Bristol City Council Tree Canopy Study

Summary Report September 2011

Introduction

In 2010 Bristol Parks GIS team undertook a GIS project to map tree canopy across the city. Following the testing of commercial canopy data products available at the time, and obtaining quotes for this work to be undertaken it was felt an in-house solution would be offered. Following analysis of test data, this was agreed and aimed to minimize costs, control data accuracy and increase in-house knowledge of applying remote sensing techniques in this field.

Hardware

The Hardware used comprised of 2 standard BCC desktop computers. One computer was upgraded with a second 250 GB internal hard drive for use with the image analysis software. This software produced huge temporary files that could not be written to network drives.

Software

The main Image Analysis / Remote Sensing software used was IDRISI Taiga produced by Clark Labs. Initially a single license was purchased but due to technical issues with the software a second license was provided free of charge by Clark Labs.

ESRI ArcGIS was used as the main GIS software and was used for post-image analysis geo-processing, manual editing and map production.

Data Products

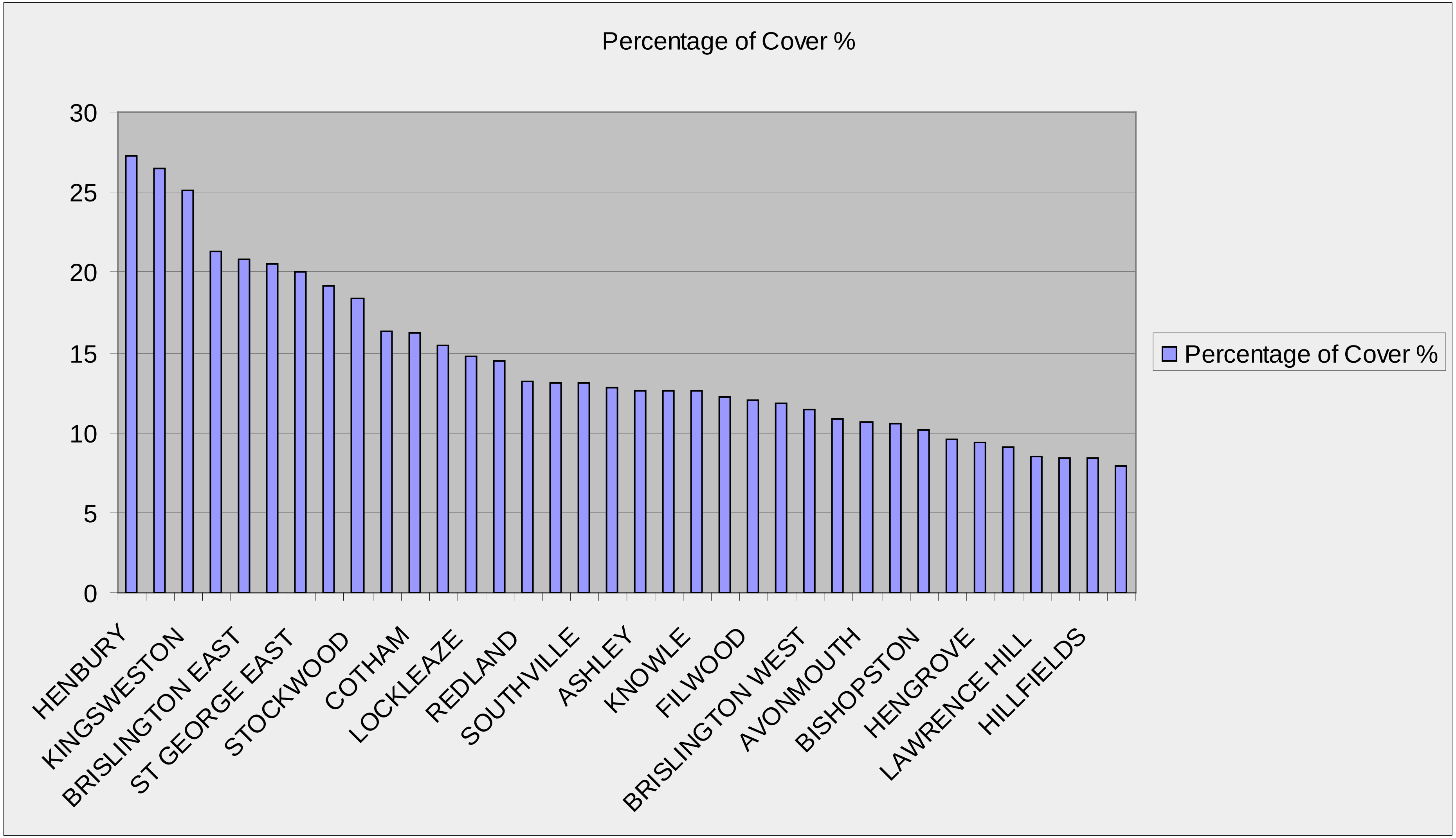
We purchased 2009 Colour Infrared (CIR) and standard colour (RGB) aerial imagery at 12.5cm resolution. Originally we carried our analysis at this resolution but due to data processing time, we re-ran the methodology at 50 cm resolution, which greatly reduced processing time without a huge impact on resolution.

Methodology

1. Mosaic the 1sq km tiles (as purchased) into 9 Sq Km tiles using ESRI ArcGIS to reduce processing time in IDRISI
2. Import these files to IDRISI Taiga Format.
3. Convert these files in to a 3-band image.
4. Use IDRISI to produce a vegetation index (NDVI) to identify whether an area contains live green vegetation or not. Isolate vegetation pixles into new dataset using ESRI ArcGIS.
5. Image was then re-classed in IDRISI to stretch the pixel values.
6. These images were then put through a segmentation module that grouped pixels by their NIR reading
7. The segmented images were then “trained” by selecting areas of tree, scrub, grass and water. This gives the programme values to associate with different types of ground cover.
8. A Classifier called Max like was then used to classify the remaining segments based on the training sites already selected.
9. These images were then imported into ArcGIS
10. Spatial analyst was used to change the raster to features based on their grid code of 1 (classification)
11. The features with a grid code that represents trees were then exported as a separate shapefile and dissolved in to one feature.
12. Minimum bounding rectangle is then drawn around this one feature and given a grid code of 0. The 2 features are then unioned together.
13. The features with a gridcode of 0 and 0 are then exploded and the larger areas deleted.
14. Any remaining feature with a gridcode of 0 and 0 are filling gaps in tree canopy, those larger than 1sqm are deleted.
15. All remaining features are dissolved into one feature.
16. This feature is once again exploded and and feature with a area of 2 sqm or less is deleted.
17. Manual editing and checking took place over each ward to correct any errors present. This was carried out at 1:1250 scale and due to time constraints involved searching for obvious mis-mapping of large sections of vegetation such as grassland / scrub, and missing large canopies.
18. Map production and Ward based % figures calculated using in ArcGIS

Results

WARD_NAME	***Ward Area SqM***	***Canopy Cover***	***Percentage of Cover %***
ASHLEY	1,776,432	224,580	13
AVONMOUTH	17,255,832	1,837,260	11
BEDMINSTER	2,539,232	201,282	8
BISHOPSTON	1,764,719	178,992	10
BISHOPSWORTH	3,564,400	454,647	13
BRISLINGTON EAST	4,095,468	851,113	21
BRISLINGTON WEST	3,296,447	375,884	11
CABOT	2,970,325	283,429	10
CLIFTON	1,711,991	327,172	19
CLIFTON EAST	952,087	155,540	16
COTHAM	1,149,471	186,236	16
EASTON	1,471,468	123,950	8
EASTVILLE	3,069,909	472,628	15
FILWOOD	2,747,526	329,898	12
FROME VALE	3,319,723	680,503	20
HARTCLIFFE	2,910,361	366,770	13
HENBURY	3,480,427	950,577	27
HENGROVE	3,526,296	330,626	9
HENLEAZE	2,095,950	274,933	13
HILLFIELDS	2,712,558	227,620	8
HORFIELD	2,385,827	216,581	9
KINGSWESTON	4,997,585	1,255,420	25
KNOWLE	1,934,859	243,430	13
LAWRENCE HILL	4,123,514	348,709	8
LOCKLEAZE	4,271,211	629,973	15
REDLAND	1,535,859	202,314	13
SOUTHMEAD	2,772,516	301,785	11
SOUTHVILLE	2,689,075	351,128	13
ST GEORGE EAST	2,303,993	461,129	20
ST GEORGE WEST	1,882,728	222,949	12
STOCKWOOD	3,055,414	562,697	18
STOKE BISHOP	4,861,501	1,036,378	21
WESTBURY ON TRYM	3,526,075	934,993	27
WHITCHURCH PARK	2,922,594	308,435	11
WINDMILL HILL	1,869,582	228,074	12
CITYWIDE CANOPY	**111,542,957**	**16,137,634**	**14**



Percentage of Cover %
30
25
20
15
10
5
0
HENBURY
KINGSWESTON
BRISLINGTON EAST
ST GEORGE EAST
STOCKWOOD
COTHAM
LOCKLEAZE
REDLAND
SOUTHVILLE
ASHLEY
KNOWLE
FILWOOD
BRISLINGTON WEST
AVONMOUTH
BISHOPSTON
HENGROVE
LAWRENCE HILL
HILLFIELDS
Percentage of Cover %

Discussion

Overall the study was not as successful as originally hoped in some areas of the city and required a large amount of manual editing to produce a satisfactory result. The study therefore took far longer to carry out than originally envisaged. The project was experimental in its nature in that a similar canopy classification methodology has not been carried out in urban areas at this scale and data resolution (111 Sq Km using 50 cm cell resolution) using relatively basic Colour infrared Data. InfraRed vegetation mapping is rarely used in urban / sub-urban areas due to the large range of values requiring classification.

Due to the experimental nature of the project a considerable amount of time at the beginning was used developing and testing the methodology. We had originally used the higher resolution 12.5cm resolution imagery, but found the data processing was too demanding on the hardware and not feasible at a citywide scale. We subsequently restarted the data processing using re-sampled aerial imagery at 50cm resolution, which was much faster.

This project aimed to use relatively cheap CIR data (3 band) to carry out image analysis to keep costs down, however in hindsight if additional data such as height data (LiDAR) and multi-band / hyper spectral data was used the results would have been better and more quickly achieved, albeit at a cost of tens of thousands of pounds for the data alone.

In areas where the image classification was not as successful, we found the following issues requiring further investigation:

- Influence of pollution on Infra Red Reflectance
- Canopy Shading issues in woodland areas
- Impact of Slope
- Vegetation Density in Woodlands
- Surrounding Vegetation such as Scrub / Grassland
- Data Quality of neighbouring tiles flown on different dates.

Time delays that occurred are due to the following reasons:

- Methodology Development - Experimental project involved trialling new methods / data resolutions
- Technical hardware limitations (processing power & Hard drive replacements).
- Software limitations (Bug found in IDRISI image analysis software slowed performance)
- Data Quality and type – 3 band image classification limited.

There was also no clear definition of Tree Canopy, or objective for mapping Tree Canopy provided at the start of the project. This issue became apparent during the manual editing stage where it was uncertain whether to include hedges, scrub, low hawthorn bush etc. If the purpose of mapping canopy is shade potential this may be an important factor. Inclusion of hedges and scrub in an environment such as Bristol would have a significant impact on the final percentage figure at ward level. In this project thin linear hedges were generally excluded if it looked like they were neatly trimmed but out grown hedges were included.

It was found that in average across Bristol it would be necessary to plant 1275 trees with a canopy of 25 Sq Metres to increase the ward canopy coverage by 1 %. On a citywide scale it would require an increase in canopy matching approx 100 full size football pitches to increase the percentage by 1 %.

Future Work:

These results can be used a baseline to measure future efforts although it would require repeating any future work using this exact methodology and data type. This original project took over a year to complete due to the problems discussed above and that no dedicated officer time was time-tabled. Having now completed the project it is estimated that one full-time GIS officer could repeat it in 4 months. This is based on 1-2 months carrying out the image classification, followed by 2 months full time GIS editing using aerial imagery.

However, we would like to continue developing the methodology, testing new data as it becomes available. Of particular interest to reduce the manual editing final stage would be incorporation of LiDAR height data and hyperspectral multiband data.

Contact:

Joe Brickley
GIS & IS Application Support Officer
0117 35 (25048)
joe.brickley@bristol.gov.uk

Nick Vague
Parks Cartographer
Nick.vague@bristol.gov.uk
0117 92 (24799)