

Urban Green Space: distance, connectivity and variability

Research Project No.134



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4893 words

June 2012

TABLE OF CONTENTS

ACKNOWLEDGMENTS.....	2
ABSTRACT.....	3
1. INTRODUCTION.....	4
2. MATERIALS AND METHODS	
2.1 The Study Area.....	7
2.2 Software used.....	10
2.3 Samples.....	11
2.4 Proportion of green area.....	12
2.5 Data Analysis.....	14
3. RESULTS	
3.1 Relationship of mean percentage of green areas with distance	15
3.2 Relationship of the variance of green areas with distance	16
3.3 Relationship of green space with distance within Borough/Districts	16
4. DISCUSSION.....	17
5. REFERENCES.....	21
APPENDIX.....	25

ACKNOWLEDGMENTS

Through this acknowledgment, I would to express my sincere gratitude to everyone who have helped me and supported me throughout this project, making it a worthwhile experience.

I am grateful to my supervisor, for her continuous support and guidance in the different matters regarding the topic from initial advice in the early stages through on-going advice, patience and her interesting ideas and thoughts that made this project easy and enjoyable.

I wish to thank my parents for their undivided support and guidance from time to time in making this project and also who encouraged me throughout the past three years of my degree.

ABSTRACT

Urban land use in today's cities is more fragmented than ever. Urbanisation creates overbuilding, lack of greenery and grim facades. It is also associated with a decline in species and trophic diversity. Recent concerns about global warming have led to a more holistic view of planning for the environment. As a result, public open spaces have been created with the purpose of improving people's health and quality of life, as well as providing habitat for different species within urban areas. Variation of green areas and habitat has been poorly documented. This motivates an investigation on how the mean and variance of the percentage of green areas varies with distance and area type. This is done by designing a method using satellite imagery in three cities: Beijing, Lima and London. It was found that the mean of green percentage and distance varied with city and with area type. In Beijing, green spaces decline to a similar plateau. In Lima, green space decreases very slightly in residential areas but rises slightly in commercial centres. In London, there is a rise to asymptote in residential areas while in the commercial ones, there is an apparent rise. The relationship between the variance of green space and distance varied with city as well. In Beijing, the variance declines exponentially with distance and decreases slightly in Lima and London. This means that the different proportion of green areas will have different effects on the biodiversity in each city. This is based on the connectivity represented by the variance and mean percentage while following principles of island biogeography.

Keywords: connectivity, dispersal, habitat areas, island biogeography, urbanisation

1. INTRODUCTION

Any urban community consists of a wide variety of geographic, social, cultural and biological patterns which interact to form the nature and condition of society (Allmendinger, 2002). Relationships between these various patterns are constantly changing given the expected population increase from the current 6 billion to 10 billion by the year 2050 (Rudd *et al*, 2002). According to Allmendinger (2002), cities are complex adaptive systems, where the planning processes of most are dominated by instrumental rationality. Therefore, green areas within urban systems were not considered until 1940s (Hall, 2002).

Due to industrialisation and urbanisation, cities were hated as late as 1913 for their overbuilding, lack of greenery, their grim facades and petty regulations (Hall, 2002). Public green spaces were created with the purpose of improving the health and quality of life, mainly of the working classes who lived in neglected and crowded conditions (Hall, 2002). As a result, policies such as the Town and Country Planning Act, the Countryside Act in the 1940s in London, England (Hall & Tewdwr-Jones, 2011). Similarly, the establishment of agencies like SERPAR in the 1960s in Lima, Peru (SERPAR, 2012), served to meet the recreational, cultural and sporting needs of society as well as the preservation of the environment in urban areas.

At present, urban land use in today's cities is more fragmented than it used to be, due to population growth, an increase in mobility and a logarithmic growing per capita consumption (Hidding & Teunissen, 2002). The proportion of people living in urban areas surpassed 60% in 2005 worldwide. Currently, half of the world's population live in urban areas (Niemela, 1999). Therefore, the need for a better understanding of urban ecosystems emerges from the increasing disproportionate impact by urban lands to regional and global systems (Pickett *et al*, 2008).

The process of urbanisation is associated with a decline in species and trophic diversity, adding to a shift toward a more tolerant community composition (Urban *et al*, 2006). Urban cities homogenise the

physical environment because they are built to meet the needs of the human population. That is why, as cities expand, biological homogenisation increases with it, as well as 'urban-adaptable' species becoming widespread and locally abundant (McKinney, 2006).

Construction work destroys different types of habitats and thus eliminates local wildlife populations (Rebele, 1994). The changes in landscape can potentially affect organisms at different scales depending on the range of changes caused to a particular species (Hostetler, 1999). According to McKinney (2006), in the United States, urbanisation endangers more species than any other activity. New York has lost 578 native species, while gaining 411 non-natives. Similarly, in the city of Plzen in the Czech Republic, 368 native species has been lost. This is a general pattern worldwide.

Habitat loss and fragmentation due to the growing urbanisation are important factors contributing in the decrease of the planet's diversity (Rudd *et al*, 2002). Species living in highly fragmented landscapes often occur as metapopulations with frequent population turnover (Hanski & Singer, 2001). This is due to the reduced patch size and increasing distance between patches (Henrik, 1994). The loss of habitat through fragmentation can also increase greenhouse emission, which contributes to global climate changes (Etter *et al*, 2005).

The management of urban green areas has therefore become increasingly important, particularly in reference to biodiversity and the intrinsic ecological value. Green areas have high levels of associated species diversity (Shepherd, 1994) and have important implications in controlling the thermal environment, water and nutrient cycle and energy use (Saito *et al*, 1990; Pickett *et al*, 2008; Botkin & Beveridge, 1997). Urban green areas can be favourable for the establishment of non-native species. This can be seen in 54 European cities, where 40% of the urban flora is alien species, while Beijing report a 53% proportion (Kowarik, 2011). Green areas are good habitat for different species within urban areas (Rafe *et al*, 1985). This can be controlled by regulating the communication between various green areas (Allmendinger, 2002). Through the use of green corridors, connectivity and the

probability of colonization of green areas increase. This, in turn, ensures survival of populations and the quality and quantity of host plants (Hanski & Singer, 2001).

In addition to their intrinsic relationship with urban biodiversity, urban green areas have been shown to enhance the positive qualities of urban life (Burgess *et al*, 1988). Green areas can have an effect on citizen's patterns of activities, the frequencies of every day recreation and the opportunities to relax from daily stress (Van Herzele & Wiedemann, 2003), as well as mitigating juvenile hyperactivity disorder (Kowarik, 2011). They are still perceived as the "lungs" of polluted cities (Giles-Corti *et al*, 2005; Greed, 2000) and together with recent concerns about global warming, it has led to a more holistic view of planning for the environment (Greed, 2000). For these reasons, research into the stability and variability of urban green spaces is highly valued.

Variation in urban habitat types has been poorly documented (Niemela, 1999). That is why I will investigate on the relationship of the mean and variance of green areas with distance. Comparative studies are important for understanding the structure of urban systems (Yang & Jinxing, 2009). This will be done by designing a method to sample the proportionality of the green open spaces in three different cities with the use of satellite imagery software. The cities of Beijing, Lima and London were investigated. Finally, I will assess whether the type of environment (commercial or residential) has an effect on the variance and mean percentage of urban green areas.

2. MATERIALS AND METHODS

2.1 The Study Area

Three capital cities were chosen as representative cities of different regions of the world (Fig.1). The differences in culture, politics, and traditions have led to a different pathway of modernization and thus of green space planning.



Figure 1 – The three cities studied in this investigation (Presentation Mall, 2012).

The city of London is an important financial, commercial and historical centre. Famous for its Victorian houses, public system and sports. It was chosen for its various gardens and royal parks for their importance in maintaining biodiversity within urban areas (The Royal Parks, 2012). 4 boroughs were chosen for the study; Royal Borough of Kensington and Chelsea, City of Westminster, Borough of Camden and the Borough of Barnet.

The Royal Borough of Kensington and Chelsea (Fig. 2a) is characterised by the high cost of residential property, which can average almost £5 million (Das, 2011). Its high demand can be partially explained by the presence of several parks and private gardens, which are used in the study. The Borough offers a wide range of award winning parks and open spaces. Seven of them are green flag standard parks, which achieved excellence in London's 'In Bloom' competition (RBKC, 2012).

The city of Westminster (Fig. 2b), residence of Queen Elizabeth II, contains 3 of the largest royal parks in London; Hyde Park, St. James Park and Green Park. These together plus gardens located in the borough are responsible for a large biodiversity (Westminster, 2012).

The Borough of Camden (Fig. 2c) is known for its street markets. Located further north from the two boroughs already described, thus moving outwards from the city centre. Camden has a policy of protecting wildlife. One way the borough does this is by adding carefully placed and chosen shrubs or trees that connect gardens with the natural landscape (Camden, 2010).

Finally the last borough studied was the Borough of Barnet (Fig. 2.d). It is the furthest north of London's Boroughs. It has more than 200 parks and open spaces. Furthermore, there is a park within one mile of the majority of the majority of homes in the borough (Barnet, 2012).



Figure 2 – Boroughs studied in London; a) Kensington and Chelsea, b) Westminster, c) Camden and d)

Barnet, all with the samples placemarks taken from each.

The city of Lima, Peru, an urban centre in a developing country, was chosen to compare whether the variation and stability of green areas is similar to its developed counterparts. Similarly, 4 districts were chosen. The first one, Lima District (Fig. 3a), which is the central district of the city, holding traditional buildings and historic places. Gardens and parks have mostly remained on site for several years adding beauty to the narrow streets of the district (Municipalidad de Lima, 2012).

The financial District of San Isidro (Fig. 3b) is located to the south. It is the centre for the headquarters for the main national and international banks and insurance companies. It is one of the districts with most green areas in Lima as it contains olive tree woods of several hectares. Furthermore green areas

embellish two of the important social clubs such as the Golf Club and the Real Club. The high cost apartments and residences in the area tend to be also surrounded by parks and have private gardens (Municipalidad de San Isidro, 2012).

Santiago de Surco District (Fig. 3c) is a residential district with a socio-economically heterogeneous population. It has won 4 times the title of “Garden District” because of its extensive gardens and parks located in exclusive developments and in three important universities. It was chosen for the study, for its title as first Ecological Touristic District of the Metropolitan Region of Lima because of its natural beauty found in parks, recreational centres and of course its people (Municipalidad de Surco, 2012).

Finally, to the north of Lima District, lies the District of San Martin de Porres (Fig 3d). Its key location sharing borders with seven other districts makes it a busy and thus attractive location to study. Furthermore, it holds several archaeological places, the best medical university in the Country; Cayetano Heredia and the main bus terminal of the province. This highlights the need and the development of green areas (Municipalidad de San Martin de Porres, 2012).



Figure 3 – Districts used for study in Lima province, each of them with their samples; a) Lima, b) San Isidro, c) Santiago de Surco and d) San Martin de Porres.

China being a major emerging country motivates its inclusion in this study. The Xicheng District (Fig. 4a) is important as a financial and commercial district in Beijing. It is a place of historic emphasis and a case of the quick urbanisation occurring. Demolishing of old houses and constructing infrastructure has quickened, as well as enhancing environmental areas (Top China Travel, 2004).

The cultural District of Dongcheng (Fig. 4b), where old Beijing meets new Beijing is famous for its landmarks and temples such as the Forbidden City, Tian'an men Square and the world heritage site Temple of Heaven. This makes it one of the most prosperous parts of the city, full of green areas and parks (Top China Travel, 2004).

Chaoyang District (Fig. 4c) is the largest suburb district of Beijing. Having a remote history as well as a good developed traffic network, it was further developed with the 2008 Beijing Olympics. It was chosen as a place of study because it shows the creativity and innovation of the Chinese people (Top China Travel, 2004).

Finally, the Shunyi District (Fig. 4d) is located northeast of Beijing. Part of it is a hive of construction activity, where the largest international exhibition centre has just opened. This makes an attractive area of study because of the rapid urbanisation of the district which involves planning of green areas (Top China Travel, 2004).



Figure 4 – Beijing's districts and samples for each one; a) Xicheng, b) Dongcheng, c) Chaoyang and d) Shunyi.

2.2 Software Used

The satellite imagery software, Google Earth v6.2.1.6014 (beta) was used to help identify the green areas in the urban cities studied. Using the [Add -> Placemark] option, placemarks were added to each sample point in order to identify them more easily. The latitude and longitude of each sampling site were recorded from the [Properties] menu of each sample.

From each point, 6 lines were drawn with different lengths (50m, 100m, 200m, 400m, 800m and 1000m) (Fig. 5a&b) using the [Show ruler] tool. The lines drawn will be used to establish the circumferences studied at each sampling site.

The [Layer] menu was used, from which [More -> Parks/Recreation Areas] (Fig. 5c) was selected in order to highlight the green in order to make the sampling easier.

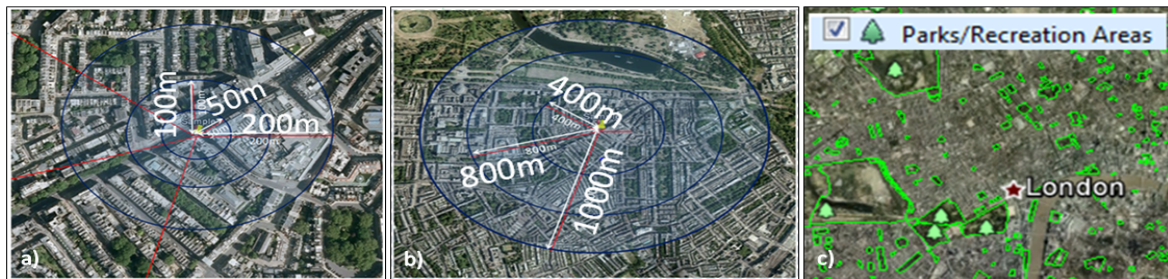


Figure 5 – Circumferences studied for each lengths of each sample (a & b) in order to get green proportion and c) highlighted green areas.

2.3 Samples

8 sample points were done in each of the 4 boroughs studied in London: Kensington & Chelsea, Camden, Westminster and Barnet; in 4 districts of Lima Province: Lima, San Martín de Porres, San Isidro and Santiago de Surco; and in 4 districts of Beijing: Xicheng, Dongcheng, Chaoyang and Shunyi between March and May 2012. Samples were chosen by a stratified sampling method, for a more representative overview of the borough or district studied. That is why 8 samples were done as this would try to prevent overlaps of green areas. Residential and commercial areas were determined by using [Street view] of the satellite imagery software, Google Earth v6.2.1.6014.

2.4 Proportion of green area

Urban green areas can be divided for use in specific situations (Table 1), especially as the fragmentation caused by the city itself disturbs the perception of a space as a whole (Van Herzele & Wiedemann, 2003). Using Table 1 as reference it was determined that because all samples were carried out within urban areas, all green spaces should be considered, which means, private gardens, neighbourhood green areas, public parks as well as green areas on the side of railways or motorways were included. In China, even at relative close distance from the city centre, in the Chaoyang and Shunyi district, crops were found, especially rice plantations, which were not included in the survey.

Table 1 - Minimum standards for urban green spaces, according to Van Herzele *et al*, 2000.

Function Level	Maximum distance from home (m)	Minimum surface (ha)
Residential green	150	
Neighbourhood green	400	1
Quarter green	800	10 (park: 5ha)
District green	1600	30 (park: 10ha)
City green	3200	60
Urban forest	5000	>200 (smaller towns) >300 (big cities)

In order to measure the percentage of green land, the total circumference was first calculated ($2\pi r$).

The lines drawn for each sample point were used as the radii to calculate the total circumference using the equation $2\pi r$. To find the proportion of green area for the circumference with each of the radii used, I employed the equation for the length of an arc:

$$L = \left(\frac{n}{180} \right) \times \pi r$$

In order to facilitate the measurements of the green areas for each of the circumferences studied, the length of the arc for 1 degree was calculated for each of the six radiuses used obtaining:

Table 2 – Arc lengths per degree and total circumference for the different radii used.

Radius (m)	Arc length for 1 degree (m)	Circumference (m)
50	0.873	314.20
100	1.745	628.40
200	3.491	1256.80
400	6.981	2513.60
800	13.964	5027.20
1000	17.456	6284.00

The number of degrees of the circumference that were green areas was counted (Fig. 6). Multiplied by the respective value of the arc length and used to find the proportion from the total circumference.

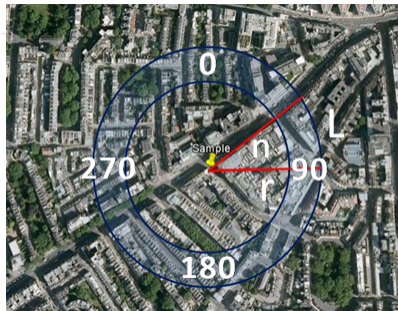


Figure 6 – Way in which the protractor was used to find the proportion of green areas.

2. 5 Data analysis

Statistical analysis was carried out using the R statistical package (v.2.14). The mean of green areas was taken from percentage of green areas of each distance for the 8 samples in the Boroughs/Districts studied. As the data obtained are percentages, an arcsine transform was appropriate to explore the relationship of the percentage with distance.

$$\text{New value} = \sin^{-1} \sqrt{\frac{\text{Percentage}}{100}}$$

The variance of green areas was obtained from the percentage of green areas found per distance from each of the 8 samples of the Boroughs/Districts studied. Maximal models were fit to the data and the significant effect was identified by a stepwise model simplification.

3. RESULTS

A total of 96 sites (Table A in Appendix) were sampled, from which 60 were classified as residential areas and 36 as commercial as stated in Section 2.3.

3.1 Relationship of mean percentage of green areas with distance

All main effects (city, distance and area type) affected the percentage of green space. There was an interaction between city and distance and area type, indicating that the relationship between green space and distance varied with city ($F = 14.6$, $df = 4$, 30 $p < 0.001$) and area type ($F = 19.8$, $df = 1$, 24 $p < 0.001$). In both residential (Fig. 7a) and commercial (Fig. 7b) areas patterns contrast.

In Beijing, green spaces declines to a similar plateau in both area types ($p < 0.01$, $t = -3.6$). In Lima, the green space decreases very slightly stable in residential areas ($p > 0.05$, $t = -1.4$) but rises slightly when moving out from commercial centres ($p < 0.001$, $t = 4.2$). In London the pattern differs with area type. In residential areas, green areas rise rapidly to asymptote at 27% green by 400 metres ($p < 0.001$, $t = 5.3$). When moving out of commercial centres, the rise is still apparent at 1000 metres ($p < 0.001$, $t = 7.30$).

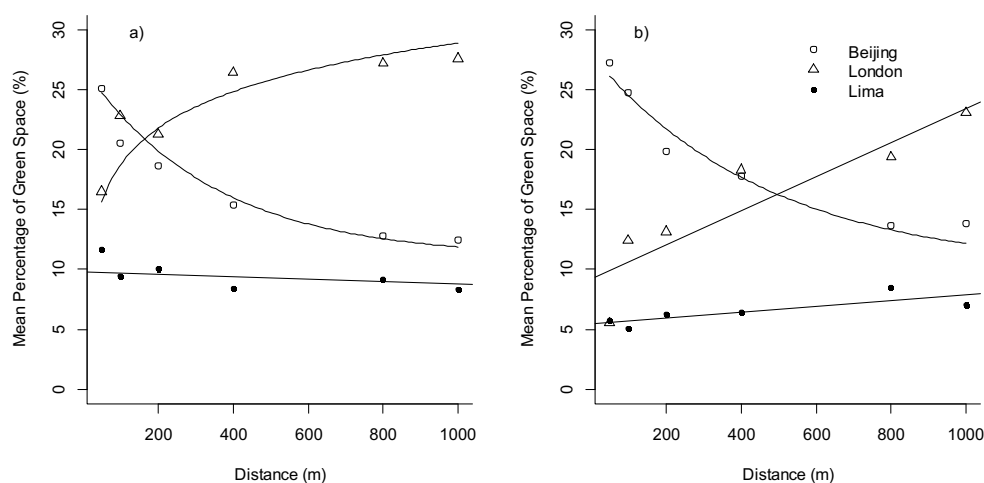


Figure 7 – The mean of green space in a) residential and b) commercial areas in the cities studied.

3.2 Relationship of the variance of green areas with distance

All main effects (city, distance and area type) affected the variance of green space. There was an interaction between city and distance, indicating that the relationship between green space and distance varied with city ($F=6.2$, $df = 4, 30$, $p<0.001$) (Fig.8). In contrast to the mean of green space, there was no interaction between city, distance and area type ($F=1.1$, $df = 1, 24$, $p>0.05$). In Beijing, the variance of green space declines exponentially with distance ($p<0.05$, $t =2.7$, $SE = 0.11$), in Lima ($p<0.05$, $t =2.3$, $SE = 0.15$) and London ($p<0.05$, $t =2.3$, $SE = 0.15$) remains stable with a very slight decrease in variability at farther distances.

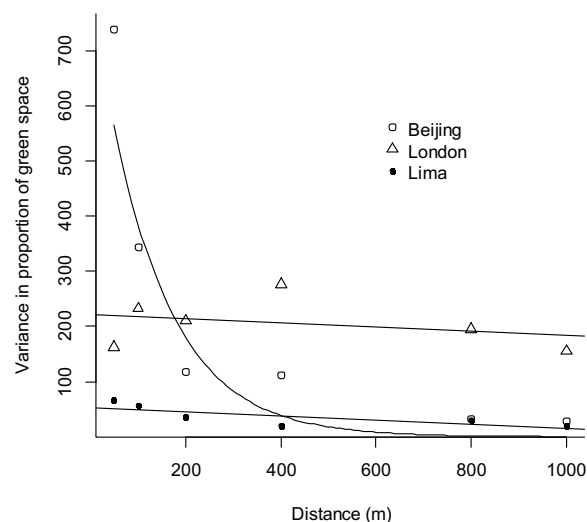


Figure 8 – The variability of green areas as a function of distance in London, Beijing and Lima.

3.3 Relationship of green space with distance within Borough/Districts

Within cities there was variation as a function of the area. This was not considered systematic, but random and was treated by averaging to avoid pseudoreplication.

4. DISCUSSION

The three different cities examined here revealed that in urban areas, distance affects both access to and reliability of access to green space and that these vary greatly with cities. In London, residents have reliable access to big parks within about 0.5km. In contrast, Beijing's residents have access to small parks within 200 metres, while fewer green spaces are located further away. This correlates with similar results in Yang & Jinxiang, (2009), where mean sizes of tree and herbaceous plants patches are small. In Lima, urban green space is low and most is held in private gardens rather than national parks.

This can be attributed, first of all to the original establishment of cities; in riparian areas or ecological transition zones (Dearborn & Kark, 2009). That is why, green areas varied with city in order to solve specific social, economic and demographic problems (Hall & Tewdwr-Jones, 2011), which change from country to country and time to time.

It can also be attributed to both policy makers and historical background of the city. According to Hall & Tewdwr-Jones (2011), it was due to the rise of cheap and efficient transport system that cities could extend their community range, thus reducing overcrowded centres and promoting the establishment of green belts.

Urban environments rely on vegetation to provide ecosystem functions such as air filtering, temperature amelioration and water storage (Williams *et al*, 2009). However, the fragmented environment which results from urban areas, not only creates numerous small and isolated populations (FitzGibbon *et al*, 2007), but also variability in the vegetation can have implications for ecological functions such as nutrient cycling, energy use and biodiversity (Pickett *et al*, 2008).

Cities used in this study play an important role in the distribution of species (Wania *et al*, 2006). With the increasing demand of housing, cities can usually only afford to preserve a few large green spaces. This is observed in London, where in a walkable distance of 400m, large percentage of green areas can be found. This relates to the Theory of Island biogeography (McArthur & Wilson, 2001) where large

green spaces tend to have high biodiversity and provide habitats for edge and transient species (Rudd *et al*, 2002).

In Beijing, the small and clustered green spaces, may not be able to support large numbers of species as in London, but are able to provide with peripheral habitat for species on large green areas (Rudd *et al*, 2002). The lack of large green areas at further distances means that wildlife movements and seed dispersal are not at their optimum in order to support a metapopulation which is more likely to occur in networks of larger, well-connected habitat patches (Williams *et al*, 2009).

In Lima, the low mean of green areas at every distance indicates that the habitat created is small and may not be able to support large numbers of species; however they can be important peripheral habitat to species in bigger green areas (Rudd *et al*, 2002). However, Lima is likely to have increased extinction rates and insufficient recolonisations of otherwise productive habitat with just 10% (Fig.7a) of green areas in residential zones and below 9% (Fig.7b) in commercial areas. This means that population sizes are likely to decrease (Linehan *et al*, 1995).

These strong correlations can be enhanced by connectivity with the use of corridors and greenways between green areas (Niemela, 1999). Functional connectivity between the fragmented landscapes facilitates the movement of individuals between patches (FitzGibbon *et al*, 2007). This increases the probability of colonisation of green areas following principals of island biogeography as well as dispersal ability. Thus, ensuring the survival of metapopulations (Rudd *et al*, 2002; Schippers, 1996). With a more holistic view of planning along with increasing concerns towards the environment have resulted on a new impetus for green belts by 1960s (Greed, 2000).

In London for example, the mean percentage of green areas increases with distance, while the variance decreases. This indicates there is a strong influence of more natural habitats in the form of big green spaces, which can act as local hot spots and ensure the survival of populations (Wania *et al*, 2006). Connectivity, however decreases slightly (Fig.8) with distance. This means that the probability

of colonisation of other green areas slightly decreases (Hanski & Singer, 2001). Consequently, suggesting the dependence on large green areas as proposed by theory of island biogeography.

Beijing's mean and variance of green areas decreases with distance. This indicates that the connectivity of green areas decreases exponentially with distance and as a result so does the chances of survival of populations and the probability of colonisation of species (Hanski & Singer, 2001). This means that species that utilize a range of microhabitats are especially vulnerable (Wilcove *et al*, 1997), especially at further distances, where connectivity and mean of green areas is low. Whereas habitat generalists could be found at close distances because they can also utilize resources in the immediate surroundings (Henrik, 1994) where connectivity is higher.

The very low percentage and variance of green areas in Lima also illustrates the effect of fragmentation in urban areas (Hidding & Teunissen, 2002) and thus will highly affect biodiversity because of the low connectivity of green areas. The low percentage and connectivity of those areas will decrease colonisation of green areas as explained by theory of island biogeography (Rudd *et al*, 2002). Hence, chances of survival of metapopulations within Lima will be low.

Urban areas are integrated systems consisting of built and biogeophysical components (Pickett *et al*, 2008), a synergy of overlapping cultural and biodiversity core areas (Stanvliet *et al*, 2004). And as such human actions can have a positive influence in the connectivity. By adding green areas, not only is the environment improved but also human development, recreational opportunities for walking, hiking, jogging, boating, fishing, nature watching and as an international green city vision (Bueno *et al*, 1995; Jim & Chen, 2008).

By creating more green areas at further distances in Beijing, a greenway network can be created so that it can ecologically reconnect the fragments of green areas. Thus, this provides wildlife habitat approximate to the natural landscape and migration corridors which prevents the loss of species. It also increases dispersal ability and chances of survival by following the principles of dispersal and

island biogeography. Consequently, this enhances biological diversity while adding aesthetic quality and a sense of community to the areas of interest (Bueno *et al*, 1995; Linehan *et al*, 1995). The use of green rooftops which can also be implemented in Beijing and London could aid further the greenway network of urban green space and enhance connectivity by increasing habitat for wildlife (Dearborn & Kark, 2009).

Lima's green areas are composed in its majority of private gardens which can be an invaluable food and habitat source for a wide range of urban species. The consideration of private areas is very important for biodiversity as it could provide the proper habitats to enhance connectivity (Rudd *et al*, 2002) by having well vegetated areas with continuous canopy of trees forming aerial corridors for birds and insects (Pickett *et al*, 2008; Savarda *et al*, 2000) This way, dispersal ability as well as colonisation increases with the increased connectivity.

In conclusion, ecological knowledge is imperative for the effects that humans have on urban ecosystems (Niemela, 1999). With this study, it was found that green areas which are habitat to several urban species vary by city as distance increases. The results are not in its entirety conclusive as just four districts or boroughs were used for each city. Further data collection of percentage green areas could be done in the remaining districts for a greater panorama of the relationship.

The different variation and relationships found in this study could be used to design conservation strategies for urban species as well as an informative method for policy makers to determine where in an urban area can more green space be implemented or removed, without affecting ecological systems, aesthetics or social interests. In this way, it can be predicted where connectivity can be enhanced so that according to principles of island biogeography and dispersal ability, metapopulations have a higher chances of survival and still be of recreational opportunities to citizens. A positive feedback loop of experience from green areas and policy (Dearborn & Kark, 2009) can lead to a more stable urban ecosystem where development not only favours human but also the wildlife within it.

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APPENDIX

Table A – Percentage of green areas per radii of the sample sites done.

City	Area Type	Area Name	Coordinates	Sample	P.G.50	P.G.100	P.G.200	P.G.400	P.G.800	P.G.1000
London	Commercial	Kensington & Chelsea	51°29'38.19"N0°10'27.67"W	1	0.83	6.94	14.72	16.66	10.00	17.50
London	Residential	Kensington & Chelsea	51°29'13.93"N0°10'52.74"W	2	10.28	7.22	18.61	13.33	21.67	5.28
London	Residential	Kensington & Chelsea	51°29'11.45"N0°10'14.71"W	3	8.06	18.33	11.94	5.55	11.39	13.06
London	Residential	Kensington & Chelsea	51°29'40.69"N0°11'28.75"W	4	4.17	12.77	6.39	11.11	9.17	13.61
London	Residential	Kensington & Chelsea	51°30'10.05"N0°11'47.90"W	5	10.56	11.94	13.61	19.16	22.50	26.39
London	Commercial	Kensington & Chelsea	51°30'46.60"N0°12'0.01"W	6	13.06	8.05	4.44	16.39	10.28	16.94
London	Commercial	Kensington & Chelsea	51°29'33.62"N0°12'0.46"W	7	2.78	6.39	12.22	5.83	11.94	21.67
London	Residential	Kensington & Chelsea	51°29'56.45"N0°9'51.95"W	8	1.39	6.11	6.94	22.50	36.67	42.22
London	Commercial	Westminster	51°29'54.96"N0°8'2.05"W	1	3.33	5.00	0.83	24.44	17.50	20.56
London	Residential	Westminster	51°29'24.11"N0°8'52.34"W	2	1.39	3.89	3.33	8.05	13.89	17.78
London	Commercial	Westminster	51°30'6.65"N0°9'8.48"W	3	2.22	24.16	24.17	45.27	31.67	26.11
London	Commercial	Westminster	51°30'37.29"N0°8'18.91"W	4	0.00	0.00	3.33	3.89	27.22	22.78
London	Commercial	Westminster	51°30'54.86"N0°9'15.29"W	5	1.39	17.22	5.28	7.22	22.78	28.89
London	Residential	Westminster	51°30'49.75"N0°11'1.39"W	6	5.83	20.27	15.28	18.89	43.33	37.78
London	Residential	Westminster	51°31'28.64"N0°9'56.38"W	7	6.11	8.05	7.50	12.22	35.56	33.61
London	Commercial	Westminster	51°31'39.82"N0°11'45.64"W	8	3.33	12.50	13.33	21.94	11.39	19.72
London	Residential	Camden	51°33'2.28"N0°8'6.20"W	1	7.22	3.61	6.39	14.16	6.39	10.56
London	Residential	Camden	51°32'53.36"N0°8'54.27"W	2	10.28	28.60	13.61	7.22	6.67	10.83
London	Residential	Camden	51°32'37.85"N0°9'40.39"W	3	26.95	18.88	13.89	12.22	16.11	11.67
London	Commercial	Camden	51°32'58.01"N0°10'52.76"W	4	23.62	31.38	10.00	20.55	10.56	14.44
London	Commercial	Camden	51°33'21.18"N0°10'38.46"W	5	3.06	21.38	26.67	21.66	34.44	39.17
London	Commercial	Camden	51°33'5.91"N0°9'55.28"W	6	7.22	3.33	29.72	17.77	25.28	26.11
London	Residential	Camden	51°32'56.14"N0°10'23.15"W	7	10.00	11.11	22.78	18.89	11.11	21.11
London	Residential	Camden	51°32'56.70"N0°9'43.45"W	8	20.28	31.10	23.33	19.44	19.17	30.00
London	Residential	Barnet	51°37'4.95"N0°9'19.85"W	1	36.12	56.65	60.00	45.27	23.06	29.44
London	Residential	Barnet	51°37'26.59"N0°7'34.31"W	2	21.67	19.72	34.17	38.05	42.50	35.83
London	Residential	Barnet	51°37'39.04"N0°10'33.30"W	3	18.06	23.05	14.17	41.10	33.89	31.94
London	Residential	Barnet	51°38'2.75"N0°8'39.43"W	4	20.01	34.71	22.50	45.83	42.50	41.11
London	Residential	Barnet	51°38'11.83"N0°6'9.75"W	5	28.34	35.82	33.61	45.27	32.78	31.39

London	Residential	Barnet	51°38'43.62"N0°9'52.49"W	6	16.12	29.99	34.44	32.49	34.72	26.67
London	Residential	Barnet	51°38'40.08"N0°7'27.97"W	7	24.45	30.82	23.89	47.49	44.72	45.00
London	Residential	Barnet	51°39'13.95"N0°9'6.77"W	8	58.90	66.65	60.55	76.93	63.33	64.72
Lima	Commercial	Lima	12°2'29.36"S77°4'27.80"W	1	3.06	1.11	2.22	0.83	4.17	3.89
Lima	Residential	Lima	12°2'26.22"S77°3'9.28"W	2	2.78	1.39	2.22	0.56	2.50	3.33
Lima	Residential	Lima	12°3'23.86"S77°4'48.30"W	3	20.01	24.71	11.39	8.61	5.56	8.06
Lima	Residential	Lima	12°3'9.85"S77°3'47.48"W	4	1.67	2.22	1.94	8.05	9.72	4.72
Lima	Commercial	Lima	12°2'59.01"S77°2'56.20"W	5	1.11	0.83	5.00	5.28	5.83	1.94
Lima	Residential	Lima	12°3'52.23"S77°5'3.10"W	6	1.39	10.55	6.39	16.94	18.89	11.67
Lima	Residential	Lima	12°3'56.77"S77°4'8.48"W	7	11.95	17.22	9.17	17.50	7.78	3.89
Lima	Residential	Lima	12°3'50.80"S77°3'20.55"W	8	17.50	9.72	5.00	7.50	5.00	4.72
Lima	Residential	San Isidro	12°5'44.93"S77°3'9.99"W	1	6.67	11.94	14.17	11.66	21.39	11.94
Lima	Commercial	San Isidro	12°5'42.88"S77°2'16.33"W	2	6.95	7.50	8.06	6.11	24.72	14.72
Lima	Commercial	San Isidro	12°5'50.21"S77°1'15.04"W	3	12.78	10.00	7.22	13.33	9.72	11.94
Lima	Residential	San Isidro	12°6'26.41"S77°3'3.04"W	4	17.78	31.10	6.39	10.00	20.28	18.89
Lima	Residential	San Isidro	12°6'31.63"S77°2'25.93"W	5	12.23	4.44	18.89	8.61	16.39	16.94
Lima	Commercial	San Isidro	12°6'32.75"S77°1'37.97"W	6	4.17	9.44	8.33	4.44	5.28	6.67
Lima	Residential	San Isidro	12°6'16.66"S77°0'56.89"W	7	8.89	11.39	21.94	8.05	8.89	5.00
Lima	Commercial	San Isidro	12°6'49.31"S77°2'12.44"W	8	6.39	3.89	10.00	7.50	4.44	6.67
Lima	Residential	Santiago de Surco	12°7'42.91"S76°58'55.21"W	1	5.56	14.16	24.17	6.39	13.06	10.56
Lima	Residential	Santiago de Surco	12°8'0.13"S76°59'55.97"W	2	20.56	9.44	15.56	14.44	5.00	7.78
Lima	Commercial	Santiago de Surco	12°8'51.26"S76°59'13.74"W	3	3.33	5.00	7.78	11.39	11.11	10.28
Lima	Residential	Santiago de Surco	12°8'47.66"S77°0'6.56"W	4	5.83	5.28	18.89	7.50	8.89	7.78
Lima	Commercial	Santiago de Surco	12°9'10.14"S77°1'6.34"W	5	4.72	3.33	7.50	6.94	7.50	3.33
Lima	Residential	Santiago de Surco	12°10'7.19"S77°0'25.42"W	6	30.56	21.94	14.72	3.33	8.33	7.22
Lima	Residential	Santiago de Surco	12°10'23.81"S77°1'11.87"W	7	2.50	3.89	8.33	7.22	5.83	12.78
Lima	Residential	Santiago de Surco	12°10'5.61"S76°59'25.41"W	8	4.72	1.11	11.11	16.11	8.61	13.61
Lima	Residential	San Martin de Porres	11°59'6.89"S77°5'47.33"W	1	0.00	0.56	5.83	8.89	6.39	8.06
Lima	Residential	San Martin de Porres	11°59'56.16"S77°5'56.85"W	2	10.56	14.72	9.17	6.39	5.56	6.11
Lima	Residential	San Martin de Porres	11°59'35.68"S77°4'24.28"W	3	31.67	1.94	5.28	4.44	6.94	9.17
Lima	Commercial	San Martin de Porres	12°0'29.02"S77°4'45.86"W	4	7.78	1.94	1.39	2.22	8.33	5.28
Lima	Commercial	San Martin de Porres	12°0'10.46"S77°3'43.03"W	5	7.22	7.50	5.00	6.39	3.89	5.56
Lima	Residential	San Martin de Porres	12°1'35.98"S77°5'1.61"W	6	9.72	2.50	3.89	2.22	5.28	2.22
Lima	Residential	San Martin de Porres	12°1'12.37"S77°3'54.79"W	7	20.56	2.22	1.94	2.50	5.83	5.28

Lima	Residential	San Martin de Porres	12°1'39.59"S77°3'10.10"W	8	14.45	5.55	5.00	7.78	5.56	3.06
Beijing	Commercial	Xicheng	39°55'57.48"N116°19'40.30"E	1	21.67	24.16	17.78	17.22	26.67	28.89
Beijing	Commercial	Xicheng	39°56'49.62"N116°21'5.92"E	2	28.62	9.72	10.56	16.39	11.11	16.67
Beijing	Residential	Xicheng	39°55'55.71"N116°21'56.39"E	3	4.17	6.94	10.00	10.55	12.50	17.50
Beijing	Residential	Xicheng	39°55'5.47"N116°19'25.95"E	4	49.18	28.88	28.05	31.94	15.56	14.17
Beijing	Commercial	Xicheng	39°55'23.59"N116°20'56.44"E	5	24.17	6.11	15.83	10.00	8.33	11.11
Beijing	Residential	Xicheng	39°54'48.71"N116°21'59.82"E	6	0.56	10.00	11.39	10.00	8.89	10.56
Beijing	Residential	Xicheng	39°54'21.17"N116°20'10.86"E	7	2.78	8.05	16.11	15.00	8.33	10.00
Beijing	Residential	Xicheng	39°54'2.70"N116°21'51.69"E	8	2.78	4.44	12.78	5.28	8.33	10.28
Beijing	Residential	Dongcheng	39°56'31.10"N116°23'26.41"E	1	7.78	15.83	17.78	13.61	14.17	15.83
Beijing	Commercial	Dongcheng	39°56'22.23"N116°25'4.17"E	2	21.67	17.49	19.17	19.44	17.22	21.11
Beijing	Commercial	Dongcheng	39°55'56.01"N116°23'58.92"E	3	20.56	15.00	16.94	15.55	21.39	15.28
Beijing	Residential	Dongcheng	39°55'48.41"N116°25'14.69"E	4	55.85	12.50	10.56	18.61	13.89	11.94
Beijing	Residential	Dongcheng	39°55'0.76"N116°24'23.68"E	5	33.34	18.61	15.83	13.61	15.56	15.00
Beijing	Commercial	Dongcheng	39°54'33.93"N116°23'17.91"E	6	56.13	46.65	40.00	13.05	10.28	15.83
Beijing	Residential	Dongcheng	39°54'43.02"N116°25'17.12"E	7	11.39	11.39	16.94	10.55	10.00	14.17
Beijing	Residential	Dongcheng	39°54'15.01"N116°24'29.86"E	8	8.06	19.99	28.05	15.83	12.22	11.39
Beijing	Commercial	Chaoyang	40°2'49.20"N116°28'54.77"E	1	1.94	11.11	14.72	12.22	11.94	9.17
Beijing	Commercial	Chaoyang	40°0'44.98"N116°26'30.60"E	2	31.12	40.26	17.78	13.61	10.00	10.56
Beijing	Commercial	Chaoyang	40°0'11.73"N116°32'20.95"E	3	51.40	57.48	18.33	33.61	16.11	16.94
Beijing	Residential	Chaoyang	39°58'37.98"N116°28'42.91"E	4	32.51	31.10	28.61	16.66	17.22	11.39
Beijing	Residential	Chaoyang	39°58'3.18"N116°32'37.36"E	5	12.23	14.72	24.44	10.28	14.17	9.72
Beijing	Residential	Chaoyang	39°56'35.26"N116°29'17.35"E	6	0.00	8.61	14.72	13.05	15.28	10.56
Beijing	Residential	Chaoyang	39°55'31.27"N116°33'44.43"E	7	91.69	45.54	21.11	12.78	10.83	13.61
Beijing	Commercial	Chaoyang	39°56'51.95"N116°37'9.43"E	8	7.22	14.44	30.00	44.16	24.44	23.89
Beijing	Commercial	Shunyi	40°11'29.46"N116°34'33.48"E	1	0.83	1.94	2.78	4.17	6.67	5.56
Beijing	Commercial	Shunyi	40°13'12.50"N116°45'36.07"E	2	1.39	3.61	2.50	3.06	3.89	4.72
Beijing	Commercial	Shunyi	40°10'17.03"N116°50'50.01"E	3	0.00	5.83	2.22	3.61	4.72	4.17
Beijing	Commercial	Shunyi	40°7'32.45"N116°32'50.89"E	4	66.68	53.59	42.22	42.21	18.89	8.89
Beijing	Residential	Shunyi	40°7'58.29"N116°44'37.23"E	5	5.00	16.38	8.06	9.44	7.50	7.50
Beijing	Residential	Shunyi	40°3'52.41"N116°38'20.74"E	6	88.91	64.70	30.83	39.44	24.44	19.17
Beijing	Residential	Shunyi	40°3'59.83"N116°47'31.76"E	7	20.56	31.66	22.50	14.44	8.61	8.61
Beijing	Commercial	Shunyi	40°6'7.29"N116°54'48.68"E	8	76.13	64.15	47.22	18.33	13.33	14.44