**GIS Research Assistant (student)**
Landscape Fragmentation Analysis within the Glasgow Metropolitan Region and Helsinki, Finland

Hours: as needed (not to exceed 40)
Hourly Pay Rate: $12.50/hour
Suggested Average Hours per Week: 6-8 (You can work at your own schedule)
End of Contract: Flexible, ending August 2015

Richard le Brasseur, The University of Edinburgh
*r.lebrasseur@ed.ac.uk*

## Research Purpose

As the EU prepares to predominantly accommodate population growth and human development through polycentric urbanisation patterns the effects of land use change and the corresponding spatial fragmentation of landscapes elicit notable concern.

Within these newly forming urbanisms, the existing ecological and socio-cultural landscapes provide a comprehensive set of ecosystem services. However, this dispersed polycentric urbanisation process of reoriented land use through human development results in significant landscape change. This change is reflected in fragmented green infrastructural networks and spaces which, importantly, have significant consequences upon the green space's ability to provide ecosystem services and benefits.

This research focuses on the connectivity and fragmentation of Paisley, Scotland's and Helsinki, Finland's green spaces under pressure of urbanisation (i.e. fragmentation impacts). Such green spaces offer significant ecosystem services to humans, including non-material benefits to wellbeing and quality of life. The goal of this research is to build a rich understanding of landscape fragmentation within the regions' green spaces and its impacts upon human quality of life.

This research will measure the impacts of green space fragmentation upon human quality of life using both spatial and aspatial data methodologies informed by a mixed-method abductive approach. This Fragmentation Analysis is but a part of the overall research methodology to inform the Research Objective (see below)

The following questions will be addressed within the larger context of the research:

*What are the specific characteristics of landscape fragmentation within emergent, polycentric urban areas and do they differ spatially and structurally from those of other urban configurations?*

**The research objective is to relate the characteristics of fragmentation - its landscape structure, patterns, and form - within Paisley, Scotland and Vantaa, Finland to green infrastructure-based benefits or ecosystem services specific to quality of life and human wellbeing in order to gain a better understanding of the factors which affect such ecosystem service delivery.**

**The goal for this analysis is to measure the existing fragmentation in the two regions. This work will not focus on habitat or other ecological features, but rather the overall landscape composition - spatial based - for multiple classes and features to best comprehend the level of landscape (natural and built environment) fragmentation.**

## Definition: Landscape Fragmentation

In the discourse of the human development process and urbanisation, the concept of landscape fragmentation is the result of transforming large areas or spaces into smaller, more isolated fragments which lack connectivity to other landscape features. Technically, landscape fragmentation is an anthropogenic process that consists of breaking up a continuous habitat, land use type, biota or ecosystem.

Most definitions are ecological founded with associated spatial-based metrics enacted thru GIS (e.g. patch density, mean patch size, mean perimeter-to-area ratio, contrasting edge ratio and contrasting edge proportion between developed and undeveloped land, mean dispersion, contrast weighted edge density, and contagion, among others).

## Research Context

The Greater Glasgow urban area has a population of 1,199,629 (2011), land area of 368.8 m2 (2005) and population density of 3252.8 per square kilometre. Helsinki's urban metropolitan region has a population of 1,159,211, land area of 631.11m2 and population density of 1,836.8 per square kilometre.

Helsinki, Finland ranks consistently high in quality of life indices whereas Glasgow, Scotland is continuously low. There has been significant landscape and land use change in the past 5 decades in and around Glasgow; public health and quality of life measures have declined as well. If there is a strong relationship between the eco-spatial characteristics of the Glasgow polycentric region and quality of life (here, negative influence), this could have profound influence on future knowledge and application in expanding urban regions across the UK and EU.

In early 2013, Glasgow received 24,000 million GBP to transform the city as a pilot to the Future Cities project to showcase 'smart city' impacts on the future of cities across the UK. There is significant interest in exploring means to improve Glasgow and this research will provide such a conduit. This portion of work is Phase 1 and is a pilot test for future communities.

The units used for this research will be the Metric System.

## GIS Responsibilities

*1. Analysing Landscape Fragmentation*

ArcMap GIS was selected as the primary landscape fragmentation analysis tool. The scale for these analyses are at the sub-regional - community scale. See Figures at end of this sheet for specifics.

There are copious GIS methodologies which can be employed to analyse landscape fragmentation and/or connectivity. However, many of these

methodologies or tools focus on forestry and ecological integrity aspects and are suited to larger scales (i.e. landscape level) and ecological-based science studies. Thus, spatial matrices chosen for identification and analysis of landscape fragmentation are both qualitative and quantitative.

**THIS IS A COMPREHENSIVE LIST OF METHODOLOGIES - ALL WILL NOT BE USED AS MANY MANY INDICES OVERLAP……**

**FRAGSTATS** (Spatial Pattern Analysis) allowed specific landscape metrics (e.g. size, shape, etc) of various patches and classes which indicate landscape composition. This tools output provided a landscape fragmentation or spatial heterogeneity analysis. These included:

*Area and edge metrics*
*Shape metrics*
*Core area metrics*
*Contrast metrics*
*Aggregation metrics*
*Diversity metrics.*
*PLAND*

*(Source: McGarigal, K., SA Cushman, and E Ene. 2012. FRAGSTATS v4: Spatial Pattern Analysis Program for Categorical and Continuous Maps. Computer software program produced by the authors at the University of Massachusetts, Amherst. Available at the following web site: http://www.umass.edu/landeco/research/fragstats/fragstats.html)*

**UGS Proximity Index - Connectivity (PLADJ)** measured connectedness to other similar patches. Isolate and connective Indices will also be measured.

**Edge density or Edge Contrast Index (ECI)** was defined by the total length of edges, the boundaries between patches, divided by the total landscape area, the boundary between two different patches, divided by the total landscape area. Edge density is a straightforward metric and provides information about the lengths of edges between dissimilar uses, which sometimes create conflicts within urbanising areas, e.g. agricultural uses and residential use.

ED = E/A

*ED = Edge Density*
*E = total edge (m)*
*A = total area (ha)*

*2. Further Data Analysis*

I am not sure what Tools ArcMap has nowadays to provide data analysis. Most indices as per above will provide the data I require but any input you may have regarding the Research Objective is valued.

3. *Compare and Contrast the Landscape Fragmentation data between the two Case Study Areas*

((This is a straightforward process. I will complete most of this as it is an analysis produced from the data provided as in #1 above (Land Frag Analysis)).

**Steps**

**EACH STEP TO BE COMPLETED FOR EACH CASE STUDY AREA: PAISLEY, SCOTLAND AND VANTAA, FINLAND**

1. *GIS Data Transfer*
Data on my server must be transferred effectively to yours and your workstation. I will need advice on how to best do this for you from my ArcMap 10.1 Project so all prior work remains intact.

2. *GIS Data Gathering (Note: 60% complete)*

2A. *GIS Orthophotos*
Glasgow orthophotos needed, Helsinki complete.
Not actively used in this assignment, but required for overall research.

2B. *GIS Shapefile Data*

Catchment area outline determined - all datasets to be trimmed to this border.

I believe no new shapefiles need to be created
Most datasets already downloaded and georeferenced in Project.

Data sources determined, on-line and municipal contacts available, but we need to track down data missing prior to analysis.

Some re-coding of shapefiles and/or patches may be required.

*I actually do not how to best approach this in the context of my research (Landscape Fragmentation - urban and natural patches). Your expertise and experience will be valued here…*

*2C. Create an overall map*
I do not what is needed to conduct these analytics (thru the tools as above) - is it a Land Cover Map? These are usually available easily .. or will we have to create an overall land cover or land use map? I do not know what is needed…

2D. *GIS Data Truthing*
I will have to compare the dataset/land map you create and confirm all the green spaces identified on a prior survey are accounted for on the map. Modifications may have to be made to some patches.

3. *GIS Analysis*
   Per tools and methodologies outlined above.

4. *GIS Maps*
   Output desired is an overall landscape fragmentation map (Land Use/Cover Map??)

**Figures**
Catchment Areas