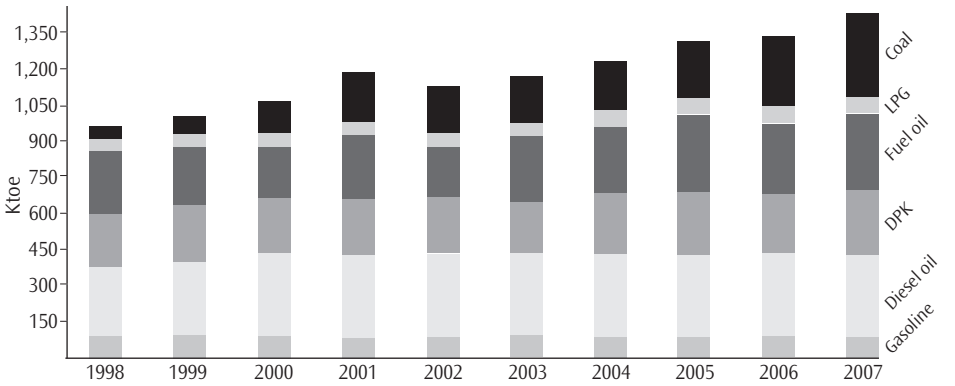


Source: Drawn from data obtained from National Transport Authority Mauritius, 2009

The average annual increase in mass transit vehicles was 1.78 per cent for buses and 4.15 per cent for taxi cars. This shows that the growth of vehicles using petrol (now unleaded) and liquefied petroleum gas (LPG) is faster than the growth of diesel-driven buses and taxis. This trend in motorisation would have a positive effect on pollution abatement. This is also a sign of a shift to cleaner technologies as a relatively high level of economic development is attained. This is a classic indication of Environmental Kuznets Curve (EKC), with levels of pollution declining with rapid economic growth.

There is another interesting part of this story. The volume of petroleum products, in thousand tonnes of oil equivalent (ktoe), imported into Mauritius over the period 1998–2007 is reported in Figure 11.3. It could be seen that there is no striking change in the quantity of

Figure 11.3. Imports of energy resources, 1997–2006



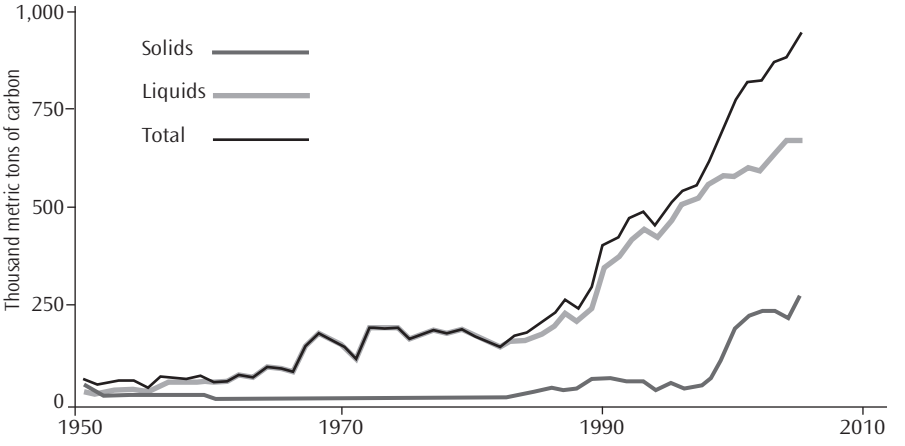
Source: Central Statistics Office, Mauritius, 2007

gasoline, diesel and LPG imported over the past ten years despite the remarkable increase in the number of road vehicles registered over the years. Indications are that the modern GLI (injection fired) vehicles consume 20 per cent less gasoline than GL (engine fitted with carburettor) vehicles for the same distance covered. With VVTI (variable valve timing injection) engines, the fuel consumption is still less. The fact is that most of the vehicles that are now being imported are injection-fired. This offers more evidence of an EKC.

However, there is a need to distinguish between emissions per vehicle – which are less nowadays with improved technology in engineering designs – and total emissions which may be more with the increase in the number of vehicles. Also, growing congestion increases emissions per vehicle as well as total emissions, as it increases fuel consumption per kilometre travelled. Generally, small islands states do not have the logistics for detailed studies on emissions. The California-based Carbon Dioxide Information Analysis Center (CDIAC) notes that the volume of CO_2 emissions has substantially increased over the past fifty years and the increase is likely to be as great in the next decade as it had been over the past two decades. The situation for Mauritius, as reported by CDIAC, is given in Figure 11.4. CO_2 emissions in the form of gases, flaring and cement are too small to be evident on the graph.

It is instructive, however, to analyse the problem dimension of these developments. The environmental benefits from the emergence of technologically more sophisticated vehicles, particularly private vehicles, can be negated by increased pollution caused by traffic congestion. It should also be added that most private vehicles are large sized vehicles, and therefore their contribution to congestion and pollution cannot be overlooked. Further, in the absence of a goods train system (abolished in 1960s), roads are extensively used to transport sugarcane from fields to sugar factories and such carriers are one of the major sources of vehicular congestion and pollution during the sugarcane harvesting season. Under the New Sugar Action Plan, attempts have been made to centralise the sugar crushing operations to reduce per unit cost of sugar production. While this arrangement is economically efficient, its environmental efficiency has not been assessed. Centralised sugar industry operations require the movement of sugar cane over long distances to reach the designated sugar mills, thereby contributing to traffic congestion in some areas.

Figure 11.4. CO_2 emissions from Mauritius



Source: Carbon Dioxide Information Analysis Center, http://cdiac.ornl.gov/

The problem of air quality has given rise to major concerns in the most advanced countries. Karim (1997) reports that studies done in Dhaka, Bangladesh indicate that motor vehicles are also a major or primary source of other toxic air pollutants, apart from carbon monoxide, hydrocarbons, photochemical oxidants, nitrogen oxides, particulate matter and lead, including benzene and a number of carcinogens, associated with particulate matter.

Onursal and Gautam (1997) relate the experiences from seven Latin American urban centres where air pollution caused by motor vehicles is a major environmental problem. If appropriate measures are not taken soon, vehicular air pollution in the region is likely to worsen, posing a great threat to human health and welfare. The authors analyse pollutants emitted by motor vehicles, their effects, pollutant-control measures targeted at vehicles, fuels, and transport management. Case studies for Mexico City, Mexico, Santiago, Chile, São Paulo, Brazil, Belo Horizonte, Brazil, Buenos Aires, Argentina, Rio de Janeiro, Brazil, and Santafé de Bogotá, Colombia, illustrate the impact of these measures in the region and how they can be strengthened.

The Executive Summary of the Latin America Regional GEF Sustainable Transport Project, World Bank Project ID: GE-P096017 (2006) reports that the transportation sector is currently responsible for more than one-third of the carbon dioxide (CO_2) emissions in Latin America, and is the fastest growing sector. The International Energy Agency projects that CO_2 emissions from vehicles will increase by a factor of 2.4 (or 140 per cent); from about 4.6 gigatonnes in 2000 to 11.2 in 2050. The vast majority of this increase will take place in developing regions, especially Latin America and Asia, as a result of increased motorisation and vehicle use.

Air pollution from vehicular emissions has not been of major concern in SIDS, partly due to the notion that SIDS benefit from favourable winds that ventilate the air and disperse the pollutants arising out of road transport. However, those SIDS that are closer to larger countries in the area can be affected by pollutants including acid rain blown away from these countries. Singapore, for example, is greatly affected by trans-boundary pollution from wild fires from mainland Asia. Air quality is being increasingly recognised as a key component in human and environmental protection and as a natural resource of value commercially, especially for island tourism. Without government intervention, unfettered market forces may result in this common resource being depleted. In Singapore and Mauritius, there has been a recognised need for government intervention to control the level of pollution especially due to vehicular emissions.

Public policy response

Policy measures to minimise the adverse effects of vehicular pollution are increasingly being adopted in many countries. Soon after the passage of the US National Environmental Policy Act of 1969, the US Environment Protection Agency (EPA) began working to reduce lead emissions, issuing the first reduction standards in 1973, which called for a gradual phase-down of lead to one tenth of a gram per gallon by 1986. The average lead content in gasoline in 1973 was 2–3 grams per gallon or about 200,000 tons of lead a year. From 1975, passenger cars and light trucks were manufactured with

a more sophisticated emission control system which included a catalytic converter that required lead-free fuel. In 1995, leaded fuel accounted for only 0.6 per cent of total gasoline sales and less than 2,000 tons of lead per year. Effective January 1, 1996, the Clean Air Act banned the sale of the small amount of leaded fuel that was still available in some parts of the country for use in on-road vehicles. EPA allowed fuel containing lead to be sold for off-road uses, including aircraft, racing cars, farm equipment, and marine engines.

In the case of SIDS, Singapore has been taking corrective measures since 1991 starting with Light-Duty Highway Vehicles. The Ministry of the Environment issued the first Singapore Green Plan (SGP) in May 1992 followed by a second Plan in August 2002 that sets targets for 2012. The SIDS have made good progress towards meeting the SGP 2012 targets. Examples include ambient air quality as measured by PSI (particles per square inch) that was in the 'good' range for at least 85 per cent of the days in each of the years between 2003 and 2007 and the annual average PM (particulate material) 2.5 level fell from 21μg/Nm^3 in 2005 to 19μg/Nm^3 in 2007.

In Mauritius, both economic incentives and command and control measures exist in different forms. By mid 1980, government started offering duty-free incentives to certain categories of economic operators for the purchase of new vehicles. Certain classes of government employees started benefiting from the scheme from 1987. It was such policies that permitted the replacement of older, high emission vehicles with fuel efficient and environmentally safer vehicles. This measure however carried with it another series of negative externalities in that it shifted a good number of public officials away from mass transit and car-pooling to private means of transport, adding to the problem of road congestion.

The control of vehicular emissions through regulatory measures in Mauritius is of most recent origin, however. The Road Traffic (Control of Vehicular Emissions) Regulations was promulgated in 2002 (Box 11.1).

Box 11.1. Mauritius: The Road Traffic (Control of Vehicular Emissions) Regulations 2002

Prior to registration:

- Every motor vehicle will have to be constructed and maintained in such a manner that smokes and noise emitted from it does not exceed the prescribed limits.
- Only petrol driven motor vehicles that shall be capable of running on unleaded petrol shall be registered as from 1st January 2003.
- No new diesel driven motor vehicle shall be registered unless it complies with a capacity limit of 40 per cent and the prescribed standard of exhaust emission as from 1st September 2003 and 1st January 2004 respectively.

Prior to the delivery of a new or used imported vehicle to its owner, a dealer will have to issue a certificate testifying that the motor vehicle meets the prescribed standards relating to both exhaust and noise emissions.

Consequently, carbon monoxide (CO) and Hydro Carbons (HC) emissions standards for motorcycles and auto cycles have now been introduced. Finally, maximum noise emission

standards for all types of motor vehicles and two-wheelers range from 79 to 92 decibel (dBA), depending on the type of vehicle. It is important to note that in 1995 leaded fuel accounted for only 0.6 per cent of total gasoline sales and less than 2,000 tons of lead per year.

Other policy measures regarding road transport include user charges and parking fees. In addition to helping to diminish the propensity of drivers to use the roads, user fees offer a source of funding for maintaining roads in good condition and compensate for the negative externalities arising out of road use. Whereas user fees are quite common in other countries, their introduction in Mauritius has not made any significant progress. SIDS may be well advised to introduce user fees where new roads are constructed especially in the coastal areas.

Parking fees are another instrument that may be used. In Mauritius, the Paid Parking Scheme introduced in 1993 was aimed at reducing parking in towns. The scheme could have been a deterrent to congestion on roads leading to town if the parking fee rates were appropriately designed and fixed. Unfortunately, the parking fee is set at a nominal level so that it has not reduced road congestion. In 2002, the parking fee rate was increased by 400 per cent, almost 7 times more than the increase that could be attributed to cumulative inflation rate of 68 per cent. However, the rate is still pegged below a deterrent value. Further revisions have not been politically feasible.

Insofar as the destruction of natural habitat is concerned, the intervention of the Mauritius government to halt a road designed to aid travel for tourists presents an illustration of a new willingness to protect the environment for the longer term advantage of the community and the environment. The aim of the road was to provide a quicker access to tourists from the airport in the South East to the hotels on the eastern coast of the island. Environmentalists opposed the project arguing that Ferney Valley, one of the country's few remaining indigenous forests, was vital for the survival of threatened flora and fauna and was home to six species of critically endangered trees, including the *Eugenia Bojeri*, *Pandanus Macrostigma* and *Pandanus Iceryi* – trees assumed extinct until their discovery in 2008. The forest is also home to half the world's population of Mauritius kestrels, once the world's rarest birds. From near extinction in the 1970s, its population had grown to almost 1,000 as a result of a captive breeding programme in Ferney Valley.

Achim Steiner, former Director-General of the World Conservation Union, argued that given the small amount of good quality tropical forest remaining on Mauritius, this development could only be viewed as 'catastrophic' to native biodiversity. The South-eastern highway was intended to run over 25 kilometres through the Ferney Valley. In response to this opposition, the government called for a re-design of the road. The Highway is now in two parts: the first part connects Plaine Magnien, near the airport, to Ferney and the second part connects Kewal Nagar to Bel Air. The earlier proposal of connecting Ferney to Kewal Nagar was shelved, thus saving the Ferney Valley. The Ferney Valley is now a protected area and a site for eco-tourism which is being encouraged in Mauritius. The environmental value of Ferney Valley can be assessed by using methods such as travel costs and contingent valuation methods. But it is also important to note that the conservation of such natural gifts would help tourism development and promote the ecological balance of the island.

Concluding remarks

The small island state of Mauritius provides an illuminating example of the challenges faced by small island states as they strive to promote economic development whilst embracing environmental and social values. Road transport has been an area in which government has sought to adjust for market failure, and to curb the effects of air pollution due to vehicular emissions. There have been some efforts at reducing air pollution on the roads but traffic congestion remains, undermining policy objectives and adding substantially to travel time for workers and school children. The challenge of further policy intervention remains. Mauritius, as a result, suffers from the tragedy of the commons. Road pricing has yet to be used to correct for the flaws in the market for road space. Plans for new by-passes, a bridge over the seaport of the capital and decentralisation of government and business premises are under review. If implemented, these measures may provide remedies for the problem of congestion. The government has converted the forested Ferney Valley, which would have been affected by a planned highway project, into an ecological protected area, safe from any further intrusion of road development. This is an example of a major policy intervention for environmental management.

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