THE TRAFFIC IMPACTS OF ROAD CAPACITY CHANGE: A REVIEW OF RECENT EVIDENCE AND POLICY DEBATES

Lisa Kane and Roger Behrens

Urban Problems Research Unit, University of Cape Town,
Private Bag, Rondebosch, 7701

1. INTRODUCTION

The National Department of Transport's *Action Agenda* of 1999 states that:

> "With traffic congestion in certain areas set to increase dramatically over the [next] 20-year[s] ... building more roads in already well served metropolitan areas is not the solution to congestion. Experience internationally has shown that more roads attract more traffic which in turn generates demand for even more roads. Instead, this strategy advocates managing car use in these congested areas, pricing mechanisms and incentives whilst at the same time investing behind the core public transport network as the emerging alternative". (DOT 1999:27)

This paper identifies and reviews the unsourced international experience referred to in this statement. The literature documenting this experience deals, in essence, with two phenomena associated with road capacity change -- 'induced' and 'suppressed' traffic. The paper begins by defining and explaining the behavioural responses that give rise to these phenomena (sections 2 and 3). It then reviews the empirical evidence supporting their existence (section 4). The paper concludes with a brief discussion on the implications this evidence has for transport planning practice and policy formulation generally, and for the South African urban transportation context more specifically (section 5).

2. DEFINITION

The watershed publication in the debate over *induced* traffic was, without doubt, a report submitted to the United Kingdom's Secretary of State for Transport in 1994, by his Standing Advisory Committee for Trunk Road Assessment (SACTRA). The SACTRA committee was chaired by Derek Wood, and its report was entitled *Trunk roads and the generation of traffic*. Although primarily focused on trunk roads (that is, roads in the national road system, managed by national government) the location of many of these routes through, or close to, conurbations meant that roads with a wide variety of traffic conditions were considered, from very congested, to virtually free-flowing. The SACTRA committee was asked to advise "on the evidence of the circumstances, nature and magnitude of traffic redistribution, mode choice and generation (resulting from new road schemes)" (SACTRA 1994:1). At the outset the committee recognised that the notion of 'roads generating traffic' was one which had gained widespread popular acceptance, but which had not been subjected to much rigorous investigation. There had been confusion and inconsistency over terminology in the literature, one reason being that the definitions of 'generated' traffic are not straightforward. Until the publication of the SACTRA report, problems in defining induced traffic had blurred real debate over the actuality of the phenomenon. There was a lack of professional consensus over what induced traffic was, and if it existed to any significant extent. The committee thus chose to address this issue of definition in detail (see Hill 1996), and this section of the paper summarises the final definition they chose to use. Others have suggested slight variants on this in the intervening years (e.g. Heanue 1998, Litman 1999) but for the purposes of this paper we stay with SACTRA's definition.

As a first step in their work, SACTRA decided that the word 'generate' was problematic to use since 'trip generation' has a very specific meaning in a transport planner's vocabulary. Usually a household or individual is understood to generate trips, as the first stage in the four-stage modelling process. With this very particular definition in mind, the notion that '*roads* generate traffic' (and implicitly, then, trips), seems nonsensical. To preclude any confusion over this particular issue, the SACTRA committee chose to replace the term 'generate' with 'induce', and to investigate whether the provision of roads induce -- that is, indirectly bring about -- traffic. In summary, the definition adopted by SACTRA was that induced traffic is the *additional* daily private vehicle traffic which may occur on a network following some road capacity increase. It does not therefore include additional traffic found on individual links if the total *network* vehicle kilometres remains constant, nor does it include additional traffic found in the peak period if the total *daily* vehicle kilometres remains constant.

The literature on the relationship between traffic levels and road capacity was broadened considerably by the more recent publication of a report entitled *Traffic impact of highway capacity reductions: Assessment of the evidence* (Cairns *et al* 1998). This report was commissioned by London Transport and the Department of Environment Transport and the Regions, and prepared by Sally Cairns, Carmen Hass-Klau and Phil Goodwin. The premise of the study was that if we accept the notion of induced traffic, we must also consider the possibility of traffic being *suppressed* when we impose road capacity reductions. The report therefore reviewed evidence of the traffic impacts of capacity *reductions* (for example as in the case of a bridge or lane closure), rather than increases. It is important to note that in this report, as well as in the earlier SACTRA report, the capacity increases or reductions in question referred specifically to road capacity change for private vehicles. The impacts of increased or reduced capacity for public transport were therefore not investigated in any significant way in this literature.

This paper reviews the literature on the explanations for, and empirical evidence of, 'induced' and 'suppressed' traffic conjointly. The earlier SACTRA definition is thus expanded to include both phenomena as follows: *Induced (or suppressed) traffic is the additional (or reduced) daily private vehicle traffic which occurs on a network following some capacity increase (or reduction), or,* as discussed in the following section, *some other reduction (or increase) in the generalised cost of travel.*

3. EXPLANATION

It is widely held in the literature on travel behaviour that motorists are most likely to adapt their behaviour when faced with significant changes to the cost of, or constraints upon, their travel choices. The phenomena of induced and suppressed traffic have thus been observed to occur in situations where a change in road capacity causes a significant change in the generalised cost or attractiveness of motor car travel. In the case of capacity increases, such cost changes would typically only occur in situations where road space is added to networks already experiencing congestion. In the case of capacity reductions, such cost changes would typically occur in situations where road space is taken away from networks that have little or no existing spare capacity. (Cairns *et al* 1998, DeCorla-Souza and Cohen 1999, Goodwin 1996)

What then happens when capacity is changed on a network with either congestion or no spare capacity, and thus how can the phenomena of induced and suppressed traffic be explained? The literature offering such behavioural explanations identifies a variety of possible travel adaptations, which tend to be noticeably different in the immediate, short and long term (Cairns *et al* 1998, DeCorla-Souza and Cohen 1999, Dowling and Colman 1998, Goodwin 1996, Kitamura 1994, Litman 1999, Noland 1999, SACTRA 1994). In many, but not all, respects behavioural responses to increased capacity mirror, in inverse form, responses to reduced capacity. These temporally differentiated responses are discussed below and summarised in Tables 1a and 1b.

In the immediate term (i.e. the first few days) drivers often simply change their driving styles in ways that adjust to the new traffic conditions. In the case of capacity reductions in particular, and often depending on the amount of forewarning received by media predictions of 'traffic chaos', they have been observed to drive slower and closer together.

In the shorter term (i.e. the first couple of months) behavioural responses tend to take the form of re-routed trips or rescheduled departure times. In the case of capacity increases, trips are attracted from other previously quicker, but now slower, routes within the network, or trips are rescheduled to a preferred departure time (sometimes referred to as the 'return-to-peak' effect) in response to the initial relief in congestion. In the case of capacity reductions, trips are re-routed to neighbouring streets, or trips are rescheduled (i.e. departing a little earlier or a little later) to avoid the worsening congestion. It should be noted that changes in departure time or route, while clearly increasing or reducing the amount of traffic on the particular link(s) subject to capacity change at a particular time, do not necessarily lead to induced or suppressed traffic as defined earlier. They may simply cause traffic to either divert from, or reappear on, other equidistant links within the network or at other times on the same link(s). The total amount of traffic on the network as a whole over the whole day would thus remain relatively constant before and after the capacity change. It is only if the re-routed trips involve significantly shorter or longer trip distances that induced or suppressed traffic occurs. Rescheduled departure times on the other hand would not strictly induce or suppress traffic, even though Robert Noland (1999) does observe that the 'return-to-peak' effect may induce new trips by freeing up capacity at other times of the day, and theoretically at least, the inverse would be true for shifts to the off-peak.

In the longer term (i.e. up to five to ten years after the capacity change) behavioural responses tend to take the form of changed mode, trip frequency or trip end. In the case of capacity increases, the reduced generalised cost of travelling by car may lead to people taking trips by car that were previously undertaken by other modes, more frequent trips, or because of improved travel speeds, trips to preferred destinations further away. In the case of capacity reductions, the failure of shorter term behavioural adjustments to avoid unacceptable congestion delays may lead to people using non-motorised or public transport modes instead of their cars, suppressing non-essential trips or at least linking previously separate trips into chains, or selecting nearer destinations. In some instances the change in travelling conditions may 'tip the balance' in decisions that were being made for other household life-cycle reasons anyway, like buying or selling a car, moving house or moving job. All these behavioural responses potentially contribute to induced or suppressed traffic effects. In addition to these behavioural responses, increased road capacity (and accessibility) can stimulate unforeseen changes in land use patterns which can generate further unexpected traffic (Headicar 1996).

Table 1a. *Behavioural responses leading to induced traffic*

Changes in….	Induce person trips/day?	Induce vehicle kms/day?
…route	No	Yes
…timing	No	No
...and in the longer term...		
…mode (to private car)	No	Yes
…vehicle occupancy (decreasing)	No	Yes
…trip frequency (increasing)	Yes	Yes
…trip destination (becoming more remote)	(Yes) [(1)]	Yes
…trip origin (becoming more remote)	(No) [(2)]	Yes

Notes:
1. In the longer term, land-use changes as a result of capacity increases may result in new destinations on offer, and hence new trips.
2. The source of trip origins is the household, and whilst the location of the household may change, there will not be any new trips simply as a result of this re-location. There may, however, be induced traffic due to the need to undertake the previously planned trips to new destinations, via new routes.

Table 1b. *Behavioural responses leading to suppressed traffic*

Changes in….	Suppress pers. trips/day?	Suppress vehicle kms/day?
…route	No	Yes
…timing	No	No
...and in the longer term...		
…mode (from private car)	No	Yes
…vehicle occupancy (increasing)	No	Yes
…trip frequency (decreasing)	Yes	Yes
…trip destination (becoming less remote)	No	Yes
…trip origin (becoming less remote)	No	Yes

In summary, it can thus be expected that -- with the caveats of only occurring on networks with either congestion or no spare capacity -- a road capacity increase or reduction may result in a change of route; timing; mode (or at least vehicle occupancy); trip frequency; trip destination; or, over the longer term, trip origin. As illustrated in Table 1 these behavioural responses have an impact on either the number of person trips, or the distance of existing trips, or both. Both impacts potentially induce or suppress traffic.

The behavioural responses discussed above have been argued to be consistent with the basic micro-economic theory of supply and demand (Goodwin 1997, Litman 1999, Noland 1999, SACTRA 1994). In terms of the micro-economics of supply and demand, any increase in supply (i.e. road capacity) results in a reduction in price (i.e. the generalised cost of travel). The theory holds that when any good (i.e. travel) is reduced in price, demand for that good increases. Hence increased road capacity leads to generalised costs going down, and so demand for motor car travel increases and traffic is induced. Conversely, reduced road capacity leads to generalised costs going up, and so demand for motor car travel decreases and traffic is suppressed. Given that such micro-economic theory underpins so much modelling and road scheme appraisal practice, as Phil Goodwin (1997) observes, 'one wonders why the phenomena are greeted with surprise'.

4. EMPIRICAL EVIDENCE

Documented empirical evidence on induced traffic has been available in the literature since the early 1960s, but it was not until the 1990s that a body of authors began investigating the topic in detail (Kitamura 1994). The seminal SACTRA report of 1994 has already been mentioned, but perhaps equally influential in the US was the San Francisco Bay Area Lawsuit (Garrett and Wachs 1996, Weiner 1997). In June 1989 two environmental organisations claimed that the State of California, the Metropolitan Transportation Commission (MTC) of San Francisco, and other regional agencies had violated the provisions of federal clean air legislation by not doing enough to meet clean air standards. The case focused on the general issue of the effects of increased road capacity on reducing public transport use, increasing traffic speeds and enabling the spread of urban sprawl, all of which were argued to contribute to greater air pollution emissions. The MTC had undertaken a conventional analysis to determine the emissions impacts of its transportation plan. The environmental groups argued that conventional travel forecasting models overstated the emission benefits of road building in that, while they fully reflected the impact of speed improvements on reducing emissions, they showed little or none of the air quality impacts of travel induced by speed improvements. The phenomenon of induced traffic thus lay at the heart of the court case. At the time of the trial the American Transportation Research Board was non-committal about the link between roads, induced traffic and environmental pollution, but later evidence emerged from California demonstrating that increased road supply did appear to increase vehicle kilometres travelled (Hansen and Huang 1997). The verdict on whether or not this increase in vehicle kilometres is detrimental to environmental pollution is still undecided. Most recently both British and American authors have concerned themselves with how to model the induced traffic which is now acknowledged to occur (DeCorla-Souza and Cohen 1999, Noland 1999, Coombe *et al* 1998).

In this section empirical evidence which appears to have swayed the debate towards an acceptance of induced and suppressed traffic phenomena are presented. Since there is a considerable volume of empirical evidence available, only the pieces of evidence which are particularly enlightening, or which appear particularly relevant to South Africa, are presented.

4.1 Evidence of induced traffic from traffic counts

Probably the most obvious means of examining this phenomenon is to inspect the results of actual road improvements or closures and to compare these with what was expected. It is enlightening to examine the case of the M25, London's orbital freeway which was finally completed in 1988. The press at that time branded the road as a 'Transport Fiasco' and 'Obsolete before it was opened', for reasons which will become evident through scrutiny of Table 2, giving the Annual Average Daily Two-way (AADT) traffic on selected links of the M25 in 1992, and the equivalent design year forecast.

Table 2. *A comparison of Design Year AADT and 1992 actual AADT on London's M25*

M25 Section	Design Year	Design Year Two-way AADT	1992 Actual Two-way AADT	Difference between 1992 Actual AADT and Design Year AADT
Junction 13-14	1997	97,100	162,000	64,900
Junction 21a-22	2001	41,500	106,000	64,500
Junction 11-12	1995	82,800	146,000	63,200
Junction 22-23	2001	56,500	114,000	57,500
Junction 20-21	2001	59,000	113,000	54,000
Junction 10-11	1998	75,900	129,000	53,100
Junction 8-9	2000	55,200	107,000	51,800
Junction 19-20	2001	59,500	110,000	50,500
Junction 14-15	2000	103,000	152,000	49,000
Junction 15-16	2000	100,000	143,000	43,000

Notes:

1. The ten sites showing the greatest difference between Design Year Two-way AADT and Actual 1992 AADT were selected for inclusion in this table.
2. Total number of junctions for which data were available was nineteen.
3. Source of information: SACTRA 1994 and Denvil Coombe pers com 2000

A review of the experience of the M25 concluded that in the years immediately following the opening of the freeway, reassignment, redistribution, mode shift and peak spreading had been important and the SACTRA report speculated that induced *development* traffic (that is, induced traffic as a result of new or changed destinations) may become important in future. SACTRA concluded that the M25 appears to confirm the notion that roads induce traffic although the exact size of this effect could not be established at that time.

Although the M25 is a widely quoted example, there are of course many smaller road improvements where comparisons similar to the one above can be made. Goodwin (1996) summarised evidence from the SACTRA report and elsewhere, and compiled a table, which has been adapted and reproduced below.

Table 3. *Summary of traffic impact of capacity increases at individual locations*

Scheme	Interval[1]	Result (after corrections, where necessary)[2]
Barnstaple Bypass	3 years	+20% overall
M62	5 years	+19%
York Northern Bypass	Not clear	Redistribution, modal diversion and new trips 2% of interviewed drivers
Severn Bridge	1 year	Authors suggest induced traffic is 44%
Westway (London)	4 months	Corridor +14% (Control[3] +2%)
	10 years	Authors suggest induced traffic of 40-50%
M11 (London)	9 years	Corridor +38%. (Control +29%)
A316 (London)	12 years	Corridor +84% (Control +66%)
Blackwall (London)	1 year	Screenline +15%
M25/Lea (London)	4 months	Corridor +9%
Rochester Way	2 years	Corridors: West +26%, East +24%, Transverse +30%
Leigh Bypass	1 year	Screenline +20%
Manchester Ring	1 year	Corridors: East-west +23%, North-south +15%

Notes:

1. 'Interval' indicates time between capacity increase and analytical study.
2. 'Result' indicates changes in traffic flow after capacity increases, as a percentage of previous flow on the link, corridor or screenline.
3. 'Control' indicates similar unimproved site, used for comparison purposes.

The conclusions from this work were that in every case the growth rates in traffic on the improved roads, which were 'unexplained' by modelling, were on average 25%. The 'unexplained' element was found to increase over time, with unweighted averages of 9.5% for less than a year, and 33% for intervals of more than 5 years. Finally, whilst a reduction in traffic was observed on alternative routes to the improved route, this was on average only half as great as the increase on the improved route itself. In other words, the relief on alternative routes was not as great as had been forecast.

Despite the weight of evidence in support of the induced traffic phenomena, the lack of controlled experimentation means that it can never be categorically proven, in the scientific sense. Although the definition of induced traffic requires a consideration of network-wide effects, in practice this is rarely possible and a consideration of corridor effects is often the best available evidence. Furthermore, it will never be possible to control the day-to day variations which are symptomatic of urban traffic, nor to provide entirely satisfactory control sites and so eradicate the effect of changes in traffic due to exogenous variables such as economic growth or local migration (Bonsall 1996, Hansen 1998). This is the reality facing all transport planners. Our transport 'laboratories' are not our own. Nevertheless, in conclusion to its own report to the UK Department of Transport in 1994, the SACTRA committee stated that:

> "Considering all these sources of evidence, we conclude that induced traffic can and does occur, probably quite extensively, though its size and significance is likely to vary widely in different circumstances". (SACTRA 1994:ii)

It may be argued that road capacity increases have indirect benefits, that is they lead to commercial activity which may not have otherwise taken place. The SACTRA report is clear on this point, and suggests that whilst indirect benefits may occur which are not accounted for in an economic evaluation, these occur only in unusual specific circumstances. In order to understand this point it is important to ask whether additional road capacity leads to any completely new commercial activity, which would not have taken place anywhere else in the country. It is rarely the case that genuinely new jobs are created as a result of a road scheme.

4.2 Evidence of suppressed traffic from traffic counts

A useful summary of the impact of capacity *reductions* on network flows is provided by Cairns *et al* (1998). The researchers collected evidence from over forty locations on the impact of capacity re-allocation as a result of bus lane implementation or pedestrianisation; maintenance or structural repairs; or natural disasters such as earthquakes. The results were wide ranging, but the unweighted average overall reduction in traffic on the network was 25% of the traffic previously using the road or area subject to capacity reduction. An extract from their analysis is provided in Table 5.

Since the publication of the SACTRA and the Cairns *et al* reports, the general consensus in the UK has been that the induced and suppressed traffic phenomena occur. The debate now is over their magnitude and importance. In the US the debate so far has focused more on induced traffic, but the consensus also appears present there (Hansen 1998).

Table 5. *Summary of traffic impact of capacity increases at individual locations*

Scheme	Interval	Result (after corrections, where necessary)
Tower Bridge closure	1 month	-80%
Bologna City Centre	8 years	-51%
Edmonton-Kinnaird Bridge Closure	3 weeks	-42%
Partingdale Lane local area	3 months	-30%
A13 closure	1 day	-23%
Luneburg	3 years	-15%
Cambridge city centre	5 months	-11%
Freiburg ring road	10 months	-7%
Edinburgh-New Town cordon	3 months	-3%
Ring of Steel London 'Square Mile'	1 year	-0.2%
Frankfurt am Main bridge closure	Not clear	+2%
Aarau	1 day	+14%

Notes:

1. The table indicates changes in traffic flow after road capacity reductions, as a percentage of the previous traffic flow in the area.
2. This table shows only a random selection of the cases listed in Cairns *et al* 1998.

5. IMPLICATIONS

What then are the implications of this general consensus for transport planning practice, and for transport policy formulation? Since practice in South Africa tends to concern itself with the provision of additional capacity, the implications of suppressed traffic are not discussed. Both induced and suppressed traffic are, however, relevant to policy and are discussed in the final sub-section.

5.1 Practical implications

To consider the practical implications of these findings -- and of induced traffic more particularly -- it is necessary to reflect on how transport modelling and economic appraisal is generally undertaken; to examine whether current practice adequately reflects induced traffic; and to ask whether, in practical terms, this is important.

Induced traffic, as defined in Table 1 of this paper, is not completely ignored in the planning process. Indeed, some components are well entrenched in modelling practice (such as changes in route), others can be included theoretically, but are often not used in practice (such as changes in destination). This inclusion of induced traffic phenomena in the modelling process is described in Table 6.

Table 6. *Inclusion of induced traffic in the modelling process*

Changes in….	Induced traffic included? (Vehicle kms/day)
…route	Generally yes
…mode	Generally no[1]
…vehicle occupancy (decreasing)	Generally no
…trip frequency (increasing)	Generally no
…trip destination (becoming more remote)	Generally no[2]
…trip origin (becoming more remote)	Generally no[3]

Notes:

1. Assumptions about mode choice changes may be made in forecasts, but a feedback loop between changes in generalised cost on the vehicle network, and the mode choice model, are not common.

2. Although in theory the trip destination model can be used for forecasting, with new inputs of future costs, in practice this is not often the case (Coombe, 1996).
3. Generally development is forecast exogenously and does not take into account the impact of the scheme under consideration on the access patterns.
4. This table was based on Table 1 from DeCorla-Souza and Cohen (1998).

Data giving an estimate of the scale of the traffic not generally included in the four stage modelling process is scarce. Goodwin (1996) suggests, from an examination of empirical evidence, that unpredicted traffic in the first year of a scheme is almost 6%, and he further suggests that the long term unpredicted traffic is double that of the short term. Heanue (1998) examined traffic growth in Milwaukee over almost thirty years and suggested that the growth which could be attributed to road capacity improvements was between 6% and 22%. Coombe (1996) tackled the problem rather differently, attempting to model all induced traffic effects, and then to compare the results with conventional model outputs. In the congested urban case studies used he found that, in the cases where traffic was induced, the overall short-term increase in trips was between 1% and about 3%. One could argue over whether these findings are significant, given the large errors inherent in conventional transport models (Atkins 1986), but this train of debate is to an extent futile, since the largest impact of induced traffic appears to be in economic assessment, rather than in modelling output.

The economic appraisal of urban road schemes usually involves the processing of aggregate data from a transport model. In the first instance, a matrix of trip movements is derived from base year data, and then this matrix is factored to some future year, using estimates of socio-demograhic data, and any information relating to land-use development expected in the study area. Alternatively, traffic flows are measured on critical links, and the forecast new link flows are estimated using simple factoring techniques. The future-year matrix, or link flow data, is then used with varying road network supply scenarios, in order to derive data for the future year under consideration. The total time spent on the network by travellers (measured in vehicle hours), vehicle operating costs, and accidents are then calculated for the do-minimum and do-something future year scenarios. The difference in time, operating and accident costs is an estimate of the economic benefit of the scheme. This information is the key input to the economic evaluation process. The important point to note is that in the evaluation process the trip matrix used is fixed, that is, it does not vary according to road supply (and hence generalised cost conditions) on the network. Given the explanation of induced traffic outlined above, this assumption of a fixed (or inelastic) demand matrix is erroneous, especially in cases of new road supply in congested urban conditions (Brand 1991).

Some may argue that induced drivers receive a benefit from using the scheme, and so induced traffic must be advantageous. It is true that, under the fixed matrix assumption, benefits to induced drivers are ignored. In most circumstances, however, the benefits to induced drivers are far outweighed by the delay costs, imposed by induced drivers, on the existing drivers on the network. These delay costs (measured in vehicle hours) are significant since, in the congested area of the speed-flow curve, even a small number of additional drivers on the network can impose substantial delay penalties on the network as a whole (Mackie 1996). Thus, when considering drivers on the network as a whole, induced traffic is not advantageous.

The question which remains is: what *practical* difference does an assumption of a fixed demand matrix make to economic evaluation? Coombe (1996) looked at the economic impact of relatively small increases in induced traffic. He found that in West London induced traffic of just 1% led to an erosion of benefits of 30% and in Norwich, induced traffic of 2.3-2.9% led to reductions in benefits of 22-20%. One reason for this is that the small increase in absolute vehicle hours, as a result of induced traffic, has a relatively large impact on the difference in vehicle hours between a do-minimum and do-something case. To understand this it is important to note that a large proportion of the benefits in economic evaluations come from savings in vehicle hours. Typically the difference in vehicle-hours between a do-minimum scenario and a do-something scenario may be of the order of only a few percent (depending on the scope of the network considered). An additional 1-3% of induced traffic, in the do-something scenario, thus has a significant impact. Hence, SACTRA were clear in their statements regarding the importance induced traffic for economic evaluation. They stated that: "the economic value of a scheme can be overestimated by the omission of even a small amount of induced traffic" (SACTRA 1994:iii).

This conclusion needs however to be viewed with some circumspection in South Africa, as it is based upon evidence from analyses of the UK economic evaluation programmes 'COBA', which is not used here (Mackie 1996). To our knowledge researchers elsewhere have not examined this topic in detail. However, given that much of the approach to transport economics is universal, and given the strong evidence and conclusions from the British literature, it seems to be timely to re-examine economic evaluation in South Africa, and to investigate the impact of induced traffic on economic evaluations. To ignore this phenomena could lead to seriously misleading economic evaluation results, and the subsequent allocation of funds to inappropriate road schemes. In particular, the SACTRA findings indicate that ignoring the induced traffic phenomena would tend to overinflate the economic benefits of schemes where the network is operating at, or near to, capacity; or where trips are suppressed by congestion (that is, roads in and around urban areas, and at freeway widening schemes).

5.2 Policy implications

With regard to implications for transport policy formulation, the evidence on induced traffic shows that an urban transport strategy with road capacity improvements at its core cannot in the long term bring relief to congestion and car dependency problems. If increased road capacity induces traffic it follows then that whatever road capacity improvement policy is implemented, with the caveat of pre-existing congestion, the amount of traffic per unit of road will increase, not decrease. The same has been argued to be true of 'advanced transport telematics' or 'intelligent transport systems' aimed at the more efficient use of road capacity through driver guidance systems and improved traffic control (Bell 1995). Martin Mogridge (1997) goes one step further and suggests that improving urban road capacity can in fact make congestion worse, due to the impact that shifts in mode have on the viability of public transport, which leads in turn to further mode shifts. This implies, as Phil Goodwin (1998) puts it somewhat bitingly, that policies based on road capacity improvements differ only with respect to 'the speed at which congestion would get worse'.

If the evidence on induced traffic illustrates the futility of supply-side policies as a means of solving urban congestion problems, the evidence on suppressed traffic perhaps provides a pointer to an appropriate policy alternative. There would however appear to be a consensus in debates around the policy implications of induced and suppressed traffic that to argue simply for no future road capacity increases for private vehicles in urban areas would be absurd. This seems particularly true in a developing country with comparatively poor infrastructure. Rather what is called for in the literature, is a balance between supply-side and demand-side strategies within an integrated transport policy framework (Bell 1995, Goodwin 1998). Within such a balanced framework, it is argued that new road construction would need to be justified in terms of its contribution to the implementation of a larger multi-modal transport plan, rather than simply in terms of its estimated congestion benefits for motorists. Some parts of the transport network may require road capacity increases, while other parts -- particularly in city centres and residential neighbourhoods -- may require selective road capacity reductions and reallocation to non-motorised and public transport modes. In the context of growing travel needs, it is argued that selective reductions in road capacity for private vehicles would need to be accompanied by increases in the capacity and quality of the public transport network. Other aspects of such an integrated policy are seen to include a variety of travel demand management measures that involve neither the increase nor decrease of capacity, but changes in the generalised cost of travel (e.g. congestion pricing, parking tariffs and public transport fares).

What then can be said about the *Moving South Africa* statement quoted in the introduction of this paper? The international experience reviewed would appear to support the policy direction expressed here unreservedly. Our only criticism is that such a fundamentally important, and often contentious, set of debates and research findings has received such cursory attention within the new policy documentation. The international experience would suggest that those who undertake the design of road schemes, and painstakingly nurse these schemes through the minefields of public and political approval, are extremely reluctant to see them struck from improvements lists (Goodwin 1998, 1999). As a consequence abandoned road schemes tend to resurface over and over again. For *Moving South Africa*'s above-mentioned policy direction to be acted upon at a sub-national level in South Africa, considerable convincing and debate will probably be required. This paper hopefully serves towards that end.

6. ACKNOWLEDGEMENTS

The authors would like to thank Wilfred Crous, Romano Del Mistro, Paul Mann, Chris Roebuck, Christo Venter, Peter Wilkinson and Keith Wolhuter for criticisms and comments on earlier versions of this paper. The comments of the two anonymous conference referees are also acknowledged. Responsibility for any errors remains our own.

7. REFERENCES

Atkins S, 1986: "Transportation Planning Models: What the Papers Say", *Traffic Engineering and Control*, Vol 27, No 9, September.

Bell M, 1995: "Solutions to Urban Traffic Problems: Towards a New Realism", *Traffic Engineering and Control*, Vol 36, No 2, February.

Bonsall P, 1996: "Can Induced Traffic be Measured by Surveys?", Special Issue on Induced Traffic, *Transportation*, Vol 23, No 1, February.

Brand D, 1994: "Use of Travel Forecasting Models to Evaluate the Travel and Environmental Effects of Added Transportation Capacity", in Shunk G (ed): "*The Effects of Added Transportation Capacity: Conference Proceedings*", DOT-T-94-12, Travel Model Improvement Program, US Government Printing Office, Washington D C.

Cairns S, Hass-Klau C and Goodwin P, 1998: "*Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence*", Transport Studies Unit, University College London, Landor, London.

Coombe D, 1996: "Induced Traffic: What Do Transportation Models Tell Us?", Special Issue on Induced Traffic, *Transportation*, Vol 23, No 1, February.

Coombe D, Bates J and Dale M, 1998: "Modelling the Traffic Impacts of Highway Capacity Reductions", *Traffic Engineering and Control*, Vol 37, No 7/8, July/August.

DeCorla-Souza P and Cohen H, 1999: "Estimating Induced Travel for Evaluation of Metropolitan Highway Expansion", *Transportation*, Vol 26, No 3, August.

DOT, 1999: "*Moving South Africa: The Action Agenda*", Department of Transport, Pretoria.

Dowling R and Colman S 1998, "Effects of Increased Highway Capacity: Results of a Household Travel Behaviour Survey", in "*Highway Capacity Expansion and Induced Travel: Evidence and Implications*", Transportation Research Circular No 481, Transportation Research Board, National Research Council.

Garrett M and Wachs M, 1996: "*Transportation Planning on Trial: The Clean Air Act and Travel Forecasting*", Sage Publications, California.

Goodwin P, 1996: "Empirical Evidence on Induced Traffic: A Review and Synthesis", Special Issue on Induced Traffic, *Transportation*, Vol 23, No 1, February.

Goodwin P, 1997: "Doomsday Postponed", *Transport Policy*, Vol 4, No 1, January.

Goodwin P, 1998: "*Some Problems in the Transformation of Transport Policy*", ESRC Transport Studies Unit Working Paper, University College London, London.

Goodwin P, 1999: "*Action or Inertia? One Year on from 'A New Deal for Transport'*", Paper presented at a Transport Planning Society Meeting at the Institution of Civil Engineers, London.

Hansen M and Huang Y, 1997: "Road Supply and Traffic in California Urban Areas", *Transportation Research A*, Vol 31, No 3.

Hansen M, 1998: "The Traffic Inducement Effect: Its Meaning and Measurement", in "*Highway Capacity Expansion and Induced Travel: Evidence and Implications*", Transportation Research Circular No 481, Transportation Research Board, National Research Council.

Headicar P, 1996: "The Local Development Effects of Major New Roads: M40 Case Study", Special Issue on Induced Traffic, *Transportation*, Vol 23, No 1, February.

Heanue K, 1998: "Highway Capacity and Induced Travel: Issues, Evidence and Implications", in "*Highway Capacity Expansion and Induced Travel: Evidence and Implications*", Transportation Research Circular No 481, Transportation Research Board, National Research Council.

Hills P, 1996: "What is Induced Traffic?", Special Issue on Induced Traffic, *Transportation*, Vol 23, No 1, February.

Kitamura R, 1994: "The Effects of Added Transportation Capacity on Travel: A Review of Theoretical and Empirical Results", in Shunk G (ed): "*The Effects of Added Transportation Capacity: Conference Proceedings*", DOT-T-94-12, Travel Model Improvement Program, US Government Printing Office, Washington D C.

Litman T, 1999: "*Generated Traffic: Implications for Transport Planning*", Victoria Transport Policy Institute, Victoria.

Mackie P, 1996: "Induced Traffic and Economic Appraisal", Special Issue on Induced Traffic, *Transportation*, Vol 23, No 1, February.

Mogridge M, 1997: "The Self-Defeating Nature of Urban Road Capacity Policy: A Review of Theories, Disputes and Available Evidence", *Transport Policy*, Vol 4, No 1, January.

Noland R, 1999: "*Relationships Between Highway Capacity and Induced Vehicle Travel*", Paper presented at the 38th Annual Meeting of the Western Regional Science Association, Ojai.

SACTRA, 1994: "*Trunk Roads and the Generation of Traffic*", Standing Advisory Committee on Trunk Road Assessment, Department of Transport, London.

Weiner E, 1997: "*Urban Transportation Planning in the United States: A Historical Overview*", Fifth Edition, Travel Model Improvement Program website (on-line).

THE TRAFFIC IMPACTS OF ROAD CAPACITY CHANGE: A REVIEW OF RECENT EVIDENCE AND POLICY DEBATES

Lisa Kane and Roger Behrens

Urban Problems Research Unit, University of Cape Town,
Private Bag, Rondebosch, 7701

CV for Lisa Kane

BEng (Cardiff) MScEng (Cape Town) AMITE

Lisa Kane is a part-time Honorary Research Associate at the Urban Problems Research Unit, University of Cape Town. Previously a consultant in transport planning in the UK, and subsequently a lecturer in transportation in the Department of Civil Engineering at UCT, she is now focusing on research in theories of transport planning, and their application to South African contexts.

CV for Roger Behrens

TRP(SA) BA MCRP (Cape Town), MSAPI

Roger Behrens is a Senior Researcher in the Urban Problems Research Unit, University of Cape Town, where he has undertaken commissioned research and consultancy work. He is currently registered as PhD student at UCT. His PhD research interests relate to activity-based travel analysis, movement network configuration-travel behaviour relationships, and transport policy analysis.