LONDON CYCLE SCHEME EXTENSION FORECAST : SIMULATION USING ARCGIS

1.0 Relevant literature & Research Question

Bike sharing systems are expending in urban environments all over the world. They promote healthy, cheap and environmentally friendly mode of transportation for cities (Martin Zaltz Austwick, Oliver O'Brien, Emanuele Strano, Matheus Viana, Plos One, 2013). Since 2010, Londoners can ride through the city without the disadvantage of carrying a private bike. Containing 781 stations, and more than 10 000 bikes, the scheme is open continuously days and nights. The following model has been designed in order to reduce motorised modes in urban environment and increase the opportunity for commuters to join or leave public transport nodes with a public bike.

Figure 1

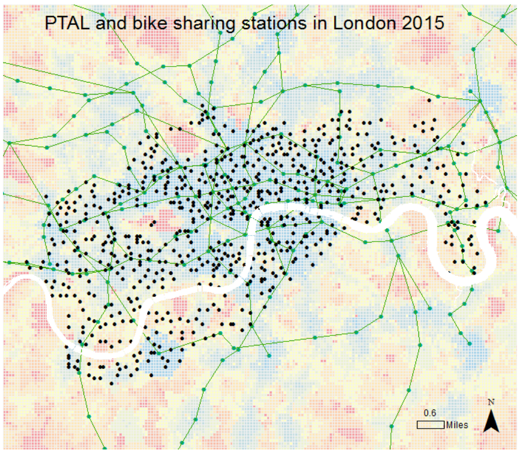
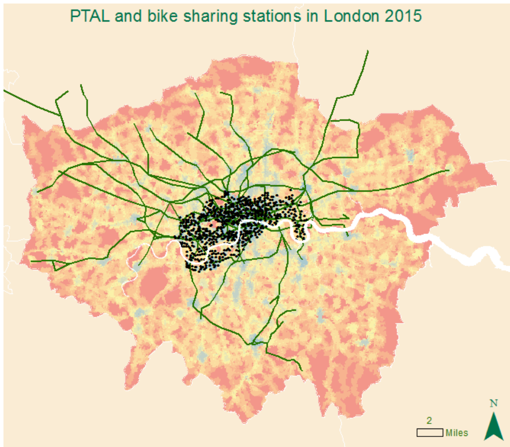


Figure 2



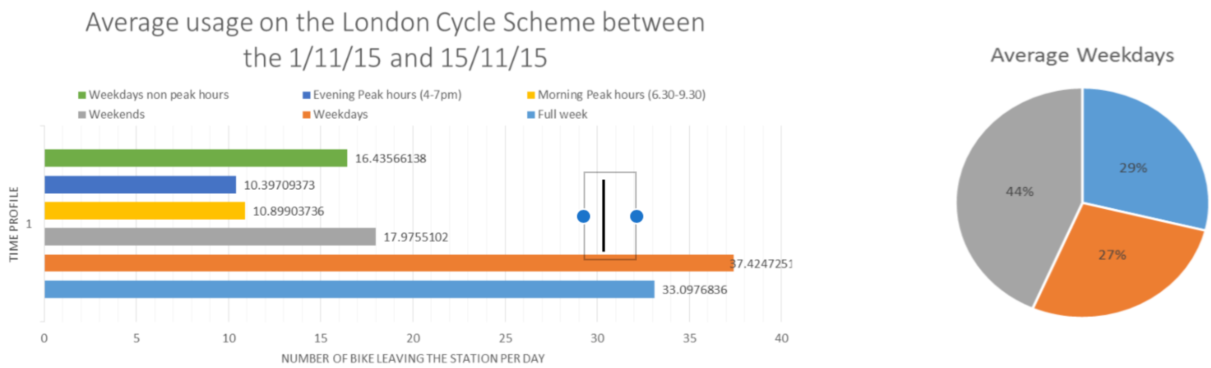
Bike sharing stations are concentrated in London centre (fig. 1,2) and are not easily accessible for commuters living in suburban areas but can be used however in inter-modality with the public transit system and for leisure purposes. Extending the network of bike stations to integrate the bike sharing system as a full mode of transportation represents an interesting opportunity for the city. The objective is to create a tool which could, on the one hand select the most efficient existing bike stations (cf efficiency index) from which the network could be strategically expanded, on the other a tool able to propose potential locations for new implementations. In other words, the output function aims at planning new implementations in a concentric way from highly connected bike stations to low accessibility level areas surrounding the cycle scheme in order to provide commuters with active and green alternatives.

3.0 Data Presentation

The data used for this analysis comes from Transport for London and consists in an Excel table containing the counts of bikes leaving at each stations over two weeks in November 2015. A shape-file has been extracted from *Web-Cat*, a web based Connectivity assessment toolkit provided by TFL, to measure public transport access levels per areas and converted to the British system of coordinates. A second shape-file contains the coordinates of the bike stations in London.

The connectivity level of each bike stations is assessed by their Accessibility to Public Transport Level (P.T.A.L.) scores which vary between 1 and 6 (fig. 1). The scores are stored in a grid composed of square meters covering every London longitude and latitude coordinates. This score takes into account the level of accessibility, the distance to, the frequency, & the reliability of the London public transport network. Higher is the score, less important is the time needed to rich any point of the city. It is why P.T.A.L. scores decrease while leaving central areas although scores remain higher along tube lines. (fig.2).

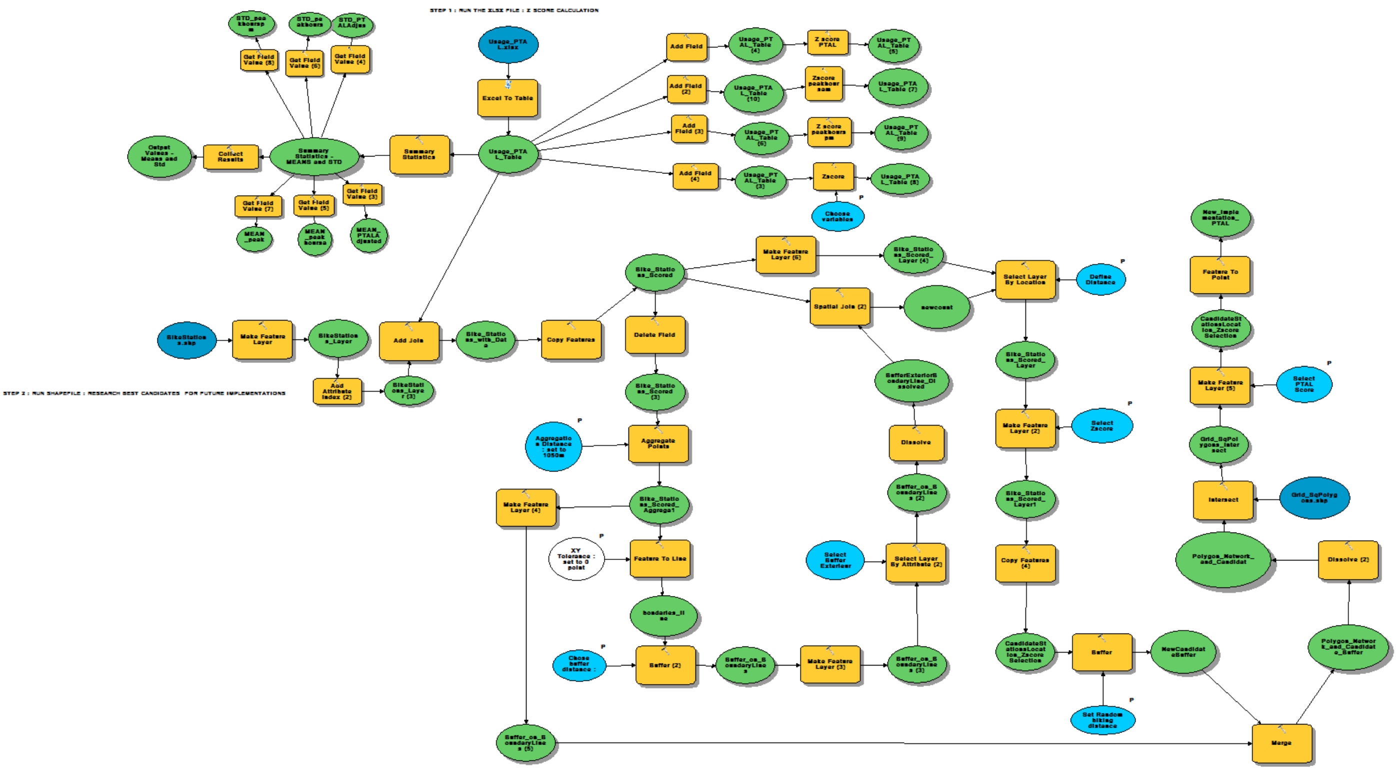
Figure 3



A rapid time profile analysis of the usage on the network shows that the scheme is highly used during the weekdays and especially during peak hours. (figure 3). It is why the analysis focuses on daily commutes and addresses inter-modal travels.

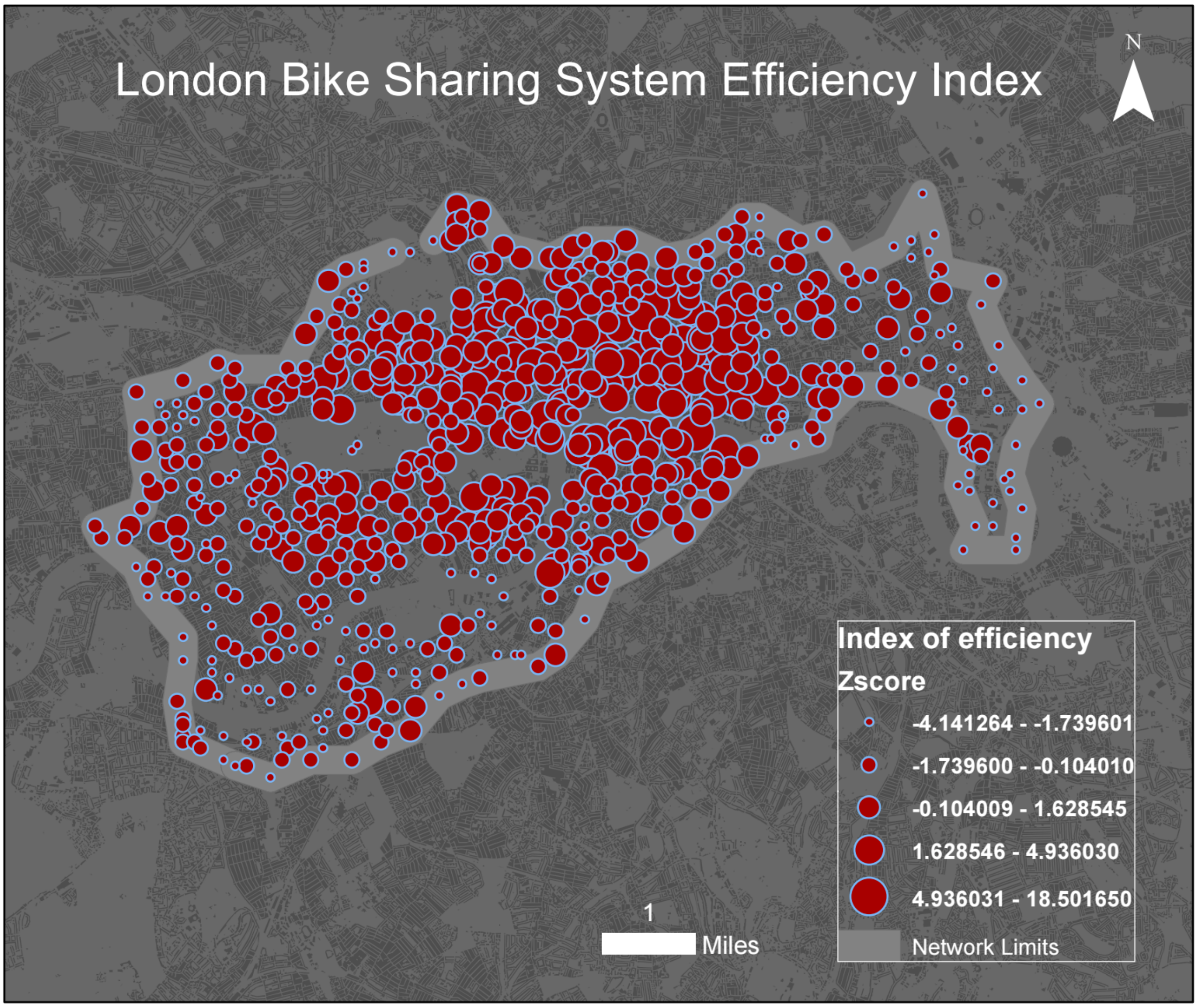
4.0 Tool Content & Methodology

Figure 4



The model (fig. 4) is divided into a statistic analysis followed by a concrete spatial application. The first algorithm consists in the creation of an efficiency index. Two variables were selected to define the notion of "efficiency": usage during peak hours and adjusted P.T.A.L. scores which are both good indicators of an active and well connected station. To be added to each other, the variables needed to be standardised with the Z-score method [(value-mean)/standard deviation]. The Z-scores of each variables were computed into a final one representing our index (fig.5). It was created within model builder using Python 9.3. (fig. 4)

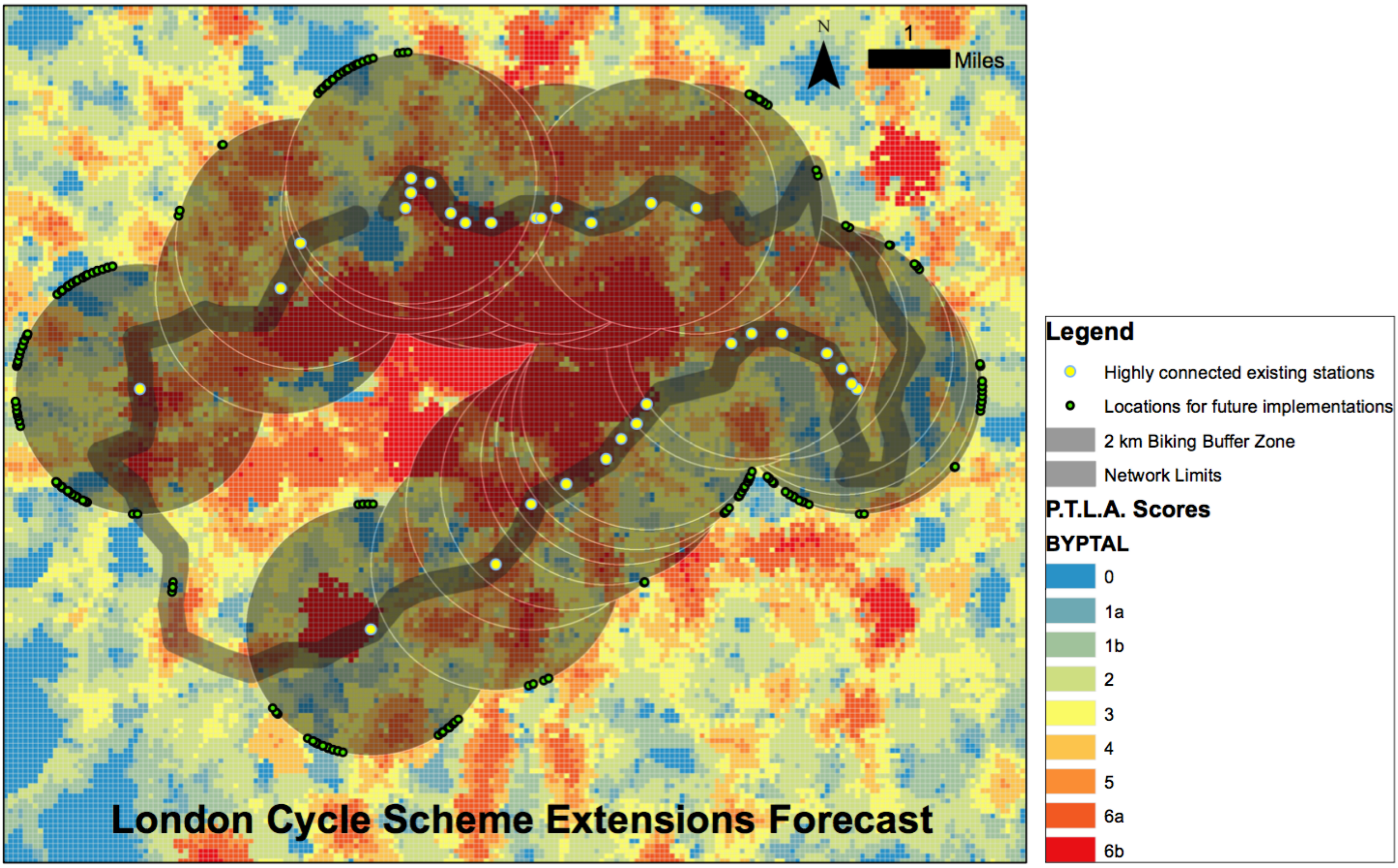
Figure 5



The second part analyses spatial attributes in order to select the best candidate stations which will act as catalysers for future extensions, and creates new feature points where future bike stations should be implemented (fig. 6). Since the extension will be concentric, the interesting stations are situated on the boundaries of the bike scheme. To spatially select "the external stations", it was needed to aggregate our values into dissolved polygons in order to draw a line around the shape of our network to create a linear buffer zone (fig. 6). A spatial join was added between the linear buffer and the stations, method which matches spatial features on the basis of their intersection. Not all the external stations were interesting, indeed there is no point to extend the network from stations which are not active. The external stations were afterward selected by attribute if having an efficiency index (Z-score) strictly superior to 0.08. This score is a "model parameter" which can be modified according to the needs of the user.

New concentric buffer zones around freshly selected candidate stations were needed to define the extension zones in which to extend the network within a random biking distance of 2.5 km. This distance is a "model parameter" which can be reseted by the user. Merging the 2.5 km buffer zones to the previous created polygon, composed of all the inner stations, was necessary to select only the spatial features outside of the existing network. The "intersect" tool was used to select the overlapping P.T.A.L scores and the concentric buffer boundaries. This tool allowed the creation of point features in subset locations with a P.T.A.L. score strictly inferior to 2.(fig. 6)

Figure 6



5.0 System Requirements & Instructions

This tool is designed to run with the ArcGIS 10.3.1 for Desktop suite. The function is contained within a zipped folder called 'Anouchka_Lettre_GIS_Final_Coursework_2016'. After extraction the user has to save it to a known and accessible drive before opening ArcMap 10.3.1 and selecting the model 'AnouchkaLettreModel' inside 'AnouchkaLettreFinal' within the ArcToolbox options.

Two geodatabases were used : one contains optional additional data, the output database contains the new layers produced by the model.

Regarding modifications, the tool is flexible. The user can complete or rearranged the index with as many variable as needed. The different Model Parameters can be opened and modified according to the intended output.

6.0 System Requirements & Instructions

-T.F.L., Assessing transport connectivity in London (PTAL), 2014.
-Eliott Fishman, lecture on Global Bikeshare, Utrecht University, 2013.
-Paul de Maio, Bike-sharing : History, impacts, Model provisions, and future, MetroBike, LLC, 2009.
-David Banister, the sustainable mobility paradigm, Transport Studies Unit, Oxford University Centre for the Environment, Oxford, UK, 2007.
-London Cycling Design Standards, T.F.L. , 2014 .
-The mayor's vision for cycling in London, an olympic legacy for all Londoners, T.F.L., 2013.
-Spatial Network in Bicycle Sharing Systems, Martin Zaltz Austwick, Oliver O'Brien, Emanuele Strano, Matheus Viana, Plos One, 2013.
-Big Data Analysis of Population Flow between TfL Oyster and Bicycle Hire Networks in London, N. Sari Aslam, J. Cheshire , T. Cheng, U.C.L., 2015.
-Estimating flows between geographical locations : 'get me started' in spatial interaction modelling, U.C.L., 2012.
-Measuring the impact of opening the London shared bicycle scheme to casual users, Neal Lathia, Saniul Ahmed, Licia Capra, U.C.L., 2011.
-Suprageography, a blog by Oliver O'bryen, U.C.L., 2015.