Tranquillity in the City: A Preliminary Assessment in Christchurch

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Abstract

This paper describes a preliminary evaluation of tranquillity in four contrasting parks in Christchurch. A prediction tool for tranquillity which has been successfully used elsewhere was employed for this purpose. Results show a wide range of tranquillity ratings. A park located near a motorway had the lowest tranquillity rating though a square in the CBD was predicted to have only slightly higher levels on this measure. Factors that had affected tranquillity ratings are considered together with suggestions for remedial measures.

Introduction

Tranquillity is defined as quality of calmness one experiences in nature and being away from manmade disturbance. Tranquil surroundings can lead to better psychological and physical restoration of people living in the urban environment. This is consistent with Kaplan's Attention Restoration Theory suggesting natural restorative environments has the ability to help people recover from sensory overload from everyday urban life (Kaplan,1995). Tranquillity is to be found in natural outdoor environments where man-made noise is at a low level though natural sounds can be at a relatively high level. Numerous studies have shown a link between such environments and stress reduction, longevity, pain relief and even how the brain processes auditory signals (Ulrich et al, 1991; Takano et al, 2002; Grahn and Stigsdotter, 2003; Lechtzin et al, 2010, Hunter et al, 2010). In addition tranquil spaces have been demonstrated to promote better health outcomes. In one landmark study it was found that patients whose windows face a natural environment appeared to have a faster recovery compared to patients whose windows were facing brick walls (Ulrich, 1984). Other studies also suggest that natural environments lower the chances of increased stress level. Prison research results show that inmates located in cells with window views of nature exhibit fewer stress symptoms (Moore, 1982). Tranquil and natural environment also help lead to positive mental states with reduced feeling of anger in subjects compared to those who were exposed to urban environment (Hartig, 2003).

For maximum benefit it is likely that tranquil environments should be accessed regularly i.e. as part of the working day. This can cause conflicts for urban dwellers due to the pace of living and many time constraints. It is no surprise therefore that easy access to such environments in the city should be an important consideration for city planners and especially for a city badged as the "Garden City".

But how tranquil are the open green spaces in the city? Can they be considered tranquil and therefore "restorative"? A method is required to provide an audit of tranquillity in green open spaces so failings can be identified, mitigation measures suggested and new spaces designed with tranquillity in mind.

Background

Previous studies have involved the investigation of the environmental factors which influence the perceived tranquillity of a place. Statistically significant factors that have been identified are the noise level (L_{Aeq} or L_{Amax}) and the percentage of natural and contextual features in the visual scene. The results of the full details of the original studies are given by Pheasant et al. (2008) and the updated formula relating these factors was reported recently as TRAPT (Tranquillity Rating Prediction Tool) (Pheasant et al., 2010) is given by:

$$TR = 9.68 + 0.041\ NCF - 0.146\ L_{day} + MF \qquad (1)$$

Where TR is the tranquillity rating on a 0 to 10 rating scale. NCF is the percentage of natural and contextual features and L_{day} is the equivalent constant A-weighted level (averaged over 7am to 7pm) of man-made noise . Contextual features include listed buildings, religious and historic buildings, landmarks, monuments and elements of the landscape, such as traditional farm buildings, that directly contribute to the visual context of the natural environment. It can be argued that when present, these visually cultural and contextual elements are as fundamental to the construction of 'tranquil space' as are strictly natural features. The moderating factor MF is added to the equation to take account of further factors such as the presence of litter and graffiti that will depress the rating and water sounds that are likely to improve the ratings. This factor is unlikely to be large and it was demonstrated that the presence of litter depressed the rating by one scale point (Watts et al, 2010). The effects of water sounds are the subject of further research . The prediction tool for the tranquillity rating TRAPT was used in previous studies to assess the tranquillity in urban green open spaces and the countryside then the predictions were validated using a questionnaire survey of visitors (Watts et al, 2013, Watts and Pheasant, 2013).

In some extreme cases, the predicted value of TR goes negative due to the linear regression technique used to relate these variables. In these cases, the calculated value is set to zero. Where TR > 10 then values are set to 10.

Figure 1 shows the relation between L_{day} and TR for 3 levels of NCF (0, 50 and 100%). Where there are no natural or contextual features (NCF = 0%) it can be observed that TR reaches zero at the relatively low noise level of 66 dB(A) but where NCF is 100% it is reached at the much higher level of 94 dB(A). This graphically demonstrates the importance for tranquillity of the natural components of the visual scene. For example a 50% increase in NCF is predicted to raise TR by approximately 2 scale points while decreasing noise level L_{Aeq} by 14 dB(A) changes TR by approximately the same amount. These trade-offs can be used to identify suitable measures to improve tranquillity.

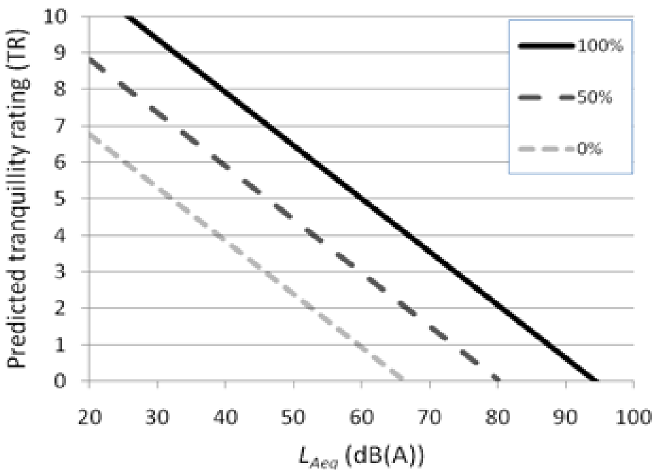

Figure 1: Linear variation of TR with L_{day} at 3 levels of NCF (0, 50 and 100%).

Methodology

Four contrasting parks that are located in different areas of Christchurch were selected. These were chosen to reflect differences in adjacent major road traffic conditions and surrounding land use. The survey was carried out in summer 2010 (pre-earthquake). The four green spaces were:

1. Leslie Park that is located in a mixed suburban and industrial area alongside the Main South Road carrying a traffic flow of 14,200 per 18hr day.
2. Fendalton Park, located near a housing area and adjacent to Fendalton Road carrying a flow of 29,980/18hr day.
3. Marylands Reserve that is located next to Christchurch Southern Motorway in an industrial/ commercial area. The 18hr traffic flow was 23,100.
4. Latimer Square located in Christchurch CBD with traffic flows of 12,330 & 9,891 on the two adjacent major roads.

The approach was to identify the most likely tranquil and non-tranquil spaces in three contrasting parks and greens and calculate the Tranquillity Rating using:

- Spot readings of A-weighted sound pressure levels
- Noise predictions based on the UK traffic noise prediction model CRTN
- Photographic survey of the percentage of natural and contextual features

Spot Readings

During the photographic surveys spot readings of the A-weighted sound pressure level were taken of background noise levels that were dominated by traffic noise. Periods of significant natural sounds were excluded from the noise sampling (e.g. bird song) as were human voices and the noise from any other mechanical sounds judged to be of only a transient nature (if present) e.g. noise from chain saw for tree surgery. The readings taken over a few minutes were used to locate the quietest and nosiest locations within the green space and later to provide a rough

check on the calculation of road traffic noise levels (see below). GPS co-ordinates were recorded using a hand held device (Garmin eTrex HC) at these locations.

Noise Predictions

Since the dominant noise source at each site was road traffic noise, predictions were carried out at the sites using CRTN (Calculation of Road Traffic Noise – Department of Transport and Welsh Office, 1988). This method predicts the 18 hour L_{A10} value from 0600 to 2400 hours. Classified traffic counts were obtained from the Christchurch City Council and distances to the nearest road, road surface type and speed limit were obtained from recorded site information. It was found that at all sites the road surface was essentially level with a bituminous wearing course. Using these predicted values the L_{day} was then obtained from the conversion formulae (DEFRA,2006):

For non-motorways:

$$L_{day} = 0.95\ L_{A10,18h} + 1.44\ dB \qquad (2)$$

For motorways:

$$L_{day} = 0.98\ L_{A10,18h} + 0.09\ dB \qquad (3)$$

Note that in other countries where CRTN is not the preferred prediction method other validated traffic noise models can be used to obtain L_{day}. Where noise from other transportation modes are dominant the L_{day} value can be calculated using the appropriate prediction model.

Photographic Survey

Having identified the quietest and noisiest areas from the relevant noise maps and spot readings, the percentage of natural and contextual features was determined using a camera giving a field of view of approximately 51 degrees in the horizontal plane on a normal (non-zoom) setting. Seven contiguous pictures were taken at a height of 1.5m (close to the average standing eye height of adults in the UK) to give an approximate field of view of 360 degrees. These pictures were pasted into Microsoft PowerPoint and analysed using a 10 x 10 grid placed over the images to determine the percentage of natural and contextual features.

Figure 2: A view from the most tranquil location at Leslie Park with overlain grid for calculating NCF.

In all cases the quietest areas also had the highest percentage of natural features so according to the prediction tool this would also be the most tranquil.

Results

An example of how the 10x10 grid is used for assessing NCF is shown in Figure 1. The sky is excluded in the calculation and for each direction the number of squares containing more than 50% of buildings or other man-made structures is counted (N_{mi}). If the total number of squares more than 50% filled is N_{ti} then the NCF in that direction NCF_i is given by: $100(N_{ti} - N_{mi})/N_{ti}$. The value of NCF is then obtained by taking the average over D directions:

$$NCF = 100 / D \sum_{(i=1)}^{D} (N_{ti} - N_{mi}) / N_{ti} \qquad (4)$$

Using formula (1) the tranquillity rating at the most tranquil and least tranquil areas at each location was calculated. Table 1 summarises the results.

It can be seen that the least tranquil parts of each park were predicted to have a rating of 2 or under while the most tranquil areas ranged from 5.9 at Fendalton Park to Marylands reserve at 4.8.

Table 1: Predicted tranquillity ratings at the four study locations

Location (approximate area in hectares)	Co-ordinates	L_{day}	NCF	TR	
Fendalton Park (4.5 ha)	Most tranquil	-43.520898,172.59272	43.4	63.5	5.9
	Least tranquil	-43.518878,172.59245	68.0	55.2	2.0
Marylands Reserve (4.6 ha)	Most tranquil	-43.544350,172.588130	58.0	88.5	4.8
	Least tranquil	-43.54585,172.58558	73.6	60.3	1.4
Leslie Park (2 ha)	Most tranquil	-43.54409,172.508375	47.9	70.3	5.6
	Least tranquil	-43.545460,172.508538	67.8	41.3	1.5
Latimer Square* (2 ha)	Most tranquil	-43.53097,172.642663	56.0	83.4	4.9
	Least tranquil	-43.529982,172.643118	66.8	49.9	2.0

*Due to earthquake damage this square is currently being redeveloped

Discussion and Conclusions

To give an indication of acceptable and non-acceptable levels of the tranquillity rating it is suggested that based on previous experience that the following provisional guidelines should apply (Watts et al., 2009):

<5 unacceptable

5.0 – 5.9 just acceptable

6.0 – 6.9 fairly good

7.0 – 7.9 good

≥ 8.0 excellent

If these descriptors apply then from Table 1 it can be seen that the most tranquil sites in Fendalton Park and Leslie Park fall in the "just acceptable" category. However at Marylands Reserve and Latimer Square failed to reach acceptable levels of tranquillity.

To obtain acceptable levels of tranquillity where currently TR< 5.0 it will be necessary to consider:

(a) Reducing transportation noise

(b) Increasing the percentage of natural features

In most cases it will be most cost effective to concentrate efforts on producing tranquil areas away from noise sources and in the middle of areas with trees, shrubs and flower beds. Local screening of the noise sources is possible e.g. use of walled gardens and noise screening at source can be affected by purpose built noise barriers or better still a decorative wall (e.g. a serpentine wall with climbers). Diversion of heavy traffic and the use of low noise road pavements are further possibilities.

Latimer Square is relatively small at only 2 hectares and had two major roads on its boundaries. This has resulted in high levels of noise even in the middle of the park (L_{day} =56 dB(A)). Increasing the percentage of natural features close to 100% would be achievable and this is predicted to increase the tranquillity rating to 5.6 which is an acceptable level. Further increases would result from a traffic management scheme which reduced traffic on the boundary roads or by introducing a water feature to distract attention away from the traffic noise and provide a measure of masking. Natural sounding water features have been shown to improve tranquillity where background traffic is present though the exact benefit has yet to be quantified (Watts et al, 2009). Note that the "Green Frame" planned for the reconstructed Christchurch presents an excellent opportunity to create accessible quality tranquil spaces.

In the case of Marylands Reserve the TR would increase to 5.3 if NCF was increased to approximately 100%. As tyre/road noise is likely to be dominant on this high speed section of road further increases could be obtained by replacing the road surface material with a low noise option. This might result in a reduction of 5 dB(A) and in this case the tranquillity rating would rise further to 6.0 which would be classified as "fairly good". A further viable option would be the construction of a noise barrier adjacent to the carriageway which would be expected to result in a similar increase in tranquillity.

In conclusion this study has shown that it is possible to achieve acceptable levels of tranquillity in urban open spaces

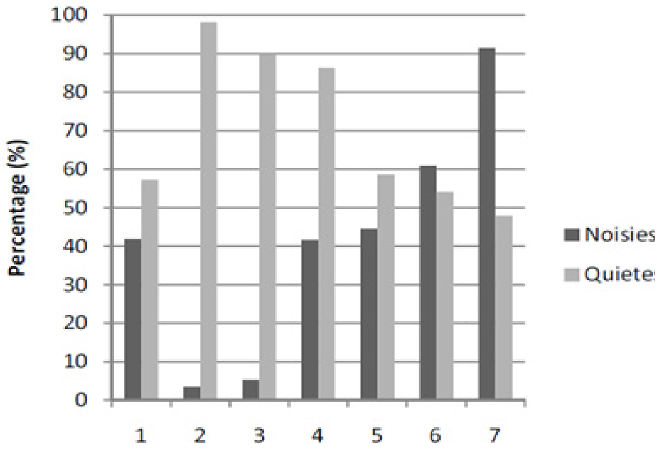

Figure 3: Variation in NCF at Leslie Park with direction of view (i = 1 to 7).

in Christchurch which are relatively densely populated area. In two cases of the four cases examined remedial treatments would be necessary to reach acceptable levels. A brief review of the literature has demonstrated the importance of tranquil spaces and some cities have enacted policy designed to enable easy access to such places. For example in New York, PLAN NYC, the sustainability agenda for the eastern US concrete jungle, includes a proposal to ensure that all New Yorkers live within a 10-minute walk of a park (Schwartz, 2011). The "High Line" in West Side Manhattan is an excellent example of how NYC authorities prompted by citizen action have risen to the challenge transforming a disused 1.6 km section of railway freight line in a derelict area to provide a linear park abundant with wild flowers, shrubs and trees and a "must see" for the city's many visitors (Figure 4).

Figure 4: Section of the popular "High Line" in NYC cutting through the old industrial Meatpacking District showing laminar flow water feature and mixed wild grasses.

The wider implications of this work are that it provides a yardstick for measuring open space performance in terms of restorative value, which can ultimately be used to prioritise amenity resources more effectively. Positive results can be employed to promote the health benefits of these spaces.

"Healthy Christchurch" is an initiative that seeks to improve the health and well being of Christchurch's residents in a number of ways and an indicator of the quality of restorative spaces should prove useful. Lesser results can be used as a spur to improve factors that affect tranquillity and thereby improve benefits to local users and visitors alike. Further work could include a more extensive audit of a larger number of open spaces based on these initial surveys and local needs. The use of a questionnaire survey to gather visitors' views on benefits, negative aspects and access problems is a useful extension that would compliment this novel approach. Finally the tranquillity prediction tool TRAPT could be used to design new spaces where tranquillity is sought e.g. as part of Christchurch City redevelopment.

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