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Urban Habitat Classification using Aerial Imagery: Mapping Green Infrastructure with a focus on Green Roofs

Abstract

Producing broad and detailed habitat classification maps for Manchester to support better planning of good quality Green Infrastructure (GI) and to classify Green Roofs (GR). The results show a promising methodology with high user and producer accuracy scores. Considering the wider delivery of objectives to help sustain urban environments whilst supporting the greening of urban areas, these maps, with a focus on GR add and diversify with an aim of simplifying the use of this data in the future.

Background

- Green infrastructure (GI) is defined as the region's life support system and is a strategically planned and delivered network comprising the broadest range of high-quality green spaces and other environmental features. It considers the development and regeneration of urban areas alongside protecting and enhancing their existent environmental assets and creating new ones
- A green space provides a range of benefits and can be viewed as a multifunctional networked resource that contributes to high-quality and accessible landscapes that benefit both people and the environment
- A green space plays a critical role in the maintenance and enhancement of the health of the natural environment and its ability to provide a wealth of ecosystem services
- GI also helps connect people to the environment with several benefits to individual and community health and well-being through the creation of attractive and accessible places for people to enjoy direct and regular contact with a natural environment
- ***Green Roofs (GR)**:* Where dense development limits opportunities to create new areas of greenspace, roof greening can help address the problem, playing a valuable role in providing additional habitat and species diversity creating a mosaic of stepping-stone habitats in urban neighbourhoods.

Objectives

- To produce broad and detailed habitat classification maps for Manchester (technical issues occured)
- To develop the methodology further by accurately identifying GR
- To assess the classification accuracy of the results produced for GR

Methodology

Data type	Source
True colour (RGB) and colour infrared (CIR) airborne imagery	Aerial Photography for Great Britain (APGB)
Digital Terrain Model (DTM) and National LiDAR Programme Point Cloud	DEFRA Data Services Platform
Ordnance Survey Master Map	DEFRA Data Services Platform
National Forest Inventory	Forest Commission Open Data portal
GI and Blue Infrastructure geodatabases	Natural England (NE)

- A desk-based survey collecting samples for both broad and detailed habitat classes in QGIS
- Trimble eCognition was used to interpret aerial imagery focusing on GR
- Using existing third-party vector datasets, land features were extracted
- Image layers e.g. Canopy Height Model (CHM), Digital Surface Model (DSM), greyscale images, and spectral indices were produced to allow object classification
- Multiresolution segmentation using the CIR Red, CIR Green, Near-Infrared (NIR), CHM layers and a scale of 10
- Broad and detailed classification using a mixture of threshold-based and machine learning classification reliant on spectral, structural, geometrical and contextual information
- Clean-up, export of final maps, and accuracy assessment

Green Roofs

Using the RGB imagery and the equation below, greyscale images for the class 'buildings' were produced

Greyscale = 0.299 Red + 0.592 + 0.114 Blue

→ (GLCM) Texture layers were generated

Buildings with Mean NDVI > 0.1

Mean NDSI >= 0.005

Brightness >= 70

Mean GLCM CHM Entropy layer > 4.7

Additional criteria of buildings with any of the vegetated classes

Results

- An overall producer and user accuracy score of 85% and 100% respectively were obtained. The high accuracy scores are indicative of a promising methodology for classifying GR, since only 1 out of the 7 GR samples in the desk-based was misclassified
- The sample that was misclassified upon further inspection, had a varying spectral signature interrupted by garden decorations
- The subset also showed promising producer and user accuracy scores for certain classes, i.e. sealed surfaces, and private gardens. However, since the focus of the study shifted entirely towards GR due to software issues, these are not discussed

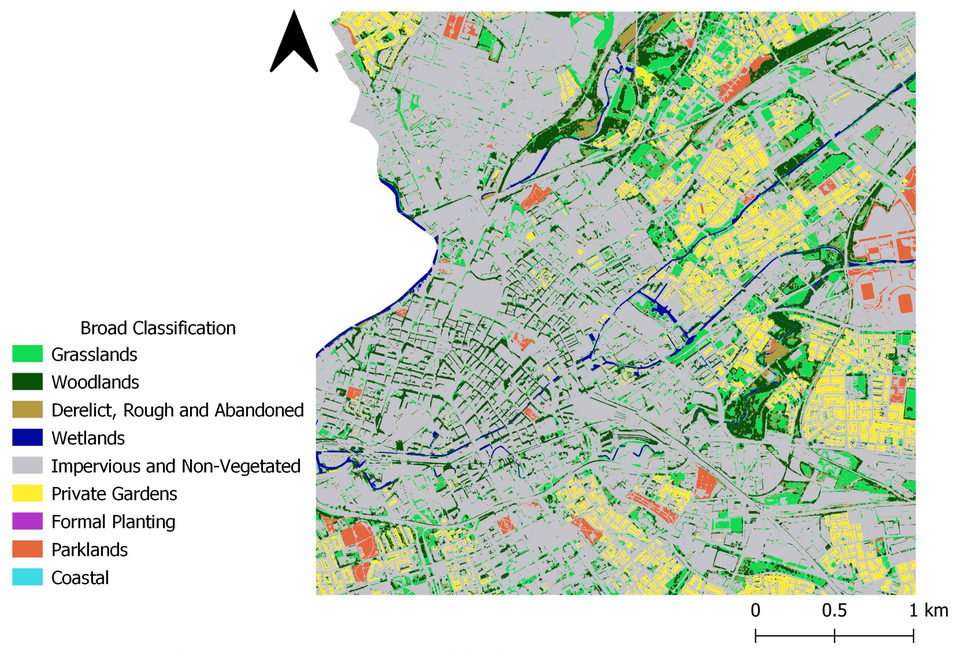

Figure 1: Broad Urban Habitat Classification map for a subset of Manchester.

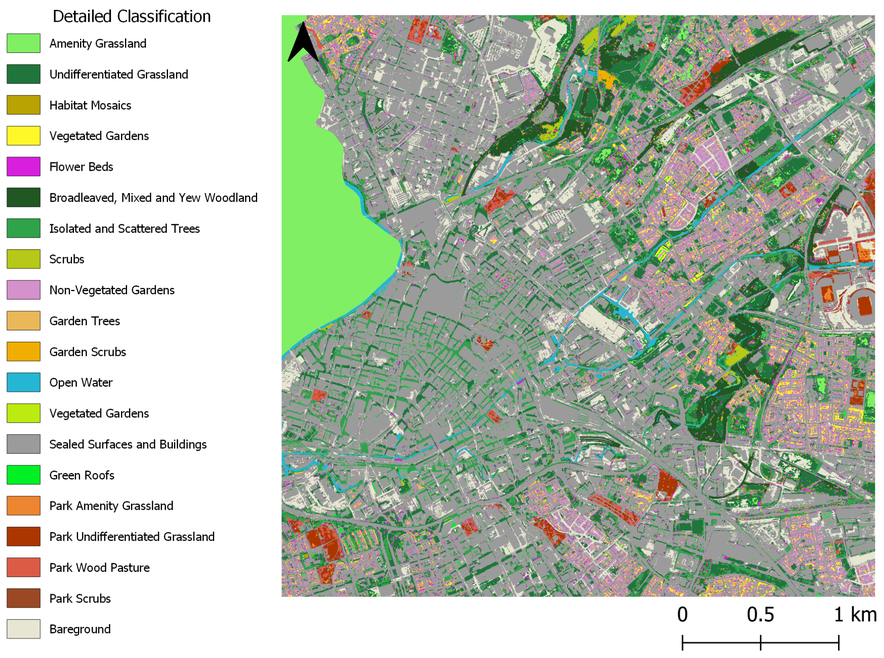

Figure 2: Detailed Urban Habitat Classification map for a subset of Manchester, showing how GR were correctly identified.

Figure 3: An aerial image showing a close-up of a GR used as reference later on in Figure 4 to depict how it was classified by eCognition.

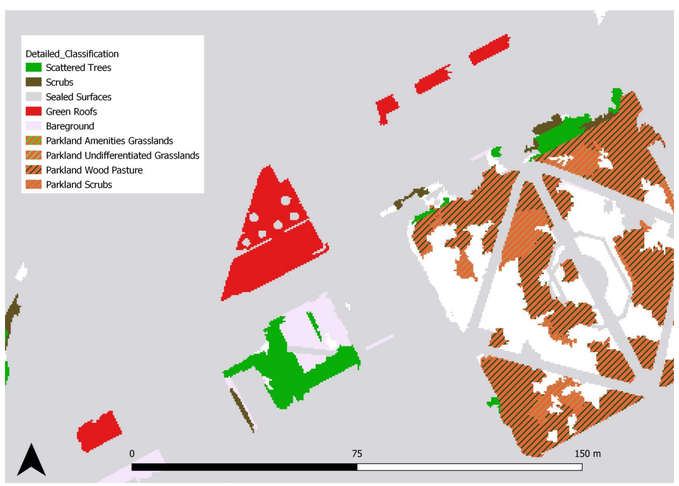

Figure 4: Showing a close-up of a GR's classification.

Conclusion

- The study was able to classify GR correctly, using texture layers as a primary tool. The significance of the thematic layer and existing database on buildings was also acknowledged at this stage
- Relying upon spectral indices alone could not help in the identification of GR and therefore, introducing texture enabled the user to view differences in the grey level co-occurrence matrix (GLCM) which looks at how often different combinations of pixel grey levels occur in an image
- The author proposes introducing geometry and height to further refine the results in an attempt to obtain a user accuracy score of 100%.
- Necessary to note that upscaling might be an issue, since texture layers take a long time to generate in eCognition. Therefore, instead of looking at the entire class of 'buildings', focus might need to be shifted towards generating texture layers for buildings with a certain NDVI

References:

Natural England (2011) *Green Infrastructure Guidance* <http://publications.naturalengland.org.uk/publication/35033>

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English Nature (2003) *Green Roofs: Their existing status and potential for conserving biodiversity in urban areas*