Lidar derived Vegetation Object Model and Riparian Shade Mapping

Alastair Duncan
Environment Agency
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National coverage Open Lidar data

- The Environment Agency's lidar archive is available from the DEFRA Data Services Platform (DSP). This includes:
  - Lidar point cloud
  - Raster (GeoTIFF) Digital Elevation Models:
    - Digital Terrain Model (DTM)
    - Digital Surface Models (DSM) – last and first surface
  - Spatial coverage metadata (extent, survey dates, etc)
  - Image Service Layers
- Archive includes data going back over two decades. Many locations have repeat surveys that can be used to view change.

Open Lidar Data info | Environment Agency Geomatics Hub

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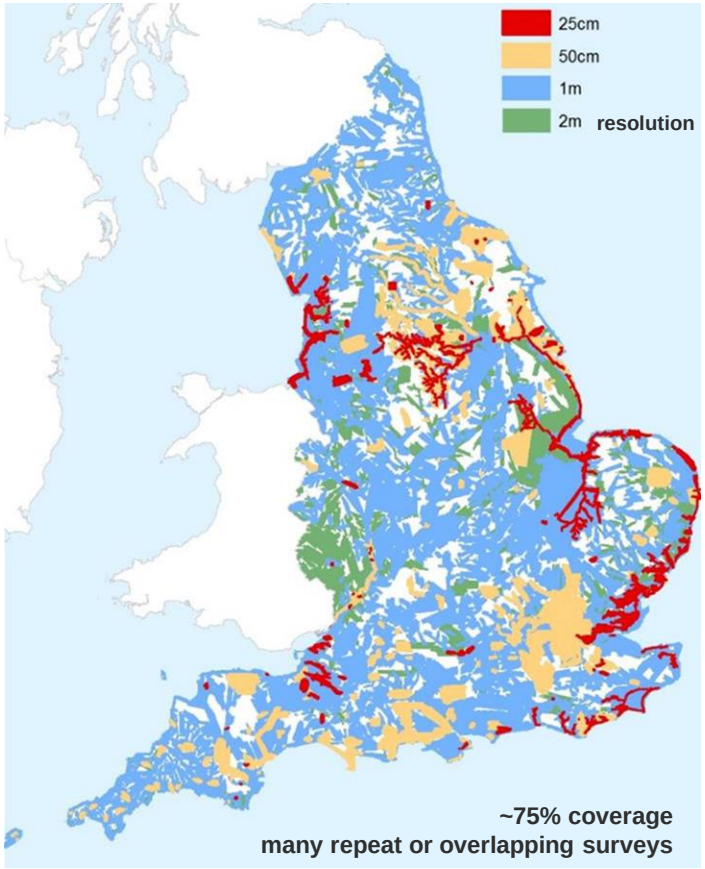
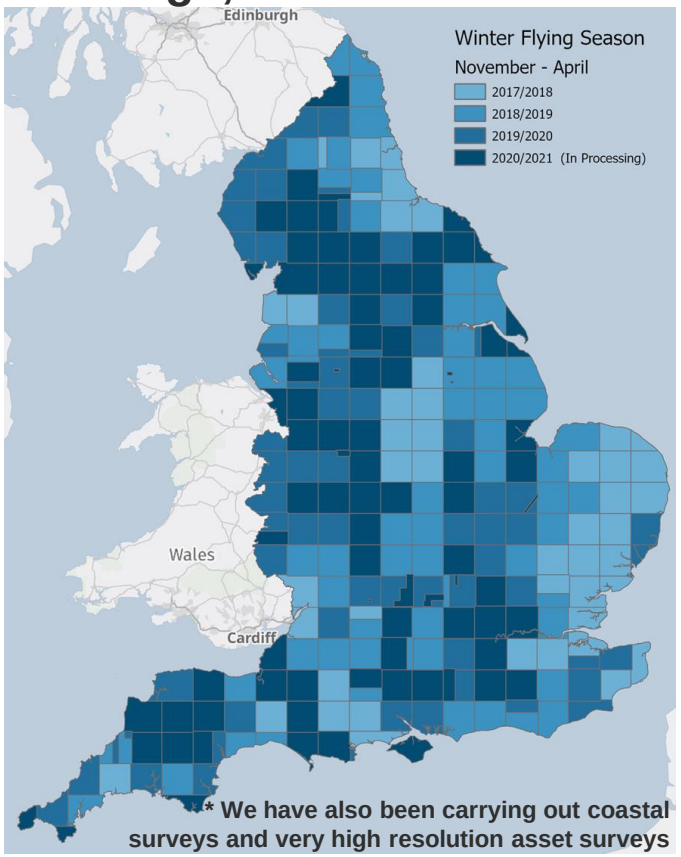
National coverage Open Lidar data

Lidar coverage, 1998 to 2017.



Change from project based surveys to full national programme

Complete 1m resolution lidar coverage, 2017 to 2022.



The accuracy specification for 1m LIDAR surveys is an RMSE of +/- 5 to 10cm in elevation. Ground truth surveys for the checking of LIDAR height accuracy are carried out on all surveys, the average of the comparative ground truth surveys for the past five years has been within +/- 4cm RMSE.

(We have compared 1,125 independent GPS ground truth surveys over the past 5 years, comparative RMSE statistics show an average RMSE of just 3.68cm with the lidar's elevation values).

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Keeping Rivers Cool project

Promote riparian shade as a climate change adaptation measure to benefit salmon and trout by reducing river temperatures throughout upland England and Wales.

Inspire action through demonstration projects, a strong evidence base, guidance and mapping tools.

Effects of riparian trees on summer water temperatures:

- Shaded channels are 1.5^{o}C lower on average than open reaches
- Or 2-3^{o}C in maximum temperatures
- Buffers associated with woodland can be up to 5^{o}C cooler

Keeping Rivers Cool map outputs

- Original lidar work carried out 2011 – 2013 when there was limited lidar coverage (~70% of England), and Last Return Digital Surface Models only
- New complete lidar coverage and First Return DSMs provide better and more complete evidence “Keeping Rivers Cool version 2” project
- Better, more efficient and accurate methodologies developed for both the Vegetation Object Model and Riparian Shade Maps.
- Used in England Woodland Creation Offer (EWCO)

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First and Last Returns

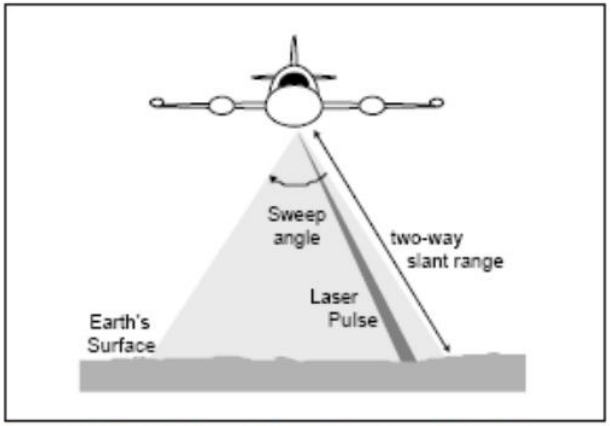

Figure 1 Principle of LIDAR data collection

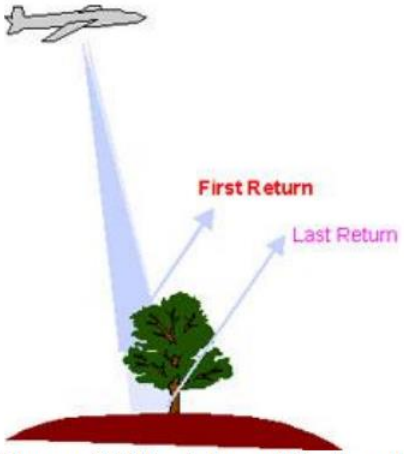

Figure 2 Principles of first and last return LIDAR capture

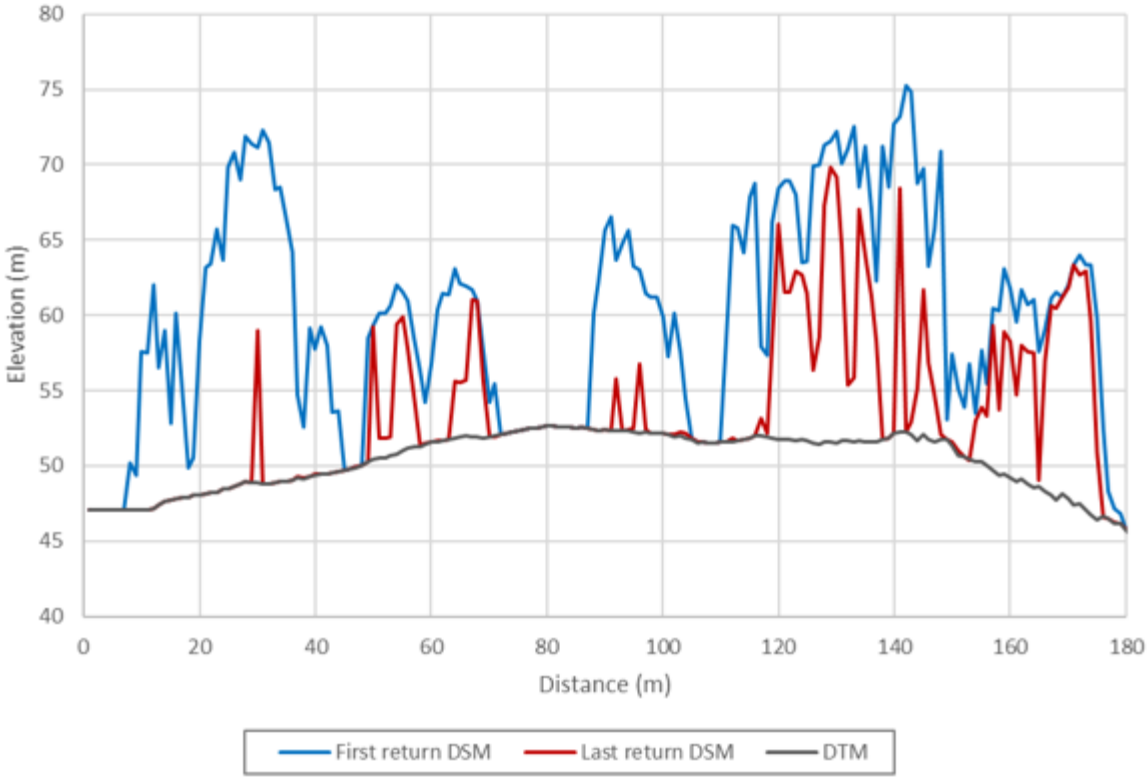

Figure 3 Lidar first return, last return and DTM data for a profile through a section of woodland. The lack of information of the canopy can be seen in the last return data.

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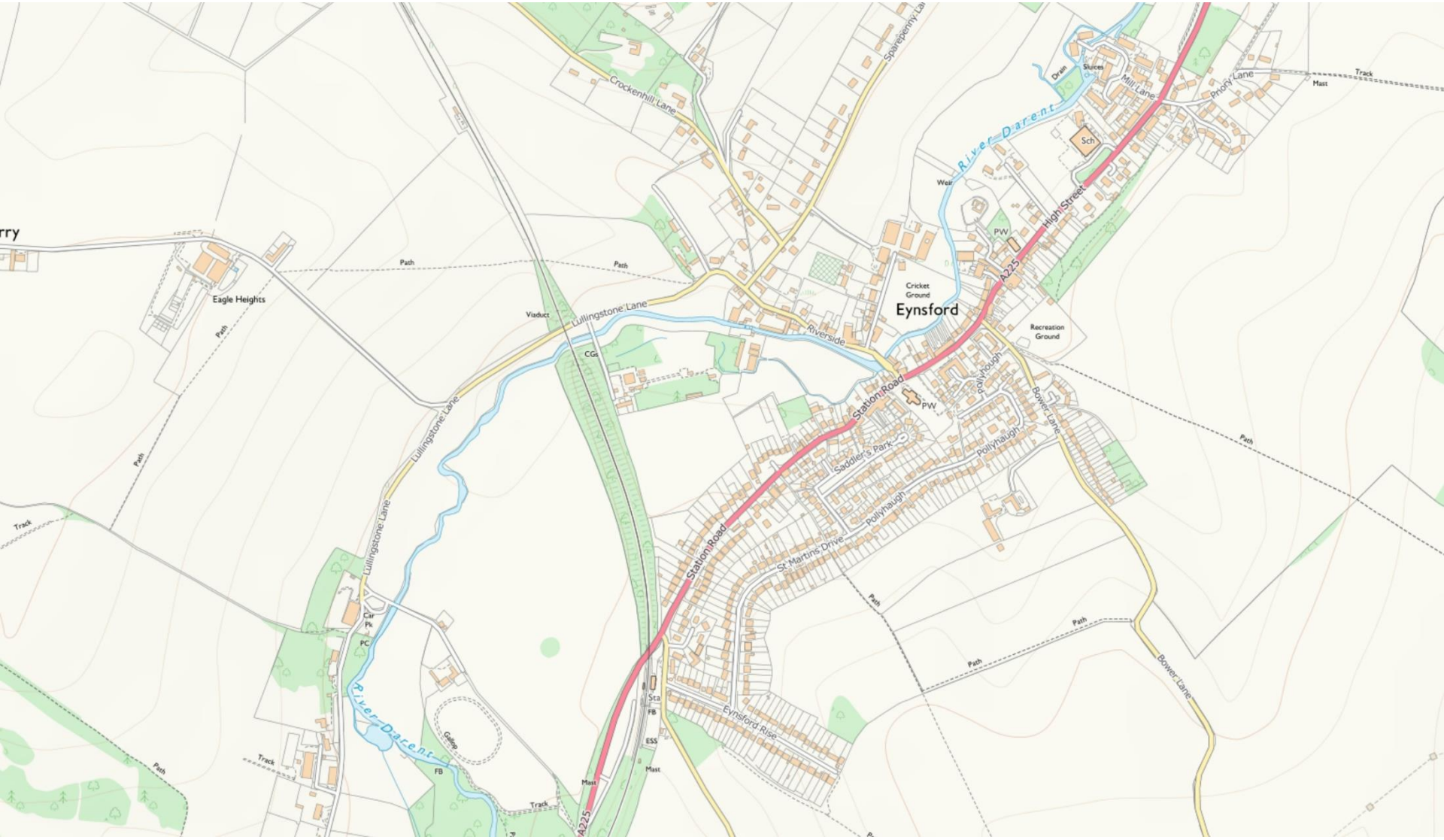
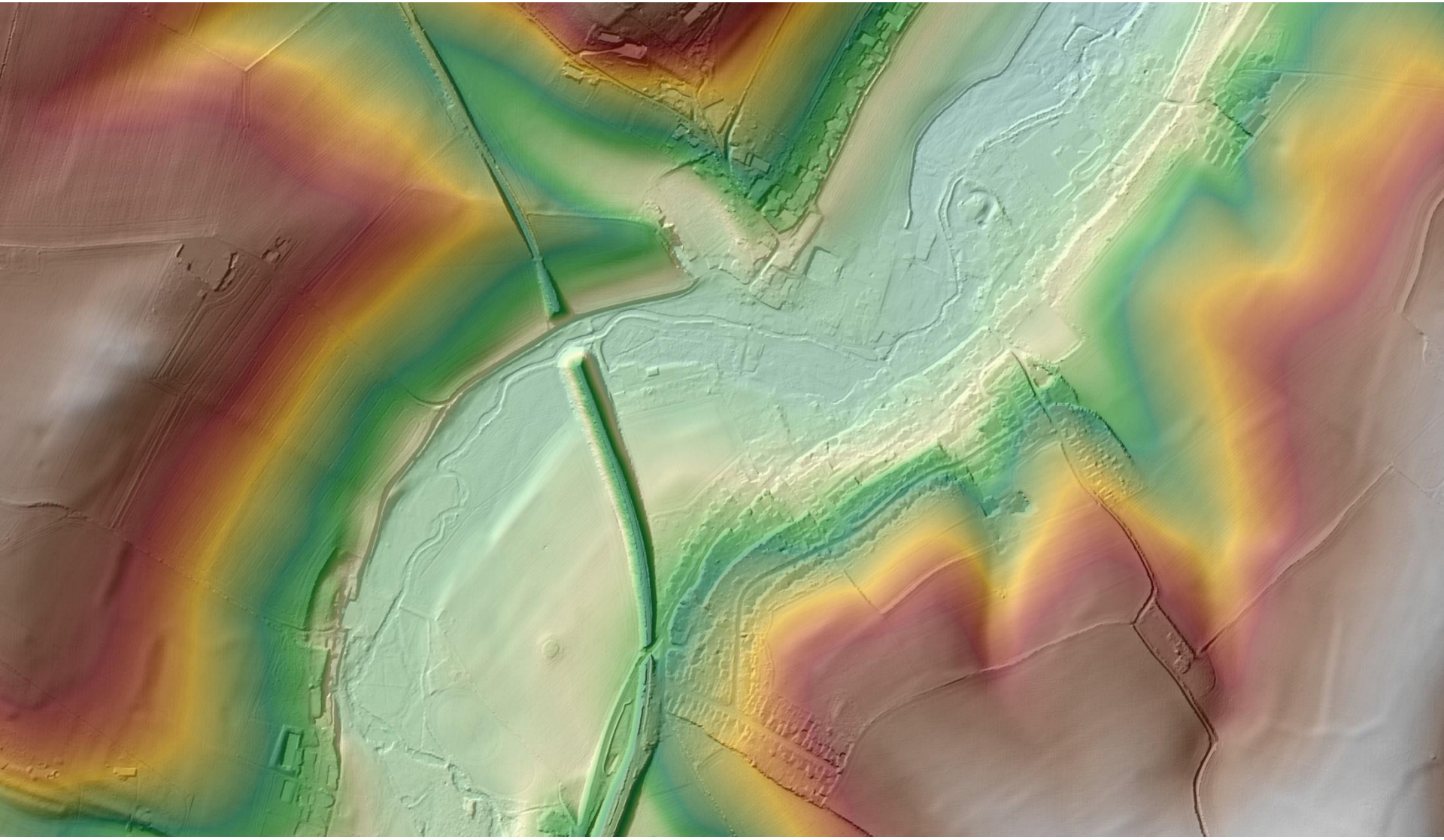
Example area from the Keeping Rivers Cool version 2 pilot project, River Darent.

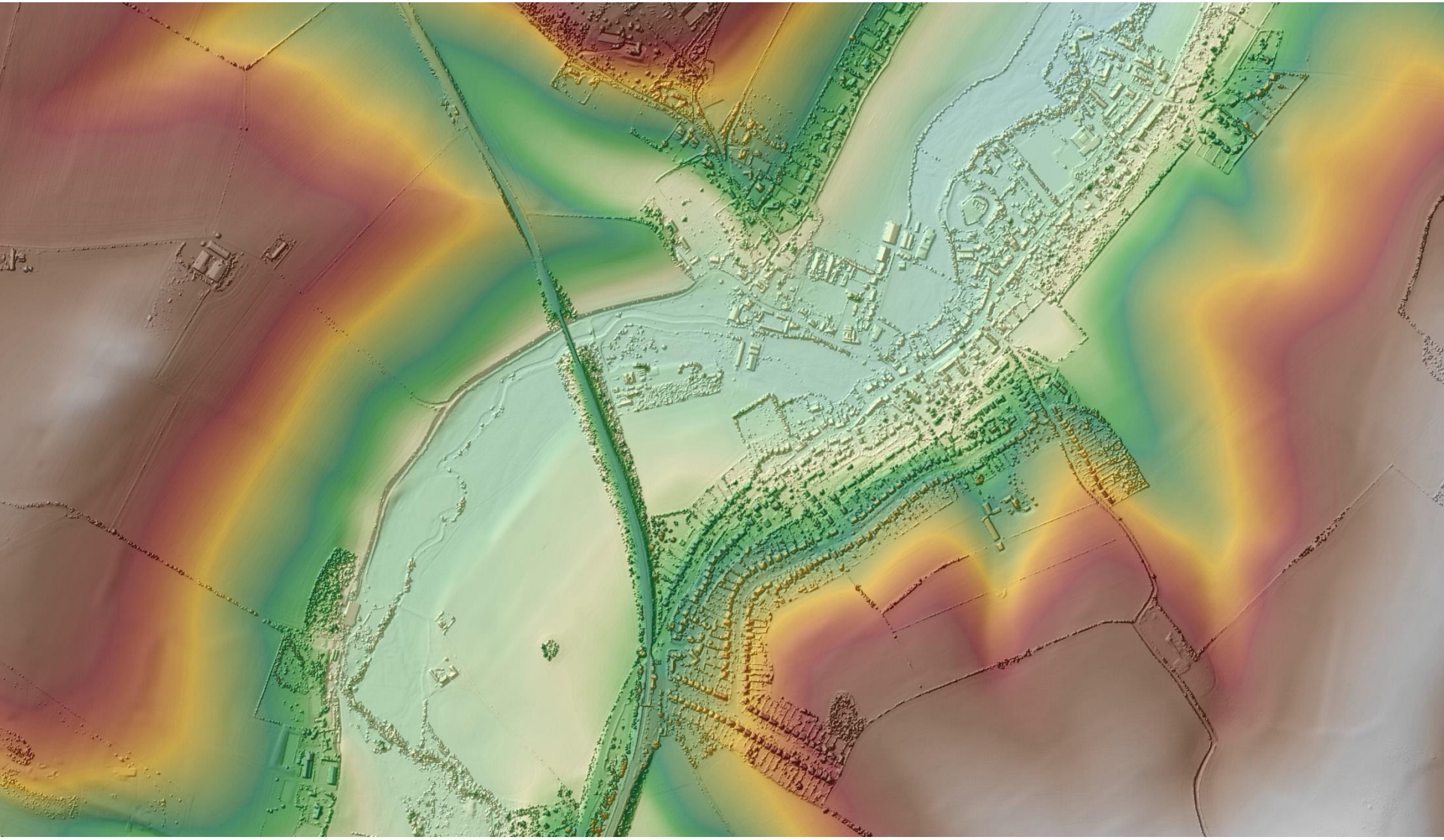


1m resolution lidar derived Digital Terrain Model



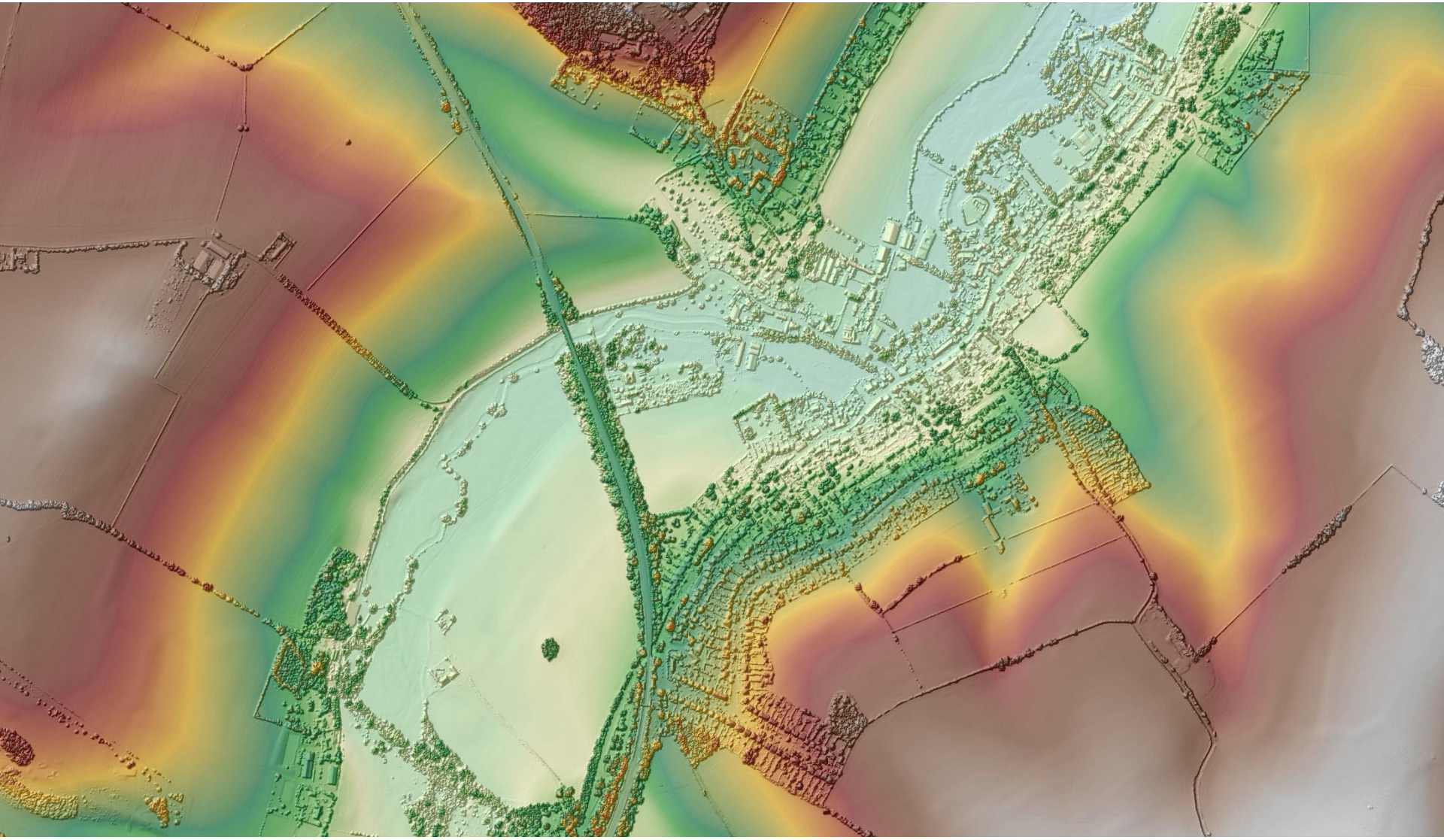
Last return lidar points have been classified into surface object and ground classes, ground class points used to generate raster DTM which is then QC-ed and manually edited further to produce the finished DTM.

1m resolution lidar derived Last Return Digital Surface Model



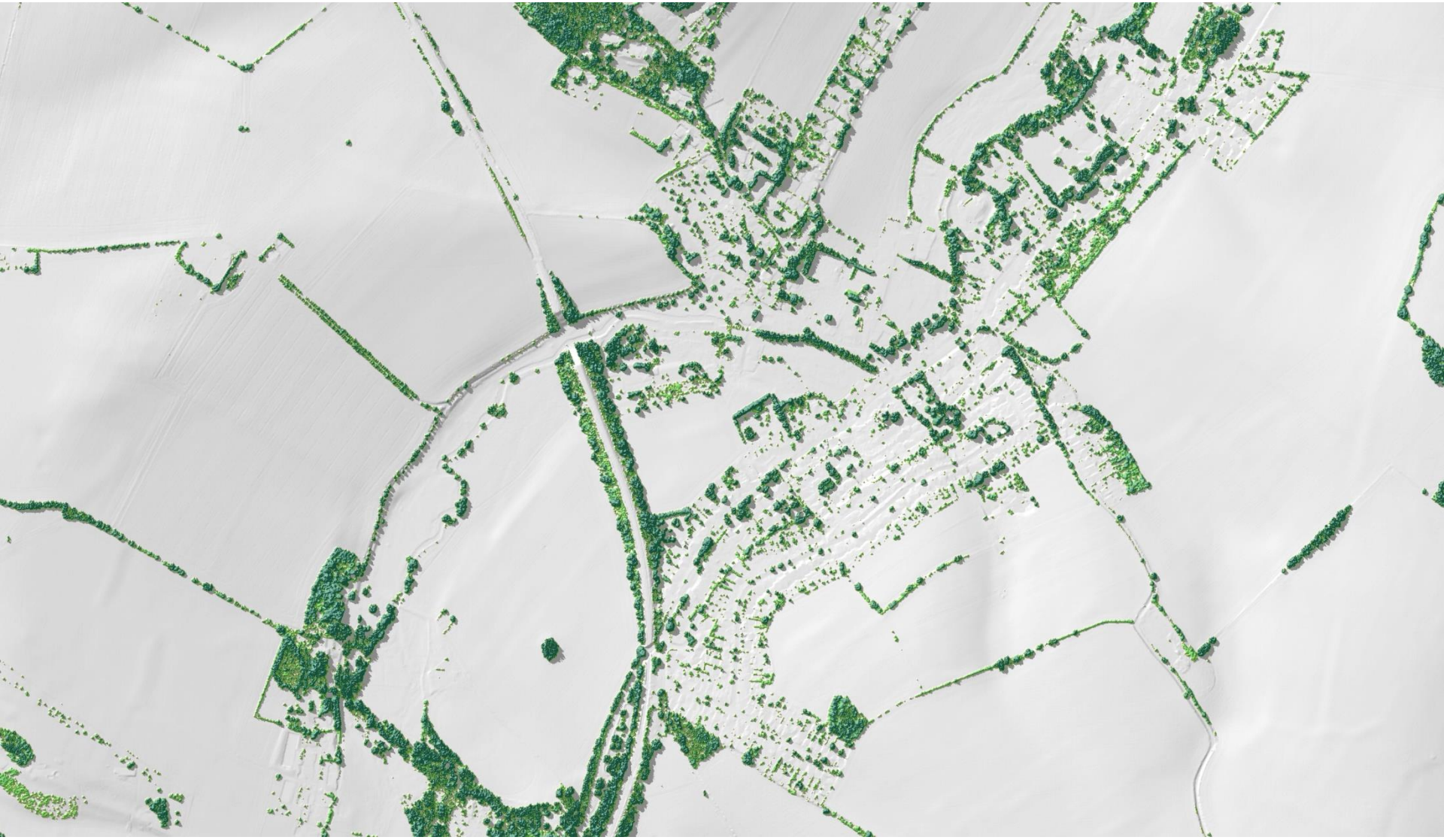
All Last return lidar points have been triangulated and fitted to the 1m raster. This represents the last object the laser pulse reflected from – be it the ground, roofs of building, top of vehicles or as far through vegetation as can be penetrated by the laser pulse.

1m resolution lidar derived First Return Digital Surface Model



All First return lidar points have been triangulated and fitted to the 1m raster. This represents the first surface of objects the laser pulse reflected from – be it the ground, roofs of building, top of vehicles or the top of the vegetation canopy. Even though the data is collected in “leaf-off” winter months there is a significant difference between the first and last return from vegetation.

Lidar derived Vegetation Object Model



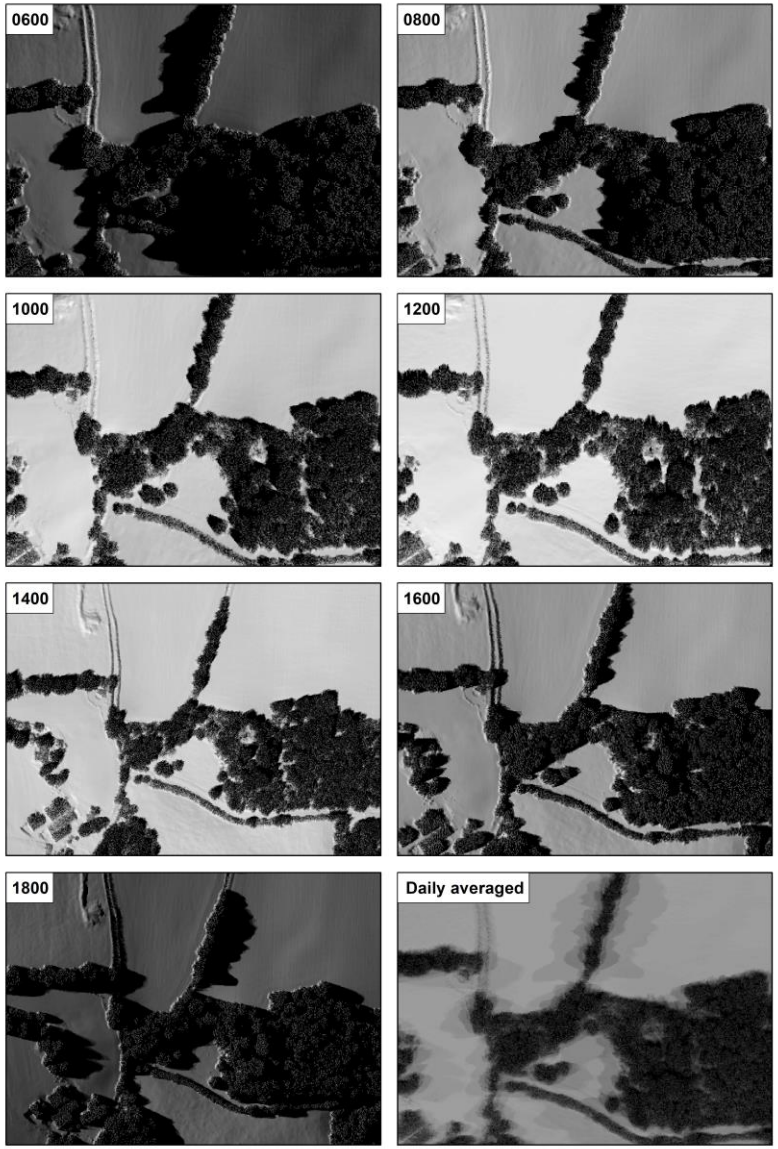
This shows all vegetation objects greater than 2.5m in height, derived from the difference of First Return DSM minus DTM, which have been classified as “vegetation”. This has been possible though clumping of pixels into objects, then screening to remove non-vegetation surface objects based on spatial proximity queries against certain features types present in OS MasterMap, by attaching and thresholding NDVI values from averaged Sentinel 2 images, by comparing percentage of similar first and last lidar returns, and by assessing shape / height / size of objects. This is a completely automated work flow, with no manual QC and editing of the results.

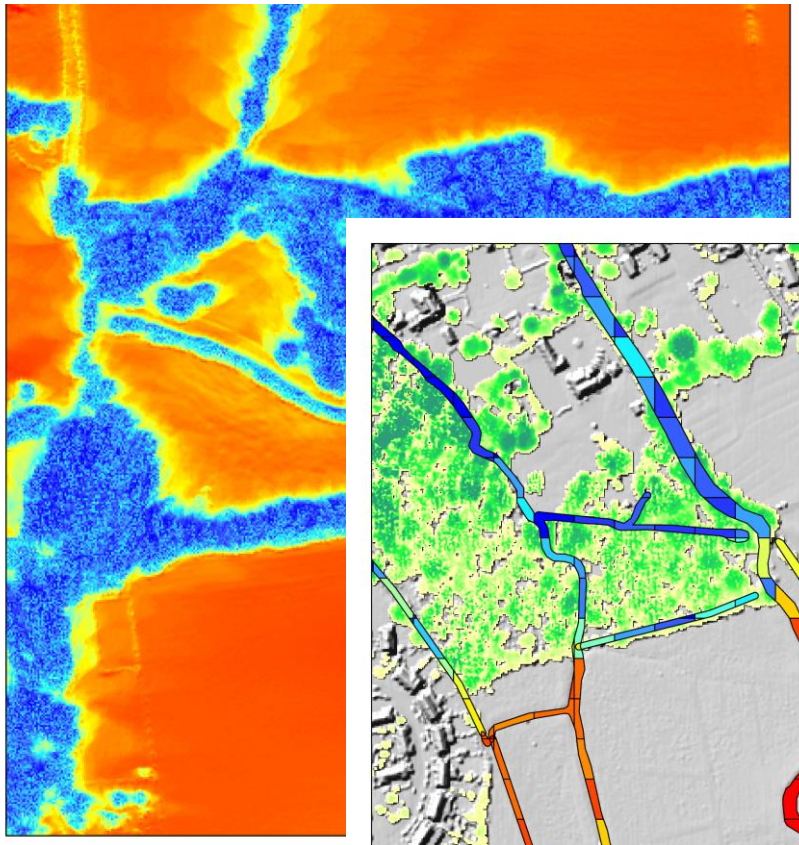
Aerial photo for comparison

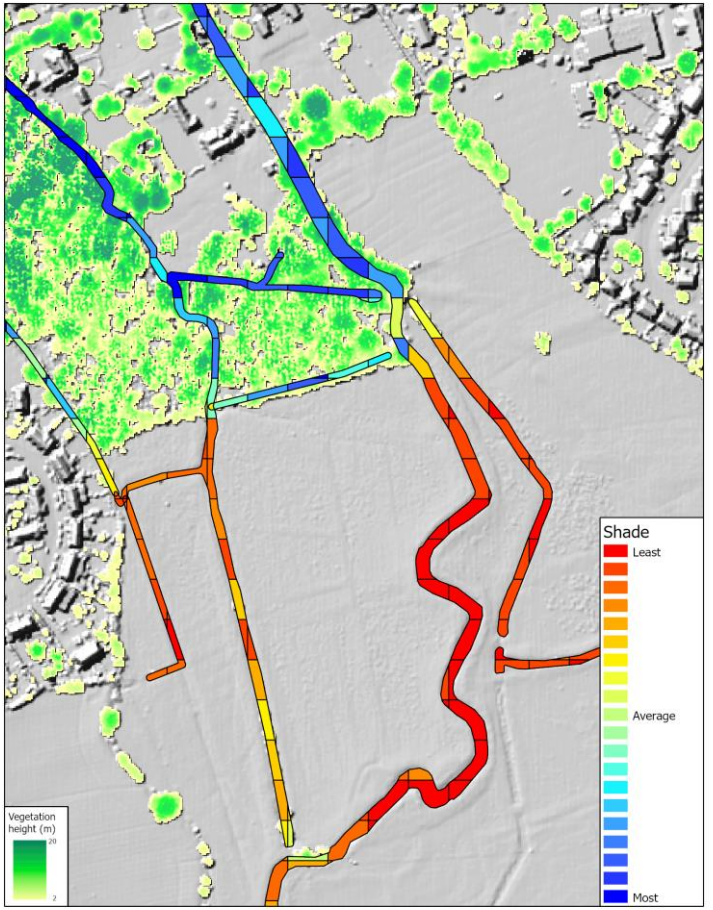
Relative Riparian Shading Map

Multi-directional sun-shading has been applied to the DTM and first return DSM, based on sun-angles throughout the day over the summer months. The differences in these shading values have been calculated, and then attached to OS Open Local Surface Water polygons, split into 25x25m blocks. These have then been ranked and classified according to their relative shading. Reds and oranges represent sections of river with the least amount of shading from surface object, so may be candidates for tree planting to give greater shading in the future.

Relative Riparian Shading Map







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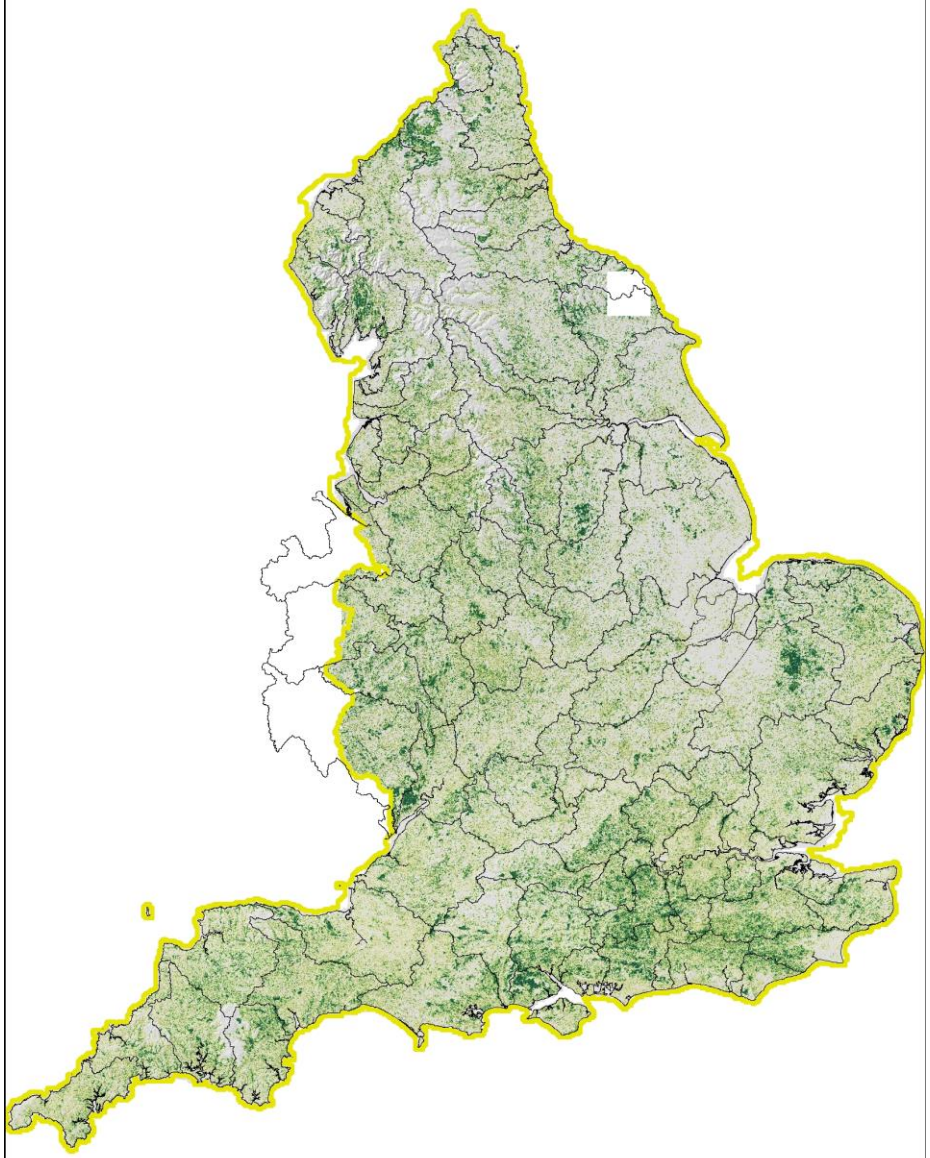
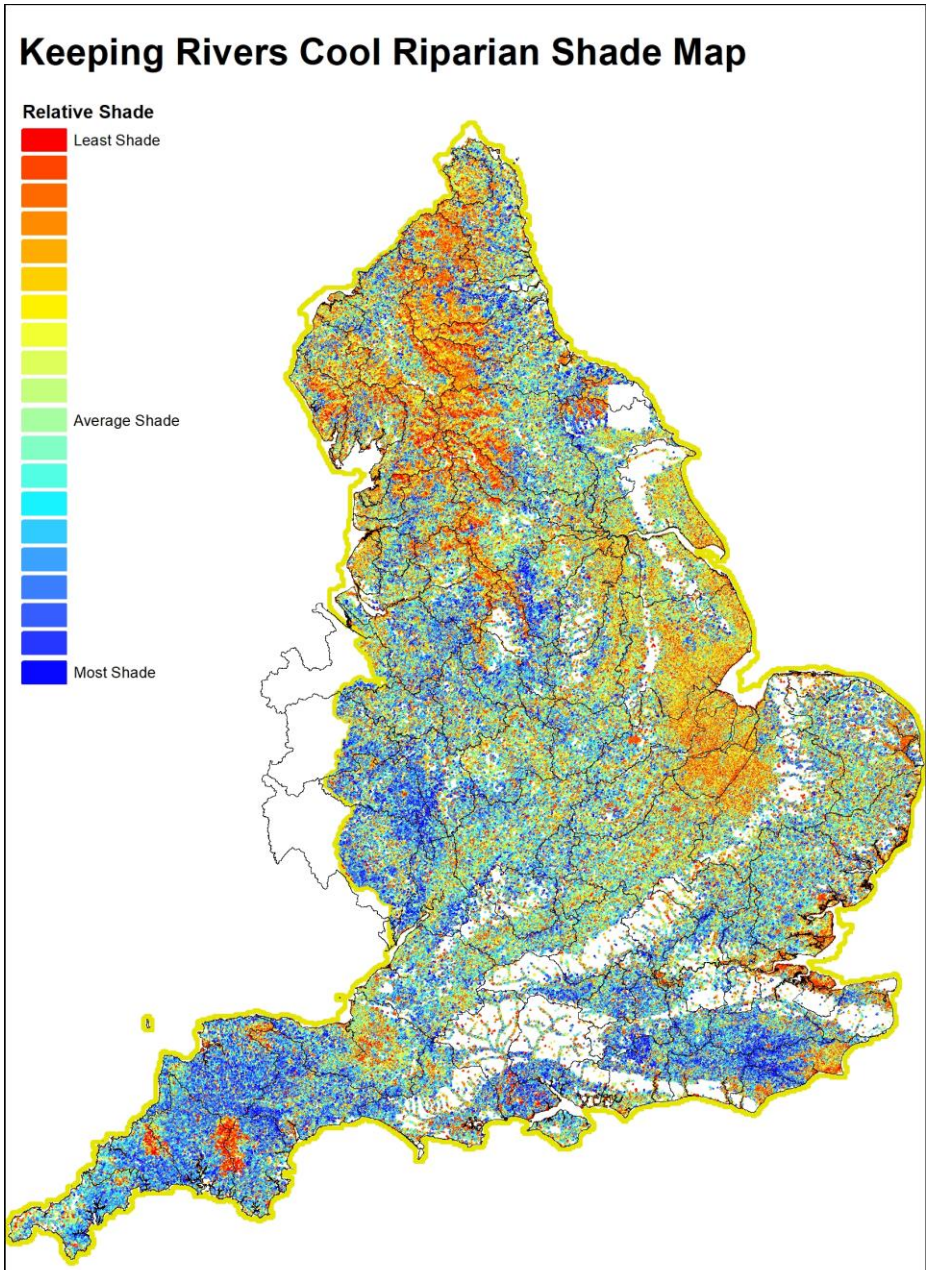
Keeping Rivers Cool products, as of June 2022

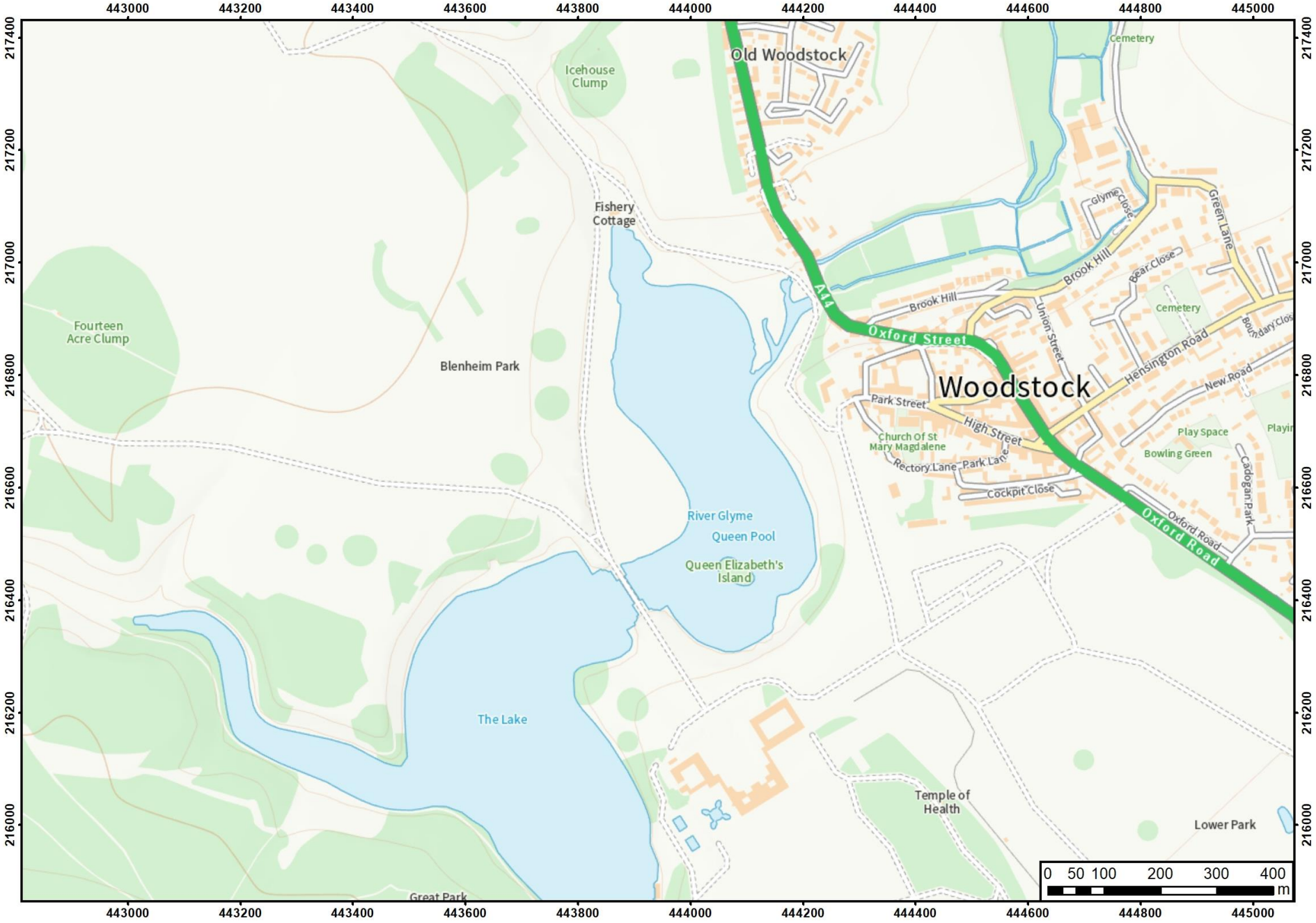
Lidar derived Vegetation Object Model (VOM)



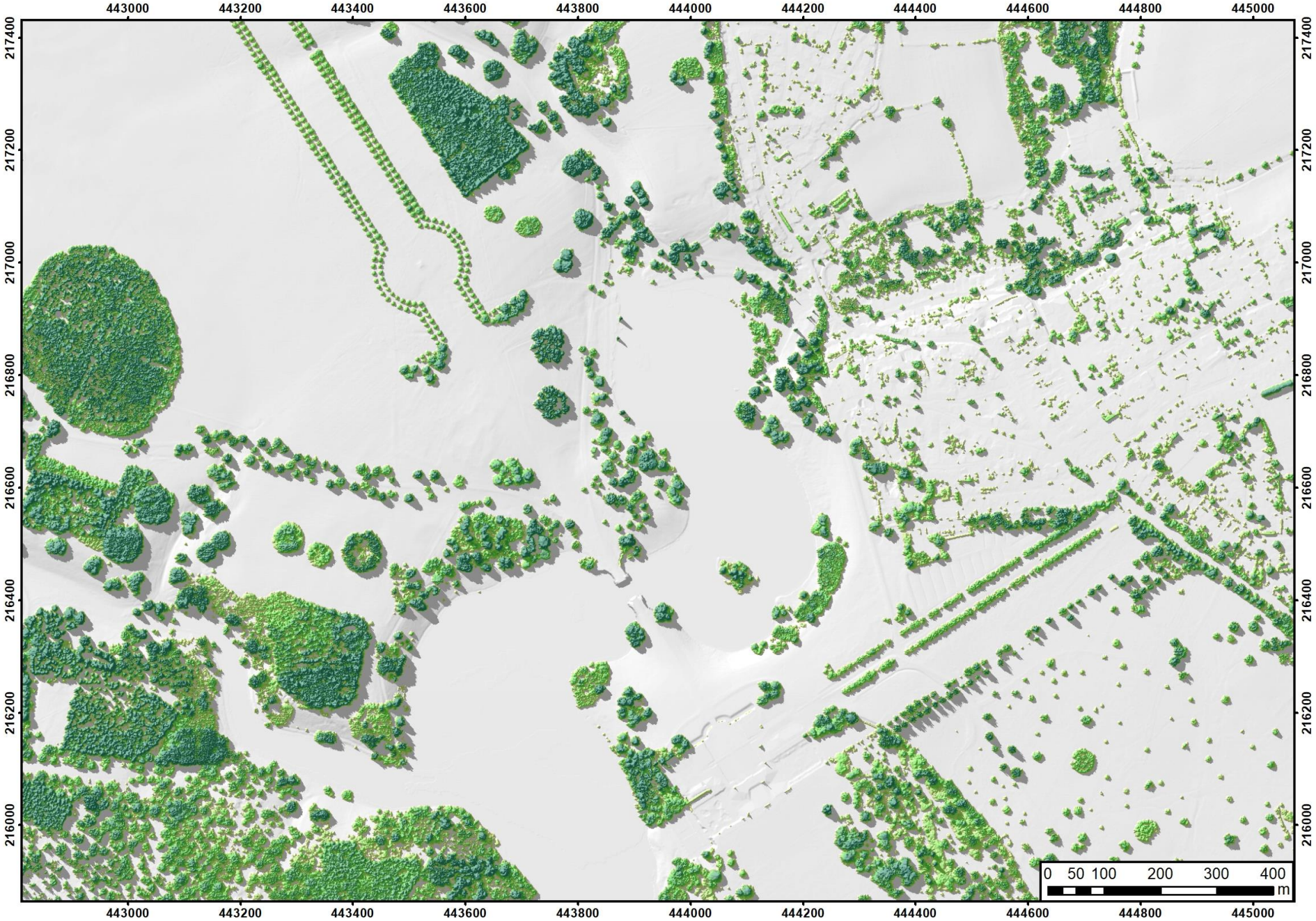
Keeping Rivers Cool Riparian Shade Map



Ordnance Survey Basemap – Blenheim, Woodstock.



Lidar derived Vegetation Object Model – Blenheim, Woodstock.

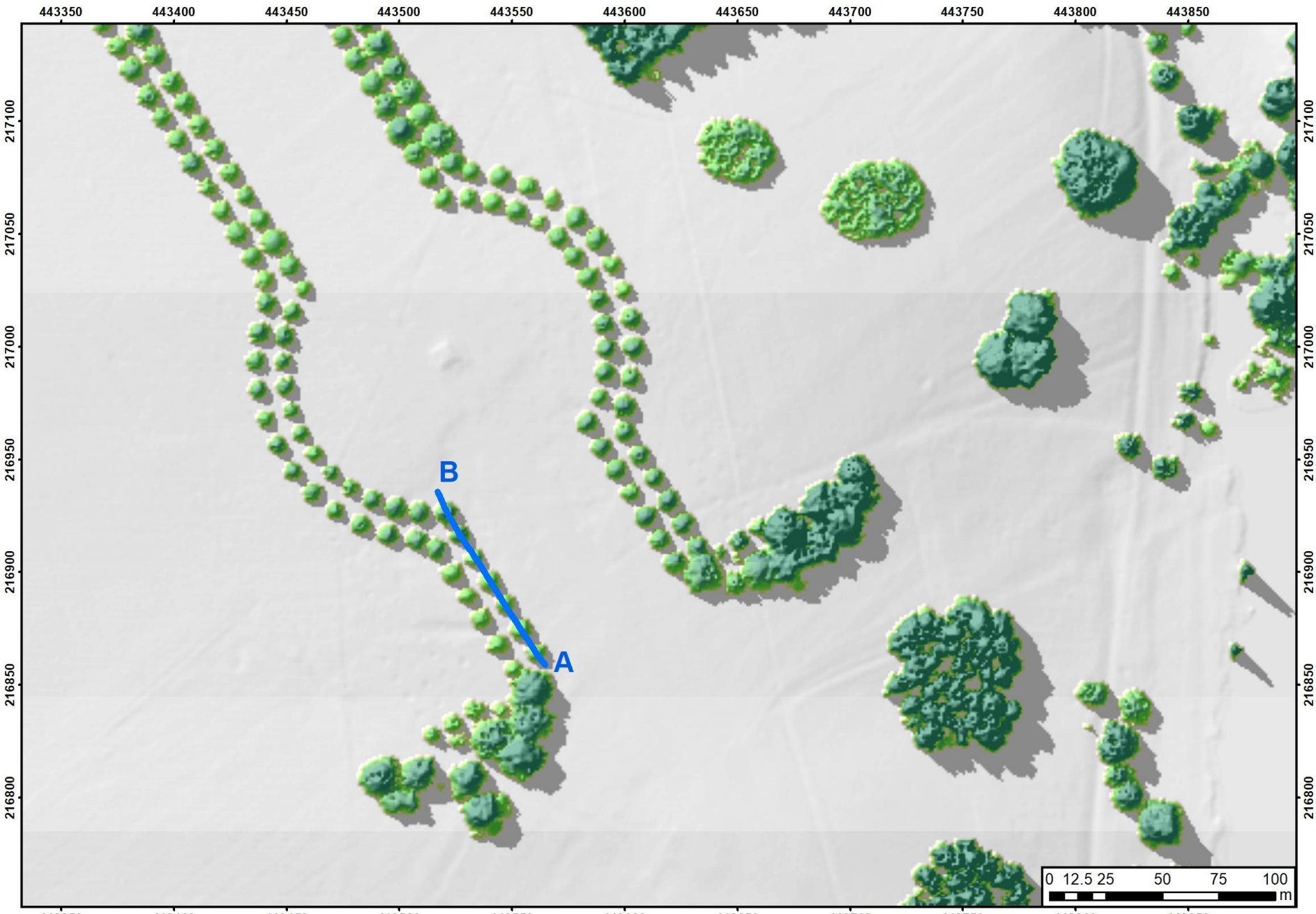


This shows all vegetation objects greater than 2.5m in height, derived from the difference of First Return DSM minus DTM, which have has been screened to remove non-vegetation surface objects present in OS MasterMap and averaged Sentinel 2 NDVI imagery, and by comparing percentage of similar first and last lidar returns.

APGB Aerial photograph for comparison

APGB Aerial photograph, zoomed to 1:2,000 scale, with a cross section profile line

Lidar derived Vegetation Object Model, with cross section profile line



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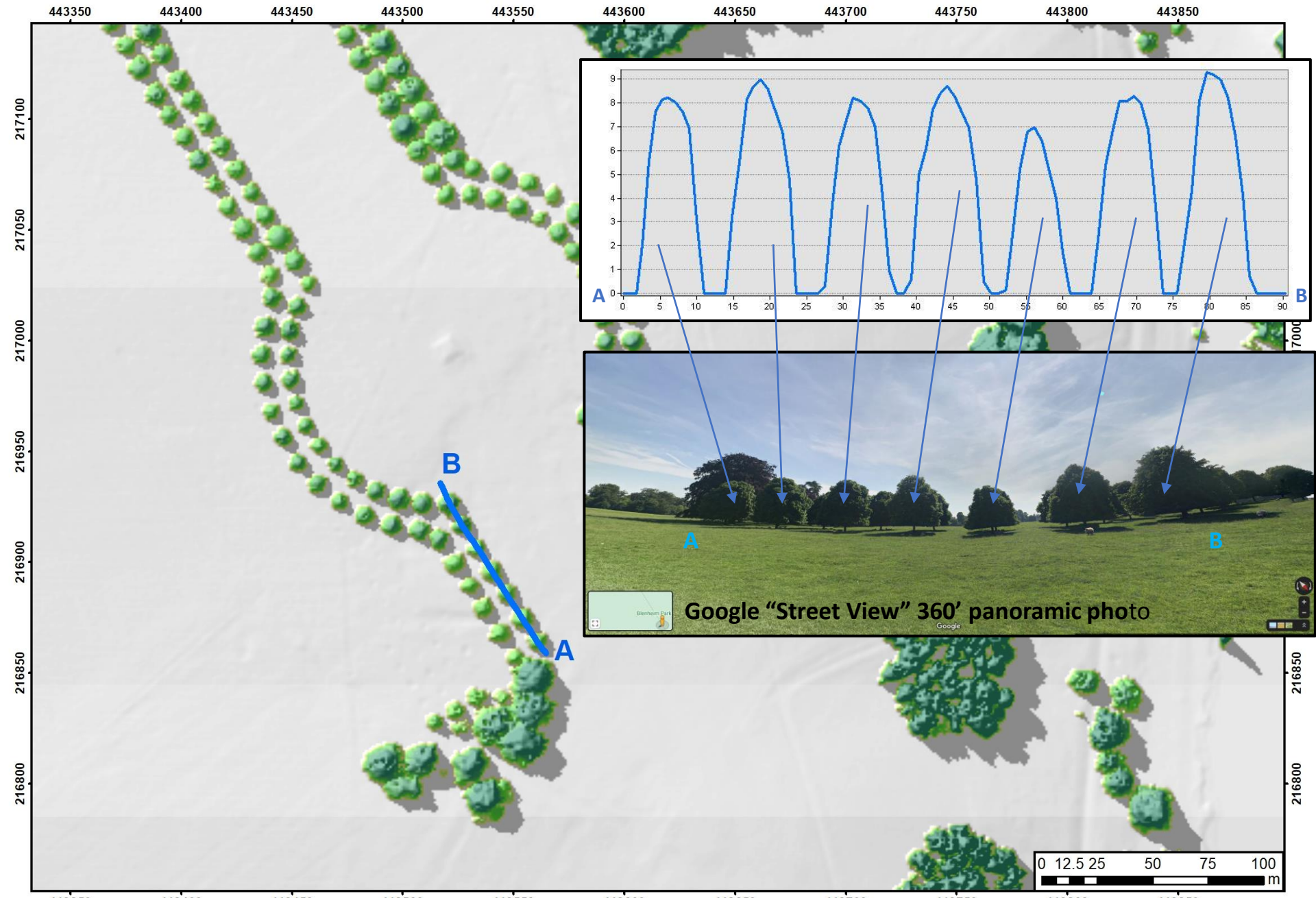
Lidar derived Vegetation Object Model , with cross section profile graph and 360’ panoramic photo from Google Street View



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Draft accuracy evaluation - ~90%

	All points	Ignore boundary points*
Overall accuracy	**87.3%**	**92.1%**

*Boundary points are considered those within 1 pixel of the boundary between classes. The resolution of the data was 1 m.

	Class accuracy (User's accuracy)		Class accuracy (Producer's accuracy)	
Cover type	All points	Ignore boundary points*	All points	Ignore boundary points*
Vegetation	92.6%	96.2%	84.2%	85.6%
Buildings	92.2%	96.0%	88.5%	92.2%
Other	79.5%	88.3%	90.5%	96.9%

		Overall accuracy	
Area of interest	Type	All points	Ignore boundary points*
AOI 1	Surburban/rural mix	93.8%	95.0%
AOI 2	Urban/Sub-urban	84.1%	90.4%
AOI 3	Urban/Sub-urban	87.0%	91.5%
AOI 4	Sub-urban/rural mix	88.5%	94.1%
AOI 5	Agriculture/rural & limited sub-urban	85.5%	89.4%

User's accuracy tells you how much of that class in the classified map is accurate

Producer's accuracy tells you how much of that class the classifier picked up.

A high User's accuracy but a low Producer's accuracy tells you that most of the areas classified as that class in the map are correct, but the classifier missed classifying areas of that class . i.e. the class was under classified

A high Producers's accuracy but a low User's accuracy tells you that most of the areas that are that class were picked up by the classifier, but it tended to over classify that class.

All points

		Vegetation	Ground Buildings	Other	User's accuracy
	Vegetation	1184	10	84	93%
Classified	Buildings	27	591	23	92%
	Other	195	67	1018	80%
	Producer's accuracy	84%	88%	90%	87.3%

Ignore boundary points*

		Vegetation	Ground Buildings	Other	User's accuracy
	Vegetation	625	4	21	96%
Classified	Buildings	7	380	9	96%
	Other	98	28	947	88%
	Producer's accuracy	86%	92%	97%	92.1%

The data production is fully automated, with no manual QC and editing of the output. There could be some mis-classifications of objects (especially static caravans, shipping containers, large tents / marquees, coastal cliffs and new buildings constructed directly under tree cover). This is a first release of this dataset, the quality of the production methods will be reviewed over the next year and improvements made where possible.

Lidar derived vegetation object model

- For all post 2017 1m national lidar programme survey datasets
- First cycle of production now complete, first datasets were released November 2021, complete set to be released very soon
- Open data, available to download from DEFRA DSP: https://environment.data.gov.uk/DefraDataDownload/?Mode=survey
- GeoTIFF format, 5x5km tiles – aligning with the other lidar derived products of the 1m lidar National Programme
- ESRI compatible Image Service is also available
  - GIS Server URL: https://environment.data.gov.uk/image/services no username or password needed, Vegetation Object Model image service layers can be found in the “Survey” folder
  - Also part of ESRI’s ArcGIS Online “Living Atlas” data collection

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Links:

- DEFRA DSP: https://environment.data.gov.uk/
- Environment Agency Geomatics Hub:
- https://experience.arcgis.com/experience/753ad2ebd3554fa696885b8c366c3049/page/home/?views=view_22
- Lidar derived Vegetation Object Model: https://experience.arcgis.com/experience/753ad2ebd3554fa696885b8c366c3049/page/LIDAR/?views=Vegetation-Object-Model
- Keeping Rivers Cool project information - https://jncc.gov.uk/our-work/keeping-rivers-cool/

Email: Alastair.Duncan@environment-agency.gov.uk

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