

Climate, Geography and the Propensity to Walk: environmental factors and walking trip rates in Brisbane

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1 Introduction

Transport planners and health promoters are presently concerned with increasing the proportion of walking trips made in urban areas in order to increase efficiencies in the transport system and rates of physical activity. However, there are numerous 'barriers to walking' that need to be overcome in order to increase walking trip rates in cities, including several environmental factors relating to the 'natural environment'. Natural environment factors include topography, and climatic variables such as heat and humidity, precipitation, and daylight availability. This study has sought to develop appropriate variables from available data sources and to synthesise them with household travel survey data so as to examine the influence of environmental factors on a person's propensity to walk in Brisbane, Australia.

The primary purpose of the study was developing and testing new methods to identify the influences of environmental factors, rather than undertaking more extensive and rigorous research to provide precise measurements. Despite this, the results reveal a new set of insights into walking in this sub-tropical city that at times confirm and at other times confound popular assumptions about pedestrian activity. The belief that Brisbane's sub-tropical summer weather and hilly terrain are not conducive to non-motorised travel is not supported by these preliminary findings. Indeed the natural environmental conditions in the city appear to have little influence on the propensity of persons to walk.

2 Context

The influence of the natural environment on non-motorised travel is not well understood, partly due to the difficulties associated with obtaining data and measuring effects. As a result, 'seldom are data about the natural and built environments, such as local topography, ... included as affecting the attractiveness of a given mode' within travel mode choice studies (Rodriguez and Joo 2004:152).

Topography is the natural environmental factor that most often appears in studies of urban environments and travel behaviour. Following the pioneering research of 1,000 Friends of Oregon et al. (1993) and Holtzclaw (1994), topography has generally been understood as being a significant influence. It has been included as one of four factors within Portland's *Pedestrian Environment Factor (PEF)* model as part of their regional travel modelling.

Our understandings of climatic conditions and mode choice are less advanced. Climatic factors are generally considered constant in any region (US Department of Transportation and Federal Highway Administration 1999) and are temporal, not spatial. They cannot be altered unlike built environment factors, and have generally been omitted from urban travel models. Nevertheless all travel is seasonal and 'bad weather' is regularly cited as a reason for not walking and cycling to school or for other purposes (Martin and Carlson 2005:951; National Highway Traffic Safety Administration and Bureau of Transportation Statistics 2003:3). Researchers have found negative associations between temperature and travel behaviour, which include reduced boardings on public transport in extreme weather (Kuby,

Barranda and Upchurch 2004), and reduced walking and cycling trip-making due to diminishing daylight availability (Hahn and Craythorn 1994).

Figure 1 provides a conceptual diagram of the way that natural environmental factors (amongst other factors) are thought to influence non-motorised travel.

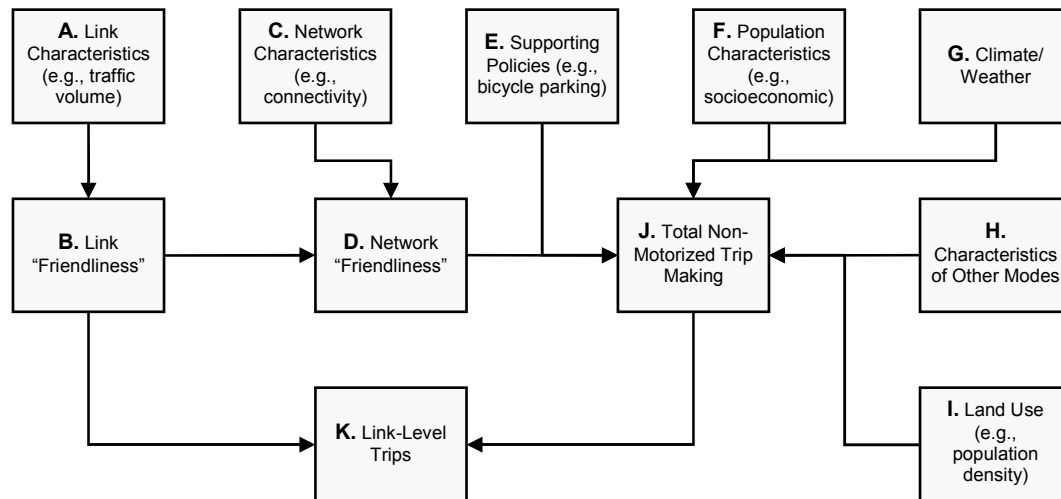


Figure 1 Relationship of Factors Influencing Non-Motorized Travel (source: U.S. Dept. of Transportation's Federal Highway Administration 1999)

3 Data and methods

3.1 Household travel survey data

The *South East Queensland Travel Survey - Brisbane Statistical Division 2003-2004* dataset (SEQTS) was used for this study. The purpose of the SEQTS was to collect information on the day-to-day travel and activities of randomly selected households in Brisbane - how they travel, where they go, when, and why. As a result, the SEQTS provides us with information on the walking trips (as well as trips by other modes) made in late 2003 and in early 2004 by 10,931 persons within the Brisbane Statistical Division, which provides considerable insight into trip making in the city (see Queensland Transport et al. 2005 for more detail on the procedures used for the collection and preparation of data within the SEQTS).

Although the SEQTS is conducted using state-of-the-art methods in travel survey collection, the primary purpose of the SEQTS was not to enable detailed analysis and modelling of pedestrian trips. Instead the survey provides inputs into important multi-modal models such as the *Brisbane Strategic Transport Model*, which enable planners to assess roads and public transport investments. There are also issues relating to data collected by household travel surveys, which are acknowledged as creating a small number of imperfections in the data. Some of these have implications for this study:

- The SEQTS did not record the actual route that persons travelled from one origin to a destination. Instead, a shortest path route was identified for all trips, using sophisticated geographic information systems (GIS) software and the city's street network. This meets the needs of road and public transport modellers, but has some limitations when considering walking trips that use off-street paths and other infrastructures. This study has therefore chosen to focus more on the reported trip rates for walking (the number of 'trip stages' made per person per day) rather than the distance travelled by either mode.

- Secondly, a clustered sampling technique was used in the SEQTS to maximise efficiencies in survey collection and to minimise costs. It is important to note that households surveyed were spatially concentrated in parts of specific statistical local areas (SLAs) within Greater Brisbane, with 118 of the SLAs in the SEQTS region surveyed. It is assumed for the purposes of this study that those households are representative of the SLA in which they are located.
- Thirdly, the travel survey only captured data on weekday travel and not travel made on weekends (Saturdays and Sundays). The analysis is therefore solely based on weekday travel patterns, and no inference should be drawn on any relationships between environmental factors and weekend travel.
- Fourth, the travel survey isolated a small but significant set of walking trips that were made from a vehicle to a destination, asking respondents to identify “how long did it take you to walk from the vehicle to (the end destination)”. A total of 5,075 trip stages were recorded in this manner, but no further information was included (such as the trip distance). These trips were not incorporated into the final set of trip stages that comprise the SEQTS dataset and have not been used in this study.
- Finally, the household travel surveys have a propensity for the under-reporting of short, often non-motorised trips, which is difficult to overcome (Richardson 1995). For the purposes of this analysis it is assumed that the rate of under-reporting is spatially constant across different parts of the city.

The research conducted in this study focuses on all trip stages made by the walking mode by all members of the survey population. A ‘trip stage’ is defined as “a one-way travel movement from an origin to a destination for a single purpose (including change of mode) and by a single mode” (Queensland Transport et al. 2005:4).

3.2 Study area

The study area is defined by the extent of the SEQTS. The survey is limited to the Brisbane Statistical Division (BSD), as defined in the 2001 Census by the Australian Bureau of Statistics. This area extends from the northern half of the Gold Coast local government area (LGA) to the southern part of Caboolture LGA and west to the eastern half of Ipswich LGA.

The SEQTS divides the BSD into 11 sub-regions, which are outlined in Figure 2. This is further broken down into Statistical Local Areas (SLAs) where the survey was conducted.

Brisbane has climatic conditions that may similarly influence behaviour - high heat and humidity in summer, storm events with significant precipitation, and varying daylight availability across the seasons.

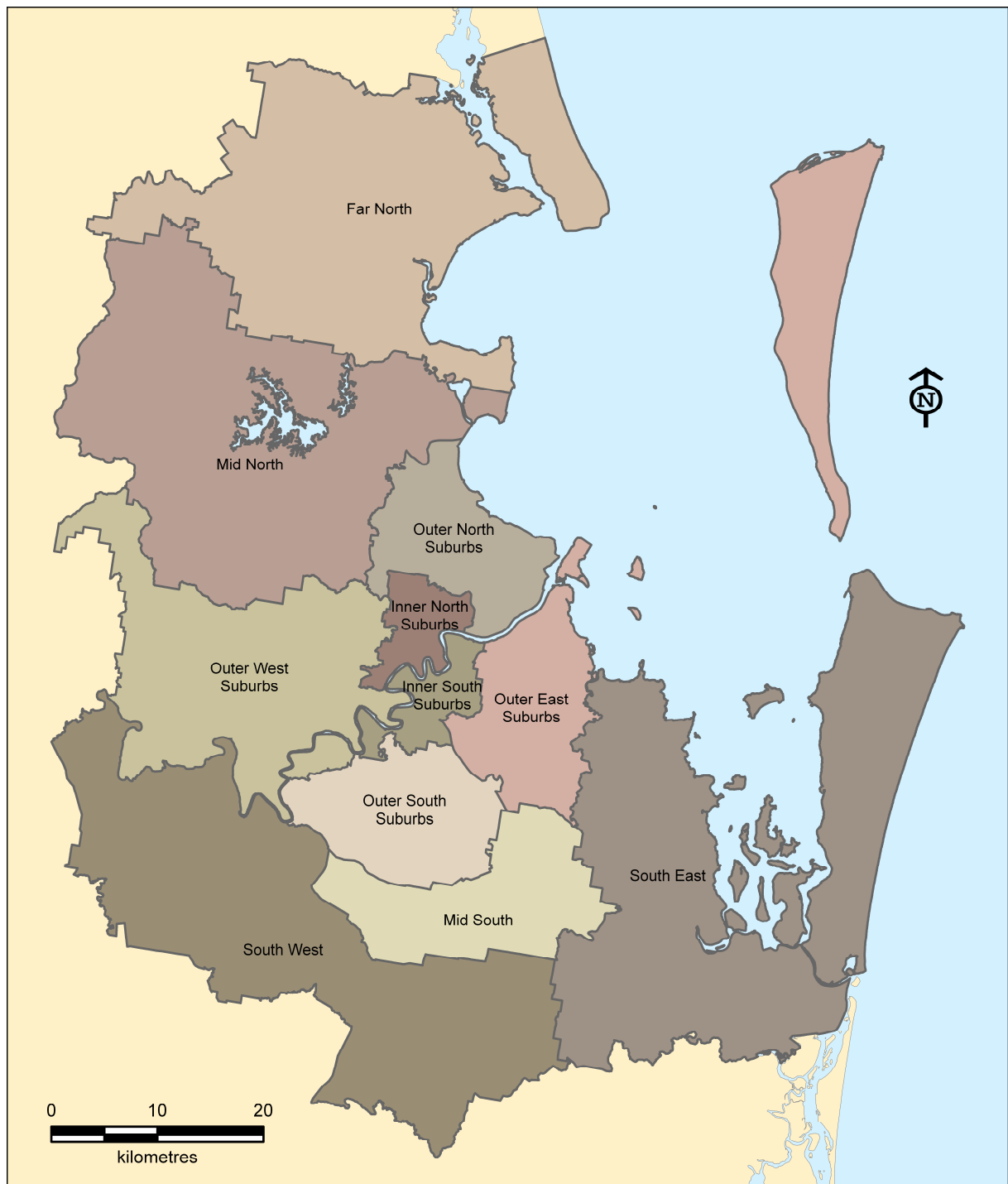


Figure 2 SEQTS Regions (Study Area)

4 Heat and humidity

It is difficult to use temperature data alone to describe how ‘hot’ a particular day feels to the average person, especially in the South East Queensland climate where humidity is a significant factor in summer weather. A measure that provides a better understanding of the effects of heat and humidity is required.

The HUMIDEX was devised by Canadian meteorologists to describe how hot and humid weather feels to the average person. The HUMIDEX combines temperature and humidity to

produce a measure that reflects the 'perceived temperature' for the average person in these conditions. Because it takes into account the two most important factors it is considered a better measure of relative discomfort than either temperature or humidity alone. However, it does ignore wind chill factor, which is known to also influence perception of temperature.

Equation 1 shows how a HUMIDEX score is calculated, Figure 3 shows the scores obtained for a set of air temperature and relative humidity levels, and Table 1 displays the relative scores and the degree of comfort generally believed to exist for persons experiencing these conditions - though these measures are solely subjective and not definitive.

$$\text{HUMIDEX} = T + 5/9 * ((6.112 * 10^{\left(\frac{7.5 * T}{237.7 + T}\right)} * H / 100) - 10)$$

Where:

T = air temperature (degrees Celsius)

H = relative humidity (%)

Equation 1 Calculation of HUMIDEX

	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
42°	48	50	52	55	57	59	62	64	66	68	71	73	75	77	80	82
41°	46	48	51	53	55	57	59	61	64	66	68	70	72	74	76	79
40°	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75
39°	43	45	47	49	51	53	55	57	59	61	63	65	66	68	70	72
38°	42	44	45	47	49	51	53	55	56	58	60	62	64	66	67	69
37°	40	42	44	45	47	49	51	52	54	56	58	59	61	63	65	66
36°	39	40	42	44	45	47	49	50	52	54	55	57	59	60	62	63
35°	37	39	40	42	44	45	47	48	50	51	53	54	56	58	59	61
34°	36	37	39	40	42	43	45	46	48	49	51	52	54	55	57	58
33°	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54	55
32°	33	34	36	37	38	40	41	42	44	45	46	48	49	50	52	53
31°	32	33	34	35	37	38	39	40	42	43	44	45	47	48	49	50
30°	30	32	33	34	35	36	37	39	40	41	42	43	45	46	47	48
29°	29	30	31	32	33	35	36	37	38	39	40	41	42	43	45	46
28°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
27°	27	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
26°	26	26	27	28	29	30	31	32	33	34	34	35	36	37	38	39
25°	25	25	26	27	27	28	29	30	31	32	33	34	34	35	36	37
24°	24	24	24	25	26	27	28	28	29	30	31	32	33	33	34	35
23°	23	23	23	24	25	25	26	27	28	28	29	30	31	32	32	33
22°	22	22	22	22	23	24	25	25	26	27	27	28	29	30	30	31

Figure 3 HUMIDEX scores by air temperature (°C) and relative humidity
(source: http://www.eurometeo.com/english/read/doc_heat)

Table 1 HUMIDEX ratings

<i>Range of HUMIDEX</i>	<i>Degree of comfort</i>
Less than 29	No discomfort
30 to 34	Some possible slight discomfort
35 to 39	Some possible moderate discomfort
40 to 45	Possible strong discomfort
46 to 53	Possible very strong discomfort

Note: values derived from www.eurometeo.com

The HUMIDEX score for each day in the SEQTS survey period was calculated and assigned to all trip stages made, allowing for a test to determine if climatic variability (i.e. how hot it feels to the average person) is associated with walking trip rates. The maximum score attained was 47.90 on the 17th of February 2004 while the minimum score was 23.95 on the 4th November 2003.

It was not feasible to calculate the HUMIDEX score at the exact time of day for each trip stage, only the score for the day during which the trip stage took place. There are limitations to this approach in that the HUMIDEX was calculated using the maximum temperature and humidity levels for each day. This can introduce error as the maximum temperature and humidity may not occur simultaneously during each day. As a result there is likely to be a small but significant over-estimation in HUMIDEX values.

Walk trip rates were then calculated for each day of the SEQTS survey period. There is a significant limitation with this approach relating to the sampling procedures used for data collection. Data was collected from households in only a few scattered statistical local areas on each date of the survey period, building cumulative data across the city until the final sample was complete. This introduces significant sampling variability when viewed on a day-by-day basis, however, it was assumed for the purposes of this study that there were no significant effects.

A comparison was then made between the trip rates for all survey days to identify any one-way association between the HUMIDEX variable and the number of walking trip stages made per person per day.

A scatterplot is used to provide a visual inspection of any possible one-way relationships involving HUMIDEX. In addition, a linear regression model was used to determine if there was any association between HUMIDEX scores and the walking trips rates for each day of the survey period. The results are shown in Figure 4 below.

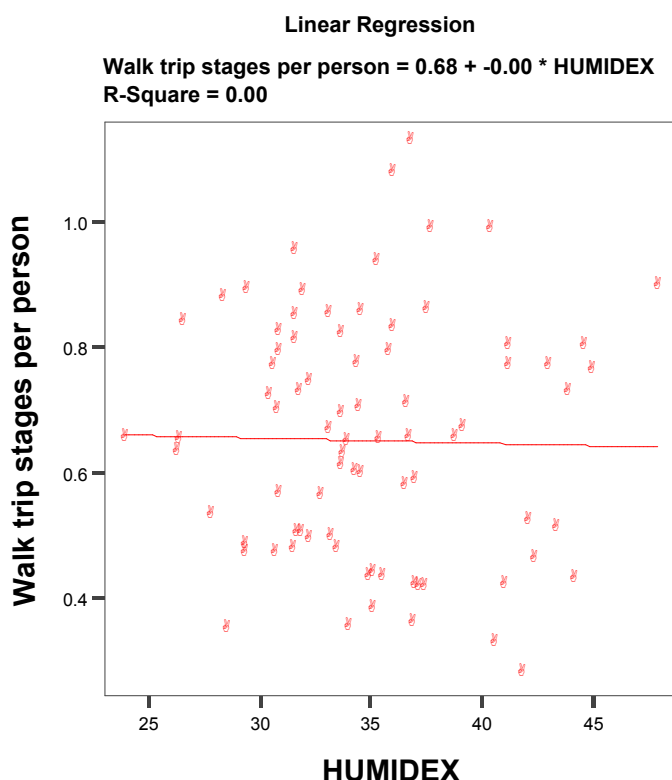


Figure 4 Scatterplot - HUMIDEX vs. No. walking trip stages per person per day

The scatterplot reveals a dispersed set of values without any distinguishable trend as HUMIDEX increases. The results of the linear regression model (R-square = 0.001; $p = 0.837$) confirm this result. There is no one-way association between the variables.

This is a confounding finding that casts doubt on the popular assumptions about the influence of heat and humidity on travel behaviour in Greater Brisbane. There is nil association between a composite index of heat and humidity with daily trip rates for either walking. Several suggestions can be made as to why this result might have been returned, other than the limitations already noted, including:

- The SEQTS did not collect data during late December and January, when heat and humidity are often highest, or in winter when there are very different conditions. This limitation may have influenced the result by reducing the overall variability in the HUMIDEX.
- The reasonably moderate scores obtained in HUMIDEX, even for days in December and February, indicate that Brisbane's summer may not be as uncomfortable for outdoor activities as is sometimes popularly suggested.
- An element of trip scheduling may be occurring, whereby persons avoid non-motorised travel during the hottest and most humid parts of the day.

5 Precipitation

It is generally understood that people try to avoid walking in rain. However it is not known whether rain events affect overall trip patterns for entire days in Brisbane - reducing walking trip rates as a result. To address this issue the walking trips within the SEQTS database were synthesised with data provided by the Bureau of Meteorology (BOM) for precipitation (rainfall) in Brisbane.

There are some important limitations for the rainfall data that should be noted:

- The BOM data is for a 24-hour period from 9am through to 9am the following day - data was not available for the period midnight to midnight. This can potentially influence results, such as when rain events occur late at night when travel is minimal, and more importantly cause disconnect between trip rates by day (midnight to midnight) and rainfall data (9am to 9am).
- Data was obtained solely at the recording station at Brisbane Airport. Rainfall varies significantly across an urban area, when compared to other variables such as temperature, introducing further possible error into the analysis.
- There may be sampling variability effects in the SEQTS data when disaggregated to specific dates.

Despite these limitations it was determined the analysis would retain some limited validity, especially given that overall travel behaviour often consists of journeys, where persons leave home for large periods of the day, and the threat of rain (as opposed to actual precipitation) may influence travel. Therefore decisions on travel made in the morning (i.e. mode of journey to work) often constrain decisions on travel made later in the day.

Once prepared, a series of linear regression models were used to identify any one-way relationship between the number of walking trip stages made per person on a given day and the precipitation occurring in the period 9am to 9am.

A scatterplot of the mean number of walk trip stages per person per day vs. precipitation is shown in Figure 5.

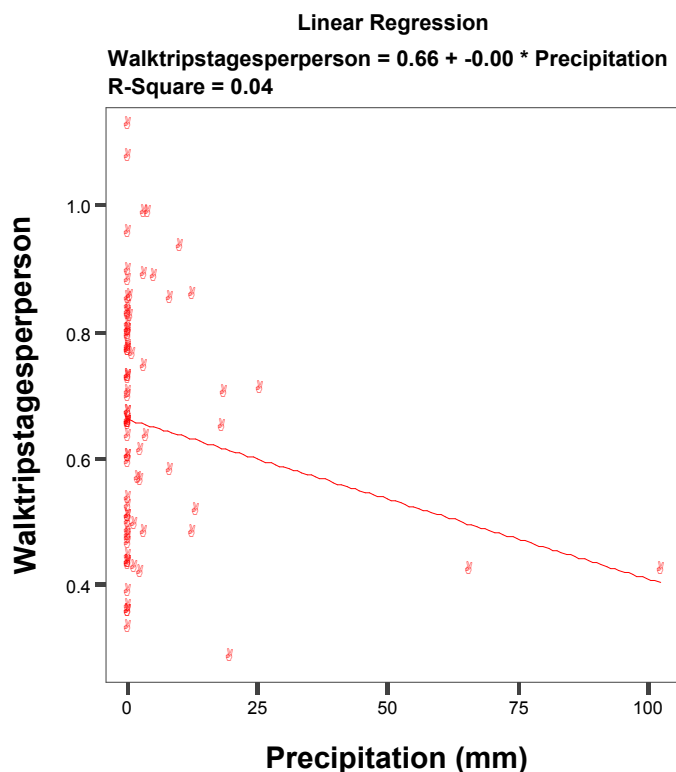


Figure 5 Scatterplot - Precipitation per day (mm) vs. Mean no. walking trip stages per person per day

There is no meaningful relationship between the two variables. The linear regression model results (R-square = 0.04; $p = 0.095$) only appear to approach statistical significance due to the presence of two outlier cases (where precipitation is greater than 50mm). Although

people may avoid non-motorised travel during actual rain events, travel across the whole day is not affected. There are several possible explanations as to why this result has been obtained.

- Rainfall is highly variable across the day and large volumes of rain may fall in very short time periods. This is particularly true in the subtropics where evening summer storms may not affect travel greatly throughout the rest of the day.
- People may still make non-motorised travel during rainfall events but seek to protect themselves from the prevailing conditions by using personal protection (i.e. use of umbrellas, wet-weather attire) or by altering routes taken so as to minimise exposure (i.e. walking under building verandas or through buildings in inner-city environments).
- Many non-motorised trips may be constrained during rainfall events (i.e. persons travel home by train and on alighting from the train find they have no alternative other than to walk home or to wait out the rainfall event).

6 Daylight availability

It is conceived that there might be an association between the length of daylight hours and the number of walking trip stages made. The majority of previous research into walking has suggested that the propensity to make a walking trip is in part related to whether there is sufficient light, including daylight, with women, seniors and other vulnerable groups less likely to make trips in darkness (i.e. see Atkins and Lynch 1988; Nair and Ditton 1994).

To clarify this situation, the SEQTS dataset was synthesised with sunrise and sunset data obtained from www.timeanddate.com for Brisbane, Queensland, at latitude 27° 30' South and longitude 153° 00' East. The datasets were then manipulated to identify all walking trip stages made by date and time. A linear regression model was used to identify any one-way relationships between the number of walking trip stages for a given time period and the number of daylight hours available.

Table 2 presents the maximum and minimum daylight hours available for the various time periods under investigation for days within which the SEQTS was conducted.

Table 2 Range of available daylight hours

	<i>Day (24 hours)</i>
Maximum	13 hours 52mins
Minimum	11 hours 55mins

Figure 6 shows the number of walking trip stages per person per day compared with the number of daylight hours available, fitted with a linear regression line.

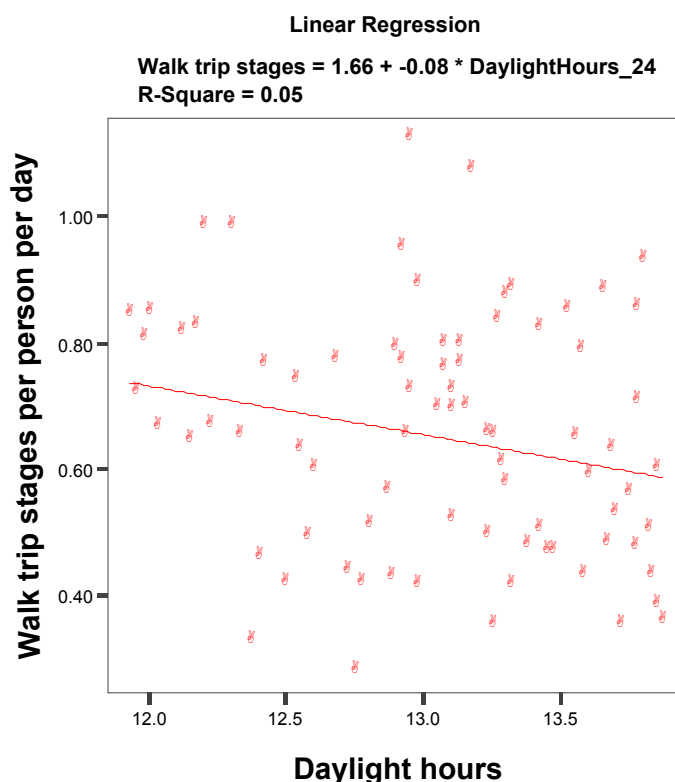


Figure 6 Scatterplot of Mean no. walk trip stages per person per day vs. Daylight hours (per day)

Table 3 shows the results of the linear regression model, including the related *t* and *p* statistics.

Table 3 Linear regression model results - No. walk trip stages per person per day vs. Daylight hours (per day)

<i>Coefficients^(a)</i>	<i>Unstandardised Coefficients</i>		<i>Standardised Coefficients</i>	<i>t</i>	<i>Sig. (p)</i>
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>		
(Constant)	1.658	.495		3.351**	.001
Daylight hours	-.077	.038	-.225	-2.037*	.045

^a *Dependent Variable: No. walking trip stages*

** *Significant at the 99% confidence level*

* *Significant at the 95% confidence level*

The result is statistically significant at the 95% confidence level and suggests that as daylight hours increase, the number of walking trip stages made by the population decreases slightly.

This confounding result immediately raised concerns about multiple effects. Further investigation found that walking trip rates decreased significantly in December and February, which could have been due to changes in travel behaviour that are related to non-weather events. For instance, school and university/TAFE holidays occur within these months and there is generally an increase in recreation leave taken by the population. Analysis confirmed this when it was found that not only did walking trip rates decrease, but trip rates for travel by all modes decreased during these months.

To partly control for this factor but retain a perspective on the influence of daylight hours on walking, the proportion of trip stages made by walking were calculated as a share of all trip stages by all modes per day.

Figure 7 shows the ratio of the proportion of all trip stages made by walking per day, compared with the daylight hours available per day, fitted with a regression line.

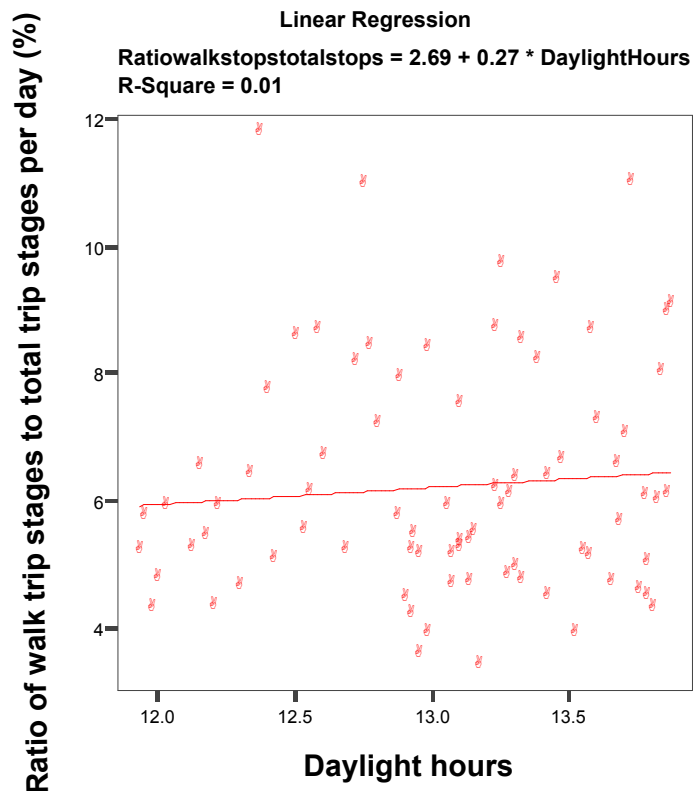


Figure 7 Ratio of walk trip stages to total trip stages vs. Daylight hours (per day)

Noticeably the association is now positive, not negative, in that increased daylight hours is associated with an increase in the proportion of trip stages made by walking per person per day. The results of the regression model are presented in Table 4, below:

Table 4 Linear regression model results - Ratio of walk trip stages to total trip stages (%) vs. Daylight hours

Dependent Variable: Ratio walk trip stages to total trip stages (%)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.083	.007	-.006	1.820

^a Predictors: (Constant), Daylight hours_24

	Unstandardised Coefficients	Std. Error	Standardised Coefficients	t	Sig. (p)
(Constant)	2.692	4.825	Beta	.558	.578
Daylight hours	.270	.370	.083	.732	.466

^a Dependent Variable: Ratio walk trip stages to total trip stages (%)

* Significant at 95% confidence level

This shows that as daylight hours increase, the proportion of trips made on foot appears to increase - though the association is minimal ($R^2 = 0.07$), and the p statistic (0.466) for the coefficient suggests the result is well within the bounds of chance alone. Based solely on this analysis, there is insufficient evidence to support the hypothesis that increased daylight hours encourage increased walking activity. When future SEQTS surveys for the region become available, it may be possible to undertake this analysis with greater precision.

7 Topography

Brisbane is regarded as a city with many hills, as captured in many of the city's suburb names (i.e. Highgate Hill, Camp Hill, Eatons Hill). It is often presumed that this topography of ridges and gullies affects the propensity of persons to walk or cycle in Brisbane, making parts of the city less conducive to non-motorised travel than others.

Topography for each SLA was calculated using point references derived from the Geosciences Australia Digital Elevation Model (DEM) of the region. Points were extracted from the DEM at 50m intervals and separated into each SLA. The minimum, maximum, mean and standard deviation were all calculated for each SLA. The standard deviation was used in this study as it was seen as the most accurate method of determining whether an area experiences significant variations in elevation. This new method was believed to provide a more accurate depiction of variations in elevation than the more simplistic methods used to evaluate topography in the study by 1,000 Friends of Oregon et al. (1000 Friends of Oregon et al. 1993)

Four SLAs were selected to demonstrate this approach:

- Rocklea SLA, on the Oxley Creek floodplain,
- St Lucia (UQ) SLA, focused on the UQ St Lucia campus, which is known to feature some small hills but no major topographical features,
- Upper Kedron SLA, which is known to feature more significant hills, and
- Brookfield SLA, which includes Mt Coot-tha, one of the highest points in the urban area.

Table 5 shows basic statistics for these SLAs, including the standard deviation of the height of each point from the mean.

Table 5 Standard deviations in topographical elevation for representative SLAs

	<i>Rocklea</i>	<i>St Lucia (UQ)</i>	<i>Upper Kedron</i>	<i>Brookfield</i>
Count:	135 points	48 points	136 points	513 points
Minimum height:	3 m	0 m	80 m	9 m
Maximum height:	25 m	39 m	157 m	282 m
Mean height:	8.65 m	9.79 m	108.07 m	97.95 m
Standard Deviation:	4.17 m	10.02 m	16.54 m	49.86 m

The standard deviation of each point from the mean is greatest in Brookfield and lowest in Rocklea, and the values obtained are generally in accordance with our presumptions as to the varying topography in these localities.

The walking trip rates for persons in each SLA by population group were calculated using the total number of trip stages made per day, including those not explicitly made to or from the person's place of residence. This decision was taken as the majority of travel is made in 'tours' or 'trip chains' (being a sequence of trips which starts at one place and eventually returns to the same place - Queensland Transport et al. 2005:4). Much of the travel that is not home-based is constrained by modal decisions taken at the start of each tour.

There remain some limitations with this approach including:

- The potential for errors in the DEM, or for variations in elevation not captured by the 50m interval point;
- Significant sampling variability in SLAs, including small numbers within particular population groups.
- Possible interactions with unconstrained non-home-based travel.
- The potential for residential self-selection bias. This problem exists where households that prefer specific travel behaviours (i.e. walking, cycling and using public transport) may deliberately choose to reside in locations with environments conducive to those behaviours, whereas households preferring alternative behaviours (i.e. relying solely on private motor vehicle use) choose locations more suited to their desires. This problem may generally be overcome only by use of extensive longitudinal research frameworks that were beyond the scope of the study.

Figure 8 gives some indication of the varied topography of Brisbane, showing the standard deviation in elevation for each SLA in the study area.

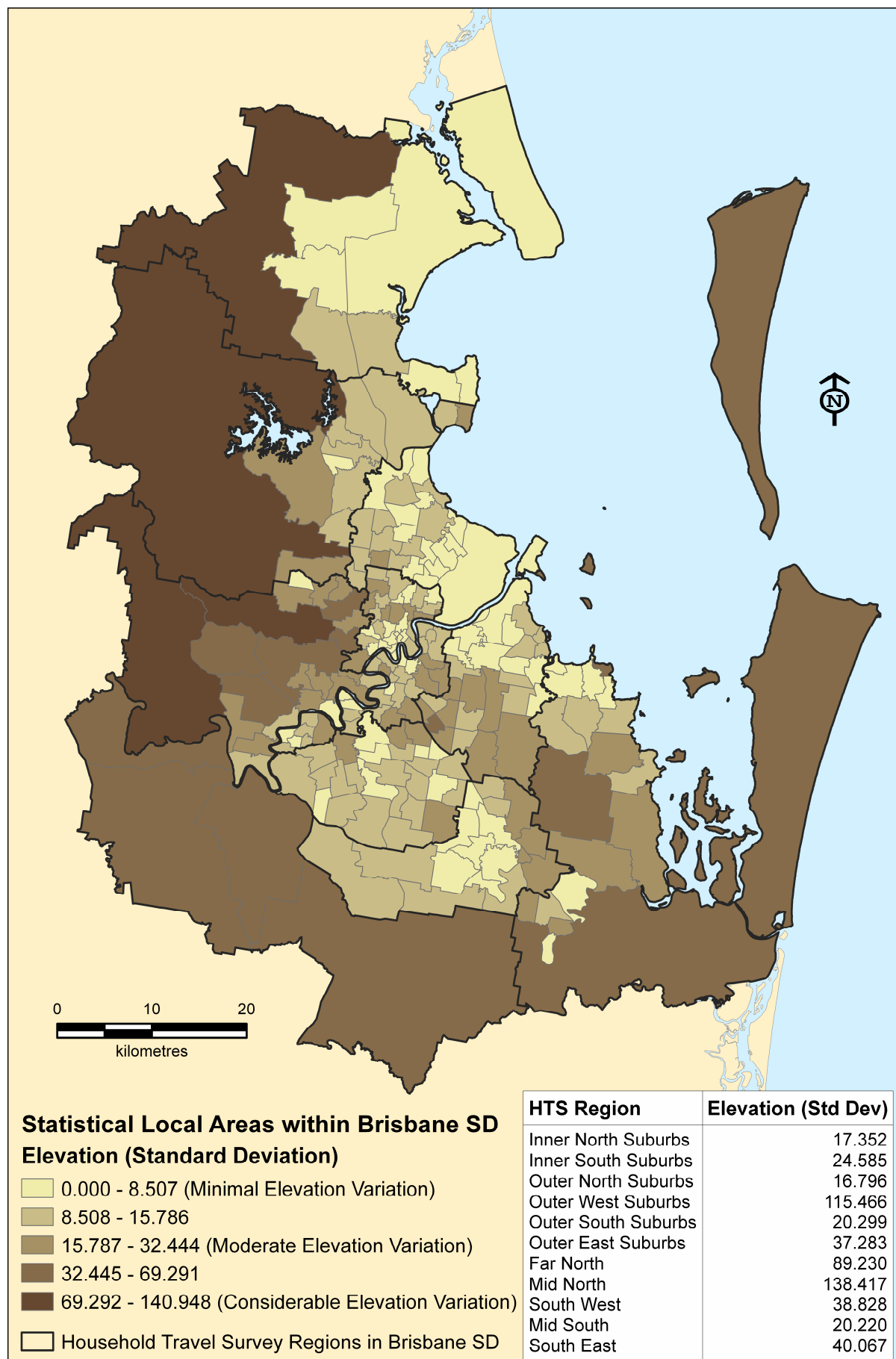


Figure 8 Standard deviation in elevation (topography) by SLA

A series of bivariate correlation tests was used to determine any association between topography and the walking trip rates by SLA for different population groups. Table 6 summarises the results.

Table 6 Pearson correlations for topography and walking trip rates for different population groups

<i>Variable (to be correlated with topography)</i>	<i>Pearson Correlation</i>	<i>Sig. (2-tailed)</i>
Mean no. walking trip stages	-0.113	0.222
Mean no. walking trip stages (Male)	-0.099	0.286
Mean no. walking trip stages (Female)	-0.127	0.171
Mean no. walking trip stages (persons aged 0-17)	-0.047	0.614
Mean no. walking trip stages (persons aged 18yrs or more)	-0.138	0.135
Mean no. walking trip stages (persons aged 65yrs or more)	-0.113	0.225

The results indicate there are no significant one-way associations between topography and the number of walking trip stages made, whether by the whole population, or by particular population sub-groups. The correlation for the whole population is negative, suggesting that as topography increases the mean number of walking trip stages per person decreases. However, the *p* value is greater than 0.10, indicating that the result is well within the bounds of what may have been obtained via chance alone. When isolated solely to persons aged 18 or more, a Pearson correlation coefficient of -0.138 is obtained, which with a *p* value of 0.135 approaches but does not achieve significance at the 90% confidence level.

Topography, as it is measured by this research, appears to have nil significant relationship with the number of walking trips made by the population of Greater Brisbane. This confounding finding is at odds with popular opinion. There are a number of potential reasons for this result, which include:

- There may be significant topographical variability within SLAs that is not matched by population distributions. Where people live and transport networks often avoid the extremes of topography, with many Brisbane streets running along ridgelines.
- The topographical variability across Brisbane is perhaps not as great as popularly imagined.
- People may still choose to travel via non-motorised means in hilly locations, but may choose paths of 'least resistance' such as walking slightly further to access a bus stop but avoiding a large hill.

8 Conclusions and recommendations

The aim of the following discussion is to provide some comments on the research findings, to place them in context, and to note opportunities for further research.

First, and most importantly, the research demonstrates that it is possible to synthesise household travel survey data on non-motorised travel with datasets covering both topography and climatic factors in order to analyse and explain the influence of these factors on walking trips. New techniques for the appraisal of the influences of topography, daylight hour availability, precipitation and heat and humidity were developed, that are appropriate to the climatic and topographical datasets presently available in the South East Queensland region.

Secondly, while this is exploratory research and findings are subject to significant limitations, these preliminary results suggest that natural environmental factors have nil significant influence on walking trip rates in Brisbane. Trip rates per person per day are relatively constant despite variations in daylight hour availability, precipitation, heat and humidity, and local topography.

The implications of these results are considerable. There may be no natural environment factors constraining increased walking in Brisbane. On the basis of our findings, any proposed interventions that seek to increase walking should not be rejected on the basis of the city's climatic conditions - even the heat of the sub-tropical summer - or its topography.

However due to the likelihood of multiple effects, these findings must be viewed with caution until such time as carefully constructed multivariate analysis is undertaken to attempt to isolate the effects of environmental factors from other factors.

The findings also relate solely to aggregated walking trips, and natural environmental factors may actually have greater influence on particular types of walking trips. With larger travel survey datasets (either from other cities or via future iterations of the SEQTS) it may be possible to interrogate the influence of natural environmental factors on disaggregated trip types such as home-based recreation walking trips, walk trips to access public transport, and walk trips to particular land use destinations. Greater data availability should also allow for more robust examinations of the influence of natural environment factors on walking and bicycle trip rates, providing another layer in our understanding of what is important in encouraging more active travel in our cities.

9 Acknowledgments and Disclaimer

This paper is based on or contains data provided by the Department of Transport, Queensland [2005] which gives no warranty in relation to the data (including accuracy, reliability, completeness or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

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