A program for monitoring vehicle speeds in South Australia

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Abstract

A program designed to monitor the speed behaviour of motorists commenced at 132 sites in South Australia in 2007. The sites selected included sites with historical measurements supplemented by new sites to give a broad range of road types. Individual speed and vehicle classification data was collected for one week on local, collector and arterial roads in metropolitan and rural areas. Surveys on a subset of 52 roads in built up areas conducted to evaluate the impact of the 50 km/h Default Urban Speed Limit were used to monitor trends dating back to 2002. The 132 sites measured in 2007 established a benchmark more representative of the road network as a whole. The paper discusses some initial comparisons with previous datasets and general points of interest in mass speed datasets from a road safety research perspective.

Keywords

Travelling speed, speed limits, speed survey

Introduction

Speed is an important determinant of crash incidence and outcomes and numerous initiatives are being implemented in South Australia with the aim of reducing the speeds of vehicles. Although the ultimate objective is to reduce the number and severity of crashes, it is desirable that changes to on-road travelling speeds also be monitored to assess the effectiveness of the initiatives and monitor the behaviour of motorists over time.

The authors conducted a review of existing speed data sets and their survey sites in South Australia and designed a survey that monitors 132 sites representative of the rural and metropolitan road network incorporating new and historical data collection sites.

This paper discusses a systematic and ongoing method of measuring vehicle speeds in South Australia and the results from the initial baseline speed survey conducted in 2007. Some comparisons are also made for sites with previously collected survey data. A full description of the survey design and its outcomes are documented in Kloeden and Woolley (1). Consequent surveys have been conducted annually and will be reported on in future conference papers. The concept and implications of a national speed database will also be discussed in a future paper along with the need for consistent data collection criteria between jurisdictions.

By consistently monitoring speed trends over time, initiatives to change the speeding behaviour of motorists can be better understood and refined. The trend data will also allow the comparison of modelled and observed changes in road trauma using current models of the risk of crash involvement associated with travelling speed.

Methods

Working with the Department for Transport, Energy and Infrastructure (DTEI), the authors identified a selection of sites in South Australia at which speed measurements could be undertaken on a yearly basis. The sites selected included sites with historical measurements supplemented by new sites to give a broad range of road types. The mid-block sites were generally located away from traffic controls, changes in speed limits and bends where free flow speeds were to be expected.

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Upon further investigation of the data following the initial survey, some sites were omitted due to changing road conditions, having a different speed limit to that originally planned, or their close proximity to changes in speed limits. A total of 132 sites formed the final set of survey sites covering the road types shown in Table 1. The survey sites consisted of 36 permanent counters on Auslink rural highways, 18 sites from an annual DTEI rural speed survey, 51 sites from a survey designed to evaluate the 50 km/h Default Urban Speed Limit and 27 new sites. With the exception of the Auslink sites, all data was collected using temporary counting equipment utilising tubes laid across the roadway.

Table 1: Speed survey sites by road type and survey source

Road type (speed limit)	Auslink Rural Highway Sites	Annual DTEI Rural Survey	Default 50km/h Evaluation Sites	New Sites	Total
Adelaide local (50)			18		18
Adelaide collector (50)			11		11
Adelaide arterial two way no median (60)			3	3	6
Adelaide arterial two way with median (60)			1	5	6
Adelaide arterial multi-lane no median (60)			2	4	6
Adelaide arterial multi-lane with median (60)			4	5	9
Adelaide arterial (80)				6	6
Rural local (50)		2	12		14
Rural arterial (60)		4			4
Rural hills arterial (80)				4	4
Rural arterial (100)	4	6			10
Rural arterial (110)	31	4			35
Outback arterial (110)	1	2			3
Total	36	18	51	27	132

The objective was to capture data at each site for a continuous one week period either in August 2007 or November 2007 depending on the site. August was selected for rural locations as this month most closely matched Annual Average Daily Traffic (AADT) conditions on the roads that were surveyed. The November period was selected for metropolitan sites to maintain consistency with previous speed surveys. Due to limitations of the equipment, multilane arterial roads with medians had their median lanes measured and multilane arterial roads without medians had their kerbside lanes measured. Due to equipment malfunctions, some of the time periods had to be extended, however, a full week of data was collected at each of the 132 sites.

The following information was recorded for each vehicle that passed during the survey period:

- date
- time (to nearest second)
- direction of travel
- speed (to nearest 0.1 km/h)
- wheelbase (to nearest 0.1 m)
- headway (to nearest 0.1 second)
- gap (to nearest 0.1 second)
- number of axles
- class of vehicle (based on number of axles and wheel bases)

The Default 50 km/h Evaluation Sites were those used in the evaluation of the introduction of the default 50 km/h speed limit and reported in Kloeden *et al.* (2). The new measured sites were additional sites surveyed by the same contractor collecting the default 50 data during the same time period in November and December 2007. They were selected to bolster the number of sites in the different road types, mainly concentrating on metropolitan arterial roads. The rural hills arterial sites consisted of six sites with 80 km/h speed limits where infrequent DTEI speed measurements were made in the past. However, two of these were dropped: one was actually a 100 km/h speed zone; and one was very close to a 100 km/h speed

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limit zone. Individual vehicle speed observations below 10 km/h were excluded from analyses however there was no maximum cut-off applied.

Results

Speeds were analysed for each site and aggregated by road type and all roads combined. Both free speed vehicles and all vehicle speeds were investigated. Free speed vehicles were defined as those that had at least a four second headway to the vehicle in front of them (ie the time between the front wheels of the two vehicles passing the measurement site was at least four seconds). In this paper only the results of all vehicle speeds are presented, however, these did not differ greatly from the summary statistics when only free speed vehicles were considered. A summary of the complete analysis can be found in Kloeden and Woolley (2).

The traffic volume and summary speed statistics for all vehicles passing the measured sites over a one week period are presented in Table 2 grouped by road type. Some speed distributions contrasting the different road types are shown in Figure 1.

Table 2: Traffic volumes and speed statistics for each road type in 2007

Road type (speed limit)	Number of sites	Vehicle count	Mean speed	Median speed	85th percentile speed	%exceeding speed limit	%exceeding speed limit by >10 km/h
Adelaide local (50)	18	118909	45.06	46.3	55.7	34.49	6.58
Adelaide collector (50)	11	249345	49.77	50.1	57.4	50.32	8.94
Adelaide arterial two way no median (60)	6	707978	56.00	57.1	62.4	28.77	1.42
Adelaide arterial two way with median (60)	6	713186	54.81	55.9	60.9	19.75	0.81
Adelaide arterial multi-lane no median (60)	6	523467	54.85	56.2	61.6	23.03	1.19
Adelaide arterial multi-lane with median (60)	9	822287	59.34	60.0	64.9	49.90	3.09
Adelaide arterial (80)	6	657753	74.77	75.7	82.6	26.66	2.02
Rural local (50)	14	110898	51.87	53.6	61.6	65.35	20.75
Rural arterial (60)	4	72254	57.60	58.2	64.6	37.79	4.77
Rural hills arterial (80)	4	92616	76.61	76.2	85.4	32.21	7.58
Rural arterial (100)	10	119126	92.11	92.7	103.8	25.66	5.64
Rural arterial (110)	35	390931	102.12	103.3	113.5	25.82	3.88
Outback arterial (110)	3	7174	105.97	107.2	120.3	42.50	15.49

An ongoing comparison of speeds at the of the Default 50 km/h Evaluation Sites was made. In 2002, just before the introduction of the default 50 km/h speed limit in built up areas, the speeds of vehicles were measured for one day at 52 sites (a week day with a preference for Wednesdays where possible). These measurements were repeated approximately one year later in 2003 and again in 2005 in order to assess the effect of the introduction of the default 50 km/h speed limit on vehicle speeds and reported in Kloeden *et al.* (2).

Since the current set of 132 surveyed sites includes 51 of these sites it is possible to compare speeds in 2007 with those measured in 2002, 2003 and 2005. Since the sites in earlier years were only surveyed for one day of the week, data for that day was taken from each of the 51 relevant sites in 2007.

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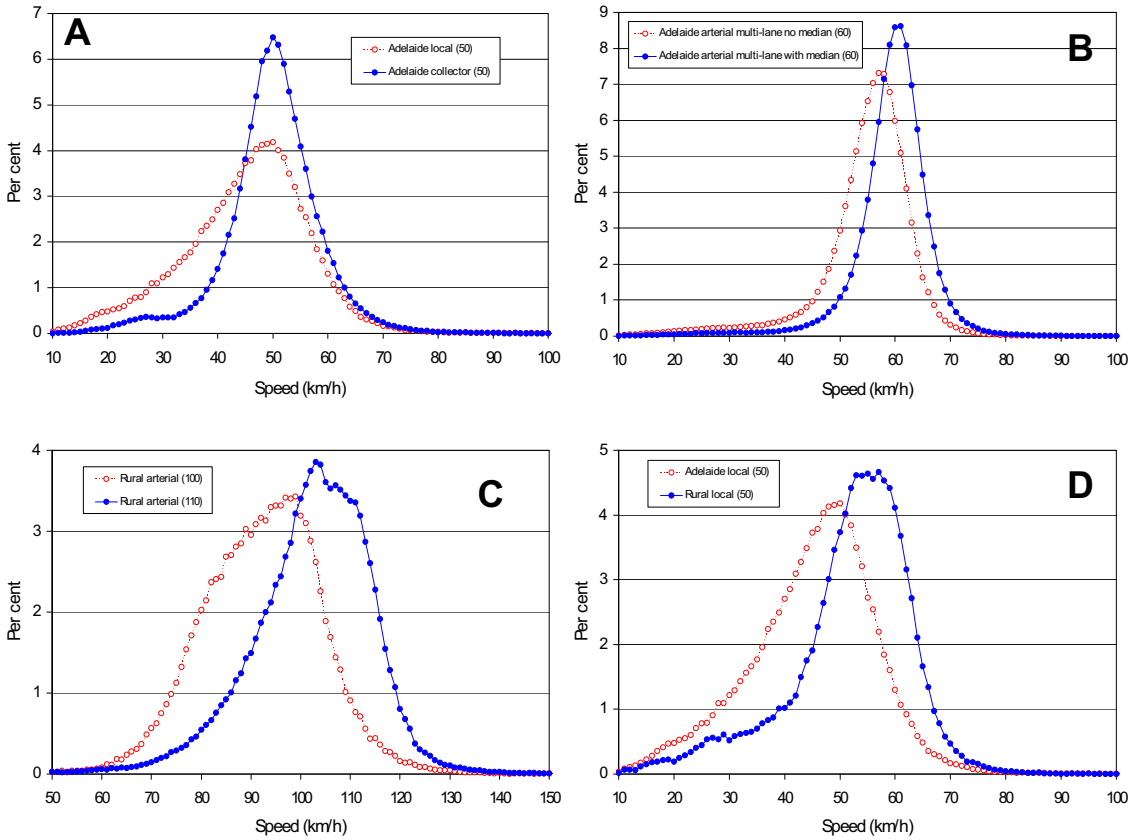

Figure 1: Comparison of speed distributions between road types: A) Metro 50 km/h Local and Collector Roads; B) Metro 60 km/h Multilane arterials with and without a median; C) Rural 110 and 100 km/h roads; and D) Metro and Rural 50 km/h local roads.

Summary volume and speed statistics are shown for metropolitan local roads in Table 3. The change in mean speeds by road type is shown in Figure 2.

Table 3: Traffic volumes and speed statistics for 50 km/h Adelaide local roads by year of survey (18 sites)

Measurement	Year of survey			
	2002	2003	2005	2007
Traffic count	17663	19207	18513	17667
Mean speed	47.91	44.78	43.65	45.07
Median speed	48.97	46.13	45.14	46.50
85th percentile speed	60.00	55.38	55.02	55.70
% exceeding 50 km/h	46.22	33.57	31.87	35.01
% exceeding 60 km/h	14.94	6.52	5.92	6.48

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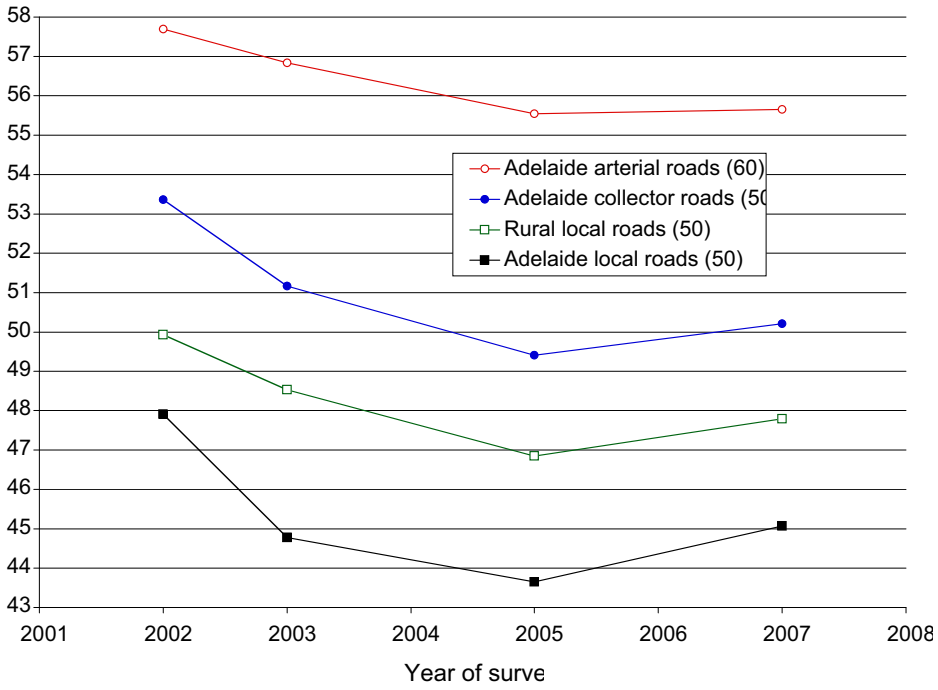

Figure 2: Change in mean speeds for the 50 km/h Evaluation sites over time by road type.

It is clear that the measured speeds increased from 2005 to 2007 on all four road types. However, a certain variation in daily speed measurements is to be expected so it is not clear if the change in speeds can be attributed to an underlying effect or to chance variation in the measurements. In order to test the statistical significance of the change in speed, each site/direction combination was treated as a single measurement with a before and after speed value and the changes in these values over the relevant sites were analysed.

As an example, consider the mean speed on Adelaide local roads in 2007 compared to 2005. There were 18 such sites (one of which was a one way street) giving 35 independent collections of speed measurements in each year. Taking the mean speed of each collection in 2005 and 2007 gives 35 pairs of mean speeds and 35 changes in mean speed. If all of the changes were in the same direction, then it would be likely that any overall difference was not the result of chance. If, however, close to half were in one direction and half were in the other direction (by about the same amounts), then the individual changes would likely have been due to chance.

The average speed changes are presented in Table 4 with the statistically significant results indicated.

Table 4: Average changes at sites in 2007 compared to 2005 by road type

Road type (speed limit)	Number of speed collections	Vehicle count	Mean speed	Median speed	85th percentile speed	%exceeding speed limit	%exceeding speed limit by more than 10 km/h
Rural local (50)	23	1.48	0.46	0.34	0.44	1.56	-0.01
Adelaide local (50)	35	-24.17	1.04*	1.12*	0.46	1.40	0.16
Adelaide collector (50)	22	87.59	0.50	0.41	0.32	2.91	0.46
Adelaide arterial (60)	20	307.65*	0.38	0.50	0.43	2.18	-0.04
All 50 roads	80	13.94	0.72*	0.70*	0.42	1.86*	0.19
All of the above roads	100	72.68*	0.66*	0.66*	0.42*	1.93*	0.15

* statistically significant ($p < 0.05$)

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The same approach was used to investigate changes in speeds on rural roads as part of the Annual DTEI Rural Speed Surveys with the results summarised in Table 5. A week of speed data was used for the comparisions.

Table 5: Average changes at sites in 2007 compared to 2006 by rural road type

Road type (speed limit)	Number of speed collections	Vehicle count	Mean speed	Median speed	85th percentile speed	%exceeding speed limit	%exceeding speed limit by more than 10 km/h
Rural local (50)	4	137.75	0.29	-0.43	-0.70	4.14	-4.94
Rural arterial (60)	8	300.25	0.72	0.74	0.85	3.23	0.86
Rural arterial (100)	12	222.67*	-0.03	0.02	-0.38	0.31	-0.81
Rural arterial (110)	12	-14.08	0.62	0.36	0.43	0.57	0.26
Outback arterial (110)	6	149.00*	0.83	0.65	-0.22	1.11	0.85
All roads <= 60 km/h	12	246.08*	0.58	0.35	0.33	3.54	-1.07
All roads > 60 km/h	30	113.23*	0.40	0.28	-0.03	0.58	-0.05
All of the above roads	42	151.19*	0.45	0.30	0.08	1.42	-0.34

* statistically significant ($p < 0.05$)

Discussion

Speed measurements at 132 sites around South Australia have been collected and will form the baseline against which future surveys at the same set of sites will be compared.

Metropolitan Roads

A subset of the 2007 survey sites on Adelaide roads had single day speed surveys conducted in 2002, 2003 and 2005 as part of the evaluation of the introduction of the default 50 km/h General Urban Speed Limit. This allowed changes in speeds from 2002 to 2007 to be examined. Previous reports by Kloeden *et al.* (2) on this data found reductions in speeds on all the road types examined from 2002 to 2003 and further reductions from 2003 to 2005.

When examining a comparable subset of the 2007 speed data, speeds on all the examined road types increased from 2005 to 2007. Further analysis found that the increase was only statistically significant for Adelaide local roads. However, the relative consistency of the increase on different road types and the fact that the increase achieves statistical significance when all road types were combined suggest that the increase in travelling speeds observed is unlikely to be due to chance. The best estimate of the size of the change for all the examined roads is a 0.66 km/h increase in mean vehicle speeds and 0.70 km/h for mean free vehicle speeds from 2005 to 2007.

Rural Roads

A subset of the 2007 survey sites on rural roads had comparable speed surveys conducted in 2006 (as part of the Annual DTEI Rural Speed Surveys). This allowed changes in speeds from 2006 to 2007 to be examined on those roads. Although there were indications of a slight increase in speeds on these roads from 2006 to 2007, further analysis found no statistically significant difference in any of the speed measures between the two years.

Rural local roads and outback arterial roads had the greatest proportion of vehicles exceeding the posted speed limit by more than 10 km/h (more than 15% of vehicles in each case).

Sampling Issues

There are a number of issues that need to be considered when conducting these types of surveys:

- Random variation
- Time of year
- Weather conditions

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- Road works
- Traffic incidents
- Changes to roads
- Enforcement practices
- Calibration and operation of equipment

The authors have yet to quantify the effects of seasonal variation and random variation on travelling speeds. Given that the data only provides a snapshot of one week in the year, further investigation is needed to establish the range of random and seasonal variation that is to be expected when making the comparisons. The data from the permanent counting sites on rural roads would allow some exploration of this issue however the capacity did not exist to monitor metropolitan sites on a permanent basis during 2007. This is currently being addressed.

The extent to which weather conditions influence travelling speeds is unknown. It may be worth monitoring rainfall and temperature so that extremes between surveys can be identified.

Incidents or road works are capable of altering speed distributions at a site. Where possible, measurements need to be repeated where data has been distorted by such events. A quality control check of data soon after it has been collected is required to identify any anomalies and allow a repeat or extended measurement to be undertaken.

The monitoring of road environment at each site is not a trivial matter and it is expected that there will be attrition amongst the sites due to changes over time. These include changing speed limits, road geometry or changes to nearby network traffic management that alters traffic patterns. A photographic record of each site is being compiled to assist with future surveys.

Future Work

The survey has established the baseline year to which future annual speed surveys will be compared. In addition to these comparisons, further work is planned in relation to the examination of time of day and day of week effects and the influence of vehicle type. A more detailed analysis of vehicle gaps is envisaged with further exploration of the concept of a "free speed" headway and if the 4 second headway remains a valid measure in the road safety context. Seasonal variation also needs to be explored at sites where continuous speed data exists. Finally, work has begun on the concept of a national speed database and the need for uniform data collection criteria.

Conclusions

A speed survey has been designed to monitor travelling speeds at 132 sites on the South Australian road network. Baseline speed measurements were obtained in 2007 and it is envisaged that this survey be repeated at the same sites on an annual basis. As many of the sites were also used in previous speed surveys, a comparison between previous years was also made for selected metropolitan and rural roads. For Metropolitan roads, the best estimate of the size of the change for all the examined roads is a 0.66 km/h increase in mean vehicle speeds and 0.70 km/h for mean free vehicle speeds from 2005 to 2007. Although there were indications of a slight increase in speeds on rural roads from 2006 to 2007, further analysis found no statistically significant difference in any of the speed measures between the two years.

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