Exploring Association between Morphology of Tree Planting and User Activities in Urban Public Space; An opportunity of Urban Public Space Revitalisation

Qi Shen, Yan Liu
Department of landscape, The University of Sheffield, Western Bank, S10 2TN, UK
qshen4@sheffield.ac.uk

Abstract. This paper discuss the association between the morphology of tree planting in urban riverside brown field and user activities. With the growth of popularity, the revitalisation of urban public space is also promising. This research used drone photography and mapping to systematically surveys sample sites. An original observation study of user activities proceed in four sample public spaces in Sheffield. The study results found there are huge popularity and duration difference of user activities between various tree planting morphologies and typologies. The public space with lawn and rounded by mature trees attracted most users with the most activity types; the neat and silent public space is the favourite choice of lunch and reading, meanwhile it got the longest activity duration; but the space with sparse morphology and small trees are more likely be forgotten and abandoned. This finding offered a great opportunity for urban public space revitalisation in post-industrial cities.

1. Introduction
The inspiration for this research was in my early study of the Sheffield urban riverside regeneration design project. Urban riverside areas are an important aspect of urban public spaces. Not only because they offer the space for social interaction, relaxation and contact with water, but they also provide opportunities for urban leisure activities (Carr, 1992). Furthermore, many urban riverside sites in Europe were used for industrial purposes in the last century, like London’s South Bank and the Spree Riverside in Berlin. However, with the growing severity of city problems, the potential aesthetic and relax value of post-industrial sites has drawn increasing planner attention. Western European governments started the regeneration process in post-industrial sites in the1970s; the treatment of brown field sites became very popular in the United Kingdom, France and Germany. Although the practice of urban riverside regeneration has achieved considerable success in environmental conservation and urban public space provision, there are still many riparian areas lack of popularity and be abandoned. Meanwhile, citizens in high-density cities like Hong Kong and Shanghai are facing severe healthy issues from physical activity shortage. How to revitalise the urban public space appropriately is a pressing question.

The growing awareness about the value of urban public space has triggered blossoming interest in both policy and practice as well as the physical, social and economic benefits of urban communities. Subsequently, the demand for high quality public space is increasing. Landscape architects use line, form, colour, and texture as basic elements to capture aesthetics and creativity (Fisher, Bell and Baum, 1984), and tree planting plays the leading role of those aspects. Arnold (1993) said: “Trees are the most exquisite material of urban design”. Tree planting has great influence on urban landscape
perception; furthermore, its prominent impact on space shape, micro-climate regulation and aesthetical attraction has made it an important element of public space revitalisation.

Tree planting in the urban public space has been studied widely in the literature. Several authors have discussed tree planting functions from different perspectives, such as trees defining space both vertically and horizontally (Arnold, 1993); the connection between biodiversity and urban tree planting (Cornelis and Hermy, 2004); and how street trees reduce urban water runoff (Armson, Stringer and Ennos, 2013). However, there are some specific issues related to user activities on post-industrial locations which have not been systematically researched.

Although most landscape architects agree that tree planting in urban riverside regeneration projects is an attraction for users and helpful for public space revitalisation, how tree planting exactly promotes the process is not that plain. Different planting morphologies and typologies will lead to distinct results and site characteristics. If the designers use them well, trees will efficiently improve project popularity, vice versa. That is why some projects fail to achieve their regeneration aims despite using many trees. A chef cannot cook the perfect meal without the right recipe, even if he has the optimum material. Sheffield was an industrial city and there are many riverside post-industrial restoration spaces. Some of them are popular but some are pathless even located in the city centre. The different results of those projects are representative and worthy of exploration. The findings will be helpful for future regeneration project designs.

According to a research from Dunnett, Swanwick and Woolley (2002), urban green space in UK been visited more than 2.5 billion time a year, which is a huge number consider of the population of UK is 65 million. Why it is so popular? Could this success be duplicated? This paper focuses on the association between tree planting morphology and user activities in urban public space, and the research question is ‘Does the morphology of tree planting influences user activities in urban public space? If so, how?’.

2. Site Survey
To obtain the present status of tree planting to support the research into the relationship between tree planting and user activities in riverside regeneration projects, a site survey was designed that investigated tree planting locations, quantity, typology and visual connections with sample river areas via ground site and aerial survey (Figure 1). As the main feature of riverside regeneration projects, the visual impact of rivers is important. So the ground site survey used a digital camera to record the visual connection between site trees and the river at user view level. Based on this survey, riverside area sections of four sites were produced to illustrate the visual impact of trees.

(Figure 1)

To eliminate the gap between outdated satellite images from Google Maps and present reality, this paper used aerial survey to record the present tree planting plan and situation. This aerial survey was achieved using a DJI Mavic Pro drone which provided clear vertical views. Photos from the aerial survey clearly showed the tree and river channel location, canopy size and planting typology, which was very helpful in producing the site tree planting plan and identifying the tree planting characteristics of different sites.

Sheffield was one of the largest industrial cities in the UK. The city is built near many rivers such as River Don, River Sheaf and Porter Brook (Figure 2). This study chose four sample areas, which
were urban riverbank landscape projects of the River Sheaf, Porter Brook and River Don (Figure 3).

![Figure 2](image1.png)

![Figure 3](image2.png)

Before the observation study, a tree planting analysis was made for every study site (Figure 4). Blue shows the river width and location. Each red circle represents a tree, and the size of circle means the tree size. The tree planting plan for the study sites clearly illustrates in-site tree location, tree size and the space the tree planting formed.

![Figure 4](image3.png)

Diagram 4 shows clearly that site A and B had more riverside trees; more planting typologies (single, avenue and grove); and the size of those trees was much more diverse, from 1 to 8 meters. Site C and D had less trees than A and B, and the trees in site C and D were younger than 5-years-old, which means they had limited size and looked thinner than the trees in A and B. (Figure 5)
In sites A and B, abundant trees were planted along the riverside, both the riverbank slope and public flat areas. Those trees stabilised the riverbank and improved the soil infiltration rate, thereby promoting urban flood mitigation capacity. However, the dense tree planting blocked visual contact between users and the adjacent river. Site C basically had no vegetation interfering between users and river; people could see and hear the river clearly in this area, which is a real use of an urban river. In site D also, no trees blocked a totally open river view and broad riverside steps to reach the water body. Trees in site C and D were scattered. The planted trees were lined along paths and looked like design decorations, some tiny trees and shrubs were self-sown in the water channel edge. The concrete embankment with terraced spatial expansion is the main defender from urban fluvial flooding by expand water capacity. (Figure 6)

3. Observation Study
This research used the observation study method to collect user activity data to investigate the impact of different tree planting strategies on in-side user activities. The inspiration for this observation study came from an open space study in New York by Whyte (2001). This study followed his research structure but enriched data content. This in-site study recorded every user’s activity type and duration from 9:00 to 15:00 in each sample area. Because this study is an individual work, only one site could be observed a day. To avoid weather and date influence on human activities, this observation study was only made on sunny weekends.

Tree planting in urban riverside regeneration projects plays an important role in human activity. Different tree planting typologies or strategies will create various space organisations, user perceptions and affect how people use this space. Low et al. (2005) argue that fulfil user’s various needs is should be the main index to assess a public space. High popularity and a live atmosphere are basic criteria for successful urban riverside regeneration projects. In this observation study, the study objectives were user and use - i.e. walking, jogging, cycling and sitting - of the sample sites and where those activities
occurred. According to Gehl and Rogers’ (2013) classification principle of common activities in
public spaces, all of the activities can be classified under three kinds: necessary, optional, and social. And the optional activities will be greatly influenced by the quality of space (Gehl and Koch, 2011). Consequently, this study focused on the quantity and density of users, user activity types, use patterns of different activity groups to evaluate the impact of tree planting strategies in riverside regeneration projects.

This observation study observed several activities such as jogging, walking, sitting and skating in study sites. Each study site had its own tree planting character, and the difference of users and uses in sites represented the different spatial feelings of the sites. Based on the literature review, the prediction of this study is that the most popular site has more riverside trees in better condition (health, size, diversity).

The study data have been organised in a visual diagram (Figure 7). Each line represents a user and different colours mean different uses. The length of line denotes the duration of use, referring to the time axis (e.g. A blue line in A column starting at 9:05 and ending at mid 9:15 means a user sitting in site A from 9:05 to 9:12). To make these data easier to read and compare moments of quantity, figures 8 and 9 are produced to illustrate quantity of use type and user at every moment from 9:00 to 15:00. Figure 10 shows the total user number for each site.

Site B had 300 visitors during the study period, which was the most. Site A was second with 230 visitors. Site C and D had far fewer, 97 and 103 visitors respectively. This result basically follows the prediction, but site A was bounded by railings which stopped a lot of joggers and pedestrians crossing the site. Still, site A was much more popular than sites C and D. Site A had the highest number of activity types with nine. In sites B and C seven were observed, and in site D, six.

Although sites A and B did not show a huge gap in total people counts, the greatest difference between them was activity duration and quantity. Figure 7 shows clearly that duration of user activities in site A was much longer than in site B. As figure 9 shows, site A had highest in-site people quantity (8-14) at its peak time (10:30-11:00; 14:00-15:00), site B did not have high numbers (4-9) but still had the second most in-site quantity for most of the day (except 13:00-14:30). Figure 8 shows site A had more activity types (3-7 types) than other sites for most of the day, especially from 10:00 to 11:00 (4-7 types) and 14:00-15:00 (3-6 types). The quantity of site B activity types fluctuated before 12:30 (1-4 types); the number of use types was basically stable (2-3 types) after 12:30. In site C also, before 12:00 the activity types fluctuated (1-4 types); after that, the quantity became stable. Site D did not show a distinct activity quantity trend. Though the visitor numbers for Sites C and D were similar the use duration pattern was very different. It was similar to the comparison between A and B; users tended to spend more time in C rather than D. Neither C or D showed a distinct trend in user quantity change during the observation period; however, an interesting result was that the moment user quantity of C and D was falling between 10:30-12:00 while A and B was increasing.

This observation study covered common public space activities. The data provide an indication of the usage patterns of different sites (Figure 7). There were always some users in site A sitting, skating, walking dogs and pursuing other activities. Furthermore, many families came to the site to relax; their children were observed playing ballgames or using outdoor facilities together. This appeared to be a great social place for adjacent residents. However, not many users stayed in site B, even though it is only on the other side of Broadfield road. Most people just walked or cycled through site B. The user sitting time for site C was the longest (10-45 mins), plus there was an upward trend of people sitting between 12:00-14:00. Although a lot of people also sat in site A to rest or look after their playing children, people sitting in site C did different things, mainly reading, eating, talking on their telephones or with their friends and other private activities. People also sat in site D, but only a few and for a short time (4-11 mins).
Figure 11 shows percentages of different activities in each site. Walking was the most common use for all sites even though the proportion differed. Site A had a more balanced ratio of uses; ball games and other activities were only observed at site A. The figure 12 divides activities into two groups: necessary and optional. Necessary activities include walking and cycling across the site; optional activities are jogging, walking dogs and other activities. The proportion of optional activities in sites A and C was over half (62% and 54%), but in site B only 26%, and site D 17%. This result conformed to prediction.

During this observation study, many users tended to sit or use the open space with a single landmark tree between riverside woodland and the avenue in site A and the river-view step terrace with groves in site C. The riverside woodland area was the most common choice for people walking and cycling. The riverside space in site D without any tree planting was least popular (only one or two users were observed).

4. Discussion and Conclusion

4.1. Tree planting and user behaviour
The initial research question, ‘Does the morphology of tree planting influences user activities in urban public space?’ can be answered with ‘yes’. The particularly observation study proceed in four sample public spaces proved that tree planting morphology has a direct impact on how public spaces are used in terms of type and duration of user activities and number of user visiting the open spaces.

The observation study recorded a range of activities occurring within the sample spaces including walking the baby, ballgames, talking with friends, sitting and eating. According to Gehl and Rogers (2013) classification principle of common activities in public spaces, all of the activities can be classified under three kinds: necessary, optional, and social (Gehl and Koch, 2011). Necessary activities like walking and cycling across the site take place with approximately the same frequency in sparse and abundant tree planting sites. For optional activities, jogging, walking dogs and other relaxations occur more frequently and diversely in the sites which have more complicated morphology. Meanwhile, different tree planting morphologies have been found to have various specific functions. For example, people prefer to walk or cycle in woodland even if they do not stay or do other activities; grove surrounds are the most popular choice when people want to sit - if there is also a clear view of the river, the user sitting duration will increase; most activities took place in spaces surrounded by riparian and avenue trees. Based on these findings, the combination and ramifications of tree planting
morphology can be applied to different specific design purposes. Those results suggest that urban public space are more likely to benefit from the combined morphology of tree planting than sparsely, hastily planted projects (like Nursery Street Pocket Park).

4.2. An applicable treatment to improve urban health?
A well designed tree planting project could improve or restore the popularity of urban public spaces. According to a public space study by CABE, the urban public space quality will directly influence residents mood (CABE, 2002). According to a study in Chicago, the urban residents who lives in apartment prefer to use ‘natural’ feeling green space than artificial, which also one of the benefits tree planting can offered. With the increase use in urban public space, the social band between users is established (Kuo et al., 1998). Furthermore, the increased use of children means they will have more interactions with peers, and this process can help them to develop interpersonal skills (Taylor et al., 1998). In such cases, tree planting project might provide considerable social improvements even with limited budget and area. So, an ideal tree planting morphology not only revitalised the popularity of urban public space, but also improved both physical and mental health of citizens.

References
[1] Armson, D., Stringer, P. and Ennos, A. (2013). The effect of street trees and amenity grass on urban surface water runoff in Manchester, UK. Urban Forestry & Urban Greening, 12(3), pp.282-286.
[2] Arnold, H. (1993). Trees in Urban design. New York, NY: Van Nostrand Reinhold, pp.1-2.
[3] CABE (2002). Streets of Shame. Summary of findings from ‘Public Attitudes to Architecture and the Built Environment’. London: CABE.
[4] Carr, S. (1992). Public space. Cambridge: Cambridge University Press.
[5] Cornelis, J. and Hermy, M. (2004). Biodiversity relationships in urban and suburban parks in Flanders. Landscape and Urban Planning, 69(4), pp.385-401.
[6] Dunnett, N., Swanwick, C. and Woolley, H. (2002). Improving Urban Parks, Play Areas and Green Spaces. london: Office of the Deputy Prime Minister.
[7] Fisher, J., Bell, P. and Baum, A. (1984). Environmental psychology. New York: Holt, Rinehart and Winston.
[8] Gehl, J. and Koch, J. (2011). Life between buildings. Washington, DC: Island Press, pp.9-14.
[9] Gehl, J. and Rogers, L. (2013). Cities for People. Washington DC: Island Press, p.21.
[10] Kuo, F., Sullivan, W., Coley, R. and Brunson, L. (1998). Fertile Ground for Community: Inner-City Neighborhood Common Spaces. American Journal of Community Psychology, 26(6), pp.823-851.
[11] Low, S., Taplin, D. and Scheld, S. (2005). Rethinking urban parks. Austin, Tex.: University of Texas Press, p.16.
[12] Sheffield Waterways Strategy Group (2014). Sheffield’s main rivers and some of the larger streams and brooks. [image] Available at: https://www.sheffield.gov.uk/content/dam/sheffield/docs/planning-and-development/conservation/Sheffield%20Waterways%20Strategy.pdf [Accessed 23 Aug. 2017].
[13] Taylor, A., Wiley, A., Kuo, F. and Sullivan, W. (1998). Growing Up in the Inner City. Environment and Behavior, 30(1), pp.2-27.
[14] Whyte, W. (2001). The social life of small urban spaces. New York: Project for Public Spaces.