



A CITIZEN SCIENCE AND SOUNDSCAPE APPROACH TO THE INVESTIGATION OF QUIET AREAS FOR LIMERICK CITY

Simon Jennings^{1*} Antonella Radicchi² Nuala O'Connell¹
Aidan Finn¹ Cathal Brodie¹ Carmel Lynch¹

¹ Limerick City and County Council, Merchant's Quay, Limerick. V94 EH90. Ireland

² Department of Social, Political and Cognitive Sciences, University of Siena, Via Roma 56, Siena 53100, Italy

ABSTRACT

Article 9 of the Environmental Noise Directive (END) requires that strategic noise maps and action plans shall be provided to the public in a clear, comprehensive and accessible manner. The aim is to raise awareness which offers an opportunity to involve the public in the decision-making process for identifying, evaluating and potentially designating quiet areas.

This paper presents the results of the application of a citizen science method for the investigation of quiet areas in Limerick City, Ireland, by public engagement using a soundscape approach. The approach uses the citizen science mobile app, Hush City, which allows the public to evaluate the context of the acoustic environment, as well as multi-dimensional experiential qualities of publicly accessible spaces. The results outline the potential of using this approach to complement quantitative analyses (based on the review of strategic noise maps) to allow consideration of the suitability of locations for quiet area designation under the END as well as to aid local authorities identify infrastructural improvements that would benefit the acoustic environment for the public.

Keywords: *Quiet areas, Hush City, Citizen science, Soundscape.*

*Corresponding author: simon.jennings@limerick.ie

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1. INTRODUCTION

The focus of the Environmental Noise Directive (END) (2002/49/EC) [1] is on preventing and reducing environmental noise levels where they may have a harmful effect on human health and to preserving environmental acoustic quality where it is good by designating quiet areas. The statutory approach for responsible authorities is to calculate and prepare strategic noise maps every five years followed by the development of noise action plans. While strategic noise maps for a city are a useful resource the approach can focus on the adverse influences of environmental noise and the search for the lowest environmental noise levels [2]. A key requirement in the Directive, in Article 9, is that information on environmental noise is made available and disseminated to the public in a clear, comprehensive and accessible manner. An emphasis on disseminating information on environmental noise management to the public can support citizens negative perception of sounds that are unwanted in their environment [3]. For example, during the public engagement phase of the Limerick Noise Action Plan for 2018 to 2023 all submissions highlighted noise problems on behalf of a mix of individuals and residential groups [4].

The European Environment Agency recommends that instead of identifying areas with low environmental noise we should be searching for calm [5]. Many studies have reported the positive effects of natural sounds on the health and well-being of humans [6] and so a healthy acoustic environment is more than simply the absence of unwanted noise. A method which collects the perceived experiences and understanding of the combined sounds in the environment where people live and work, a soundscape approach [7], complements environmental noise management and has multiple benefits by offering the

potential to involve citizens in the identification, assessment and planning of urban environments.

2. THE HUSH CITY APP

There is a need at a European policy level for guidance on how to integrate the subjective nature of urban quietness in our cities with the environmental noise management approach, to assess and protect quiet areas [5]. The Hush City participatory framework was developed to address this gap [8-10]. The framework is based on three pillars: (1) the soundscape concept; (2) the use of citizen science mobile technology as a medium for participation in the mapping and assessing of quiet areas; and (3) the idea that quiet areas are urban commons, defined as “everyday quiet areas” i.e. that quiet areas should be considered as natural resources accessible to everyone in society [8, 9]. As per this framework, data can be collected using the Hush City app, a free novel mobile application that was launched in 2017, which empowers citizens to map and assess quiet areas and share their location and related data on an open access platform, either individually themselves or by soundwalks¹ led by a moderator.

The app allows the sequential collection of a mix of data by a user in a location over a short timeframe (approximately three minutes). That data includes an audio recording and associated sound pressure level, an image of the location where the sound was recorded and user feedback at that same location. User feedback is collected through a predefined questionnaire structured in three sections on the soundscape, general and behavioural issues and questions are designed to explore the relationship between the soundscape and topics regarding emotional responses, semantic descriptors, the perceived quietness, positive and negative sounds, oral and social interaction, sense of place, landscape quality, level of maintenance and cleanliness, sense of security and a location’s accessibility [12].

The development of the Hush City app was integral in the methodology of the “*Beyond the Noise: Open Source Soundscapes*” project, conducted in 2016-2018 [13] and the *Hush City Mobile Lab* project (2018-2020). Subsequently, the use of the app helped identify and evaluate an extensive network of small quiet areas distributed throughout Berlin. These “everyday quiet areas” are places within walkability of where people live and work, places that citizens favour

¹ “Soundwalks are a participatory group sound and listening walks through the environment. Soundscape analysts observe and measure the perceptual responses of the participants to the acoustical, visual, aesthetic, geographic, social and cultural differences” [11].

relaxation and social interaction, characterised by a mixture of natural and human sounds [10]. It is of benefit to identify “everyday quiet areas” in cities and integrate them in noise action plans to bring environmental and social justice to the public.

3. SOUNDSCAPE AND CITIZEN SCIENCE APPROACH – LIMERICK: MATERIALS & RESULTS

A soundscape and citizen science approach has been undertaken to evaluate a section of one of the principal walks in Limerick City, the Three Bridges Walk, along Clancy’s Strand and O’Callaghan Strand (Figure 1) on the basis that sound quality along walkways affects our walking experience [14].

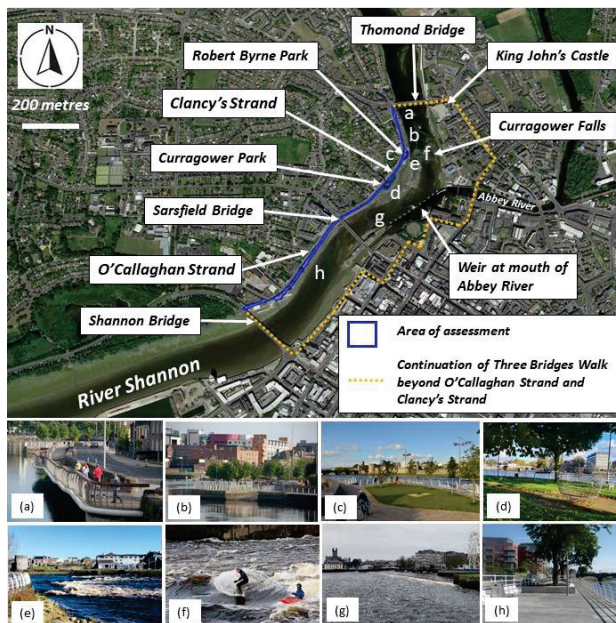


Figure 1. Area of assessment in Limerick City: Clancy’s Strand / O’Callaghan Strand section of the Three Bridges Walk.

The investigation includes a review of the strategic noise mapping to understand the expected environmental noise levels along the walkway. The soundscape approach evaluates the results of two moderator-led soundwalks using Hush City carried out by citizens that live and/or work in Limerick.

3.1 Clancy's/O'Callaghan Strands

The Three Bridges Walk along Clancy's Strand and O'Callaghan Strand is an approximate one kilometre walk besides the majestic River Shannon (Figure 1), which is tidal in this section (approximate six metres rise and fall of water level). The strands are located besides the road with a boardwalk section between Thomond Bridge and the Robert Byrne Park, separated from the road by a stone wall with seating (Figure 1a). The Robert Byrne Park (Figures 1b and 1c) and Curragower Park (Figure 1d) are pocket parks in close proximity to each other with the remaining pavement between Curragower Park and Sarsfield Bridge beside the road. This section of the walk provides views back across the river towards the City, as well as King John's Castle and Thomond Bridge (Figure 1c), with the Clare Hills in the background. The boardwalk and Robert Byrne Park are adjacent to the Curragower Falls (Figures 1e and 1f) and a weir at the mouth of the Abbey River (Figure 1g). The falls are formed when the River Shannon drops over a rock ledge and waves form on a turning low tide that are used by surfers and kayakers (Figure 1f). O'Callaghan Strand, between Sarsfield Bridge and Shannon Bridge is a wide riverside footpath with views across the river towards the opposite quayside, and upstream and downstream of the River Shannon (Figure 1h). The Strands are bounded at each end, north and south, by major trunk roads into the City that pass across Thomond Bridge, Sarsfield Bridge and Shannon Bridge.

3.2 Strategic noise mapping

Predicted environmental noise levels along the walkway are expected to be high based on the strategic noise mapping (Figure 2), with the majority of the area expected to be exposed to between 55 and 64 dB $L_{Aeq,12hr}$ (88%). The walkway would not be considered to provide benefit as a quiet location based on an environmental noise management approach. The potential for the walkway to provide a sense of quietness was examined given its popularity among walkers in Limerick [15].

3.3 Soundwalks

A soundscape approach, undertaking soundwalks using Hush City, were used to assess the experiential qualities of the walkway because the potential for perceived quietness does not emerge from the noise mapping and because there is the potential for the acoustic environment to change depending on the tidal level in the River Shannon. Social media strategies were implemented by Limerick City and County Council and the Limerick Public Participation

Network (PPN) to encourage participants to attend the soundwalks. The Limerick PPN is a county-wide network that facilitates citizens from the community, social inclusion and environmental pillars to participate in local decision-making and policy-development structures. The proposed soundwalks were advertised through popular social media platforms, an online webinar event and the Limerick PPN's online chat management tool during the two months leading up to the soundwalks.

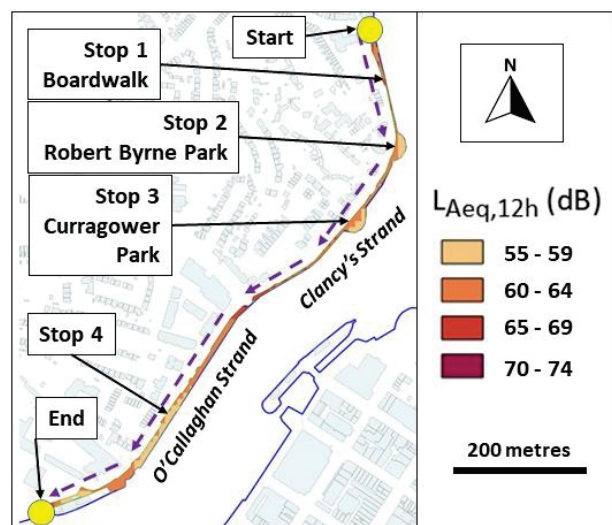


Figure 2. Predicted environmental noise levels (10-metres grids) along Clancy's Strand and O'Callaghan Strand including the route of the soundwalk (arrows) and the predefined stops.

Moderator-led soundwalks were undertaken at low tide (starting at 13:00 hrs UST, Monday 6th March 2023) and at high tide (starting at 11:30 hrs Tuesday 14th March 2023) under similar meteorological and traffic conditions. Forty-eight datasets were collected in total from twelve participants at the four predefined stops for the soundwalk at low tide and sixty-four datasets were collected in total from the sixty-four participants at the four predefined stops for the soundwalk at high tide. Each dataset was collected through the Hush City app's questionnaire, which is composed of twenty questions [12]. The predefined Stops 1 (the boardwalk, Clancy's Strand), 2 (Robert Byrne Park), 3 (Curragower Park) and 4 (O'Callaghan Strand) were located at public and recreational locations along the walking route with seating (Figure 2). The salient results from the soundwalks are presented in Figures 3 and 4 and are discussed below.

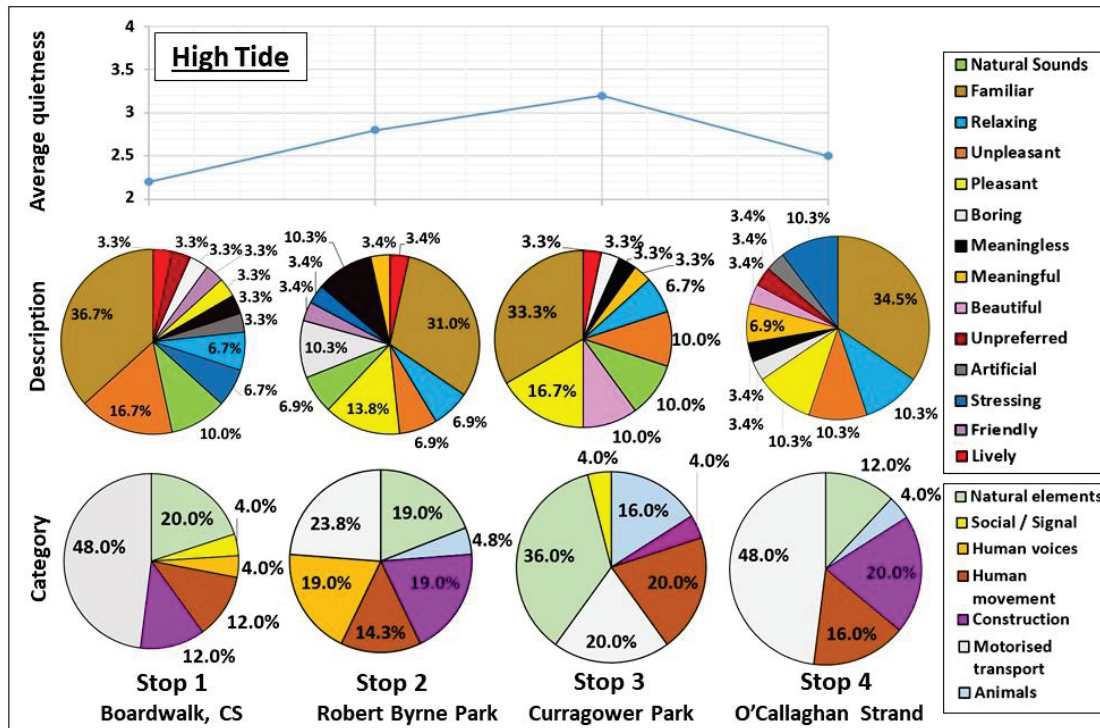


Figure 3. Summary of Hush City results for the perceived quietness, description of sounds and their categorisation at Stops 1 to 4 along Clancy's Strand (CS) and O'Callaghan Strand at high tide (14th March 2023).

3.3.1 High tide (Figure 3)

The route was dominated by people passing through (indicated by 80.5% of responses) although there was generally a neutral indication of favourable conditions for communication and having conversations (3.0 was the average of the Likert scale results). However, it was considered that there were favourable conditions for communication and conversations at Stop 3, the Curragower Park (3.4 average). The sounds contributing most to participants positive perception of quietness at all stops were from the river and wildlife, particularly birds (46.3% and 40.3%, respectively). Sound pressure levels were lowest at Stop 3 (measured 49.8 to 53.9 dB) which correlates well with the perceived quietness during the soundwalk. The sound pressure levels at Stops 1, 2 and 4 were similar (55.9 to 59.1 dB, 51.4 to 56.9 dB and 52.9 to 57.7 dB) although Stops 1 and 4 were perceived on average to be slightly less quiet than Stop 2, potentially due to increased sounds from motorised transport and construction.

Motorised sounds were categorised as being dominant at Stops 1 and 4 (48.0% at each) and were also significant at Stops 2 and 3 (23.8% and 20.0%, respectively). Sounds were also categorised as being construction at all of the stops ranging between 12.0% and 20.0% at Stops 1, 2 and 4, but construction was least at Stop 3 at 4.0%. Human movement was categorised at all of the stops, with social sounds at Stops 1 and 3, corresponding with the area being a walkway. The categories of natural elements and animals were greatest at Stop 3 (combined 52.0%), with 41.1% and 64.7% of participants referring to the river and birds, respectively, as being positive to their sense of quietness. The categories of natural elements and animals were least at Stops 1, 2 and 4, in combination ranging between 13.8% and 23.8%.

There was a broad range of descriptions of the sounds, mainly that they were familiar (between 31.0% to 36.7%). Negative descriptions such as unpleasant, boring, meaningless, unpreferred, artificial and stressing were recorded at most of the stops (as a combination between 16.6% and 36.7%), with artificial and unpreferred only being recorded by participants at Stops 1 and 4 (6.7% and

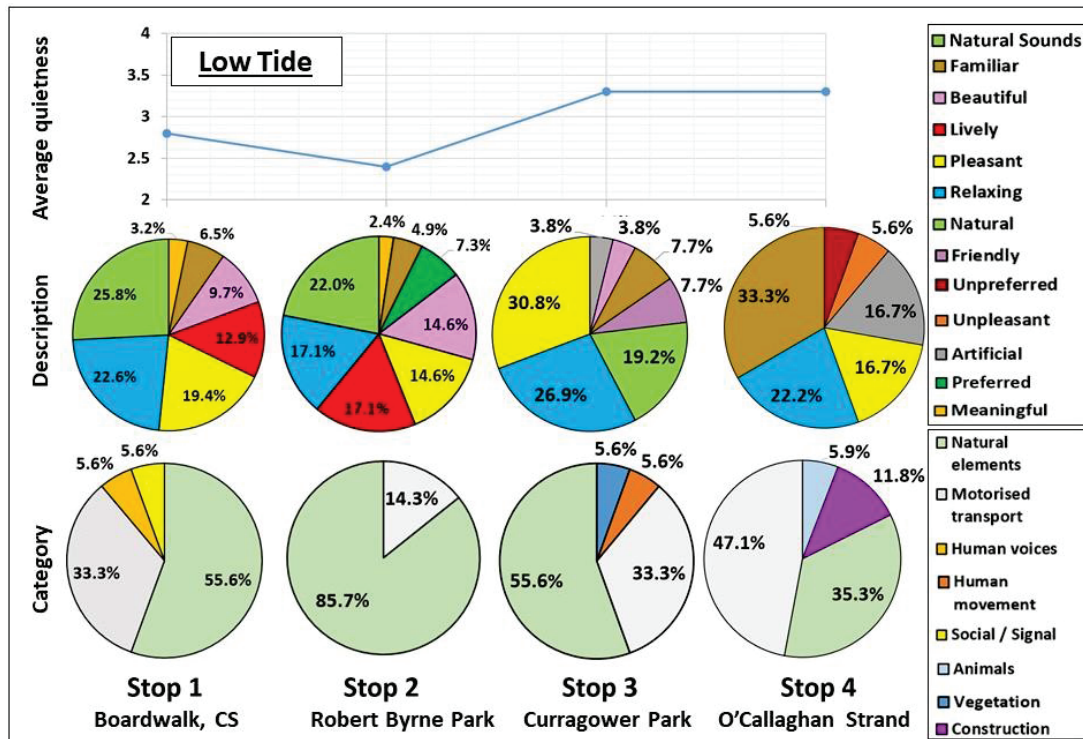


Figure 4. Summary of Hush City results for the perceived quietness, description of sounds and their categorisation at Stops 1 to 4 along Clancy's Strand (CS) and O'Callaghan Strand at low tide (6th March 2023).

6.9% respectively). Positive descriptions such as natural sounds, pleasant, beautiful, relaxing, friendly and meaningful ranged between 23.3% and 34.2% at Stops 1, 2 and 4 but were highest at Stop 3 at 46.7%.

The quality, cleanliness, maintenance, security and accessibility of the walkway were all rated relatively highly with all average Likert scale results ranging between 3.3 and 4.7.

Based on the results of the soundwalk at high tide it would appear that while there are elements of the sound quality along the walkway that are good, particularly at Stop 3, the Curragower Park, environmental noise was dominant.

3.3.2 Low tide (Figure 4)

The route was dominated by people passing through (indicated by 79.2% of responses) and favoured communication and having conversations (3.5 average). The sounds contributing most to participants positive perception of quietness were from the river (93.8%), 29.2% and 18.8% of responses at Stops 1 and 2 specifically referring to the Curragower Falls and birds, respectively.

Sound pressure levels were generally higher at Stop 2 besides the Curragower Falls (measured 66.4 to 68.9 dB) compared to Stops 1 and 3 (measured 63.3 to 67.1 dB and 62.1 to 65.8 dB, respectively) and Stop 4 (58.9 – 62.3 dB) which correlates well with the perceived quietness along the soundwalk, the most quiet areas being perceived to be Stops 3 and 4. At Stop 2 (high sound pressure levels) 85.7% of participants categorised the sound as natural elements. The majority of participants also categorised the sounds at Stops 1 and 3 as natural elements as well (both 55.6%), although there was increased categorisation of motorised transport (both 33.3%) at Stops 1 and 3 compared to Stop 2 (14.3%). Participants mainly described the sounds at Stops 1, 2 and 3 positively (relaxing, pleasant, beautiful, meaningful, friendly, preferred and natural), ranging between 78.0% and 88.4% compared to 38.9% at Stop 4. The participants also described the sound at Stops 1 and 2 being lively (12.9% and 17.1%, respectively). At Stop 3, 8.3% of responses highlighted the weir at the mouth of the Abbey River as being the source of sounds that contributed to the identity of the location indicating that it makes a contribution to the overall sound in that location. At Stop 4 27.9% of the

participants described the sound as being artificial, unpleasant and unpreferred.

While 35.5% of participants described the category of sounds as natural at Stop 4, 47.1% categorised the sounds as motorised. In addition, 11.8% categorised the sounds as construction, which was not indicated at Stops 1, 2 and 3. Even though participants gave positive descriptions of the sounds at Stop 4 there were 27.9% of participants that described them negatively (unpleasant, unpreferred, artificial). Even though the sound was perceived as being relatively quiet at Stop 4 (correlating with the sound pressure level measurements) it was the least preferred location.

The quality, cleanliness, maintenance, security and accessibility to the location all rated relatively highly with all average Likert scale results ranging between 3.3 and 4.5, very similar to the results of the soundwalk at high tide.

Based on the results of the soundwalk at low tide it would appear that Stops 1, 2 and 3, along Clancy's Strand, provide greater perceived quiet than O'Callaghan Strand, even though the boardwalk and the Robert Byrne Park have high sound pressure levels (natural sounds from the Curragower Falls contributing most), with the Curragower Park being most pleasant and relaxing.

4. DISCUSSION

4.1 Interpretation of the soundwalks results

The majority of responses from participants at all of the predefined stops indicated that the people around them were "passing through", either walking, cycling or relaxing, which correlates well with the fact that the walkway is popular among citizens in Limerick. The hearing of human movement and voices also highlights that this is a walkway where people socialise.

Although the sound along the walkway was perceived by the participants to be intense at the Robert Byrne Park at low tide, natural sounds from the Curragower Falls were dominant and the soundwalkers emotional responses were primarily positive ("natural", "relaxing", "lively", "pleasant", "beautiful" and "preferred"). The Curragower Park was perceived to have approximately the same level of quietness at low and high tide even though the sound pressure level was higher at low tide and motorised transport was more audible. The perceived responses for the Robert Byrne Park and Curragower Park were mainly positive, that the acoustic environment was "pleasant", "relaxing" and "natural". The sound emitted from the Curragower Falls and the weir at the mouth of the Abbey River creates time dependent quiet locations at the pocket

parks at low tide, which masks other sounds (e.g. traffic, wildlife, people's conversations and human movement). For the Curragower Park, that perceived quietness persists at high tide with the sounds of nature and birds dominating, and the majority of emotional responses suggesting that it is a "pleasant", "beautiful", "natural" and "relaxing" area. These locations are considered to be accessible to the public, are well maintained, clean and provide a sense of security according the responses of the participants. The walkway itself along Clancy's and O'Callaghan Strands would probably not be perceived to be quiet along its length, but the Robert Byrne and Curragower Parks would, at least at low tide.

There is an indication that acoustic environments with high sound pressure levels, where the combined quality of the sounds are good, can prompt positive emotional responses. There is also a suggestion that the participants of the soundwalks were most familiar with acoustic environments with a broad mixture of sounds including a combination of motorised transport, natural sounds, construction and human movement, rather than where natural elements dominate.

4.2 The role of Hush City: Impact on research and planning

Data collected by citizens using Hush City has identified time dependent quiet locations at two pocket parks along the River Shannon, at low tide. These pocket parks would not be identified by the review of strategic noise mapping because road noise levels are high along the walkway. It is unlikely that an application for quiet area designation under the END would be formulated though because no criteria exists for a designation based on a soundscape approach only. It is more likely that soundscape data collected through Hush City would support an application for a location where there was an appropriate amount of quantitative data demonstrating low or relatively low environmental noise levels. This investigation does highlight though that locations with high levels of environmental noise can be perceived as being quiet where sound pressure levels from preferred positive sounds in the environment are more dominant.

The advantage of designating a location as a quiet area under the END is that it promotes the benefits of that location to human health and well-being. However, there is no legislation in Ireland to protect designated quiet areas over and above existing planning and noise nuisance legislation. Additionally, where long-term sound level monitoring is required to investigate potential quiet areas

then there are financial implications that have to be balanced against affordability to undertake those investigations. There are potentially more “everyday quiet areas” than a local authority can afford to monitor, which can be disadvantageous in terms of raising awareness of their benefits among the public.

Potentially a focus for Limerick City and County Council should be to investigate data on the acoustic environment collected by citizens, in locations unlikely to be monitored, by undertaking soundwalks using Hush City. Arguably, there is an advantage to the local authority engaging with citizens to identify locations of good sound quality in “everyday quiet areas” and raise awareness of those locations among the wider public for their health and well-being, rather than only monitoring a limited number of parks or recreational areas for quiet area designation under the END. Consideration should be given by Limerick to designating local quiet areas as part of its next Noise Action Plan, 2024-2028, based on the use of soundscape data collected by the public.

Engagement with the public through the Hush City app should also be used to raise awareness within the local authority to feed into work programmes and strategies such as:

- **recreation and public realm** – local designation of “everyday quiet areas” as well as targeting infrastructural improvements based on demographics to provide social and environmental justice;
- **green and blue infrastructure** – aid the design of quiet spaces based on novel green solutions [16];
- **active travel** – identifying and raising awareness of low noise routes and demonstrate their benefit in comparison to more noisy (busily trafficked) routes to promote and allow the public make educated decisions on their active travel journeys around the City;
- **tourism** – identifying and raising awareness of low noise destinations in Limerick.

Additionally, it should be ensured that the public has access to comfortable outdoor public acoustic environments in areas where planning policy can facilitate residential developments in noisy environments [17].

The benefit to the public by using Hush City is that they can share with the local authority their experiences, perceptions and preferences which can aid the Council in decision-making from the earliest stages of projects. Limerick PPN’s social media channels are an appropriate mechanism to encourage the public to use the app given that the network has a statutory basis to connect local communities and

voluntary groups with local decision-making and policy-development.

5. CONCLUSIONS

Hush City has been used to evaluate the acoustic environment of a principal walkway in Limerick City along Clancy’s Strand and O’Callaghan Strand besides the River Shannon. Time dependent “everyday quiet areas” have been identified at the Robert Byrne Park and Curragower Park, at low tide in the River Shannon, even though there are high environmental noise levels from the adjacent road. These are pocket parks where people socialise with a mixture of natural and human sounds. Perceived quiet extends to high tide at the Curragower Park with wildlife (birds) becoming more noticeable as the sound of water from the Curragower Falls and weir decrease in intensity.

The use of the citizen science mobile app, Hush City, has been shown to be a reliable method to evaluate the quality of the acoustic environment and consideration should be given by Limerick City and County Council in the preparation of its next Noise Action Plan, 2024-2028, to develop a mechanism to designate local quiet areas based on soundscape data collected by local communities. While the app collects data pertinent to the acoustic environment it also collects important information on multi-dimensional experiential qualities of public spaces (quality, cleanliness, maintenance, feeling of security and accessibility). Therefore it can be recommended as a suitable tool for policy-makers in local authorities to complement the traditional environmental noise management approach to identify and evaluate quiet areas and integrate them with noise action plans. Furthermore, the app is a tool that can be used to raise awareness within local authorities and inform infrastructural improvements at a local level through work programmes and strategies, including the public in its decision-making.

Future research should focus on developing a criteria that can be used for designation of quiet areas under the END based on the subjective assessment of the acoustic environment, where the traditional environmental noise approach is not sufficient.

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