Urban vegetation and the drivers for change: a case study of Runcorn, UK

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Abstract

Incorporating green areas into urban environments can aid sustainability and enhance the quality of life for those living and working in urban areas. The objective of this research is to examine the relationship between vegetation and its role within urban environments and to consider the external forces that are likely to cause change. This work will inform land owners within Runcorn with respect to future management strategies to circa 2060. Existing topography and vegetation complemented by large scale landscaping and tree planting guided the development of Runcorn, a town in northwest England. As a result, there is, within Runcorn, a comprehensive open space system comprising playing fields, parks, woodlands and greenways. These areas form vegetative frameworks which were planted across the town at the same time and using just one species prescription. The trees within these vegetated areas have reached maturity and questions are being asked about their future. In this paper the results of botanical surveys conducted within the town are presented. Species lists and abundance readings have been used to assess the impacts of predicted climate change. The authors discuss current management practices amongst landowners within Runcorn. Findings on floral composition and diversity demonstrate the variations present within the planting. This suggests that external forces are driving change amongst the vegetation within Runcorn. The paper concludes with a description of future work that will measure the existing ecosystem services attributed to Runcorn's greenspaces.

1. Introduction

Vegetation incorporated into urban environments has an ecological role and a societal value that helps sustain public health and well being (Williams *et al.,* 2009)**.** Plants can filter air by physically trapping particles such as dust from the atmosphere and absorbing harmful gases (Beckett *et al.,* 1998). Vegetation can retain and store water: this allows for natural drainage which reduces surface run off and, therefore, reduces the risk of flooding (de Groot *et al.,* 2002). Vegetation can regulate climate (Bolund and Hunhmmar, 1999). It can reduce effects of wind and provide shelter during both warm and cold weather (NUFU, 1998; Dimoudi and Nikolopoulou, 2003). Vegetation in the urban environment provides habitats for wildlife and, therefore, can help maintain and enhance biological and genetic diversity (Attwell, 2000). The aesthetic value of vegetation can enhance residents' satisfaction, attachment and sense of responsibility thereby improving their overall well being (Groenewegen *et al.,* 2006). Urban greenery can also provide opportunities for education and encourage physical activity (De Vries *et al.,* 2003). Access to urban green spaces is usually free to all, which is why they promote social inclusion and provide opportunities for social interaction (Swanwick *et al.,* 2003). Vegetation can reduce noise pollution. Only very dense vegetation cover can physically diminish noise levels, but there is evidence to suggest that screening the source of noise by trees can reduce the perceived noise level (Anderson, 1984; Bolund and Hunhammar, 1999). Studies have found a positive correlation between property prices and a close proximity to green areas (Luttik, 2000 Tyrväinen and Miettinen, 2000). According to the Commission for Architecture and the Built Environment (2004) the provision of quality urban green space can enhance a city's reputation for high quality living environments and urban governance.

Urban green spaces provide employment opportunities, and they help attract businesses and tourists to an area (Swanwick *et al.,* 2003). What is not known, is how resilient urban vegetation is and will it change over time. This is particularly relevant in the context of predictions for climate change and changing social and personal values related to open space (Wu, 2008). If urban vegetation is likely to change then this raises questions about the effects on the ecosystem services it provides.

Human activity is a significant driver of change influencing vegetation in the built environment. The inclusion and use of vegetation within urban areas is controlled by human perception. Vegetation density is a variable that determines the perceived appropriateness of green space (Bjerke *et al.,* 2006). Dense vegetation is thought to facilitate crime, as it reduces visibility and the perception is that it can, therefore, conceal criminal activity. As a result densely vegetated areas often evoke feelings of insecurity (Kuo and Sullivan, 2001).

The most influential criticism of naturalistic landscapes is their appearance (Özgüner *et al.,* 2007). If a site is considered to be untidy and not maintained it can attract waste dumping as well as vandalism and the perceived worth decreases (Lee *et al.,* 2008). Urban trees can be considered a liability due to concerns over safety and subsidence damage to property (Britt *et al*., 2008).Those who manage urban green spaces have the obligation to meet high demands in relation to land-use and to create areas that meet the social, economic and environmental needs of the local community. One of the difficulties associated with the management of urban green space is the issue of finance. Ecosystem services are often undervalued (de Groot, 2006) and it is often the case that short term management options at low cost are preferred to costly long term strategies (Germann-Chiari and Seeland, 2004).

The UK is expected to experience increased summer and winter temperatures, a decrease in summer precipitation and an increase in winter precipitation (Jenkins *et al.,* 2008). Anticipated changes to vegetation include alterations to phenology, the arrival of non-native species and changes to community compositions (Walther *et al.,* 2002). Urban landscape managers must now consider implementing adaptation strategies to minimise the effects threatened by climate change.

The objective of this research is to examine the relationship between vegetation and its role within urban environments and to consider the external forces that are likely to cause change. This paper presents the results from botanical surveys conducted within Runcorn and explores the characteristics of this urban planting. Predictions for future climate change and its influence on current flora compositions are considered. Current management practices and the possible effects these have on the plantings future are discussed.

2. Methods

This study has been carried out within the town of Runcorn, in Northwest England. During the development of Runcorn existing topography and vegetation was complemented by large scale landscaping and tree planting (New Towns Record, 2002). This landscaping and planting began in 1966 and was completed in 1972. As a result of this landscaping Runcorn has a comprehensive open space system which includes playing fields, parks, woodlands and greenways; these areas form vegetative frameworks which were planted across the town at the same time and using just one species prescription. The trees and shrubs planted have been growing for *circa* 40 years. This provides the opportunity for gaining insight into the ecological and social issues associated with urban vegetation and to ask questions about their future.

Floristic data was collected from March 2009 to March 2010. All sites of naturalistic planting currently owned by the local authority for Runcorn; Halton Borough Council was digitally mapped. From these sites a total of forty five were randomly selected and surveyed. All higher plant species were considered. A detailed species inventory was compiled for each sampling site. Abundance readings were taken for all tree and shrub species using the method described in Rodwell (2006). Soil compaction, humidity and pH readings were also taken at each site. Soil compaction was measured using a pocket penetrometer which gave a unit reading of $kgcm^{-2}$, pH was measured using a pH probe (IQ 120) and soil humidity was measured using a hygrometer (TENAX). Ecological Site Classification (ESC) has been used to predict future suitability for tree species within Runcorn. Sites are classified within the ESC program in terms of its climate and soil quality (Pyatt *et al.,* 2001). It assesses the suitability of a site based on the characteristics of the site and the requirements of different tree species. This research will assess how the local population influences the management of urban green spaces. The service requests received by the Landscape Services Division of Halton Borough Council (HBC) were chosen for analysis. Service requests are calls that HBC receive from the public which ask for intervention to be carried out on particular vegetation. The requests analysed were received between January 2005 and January 2010.

3. Results

A total of 131 floral species from 44 families were recorded (27 tree, 19 shrub and 85 ground species). There is a relatively high variation amongst each site in terms of species richness as values ranged from 16 to 62. All 45 sites had pH levels within a range of 7 to 7.9 with a mean of 7.4±0.27 which indicates that the soils are neutral to alkaline. The pH levels present at these sites fit within the typical range for UK soils and the limited range suggests that the whole of Runcorn is relatively homogenous with respect to this soil characteristic. A Canonical Correspondence Analysis two-dimensional ordination plot was used to illustrate the dissimilarity in species composition between the sample units (Figure 1), the closer sites are to each other the greater the similarity. There are no clusters in figure 1 which indicates that there is not much similarity between the sites. At present the most abundant trees species are *Acer pseudoplatanus, Fraxinus excelsior, Prunus avium, Acer campestre, Alnus glutinosa* and *Quercus robur* (Table 2).

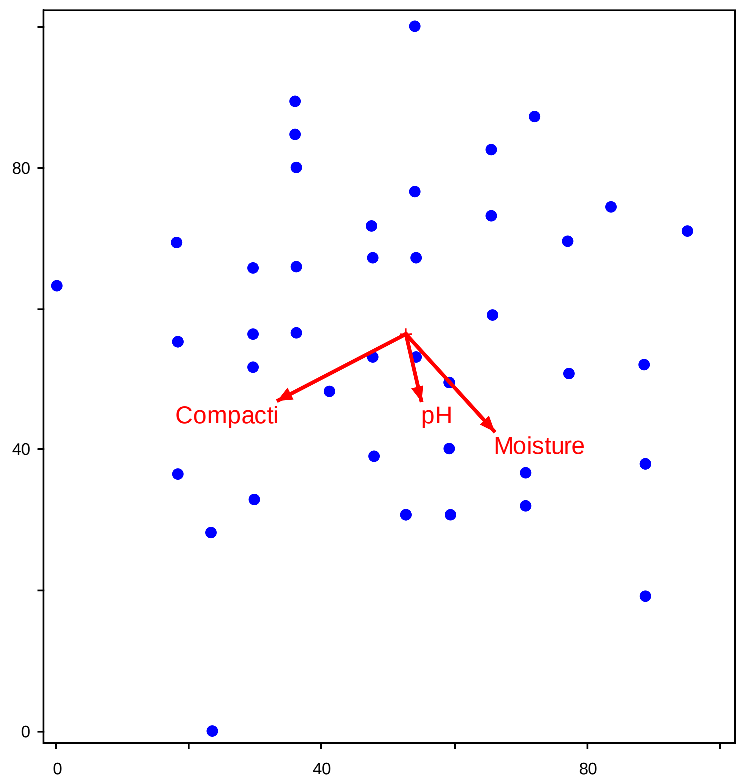

Figure 1: Canonical correspondence analysis plot. Points represent sampling sites they are distributed according to the strength of relationship between their species and environmental variables.

3.2 Climate change

The current version of the ESC program contains data for seven of the tree species recorded within Runcorn. The suitability maps (figure 2, 3, 4 and 5) illustrate the site suitability for individual species. If a site is suitable it means that in this location a species will achieve optimal performance. Unsuitable sites are areas in which a species can exist but will not thrive to its true optimum. The present-day suitability map for *Betula pendula, Alnus glutinosa, Fagus sylvatica, Quercus robur* and *Prunus avium* (Figure 2) illustrates that a large area on the west side of

Runcorn is consider an unsuitable location for these species based on the climate and soil quality of the area. Figure 4 and 5 show change in the spatial distribution of suitable sites for these five tree species with the predicted climate change. *Fraxinus excelsior* and *Acer pseudoplatanus* are considered suitable at present (Figure 3) across the whole of Runcorn and this does not change with the future climate projections (Figure 6).

Table 1: Percentage contribution of each tree species to the overall tree abundance and the number of occupied sampling sites.

Species	Abundance %	Sites occupied %	Species	Abundance %	Sites occupied %
Acer pseudoplatanus	14	87	*Tilia platyphyllos*	2	13
Fraxinus excelsior	10	60	*Sorbus intermedia*	2	11
Prunus avium	10	60	*Populus tremula*	2	11
Betula pendula	9	53	*Pinus sylvestris*	1	11
Acer campestre	8	49	*Prunus cerasifera*	1	11
Alnus glutinosa	7	49	*Sorbus aria*	1	11
Quercus robur	6	44	*Castanea sativa*	1	11
Sorbus aucuparia	4	33	*Populus alba*	1	9
Salix fragilis	4	24	*Malus domestrica*	1	9
Aesculus hippocastanum	4	20	*Taxus baccata*	1	7
Tilia cordata	3	20	*Carpinus betulus*	<1	7
Populus nigra	3	16	*Malus sylvestris*	<1	2
Fagus sylvatica	2	18	*Populus nigra italica*	<1	2

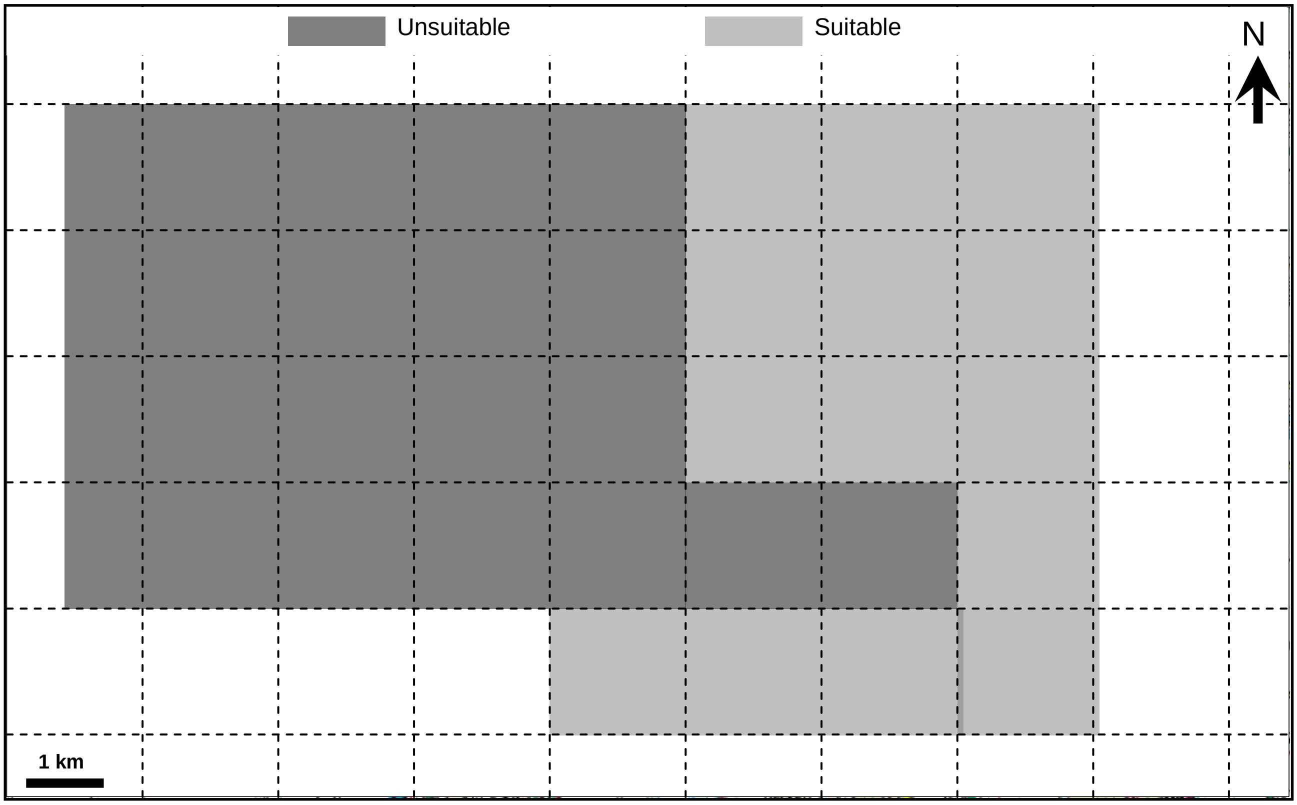

Figure 2: Present-day suitability maps for *Betula pendula, Alnus glutinosa, Fagus sylvatica, Quercus robur* and *Prunus avium* based on ESC data (© Crown Copyright/database right 2010 An Ordnance Survey/EDINA supplied service).

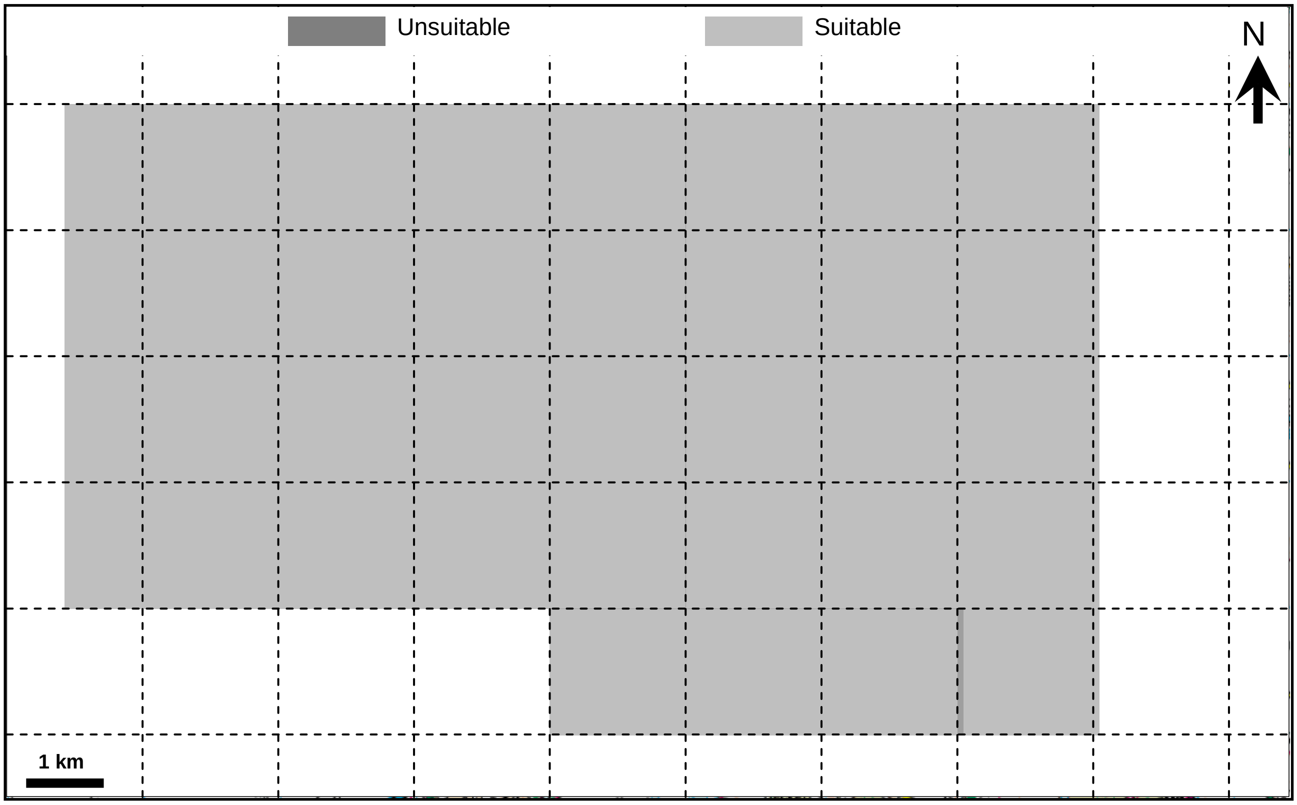

Figure 3: Present-day suitability maps for *Fraxinus excelsior* and *Acer pseudoplatanus* based on ESC data (© Crown Copyright/database right 2010 An Ordnance Survey/EDINA supplied service)

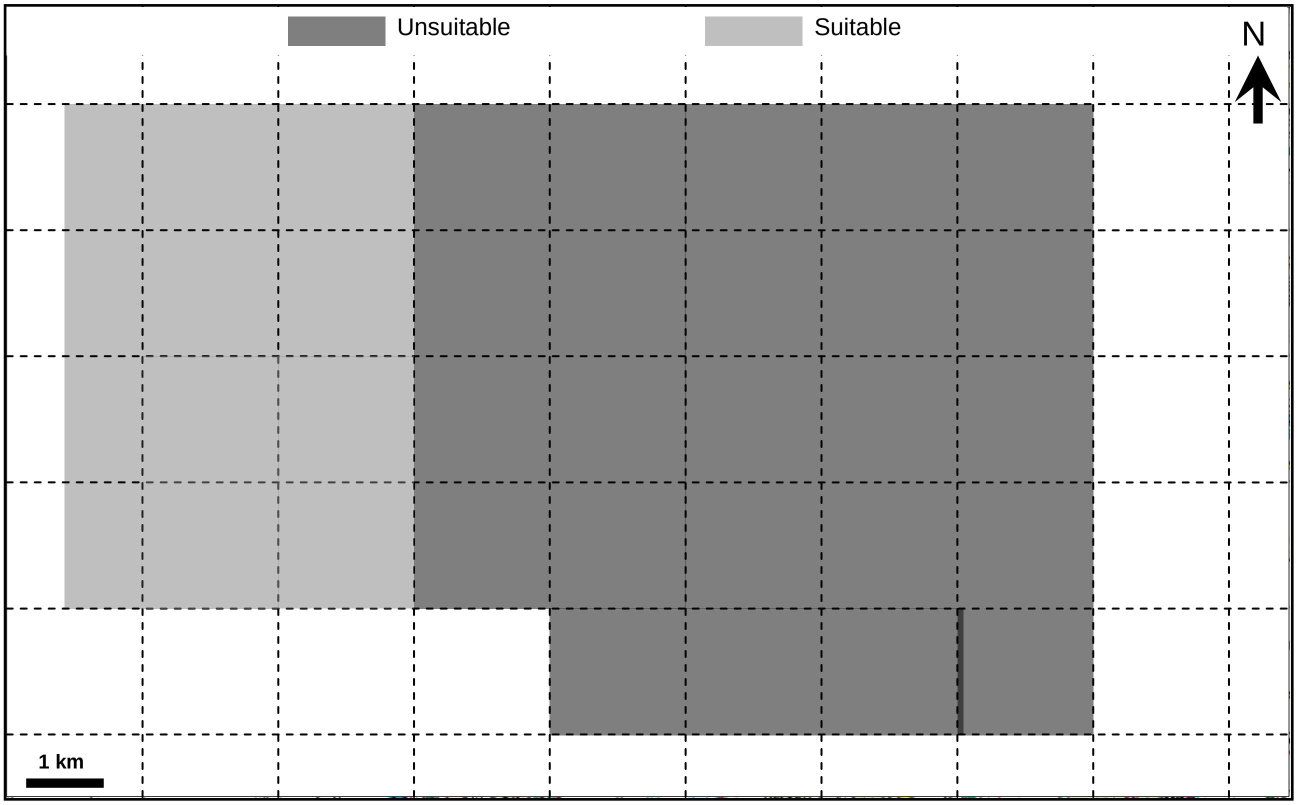

Figure 4: Suitability map for *Betula pendula, Alnus glutinosa, Fagus sylvatica* and *Quercus robur* under 2050s and 2080s low and high emissions UKCIP09 scenarios (© Crown Copyright/database right 2010 An Ordnance Survey/EDINA supplied service)

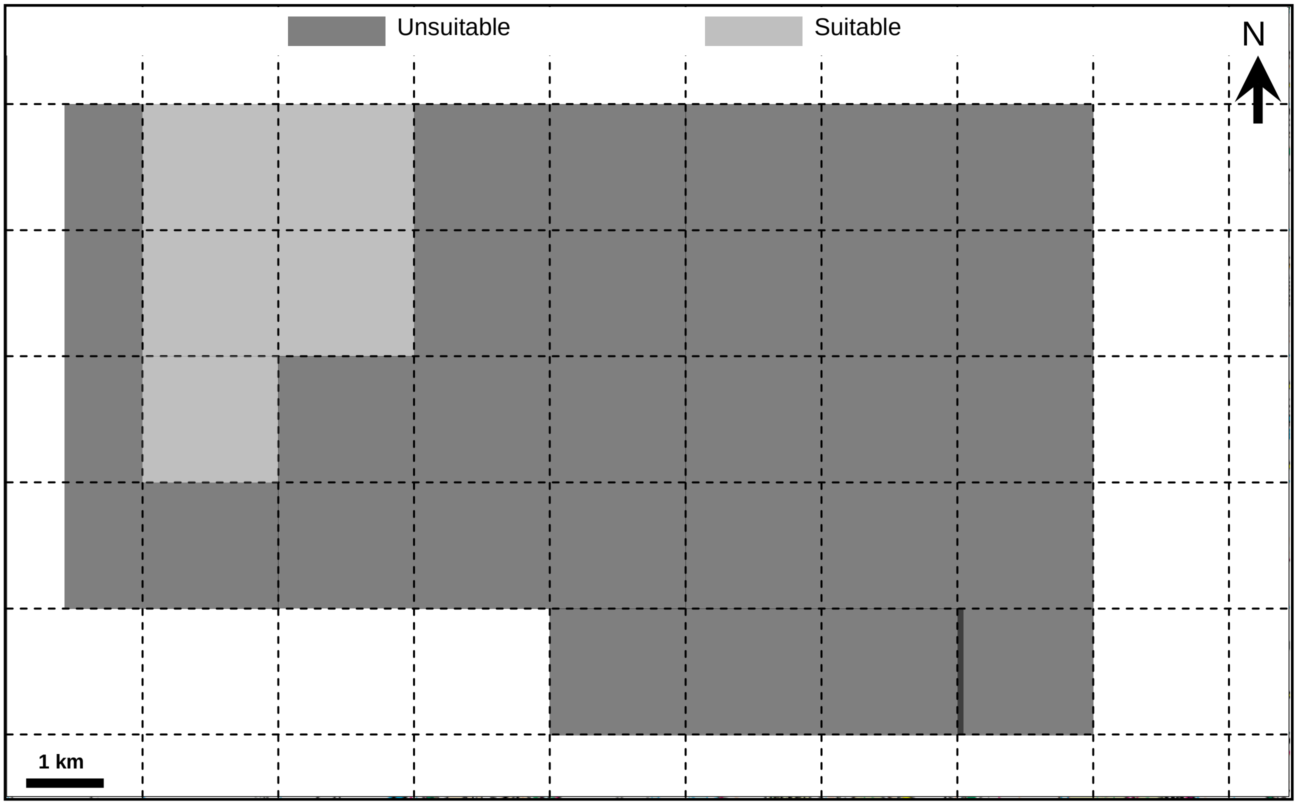

Figure 5: Suitability map for *Prunus avium* under 2050s and 2080s low and high emissions UKCIP09 scenarios (© Crown Copyright/database right 2010 An Ordnance Survey/EDINA supplied service)

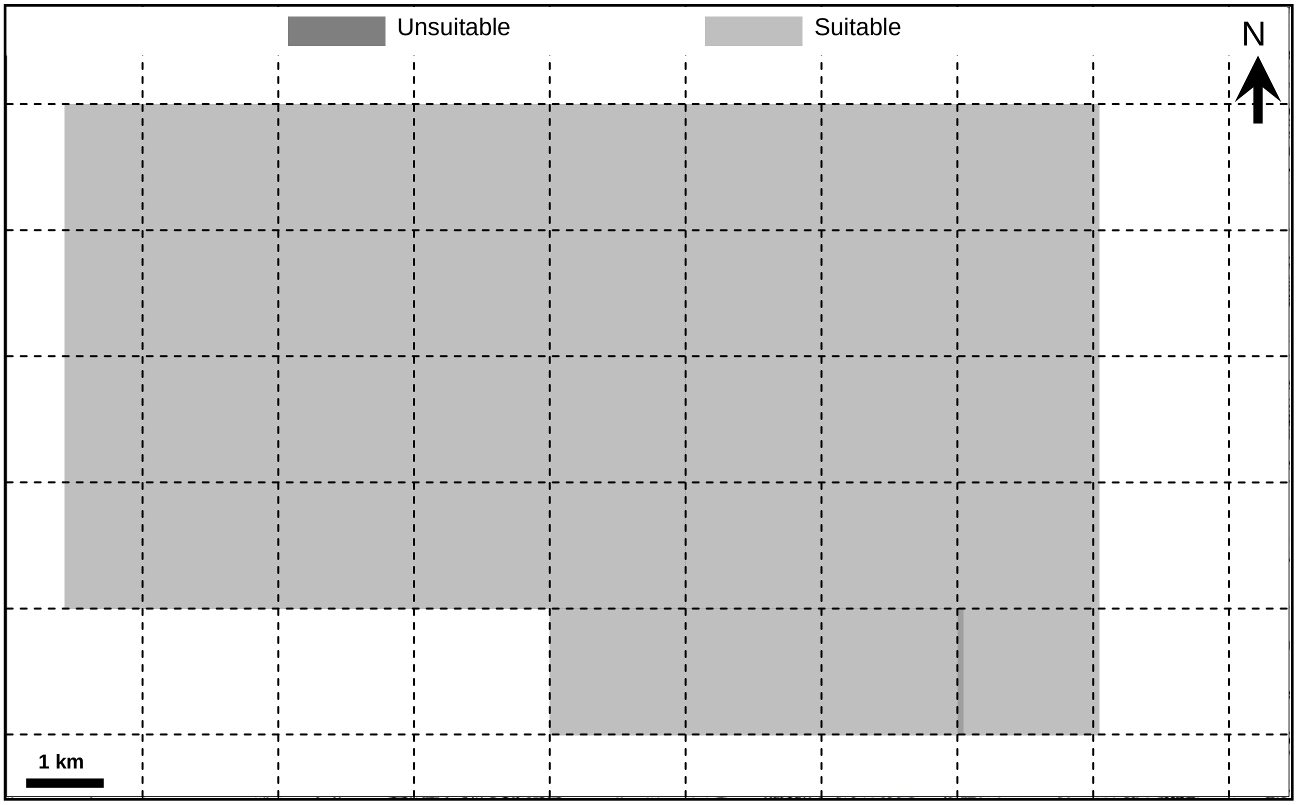

Figure 6: Suitability map for *Fraxinus excelsior* and *Acer pseudoplatanus* under 2050s and 2080s low and high emissions UKCIP09 scenarios (© Crown Copyright/database right 2010 An Ordnance Survey/EDINA supplied service)

From the total number of service requests received by Halton Borough Council the response to 52% was for immediate intervention. The Council undertook immediate actions to clear the obstructions reported in 67% of the relevant requests. The highest number of requests was in relation to vegetation that was perceived as having encroached on to private property, the Council acted on 49% of these requests. Of the requests relating to overgrown vegetation 63% did not result in intervention by the Council.

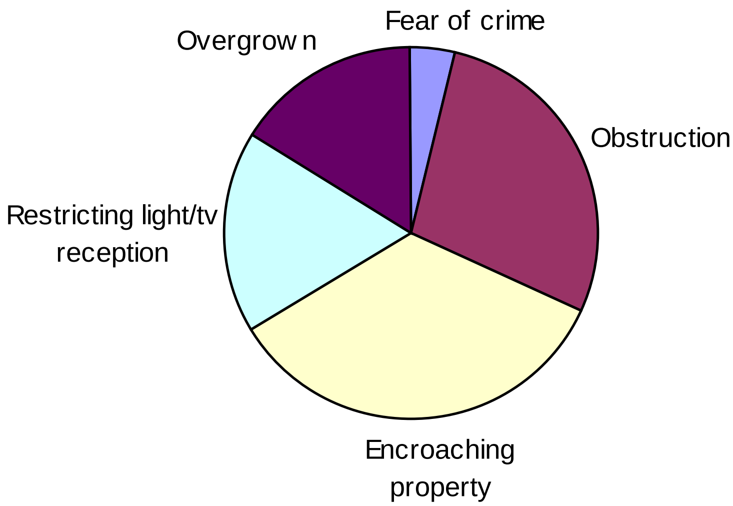

Figure 7: Proportion of requests for each category. Obstruction includes all requests that related to vegetation that was restricting access on public footpaths and roads. Encroaching property are all requests relating to vegetation that crossed from council land into privately owned land. The category of overgrown includes all requests relating to vegetation that people feel is overgrown but that does not cause an obstruction or encroach private property. Fear of crime includes request relating to vegetation that has made people feel unsafe.

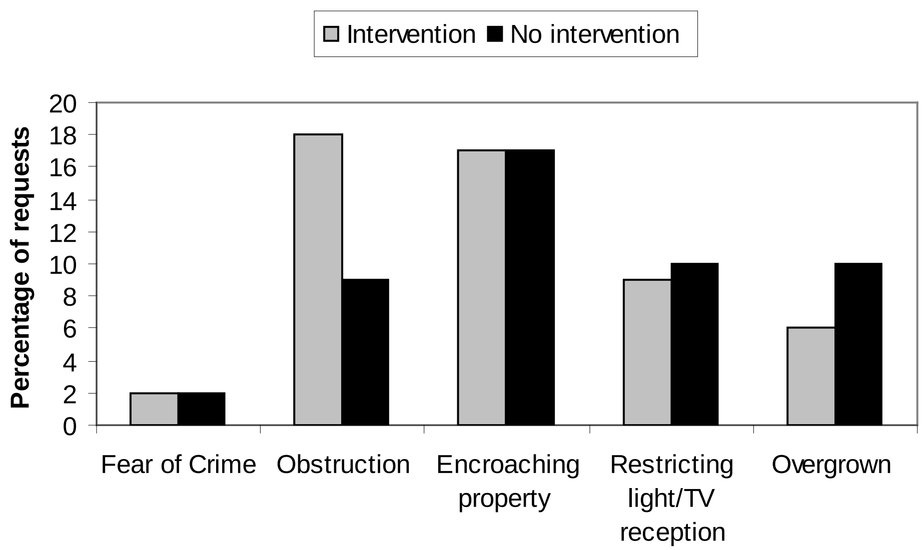

Figure 8: the percentage of requests within each service category that received intervention from Halton Borough Council.

4. Discussion

The vegetation framework throughout Runcorn was planted using the same species prescription. The results from the botanical survey showed high variation in terms of floristic composition amongst the green spaces in Runcorn. This indicates that climatic or anthropogenic forces are driving change amongst the vegetation within Runcorn.

Only a small number of tree species recorded in Runcorn are included in the current ESC program. This limits the analysis of the impact of climate change predictions on the vegetation in Runcorn at this time. As more species are added to the program a fuller picture of the likely impact will emerge. At this time results relating to the seven species presented in this paper suggest that the trees and woodlands within Runcorn are going to be altered significantly. The east of Runcorn is considered to have ideal conditions for *Betula pendula, Alnus glutinosa, Fagus sylvatica,* *Quercus robur* and *Prunus avium*. However, climate change predictions suggest that by the 2080 the location where these species are expected to thrive is going to reduce and relocate to the west. Figure 2 shows that at present there is a large proportion of Runcorn that is considered unsuitable for five tree species. These species contribute to 34% of the overall tree abundance and are widely distributed around Runcorn (Table 1). According to the results from the ESC data the suitable sites have a slightly warmer accumulated temperature, higher moisture deficit and less exposure. As these species require a milder climate and well-drained soils (Pyatt *et al.,* 2001) this could be the reason for the difference in suitability across Runcorn. With the projected climate change the suitability for these species is expected to change dramatically. The reason for this is the expected alteration in climatic conditions and soil quality. This shift in species distribution across Runcorn and the reduction in species present will have an effect on the value of green spaces to other wildlife across Runcorn. According to Southwood (1961) and Rose and harding (1978) *Quercus robur* has the highest number of associated insect (284) and lichen (324) species of any tree and shrub species. Other species such as *Betula pendula* and *Alnus glutinosa* also rank highly with regard to the number of associated insect (229-90) and lichen (126-105) species. *Fraxinus excelsior* ranks significantly lower in terms of associated insect species and have only 41. *Acer pseudoplatanus* have 15 associated insect species and 183 associated lichen species. Therefore, the changes in the tree communities across Runcorn could lead to a reduced number of invertebrate fauna and as a result, could affect the number of avian fauna. With a change in species distribution predicted across the town Halton Borough Council will need to consider implementing a strategy to deal with the changes.

The service requests received by Halton Borough Council show that the biggest concern for residents of the local area is vegetation that encroaches into their private property. Only a very small proportion of the calls were concerned with the fear of safety 4%. This could indicate that Runcorn's open space network has been a success in providing a naturalistic landscape but one that does not compromise resident's sense of safety. Özgüner *et al.,* (2007) suggests that naturalistic plantings can be considered unattractive and this can influence its management. But in Runcorn requests regarding overgrown vegetation received the lowest number of responses from the Council. Therefore, although people do have different attitudes towards planting styles, it may not be a direct driver of change for urban green spaces. Half the number of calls from local residents received intervention from the Council. The majority of the requests that did bring about immediate management were those considered to be a threat to either people's safety or damage to property.

The data presented illustrates that climate change will affect vegetation already present within Runcorn. The climate changes it will experience are going to have an impact on the plant community compositions of the town. It is also evident that human requests can determine the appropriateness and therefore inclusion of vegetation within built environments. Both the effects of climate change and human intervention are likely to have an impact on the current ecosystem services which Runcorn's green spaces currently provide.

Future work will include, collecting data concerning current management practices amongst landowners within Runcorn, examining further impacts of predicted climate change and to measure the ecosystem services attributed to Runcorn's green infrastructure, in order to produce future management scenarios for this landscaping to *circa* 2060.

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