Creating Base Map Templates in OOM from LiDAR and other Sources

Martin Hore, Suffolk Orienteering Club.   Version 3 - May 2021

Contents

Introduction

These guidance notes describe the methods I'm currently using to process LiDAR data for use as templates in Open Orienteering Mapper (OOM). I also cover the use of data from other sources, such as Ordnance Survey mapping and aerial photographs. These are my first tasks when drawing a new or substantially updated orienteering map. I can then draw up an accurate and reasonably detailed base map which saves a lot of surveying time in the field.

Mappers using the latest OCAD version can make use of OCAD's in-built tools for processing LiDAR data. OOM is alternative, open source (free) software which I find very satisfactory as a tool for drawing orienteering maps. However, OOM doesn't currently have an in-built facility to process LiDAR. The procedures described in these notes produce similar results to those obtained using the latest OCAD. I find they work well with OOM, and should also be adaptable for use with earlier OCAD versions.

Now I'm familiar with these procedures, it takes me between one and two hours to source, process and load into OOM all the templates I need for a new map. The time depends on the size of my map footprint and on whether I include a "point cloud"-based undergrowth template and a template from non-OpenData OS mapping, which both take rather longer to process than the other templates. This is significantly longer than using the latest OCAD, but not, I think, excessively time-consuming compared to the overall time it takes to produce a new map.

Processing LiDAR data outside of OCAD requires the use of GIS (Geographical Information System) software. Several open source GIS options are available free of charge. QGIS is perhaps the best known. Largely because it's where I started, I've opted to use SAGA-GIS which is, I think, equally well suited for this work.

I've written these notes partly to serve as a reminder to myself. I only use these procedures when starting a new mapping project, and I don't always remember exactly what I've done from one map to the next! But I hope the notes will be helpful to others too, including orienteers new to mapping.

I've illustrated the notes with example base map templates for three orienteering venues in Suffolk: Tunstall Forest, Bridge Wood and Holywells Park. Tunstall Forest is a large area of typical Forestry Commission plantation which Suffolk Orienteering Club uses for regional events. Bridge Wood is a small, well-contoured, woodland country park, adjacent to the Orwell estuary, which we use for local events. Holywells is an urban park in Ipswich. Each area best illustrates different aspects. For example, I've used Tunstall Forest to illustrate how to merge several LiDAR tiles together, whereas Bridge Wood better illustrates contour templates. Holywells shows the value of obtaining detailed OS mapping.

I'm still very much on a learning curve with this and I find I'm picking up new tricks all the time. I've been using some of the procedures described here for several years; others for just a few maps so far. If you spot any errors in these guidance notes, or recognise anything that can be achieved more simply, please let me know (email address below) so that I can update these notes - and borrow your ideas!

I must acknowledge the help I've received in developing these notes from members of British Orienteering's Map Advisory Group, from fellow contributors to British Orienteering's recent mapping webinars, from the authors of other guidance notes on the Mapping Resources page on the British Orienteering website, and from fellow club mappers in SUFFOC and WAOC. Many thanks to all.

I've covered the following topics in these guidance notes:

I recommend readers work through Chapters 1 - 3 before dipping into the other chapters according to your interests. I've tried in Chapter 3 to give an introduction to the features in SAGA-GIS which form the basis for the processes described in the subsequent chapters. I've written the other chapters to follow in sequence, but they should be readable in any order.

A note on hardware and software.

I currently use a PC or laptop both running Windows 10. I'm not sure how, if at all, the processes described here can be transferred to a Mac. Processing raw LiDAR point cloud data is very memory intensive, as is handling high resolution aerial photography. My old laptop has 4GB of RAM and an Intel Core i3 Processor. It can struggle with LiDAR point cloud files, so I normally use my wife's more powerful desktop to process those. My laptop is fine, however, for handling all the other processes described in these notes.

All the software applications I use are free to download as are the sources of LiDAR, aerial photography and, with one exception, OS mapping data. For ease of working I've set up shortcuts on my laptop to each of these applications and websites. All the web links are below. Please note that I cannot guarantee that the processes described here will work with future updates of these applications.

Open Orienteering Mapper (OOM): https://www.openorienteering.org/apps/mapper/. These notes have been updated to be compatible with Version 9.5.

SAGA-GIS: https://sourceforge.net/projects/saga-gis/files/ These notes have been checked for compatibility with Version 7.9.0.

SASPlanet (for aerial photography) http://www.sasgis.org/programs/sasplanet/SASPlanet_200606.zip This 06/06/20 version is the one I'm using.

LAStools (for processing LiDAR point-clouds) : http://www.cs.unc.edu/~isenburg/laszip/ I use this only for obtaining undergrowth templates as described in Chapter 6. I found my Norton antivirus software reported LAStools as unsafe. But it's established industry-standard software. I bypassed the Norton wall without adverse consequences.

UK Environment Agency (DEFRA) LiDAR download site:
https://environment.data.gov.uk/DefraDataDownload/?Mode=survey

Ordnance Survey OpenData: https://osdatahub.os.uk/downloads/open

DEFRA MAGIC (MagicMap) site https://magic.defra.gov.uk/MagicMap.aspx

Promap: https://www2.promap.co.uk/

Note that there are copyright requirements to observe in relation to all OS mapping. Please see the separate note on copyright in Chapters 9.

Note for non-UK (or non-English) readers.

UK Orienteering maps are generally drawn aligned to the OSGB36 map projection (EPSG code 27700). All the LiDAR and Ordnance Survey data I use is based on same projection. The methods described here will need to be adapted if either your final map, or your data sources, are based on other projections, OOM version 9.5 offers an in-built projection transformation facility which can convert between different map projections. I use this to process aerial photographs from SASPlanet, and also if I want to export my final map in KMZ format in order to use it with MapRun.

Many environmental matters in the UK are devolved government responsibilities. The Environment Agency (DEFRA) LiDAR sources I use are not necessarily available or matched outside of England.

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<u>**Chapter 1: Setting up a Geo-referenced map in OOM**</u>

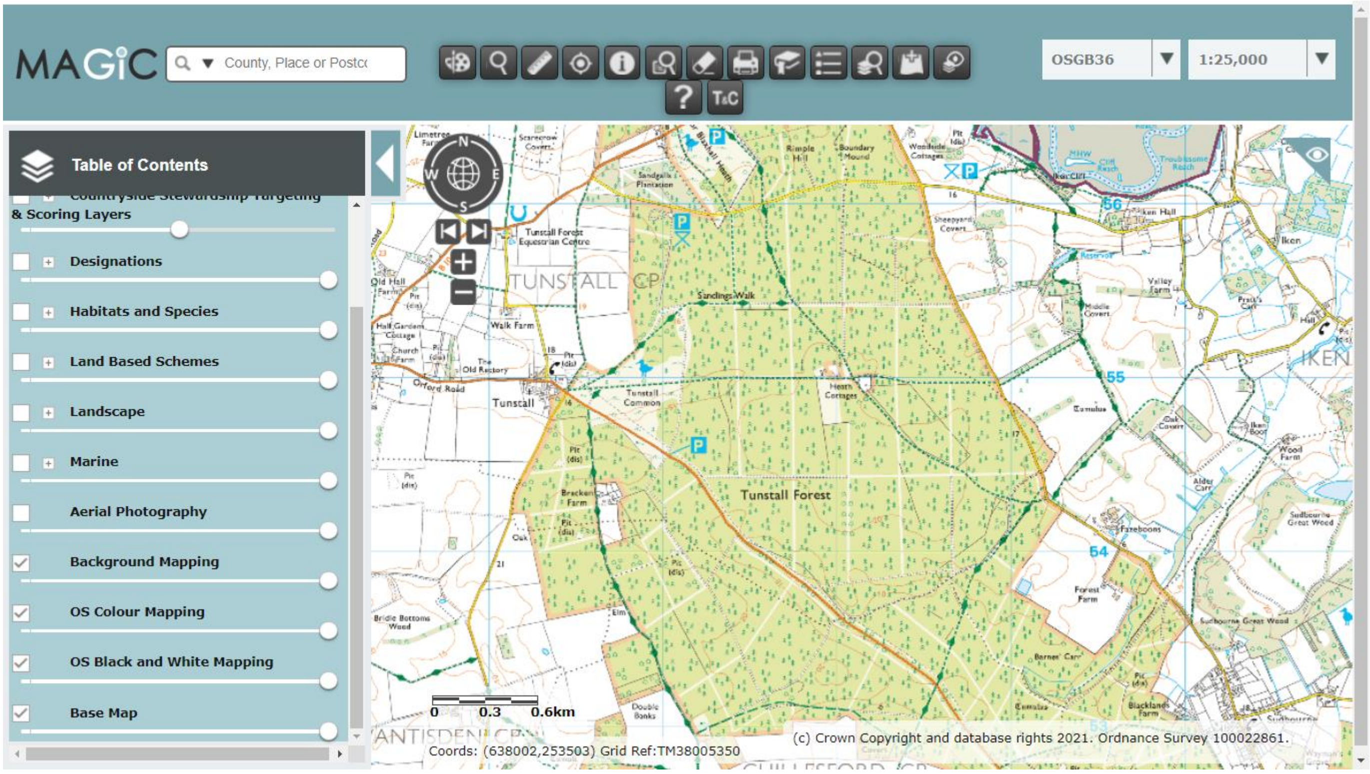
A geo-referenced map is one where the on-screen map co-ordinates of every feature on the map match the co-ordinates of the same feature in the real world. The real world co-ordinates are defined by a co-ordinate reference system, or projection, which projects the curved surface of the earth onto a plane. For UK mappers the standard projection is the Ordnance Survey Grid (OSGB36). Once an orienteering map is geo-referenced, any templates or imported data will open exactly aligned, provided the data is geo-referenced to the same co-ordinate reference system.

SUFFOC's catalogue of past orienteering maps are generally not geo-referenced at all, or not accurately geo-referenced across the whole map. Most clubs are probably in the same position. Producing the first geo-referenced update of an old map may be time-consuming – it's often easiest to do a full re-draw - but once the map has been accurately geo-referenced, future updates should be more straightforward.

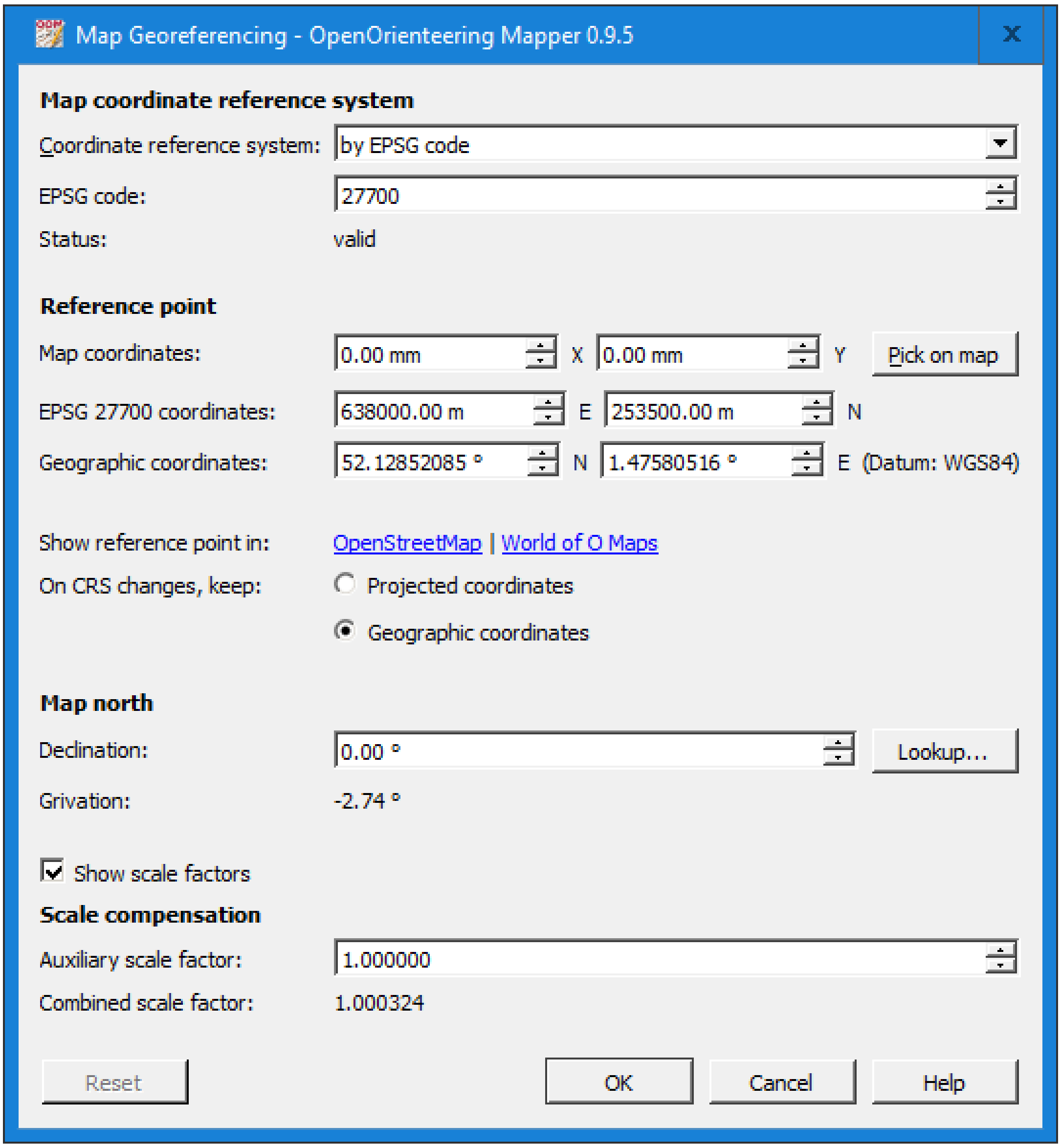
In OOM it's possible to geo-reference a map automatically when opening the first geo-referenced template. But I prefer to geo-reference the map as my first action before opening any templates or importing any data. The method I use is as follows:

First I establish the Ordnance Survey co-ordinates of the corners of my "bounding rectangle", that is the rectangle which contains the full map footprint. I round these co-ordinates to the nearest 100m. The bounding rectangle can be obtained from a paper OS map but I find it easier to use the DEFRA MagicMap site – see the screenshot below.

I pan and zoom the map so that my footprint fills the screen. Check that the projection (top right) is set to OSGB36. The screenshot shows the footprint of the area I recently mapped in Tunstall Forest. The Co-ordinates and Grid Reference displayed at bottom-screen are of the SW corner of my bounding rectangle (My mouse position is hidden in the screenshot.) I record the 1m co-ordinates (638000, 253500) rather than the 10m ("8 figure") grid reference. Both are shown. I then repeat for the NE corner, which in this case has 1m co-ordinates 640300, 256200.



I then create a new map in OOM. First you have to set the scale and symbol set. I chose 1:10000 and ISOM 2017–2_10000 for this map. The grey "ready to draw" screen appears. Click the "Map" tab and select "Geo-referencing" to display the dialogue window below.



I've selected "by EPSG code" as the co-ordinate reference system, and entered 27700 which is the correct code for the UK Ordnance Survey Grid. Under "Reference Point" I've then set the origin of my map at the SW corner of my bounding rectangle by leaving 0.00, 0.00 as the map co-ordinates and entering the OS co-ordinates of the SW corner as the EPSG co-ordinates.

At this point, the default "Declination" and "Grivation" figures under "Map North" remain zero. To set these correctly it's necessary first to close the geo-referencing dialogue by clicking "OK". Then re-click the "Map" tab and select "Geo-referencing" again to re-open the geo-referencing dialogue. The dialogue window will now display as above. "Declination" is still defaulting to zero, but the "Grivation" setting is no longer zero. "Declination" is the difference between magnetic north and true north. OOM assumes this to be zero until told otherwise. "Grivation" is, strictly, the difference between magnetic north and grid north, which UK users normally refer to as the "magnetic variation". However, with "Declination" falsely set at zero, the figure displayed as "Grivation" is the difference between grid north and true north. This varies across the UK, but is fixed at this location, regardless of the movement of magnetic north over time.

The OOM map screen is always aligned to what it assumes to be magnetic north. So at this point you have two sensible options:

1. Set the correct current direction of magnetic north by entering the difference between true and magnetic north at this location in the "Declination" box. An approximate value can be found by clicking the "Lookup" button. A more accurate value is available from the British Geological Survey (BGS) here. Note however that BGS will give you the angle between grid and magnetic north when what you need to enter here is the angle between true and magnetic north. So you

need to adjust for the difference between grid north and true north which was displayed initially as “Grivation”. The correct *magnetic north* will now be straight up the map, but UK geo-referenced templates will not open square on the screen.

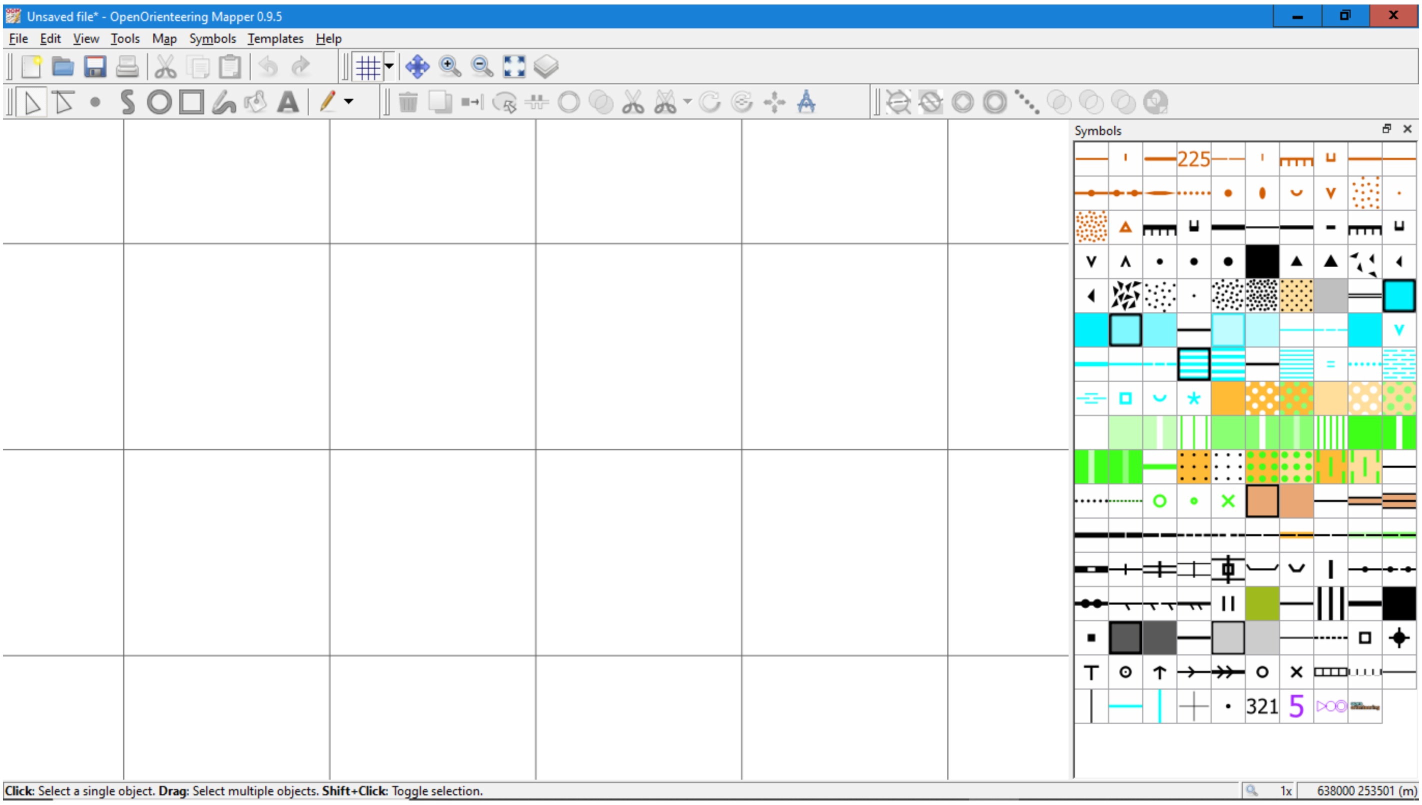
2. Alternatively, make a false entry in the “Declination” box to reset “Grivation” to zero. The value to enter is minus the value initially shown as “Grivation”. This has the effect of setting *grid north* straight up the map. UK geo-referenced templates will now open square on the screen.

Method 1 has the advantage of setting your map correctly to magnetic north right at the start. But as magnetic north is not constant this may need further adjustment when the map is used for events in the future. It’s also potentially confusing whether to assign + or - to “Declination”, especially as magnetic north is moving from west of true and grid north to east of true and grid north during this current period.

Method 2 is simpler and has the advantage of keeping all your templates square on the screen. This is the method I prefer and is how all my OOM screenshots are shown in the remainder of this document. I can then rotate my final map later to the correct magnetic north for the date of the event. The disadvantage of this method is that if you print your base map without adjustment, you must correct for magnetic variation every time you take survey bearings in the field. As a regular user of OS maps this is instinctive for me and I don’t find it a problem, but you may prefer method 1 for this reason.

Returning to the OOM drawing screen I now click the “Map” tab and select “Configure Grid”. I turn “snap to grid” off, set alignment to “magnetic north” (or to either “grid north” or “magnetic north” if using method 2) and set the horizontal and vertical spacings to 100m. This provides a check that all templates are opened correctly as they should sit flush with the grid.

Finally I set the co-ordinate display in the bottom right hand corner to EPSG 27700 co-ordinates, as shown below. The co-ordinates here show the position of the cursor (which is invisible in the screenshot) positioned centre screen at the map origin.



My newly created map is now ready to accept templates. I normally save it within a folder created for the new map project in a sub-folder named “Templates”. I find that having the map file together with its associated templates in the same folder is useful if I later want to forward the map to another mapper, or move it to another computer.

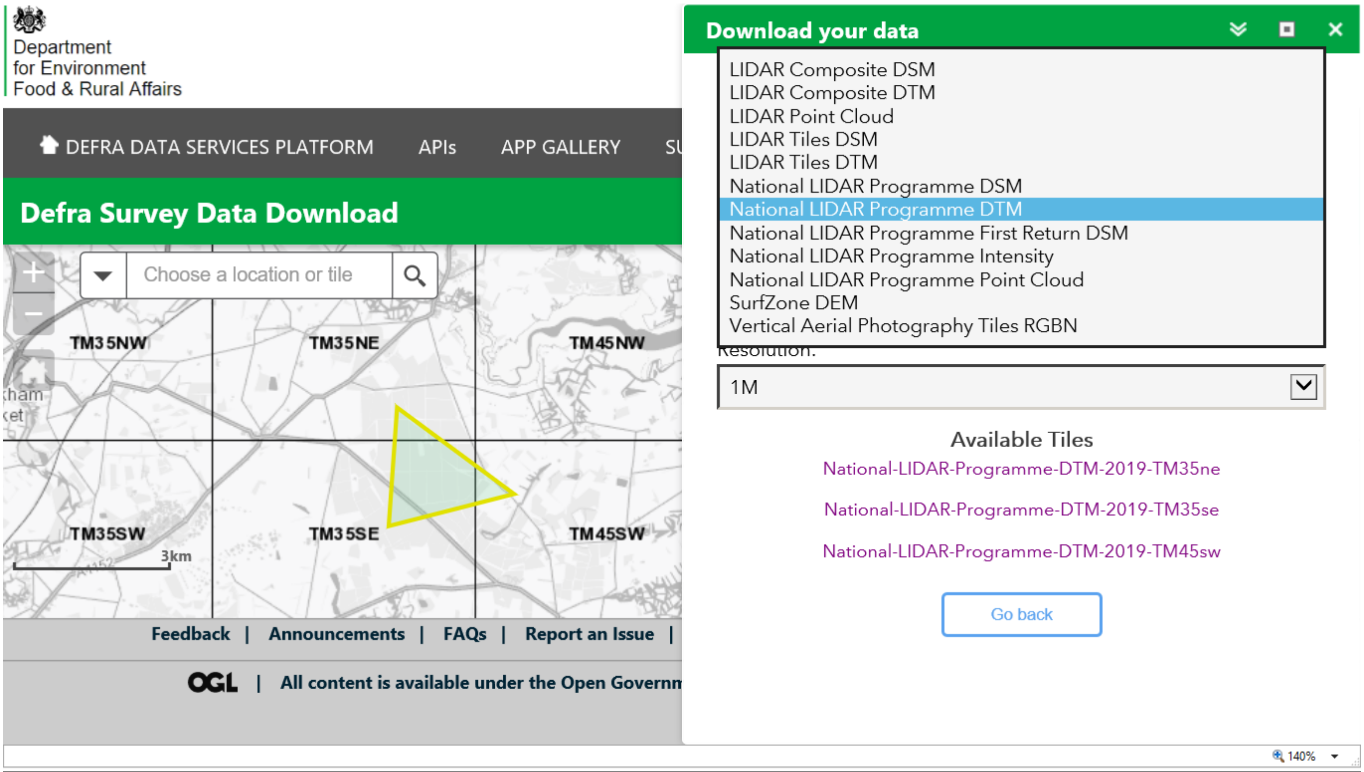
Chapter 2: Downloading LiDAR data from the UK DEFRA website.

For an explanation of the value of LiDAR for orienteering mapping please see the article on the British Orienteering website here. Lots more detail on the different LiDAR formats available from the UK Environment Agency via the DEFRA website is given here.

The DEFRA LiDAR download site is here. The screenshot below shows the site with the map zoomed in and the three tiles I require for Tunstall Forest selected. I used the polygon drawing tool in the “Download Your Data” window to make my selection. This should display as default on opening the site. Note that I only needed to draw a triangle including the tiles I need. There’s no advantage to drawing accurately around your map footprint.

Each tile is labelled on the map in the format “TM35NE”. TM35 is the 10km OS grid square with SW coordinates 630000, 250000 in 12 figure (1metre) format. TM35NE is the north-eastern of the four 5km tiles within this 10km grid square.

I then clicked on “Get Available Tiles” – you may need to scroll down the “Download Your Data” window to see this – and clicked the “Product” dropdown to display the available data formats for this area as shown below.



The proliferation of LiDAR data offered by DEFRA can be a little confusing. Until recently, I used the “Composite DTM” (Digital Terrain Model) and “Composite DSM” (Digital Surface Model) data – still the best option in some areas. But the “National LiDAR Programme” datasets generally have the most up to date and best resolution data for the areas of the country they cover. The National LiDAR Programme is scheduled to cover all of England by the end of 2021.

Five formats or “models” are available within the National LiDAR Programme as indicated in the screenshot. The “Point Cloud” model is the raw data from which the other LiDAR data sets are processed. I’ve only used raw point cloud data to produce undergrowth templates. The point cloud model is the only one that records intermediate reflections between the “first return” - the reflection of each laser pulse from the treetops, and the “last return” - the reflection of each laser pulse from the ground. But when the ground or the treetop elevation is what we want to see, the other, processed, data formats are easier to use.

The DTM data model records the last laser return. This is normally the ground. The data is cleverly adjusted to ignore buildings. Occasional anomalies do occur when the tree cover is so dense that no light reaches the ground, but these anomalies are mostly avoided by surveying in winter. DTM data can be processed to produce accurate contour maps as well as hillshade and slope gradient templates.

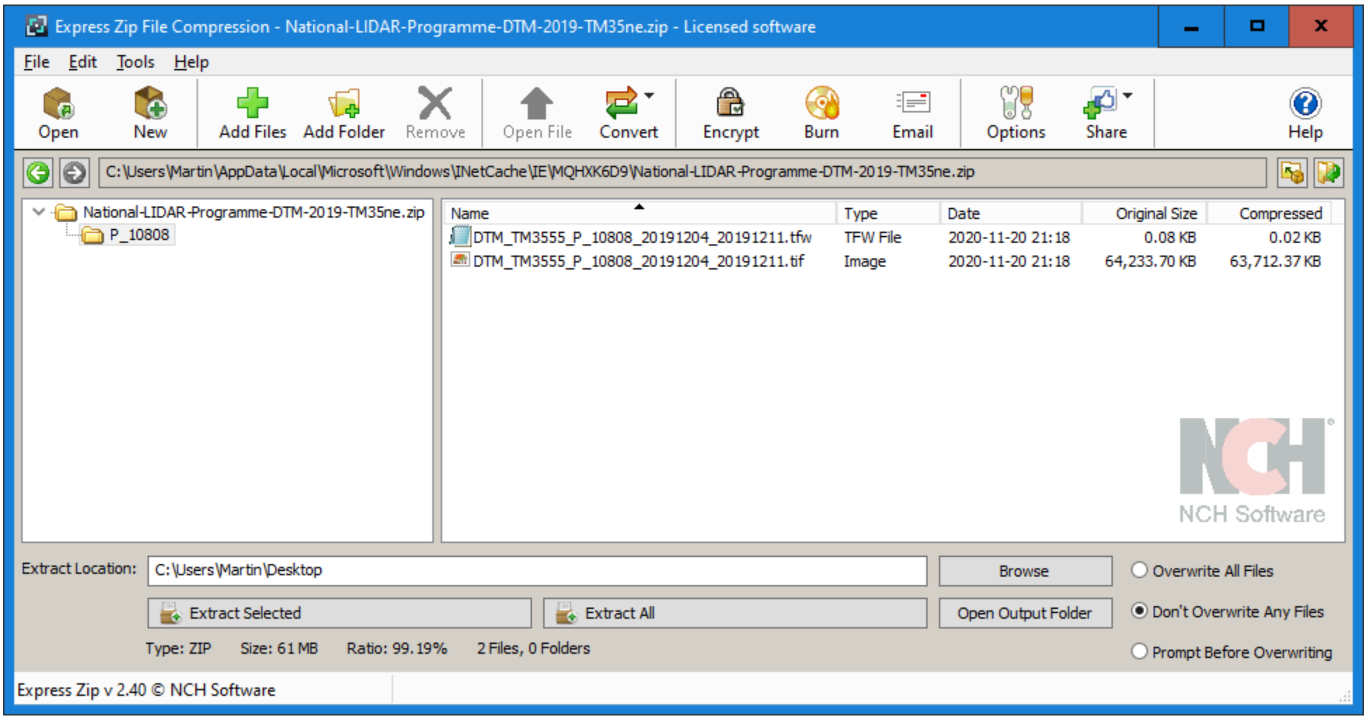
There are two National Programme DSM data models listed. I'm not certain of the distinction between them, but I've found that the "First Return DSM" provides the better indication of tree cover. First Return DSM records features that exist above ground level, including buildings, but only if they are the highest feature, the feature reflecting the first laser return. DSM data records the absolute altitude of the treetops and roofs above sea level and must be "normalised" to show height above ground. This can be done in SAGA-GIS. A normalised DSM template displays boundaries between different *heights* of vegetation well – usually better than aerial photographs.

The "Intensity" data model records the intensity or reflectivity of the surface met by each laser pulse. Templates derived from this data are not obvious to interpret on their own, but they can provide a good indication of the boundaries between different *types* of vegetation, independent of vegetation *height*. Roads and other tarmac areas are also particularly clearly defined, as are compacted paths in open areas, or even sometimes under tree cover.

Partially hidden by the dropdown list in the screenshot above are options to select the date and resolution of the survey. But there is normally no choice for National LiDAR Programme data. The resolution will be 1metre and the sole survey date between 2016 and 2021.

All the National LiDAR Programme datasets are provided as 5km tiles. All except the point cloud data is downloaded in GeoTIFF file format. In the screenshot above, I've selected the National LiDAR Programme DTM model and the three 5km DTM tiles I need for my map footprint are displayed.

I then click on the first tile to download the DTM dataset. It will download as a zipped folder with one sub-folder. I then open the sub folder as shown below. I can then drag and drop both the GeoTIFF "Image" file and the TFW file into a "LiDAR" sub-folder of my project folder for the current map. This is the best file location if following the examples in these notes. Alternatively you can drag and drop just the GeoTIFF file directly into the SAGA-GIS data window. The tiny TFW File provides geo-referencing information. SAGA-GIS reads this automatically on loading.



I then repeat the download for the other two DTM tiles plus the three First Return DSM tiles and, optionally, the three Intensity tiles. I prefer to leave the point cloud format tiles for now. Clearly this is a quicker process when you only require one 5km tile in each format which is the case with Bridge Wood.

Until the whole of England is covered by the National LiDAR Programme, it may be necessary to continue to use the alternative composite datasets in areas not yet reached. Composite DTM is provided in 5km GeoTIFF tiles and can be downloaded as above. Composite DSM is, however, still currently provided in 1km tiles in the older ASCII format. Downloading is reasonably intuitive. For most orienteering map footprints there will be several 1km tiles to merge. This can be done in SAGA-GIS.

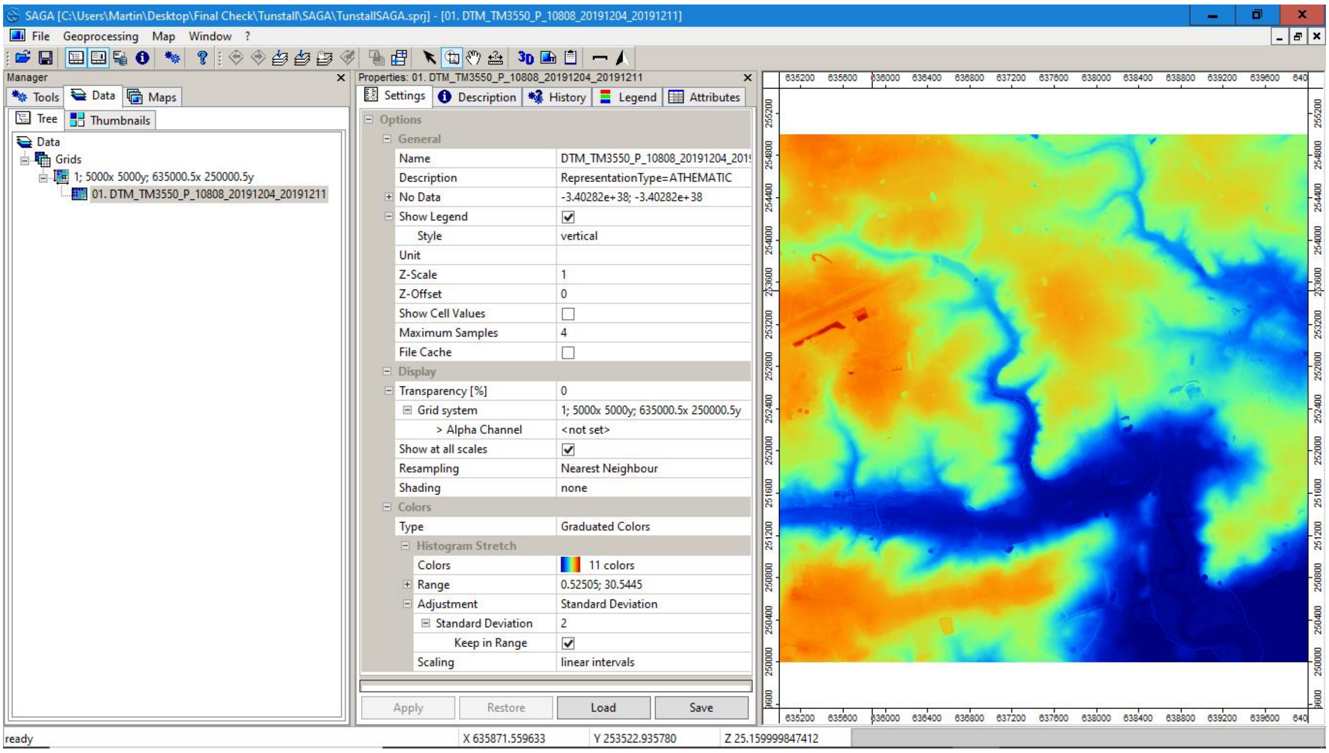
Chapter 3: An Introduction to SAGA-GIS for Orienteering Mappers

SAGA-GIS is the GIS application which I've been using since I started working with LiDAR. I'm not familiar with QGIS, which is, I think, a more widely used alternative, but I find SAGA-GIS does everything I need. Both are free, open source, applications.

If you are new to SAGA-GIS you may find it helpful to follow the procedures described in this chapter as an introduction. You will need to have one or more DTM LiDAR tiles downloaded into your LiDAR sub-folder ready to load into SAGA-GIS. The examples below use the three DTM tiles for Tunstall Forest, downloaded as described in Chapter 2.

Initially I found the scope of SAGA-GIS a little off-putting. It's capable of doing a vast amount more than orienteering mappers require. But I've now developed a set of routines in SAGA-GIS for processing LiDAR data, and I also now use SAGA-GIS for merging, cropping and geo-referencing Ordnance Survey mapping and some aerial photography. There was a lot to learn initially, but now they've become familiar, the processes described here go quite quickly, and I'm very happy to recommend them.

To start SAGA-GIS open the file "saga_gui.exe" which is one of many files saved when you download the application here. I've created a shortcut to this file on my desktop for convenience. The screenshot below was taken after I'd started SAGA-GIS and loaded one of the three 5km National LiDAR Programme DTM tiles for Tunstall Forest.



Three windows are visible. On the left is the "Manager" window, although I usually have it set with "Data" and "Tree" selected as shown and will refer to it as the "Data" window.

You can load LiDAR data tiles using "File" / "Open" or by simply dragging and dropping your files into the Data window. For LiDAR tiles you only need to drag and drop the GeoTIFF "Image" file. SAGA-GIS automatically reads the associated TFW file, provided it's in the same folder.

The data window above displays two lines, under the heading "Grids", for the 5km LiDAR tile I've loaded. First is the "Grid System", in this case "1; 5000x 5000y; 635000.5x 250000.5y". These figures indicate:

• "1"	the size of each cell in metres
• "5000x 5000y"	the number of columns and rows in the tile (5000 for a 5km tile).
• "635000.5x 250000.5y"	the 12 figure (1 metre) grid reference of the SW corner of the tile.

The grid reference given is not of the actual SW corner of the tile. It's the centre of the SW-most 1m cell – so 0.5m in from the corner. SAGA-GIS generally references tiles this way.

The second line in the data window just gives the filename of the tile I've downloaded from the DEFRA LiDAR download site. It's identified as "TM3550" which is the SW-most 1km grid square of the 5km tile "TM35SE". The remaining figures in the filename identify the survey date. And the initial "01" is added by SAGA-GIS to indicate that this is the first tile created under this Grid System. Individual data tiles are normally referred to in SAGA-GIS as a "Grid", though I'll continue to use "tile".

The central window in the SAGA-GIS screen displays the "Properties" of the selected tile. Select the properties with a single click on the tile name in the Data window. (A double click may sometimes be necessary). I've left these set to their default values for now.

The right hand "Map" window displays the current image. If this is not visible, double click the relevant tile name in the Data window and select "New" if prompted. The icons in the right hand section of the top tool bar enable the actions of panning, zooming and reverting to full extent in the Map window. The axes of the map window depend on the Grid System. Here they display the OS 12 figure (1 metre) grid reference. The exact X, Y coordinates of your cursor position are given in the bottom bar, as is a "Z" value, which in this case – a DTM tile - measures altitude.

SAGA-GIS may open with other windows visible, for example the "Data Source" window and the "Messages" window. For clarity, I've closed these using icons in the left hand section of the top tool bar. The bottom right-hand section of the screen displays a green progress bar when work is in progress.

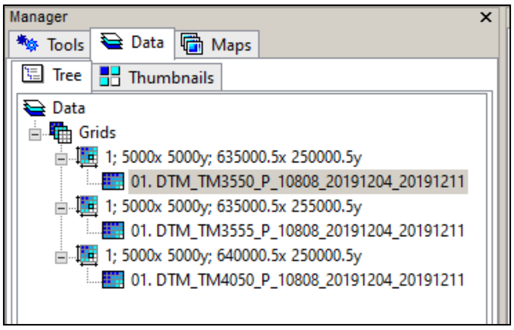
SAGA-GIS has several hundred tools for processing data of which I've so far only used a handful. In this introduction I will describe how to use the "Mosaicking" tool to merge and crop tiles. I will also give an example of how to alter the display parameters of the resulting tile in the Properties window. The remaining chapters then describe how to produce the range of different templates that I use to create base maps in OOM.

<u>Merging and Cropping Tiles in SAGA-GIS</u>

I'll assume here that you have already recorded the co-ordinates of the SW and NE corners of your bounding rectangle as described in Chapter 1. For my Tunstall Forest footprint these co-ordinates are 638000, 253500 and 640300, 256200.

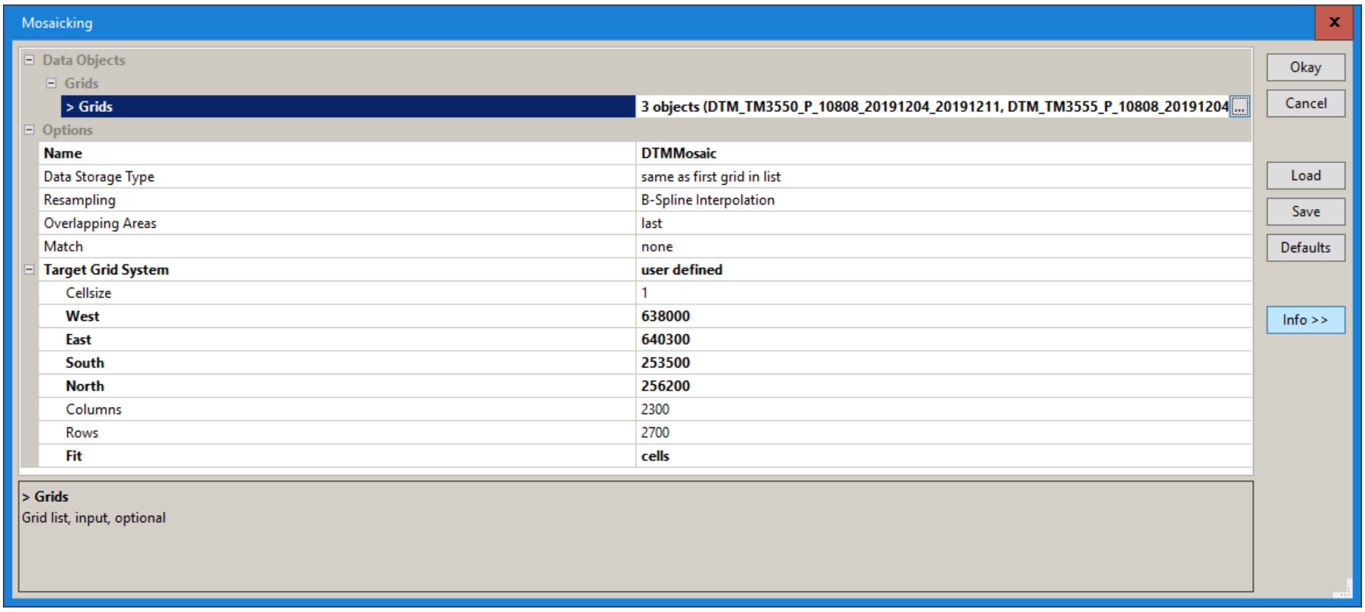
If more than one 5km LiDAR tile is required to cover your map footprint, as at Tunstall Forest, you first need to merge the tiles using the SAGA-GIS "Mosaicking" tool which merges two or more tiles and also crops the merged image to your bounding rectangle. If you only need one 5km tile, you can also crop this to your bounding rectangle using the "Mosaicking" tool. SAGA-GIS has a specific tool for just cropping tiles called "Clip Grids", which I describe later in Chapter 9, but for LiDAR tiles I find it simpler to use the "Mosaicking" tool for all merging and cropping duties.

For Tunstall Forest, I must first drag and drop my remaining two DTM tiles into the SAGA-GIS data window. Each will be displayed with its own grid system as in the screen extract opposite.



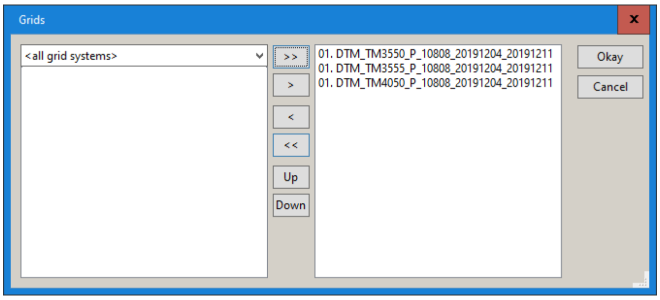
SAGA-GIS tools can be selected by clicking the "Tools" button in the Data window, in which case the tool's parameters are displayed in the Properties window. But this is not very helpful unless you know where the tool is located among the hundreds of tools in the SAGA-GIS filing system.

I generally use the “Find and Run Tool” icon on the top toolbar (the cogs). Click this and you can then enter a few initial letters of the tool you want (eg “mos” for “mosaicking”) and choose the correct tool from a drop-down list. In this case the tool’s parameters are displayed in a separate window. This is how I’ve displayed the tool screenshots in the remainder of this guidance. The mosaicking tool is shown below.



It’s worth noting here that entering parameters in SAGA-GIS is always done either by typing text (always keying Enter to finish), by selecting from a drop-down list, or by clicking an ellipsis (…) which opens another data-entry window.

For all tools you first need to confirm the tiles (or “Grids”) that you want the tool to operate on, in this case by clicking the ellipsis (…) in the “Grids” line. This displays a new dialogue box as shown opposite. I’ve moved the tiles I want – all three in this case - over to the right hand window. Clicking “Okay” loads the three tiles into the “Grids” line as shown above.



I then set “Target Grid System” to “user defined” and “Fit” to “cells”. I can then enter the bounding coordinates of the Tunstall Forest footprint as shown above. I also named the new merged tile “DTMMosaic”. I’ve left the other parameters set at their default values.

Click “Okay” (twice if necessary) and the mosaicking tool will merge the three tiles and crop to the defined footprint in one go. A new Grid System with the DTMMosaic tile will appear in the Data window.

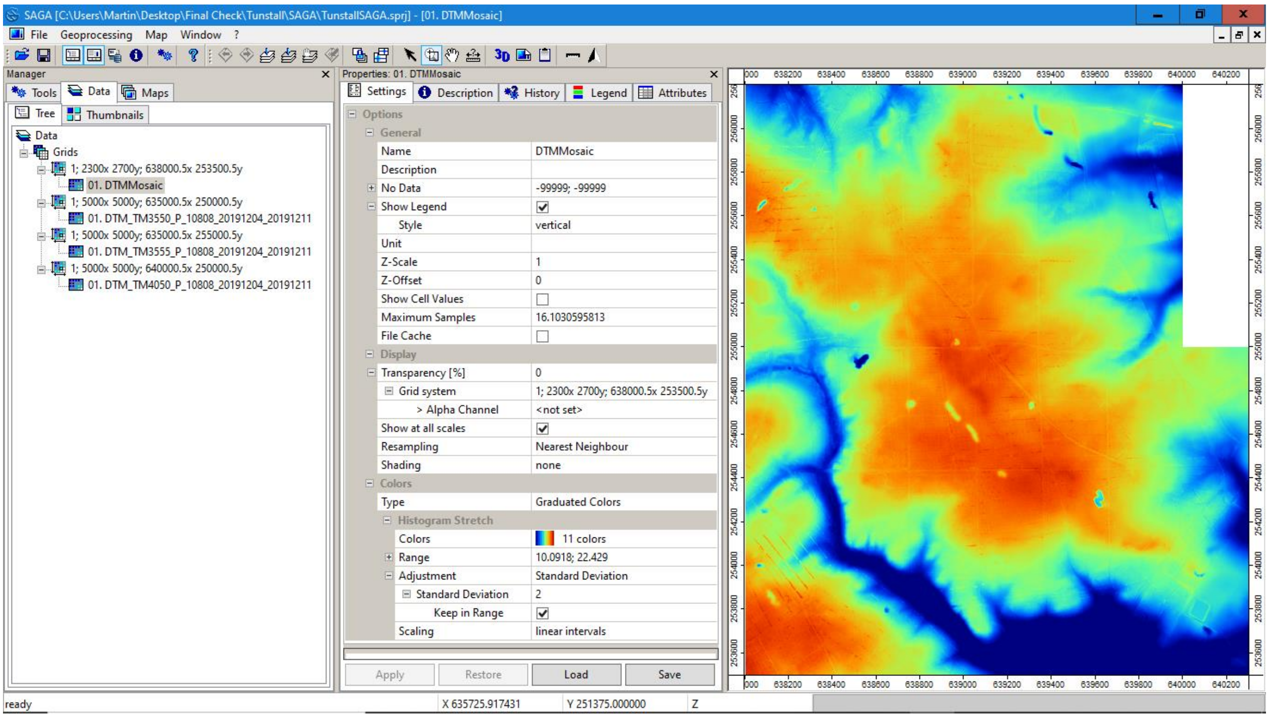
Setting “Fit” to “cells” allows you to use whole number corner coordinates to define your cropped footprint as in the screenshot. The new Grid System is automatically defined in the Data window by the coordinates of the centre of its SW-most cell, in this case 638000.5 and 253500.5.

Having completed this task it’s worth saving your project. When working in SAGA-GIS I regularly save using “File” / “Project” / “Save Project As” the first time, and just “Save” thereafter. Tick “Save All” if an additional window requesting this appears before saving. You need to save in a dedicated folder for this SAGA-GIS project as lots of files are saved. I usually save in a “SAGA” sub-folder in my project folder for the current map. I made the mistake once of saving a SAGA-GIS project straight to my desktop and filled the whole desktop with SAGA-GIS file icons!

You can then close SAGA-GIS if you need to and re-open it in the same state later. The saved project should appear in a list of options when you re-open SAGA-GIS next time, or you can use “File” / “Project” / “Load Project”. The original downloaded tiles may not be saved when you save a project, but any processed tiles will be. It’s particular important to keep your work saved because I’ve found that SAGA-

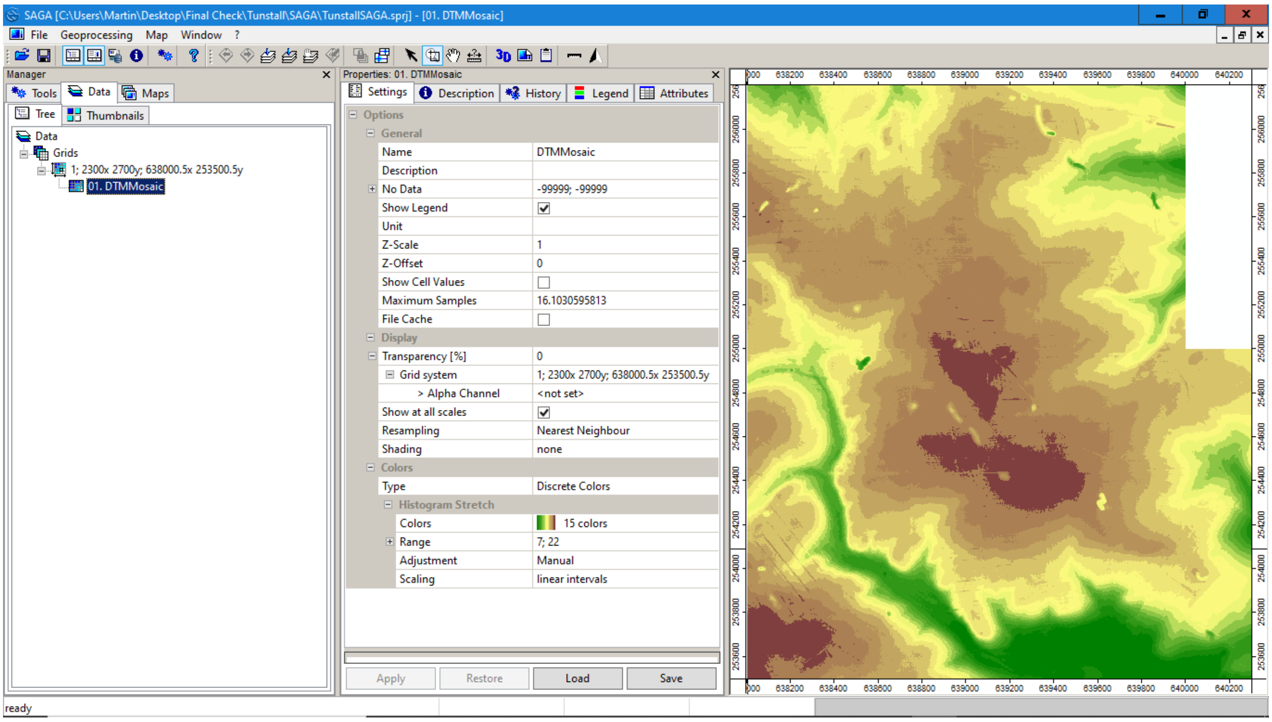
GIS will occasionally respond to a command it can't execute by closing down automatically rather than displaying an error message.

The next screenshot shows the DTMMosaic tile for Tunstall Forest in the Map window. This is displayed by double clicking DTMMosaic in the Data window and selecting "New" in the next dialogue box if requested. I've left all the parameters in the Properties window set at their default values for now. The cut-out on the right side of the map is part of a fourth 5km LiDAR tile. Although my bounding rectangle overlaps this tile the actual map doesn't, so I didn't bother to download this tile from the DEFRA site.

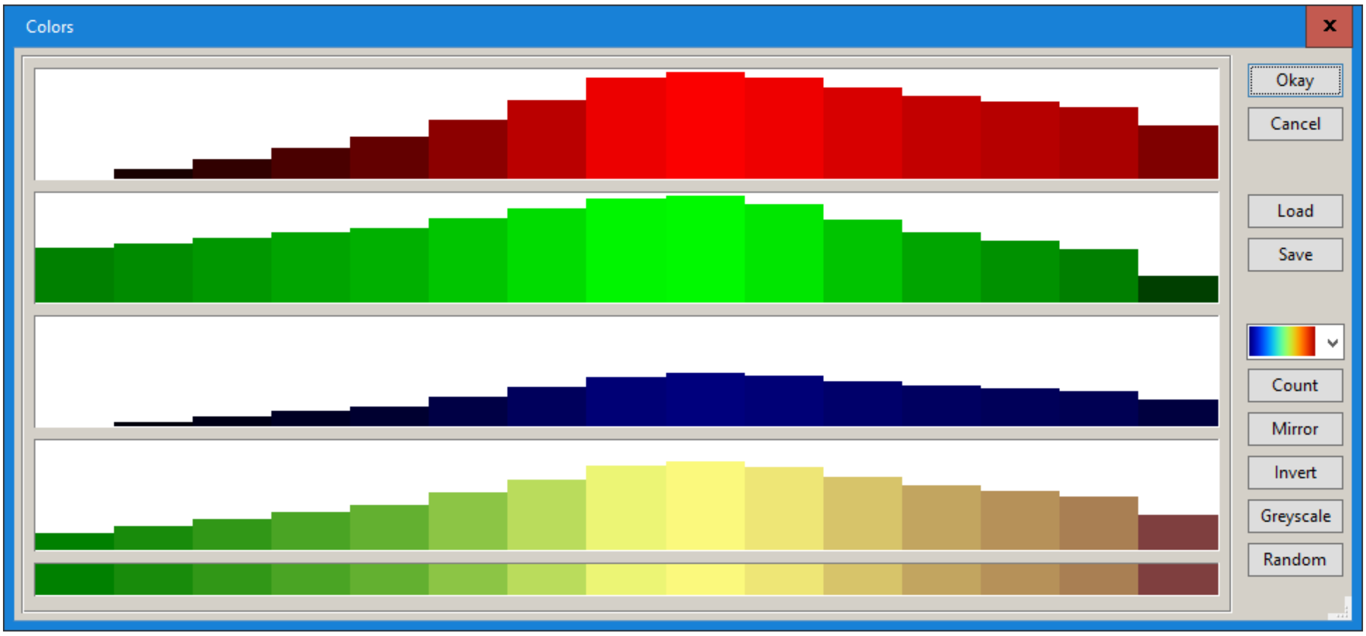


Creating a template

The next process described in this introduction is adjusting the parameters in the Properties window to "improve" an image before saving it as a template. The following screenshot shows the cropped Tunstall footprint after the adjustment. This image shows the relief in more familiar colours with discrete boundaries corresponding, in this case, to a contour interval of 1m.



To obtain this image I've made the following adjustments in the "Colors" section of the Properties window (forgive the American spellings). I've set the "Type" to "Discrete Colors". I've then adjusted the "Range", which originally showed the minimum and maximum altitudes recorded in this tile, so that both values are now round numbers. I've then chosen the actual colours by clicking the ellipsis (…) in the "Colors" line which opens the following window.



In this window I've set "Count" = 15 to display colours at 1m intervals and fill my "Range". 1m is arbitrary but it's best to choose a number that divides exactly into the final contour interval – 5m in this case – and gives a "Count" less than 20. I've chosen the green / yellow / brown colourway from the rainbow dropdown which gives a familiar green = low, brown = high relief map. (It's the 11th option up from the bottom of the palette). I then clicked "Okay". It's best to select the colourway after selecting the "Count".

To save changes in the Properties window you must first key "Enter" after the last change, then click "Apply" at the bottom of the Properties Window. If your changes don't display in the Map window just double click the relevant tile in the Data Window and select "New".

<u>Saving your Template</u>

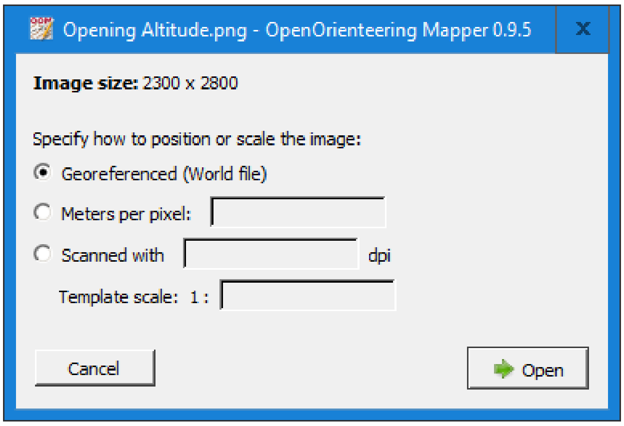
I prefer to keep all my finished templates in a dedicated "Templates" sub-folder in the project folder for my map. To save this image as a template, right click "DTMMosaic" in the Data window and click "Save as Image" to save in your templates folder. I save this template in .png format, with the filename "Altitude". In the next dialogue window tick to save the "Georeference" but not the "Legend". This will create a small .pgw file with the geo-referencing information which must be kept with the .png file.

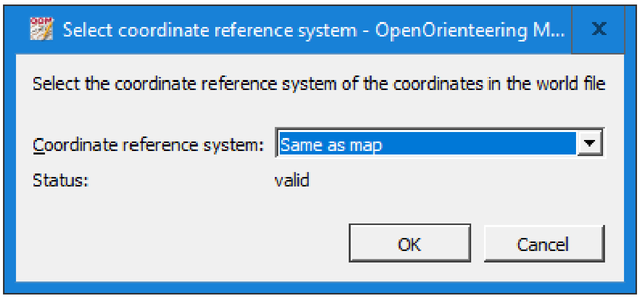
Creating a coloured relief template like this makes a good introduction to the basic processes for handling LiDAR data in SAGA-GIS. However, it's not a particularly useful template in practice. I've sometimes found it useful in complex contour areas to confirm what's "up" and what's "down". But for most relief features I rely on contour, hillshade and slope gradient templates as described in the next chapters. I also describe there how to "smooth" the excessively jagged edges evident in this image.

<u>Opening your template in OOM.</u>

I've assumed here that you have followed the procedure described in Chapter 1 and already have your new geo-referenced map prepared. The notes and screenshots below assume that you've used Method 2 to set a false "declination" so that the map's grid aligns to OS grid north. If you've chosen Method 1 the templates will open skewed on the screen, but they are still perfectly useable.

To open a template you now need to select “Templates” / “Open Template” from the OOM tool bar, navigate to your templates folder and open the “Altitude” .png file. OOM will automatically read the geo-referencing information from the associated .pgw file. The following dialogue windows will display. The first should open with “Geo-referenced (World file)” pre-selected. Just click “Open”. The second should confirm that the coordinate reference system of your template is the same as your map. Just click “OK”.



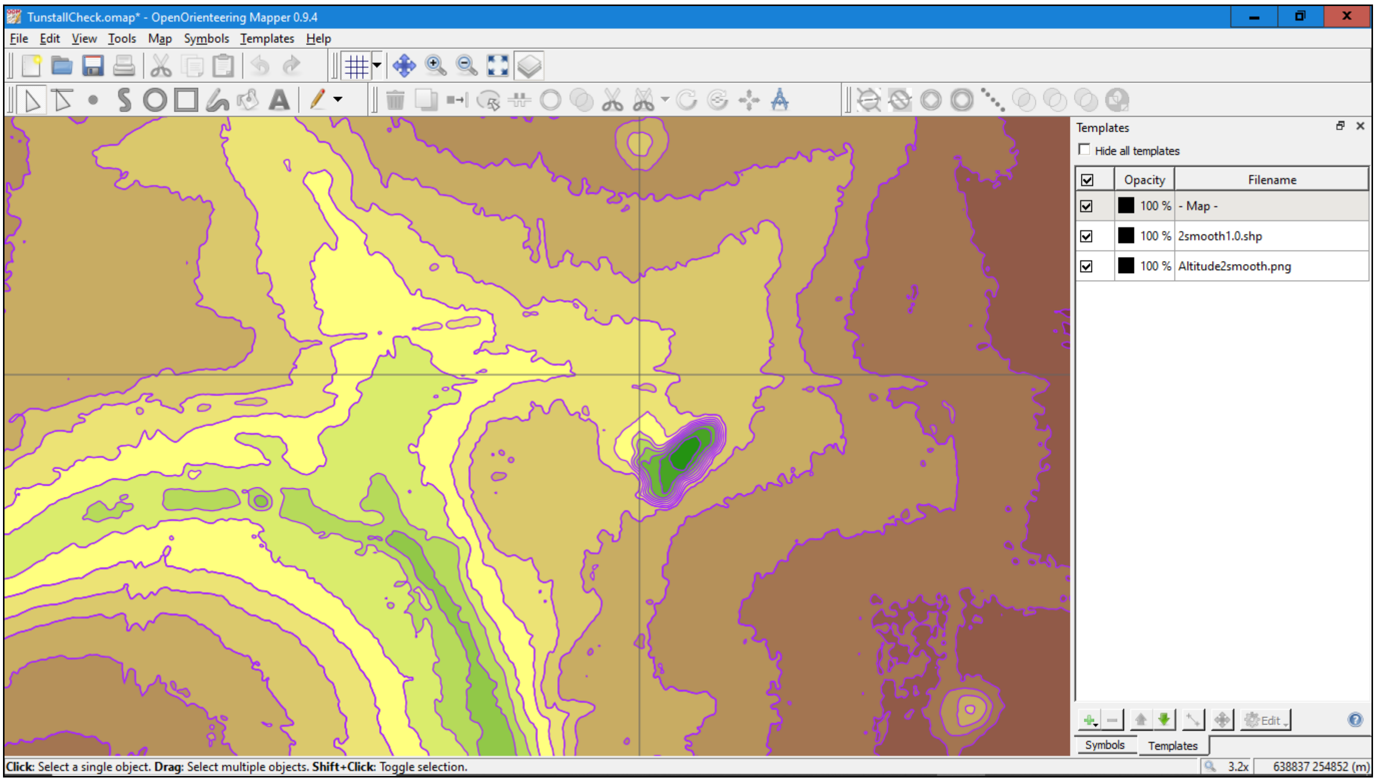


The template should now appear, in the correct location and correctly aligned. It will also be listed in the OOM template setup window.

The template should open with the SW corner of your bounding rectangle centre screen. Just click the “Show whole map” icon in the top tool bar to bring the full template centre screen.

The following screenshot illustrates the result in OOM. This actually shows a slightly “smoothed” altitude template layered underneath a similarly smoothed contour template with the same vertical interval (1m in this case). In the next chapter I describe how to produce smoothed templates and contour templates from DTM data in SAGA-GIS.

I’ve zoomed in to show detail in one of the more interesting parts of the map. Less interesting than it looks though. These are 1m contours. Apart from a few large pits, Tunstall is actually pretty flat!



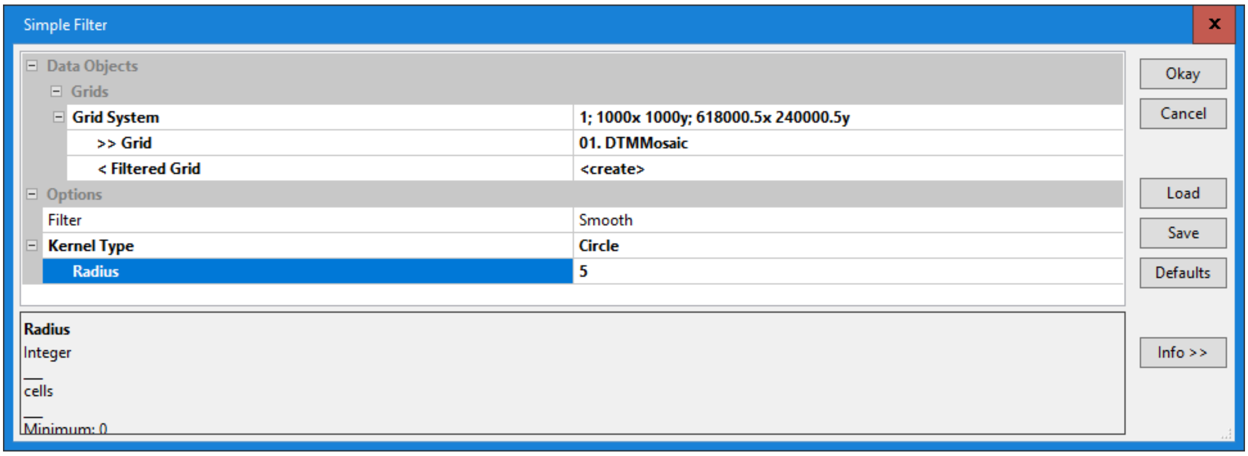
Chapter 4: Obtaining Contours from LiDAR

I've used Bridge Wood to illustrate this chapter as it is a much hillier area than Tunstall Forest. Bridge Wood requires only one 5km DTM LiDAR tile. No merging of tiles is required but I used the mosaicking tool in SAGA-GIS to crop the 5km tile to match the Bridge Wood footprint. This coincides with the 1km OS grid square TM1840. The SW and NE coordinates are 618000, 240000 and 619000, 241000.

I first create contour lines at the final contour interval for the map – normally 5m or 2.5m. Some mappers prefer to use these as a template to trace over, but I prefer to import these directly into OOM. I then produce contour templates at smaller vertical intervals which act as a guide to make fine adjustments to the imported contours and add form lines where appropriate to highlight useful detail. Smaller interval contour templates can also pick out accurately the positions of features such as small pits and knolls.

Contours can be created in SAGA-GIS straight from a DTM LiDAR tile, but these tend to be rather jagged with a lot of "noisy" detail which is not evident on the ground. For better results I first apply some "smoothing" in SAGA-GIS using the "Simple Filter" tool.

Confusingly, there are two "Simple Filter" tools in the SAGA-GIS toolkit. The correct one is has the parameter options as set out in the next screenshot. The incorrect one has an extra line.



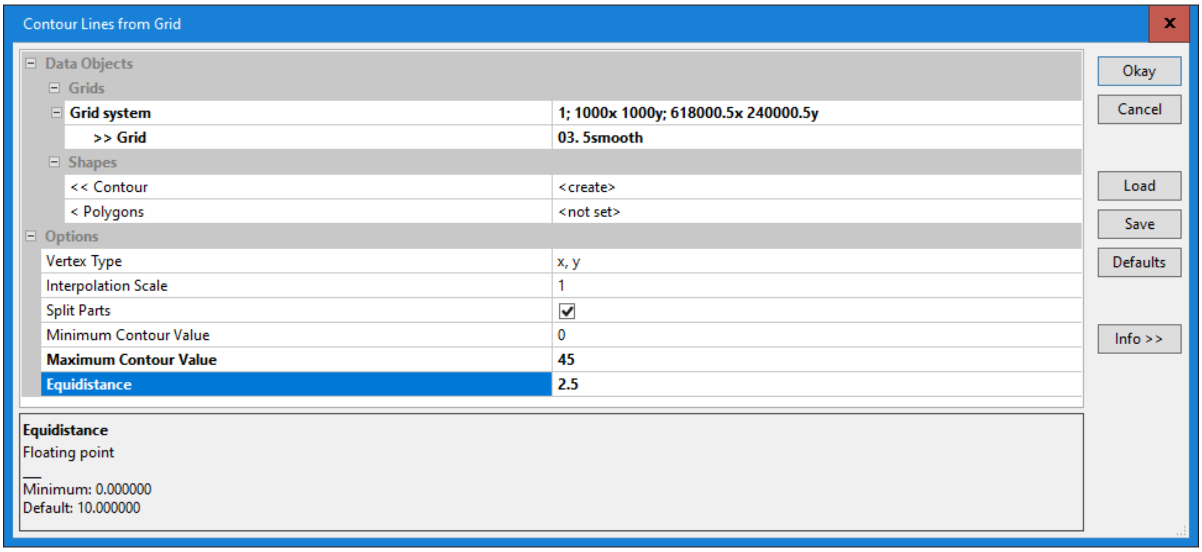
The screenshot shows the Grid System and Grid (the DTM tile) already set. I'm using here a cropped "DTMMosaic" tile that I've created for Bridge Wood as in Chapter 3. "Filtered Grid" is set to "create" – this is important. "Filter" and "Kernel Type are set to their default values. The key setting is "Radius".

To produce smoothed contours for direct import into OOM I've set the radius to 5. The contours then normally require little further smoothing in OOM. Some undoing of the smoothing may be needed to match detail that has been smoothed out in areas with complex contour detail, but I find this easier than starting with too little smoothing and having to adjust the contours to impose it across the entire map in OOM. You may want to experiment with different smoothing levels to achieve a result that works best for you. I've used radius 10 in the past, but now normally prefer 5. 10 may work better for less hilly areas.

For contour templates at smaller intervals I normally process the DTMMosaic tile a second time with the radius set at 2. This reduces the jaggedness without smoothing out useful detail. Don't forget to set "Filtered Grid" to "create". Otherwise SAGA-GIS will overwrite the previous tile. You may prefer to use 1 as this second radius value, or just stick with the unsmoothed tile to create contour templates.

With the parameters set, click "Okay" to generate a new tile in the Data window also called "DTMMosaic" (with a new serial number). I rename these in the Properties window as "5smooth" or "2smooth".

The contour lines themselves are created using the "Contour Lines from Grid" tool. The next screenshot shows the parameters set to produce contours from the "5smooth" tile to import directly into OOM at a final 2.5m interval. I've set the interval (or "equidistance") to 2.5m and expanded the minimum and maximum values as necessary to fit this interval. "Contour" is set to "create".



Contour tiles are vector files (“shapefiles”) rather than raster (pixel) images. Click “Okay” and a new shapefile will appear in the Data window under the sub-heading “Shapes”. If you double click this to view the contours in the map window the contours may be an odd colour but you can ignore this.

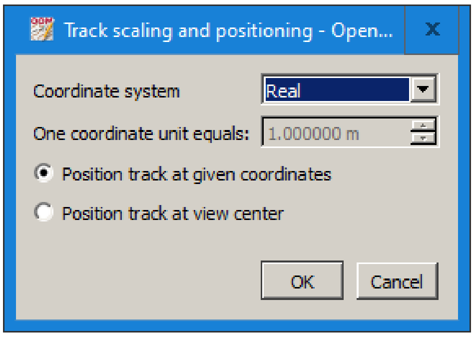
As a check, you can create a coloured relief map from the “5smooth” tile as in the previous chapter. You can then show the contour lines superimposed over this by selecting “5smooth” instead of “New” when you double click the new shapefile.

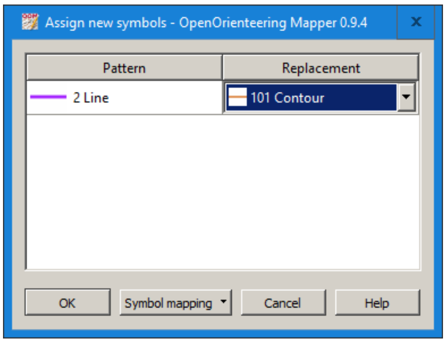
I then repeat the process to produce one or more reduced interval contour templates, this time from the “2smooth” tile. Remember to set “Contour” to “create” in the tool parameter window to avoid overwriting the previous contours. I usually produce a template at one fifth the final interval: 0.5m in this case.

To save a shapefile right click on it in the Data window and “Save as” (rather than “Save as Image”) in your templates folder for the project. I name the files eg “5smooth2.5m”, “2smooth0.5m”. Several files are saved each time. The .shp file holds the data but the other files must also be kept in the folder..

Loading the contours in OOM

The smoothed contours at the final contour interval can now be imported directly into the geo-referenced OOM map. I find this best to do before drawing other features on the map. In OOM I select “File / Import” and navigate to and open the .shp file which I had named “5smooth2.5m”. I then just click “OK” in the next window if it appears, and select the contour symbol in the second window as shown below. Click “No” when then asked if you want to save the cross reference table.





The imported contours should then appear as map objects, correctly positioned. They should all be selected, but if not you can easily select them all in the normal way, especially if nothing else has been drawn on the map. I then use OOM’s “convert to curves” tool followed by the “simplify path” tool to simplify the contour lines – this doesn’t significantly displace them, but it makes them less memory-intensive and much easier to edit. “Convert to curves” can take a few minutes for a large map footprint.

You can then change every fifth contour to an index contour. It's possible to automate this, but we have relatively few contours on most SUFFOC maps so I find it's easier to do it by hand.

The full process is not especially quick, but it's a lot quicker than manually drawing the contours by tracing over templates.

The contours generated at smaller vertical intervals are not needed on the map itself but can be opened instead as templates. Shapefiles can be opened as templates in a similar way to image files. Select "Templates" / "Open Template", and navigate to and open the correct .shp file. Just click "OK" if you see a dialogue window with "Position Track at given coordinates". The contour template should open with purple contour lines, correctly aligned, which you may need to zoom in to see.

You can now overlay the map layer, which contains the draft final ("5smooth") contours, over the "2smooth" contour template with reduced contour intervals and compare the two. You can edit the map contours where, for example, the smoothing process has smoothed out useful contour detail. Regardless of smoothing, 5m or 2.5m interval contours may miss features which smaller interval contours will display. Using the template as a guide you can "nudge" a contour line a little or add a form line to better display this detail.

"Micro-interval" contour templates - an optional extra

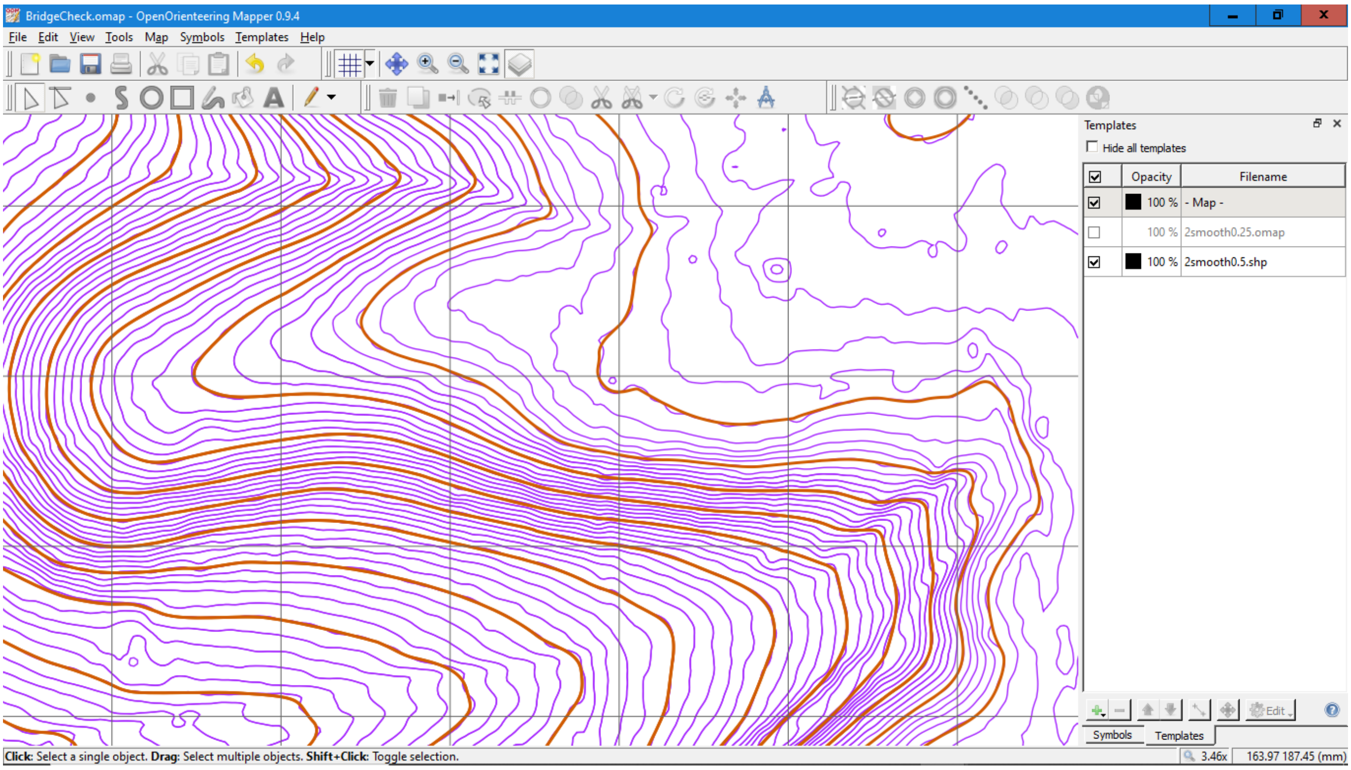
SAGA-GIS will produce contours from a DTM LiDAR tile at any vertical interval you specify. I was initially wary of trusting LiDAR-based contour templates with a sub-0.5m vertical interval, and I didn't bother with them. Intuitively, it didn't seem possible that data sampled at 1m horizontal resolution could produce meaningful contours at such small vertical intervals. However, having now checked in a variety of locations against actual terrain in the field, I do think these "micro-interval" contour templates have value, particularly in identifying the location of pits, knolls, small re-entrants and spurs. Many such features will not be prominent enough to appear on the final map without over-cluttering it, and sometimes LiDAR will introduce misleading artefacts. But, in complex areas, I'm finding that having everything laid out in a remarkably accurate high resolution contour map is a good start from which I can then interpret in the field and generalise for the final map.

So for a 1:10,000 map at 5m final contour interval I now produce an additional template from the "2smooth" tile with a 0.2m vertical interval to complement the one at 1m interval. For a 1:4,000 scale sprint map with a 2.5m final contour interval I produce an extra template at 0.25m, or even 0.1m, vertical interval. Note that SAGA-GIS may take several minutes to process these, depending on your computer speed.

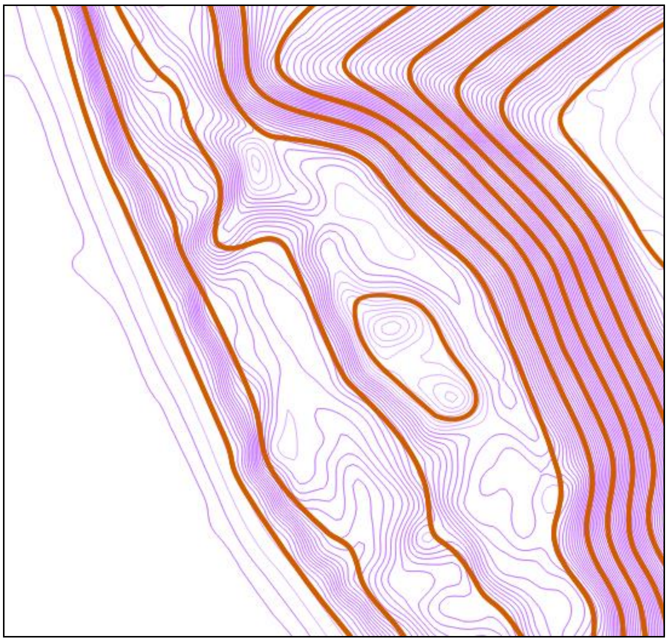
For these micro-interval contour templates, just opening the .shp file as a template in OOM results in lines that are too thick and merge into solid purple on steep terrain. To solve this I create a new OOM map file with the same scale and symbol set, geo-reference it to the same co-ordinates, and *import* the .shp file into this new map, as described above for the smoothed contours. This time I import the contours as the new purple line symbol ("2 Line") without replacement. Once the import is finished I edit the new line symbol (right click the new icon in the Symbols window) to give it narrower line width (0.02mm). The imported contours then disappear, but will re-appear if you zoom in. I then save the new OOM file in my templates sub-folder as eg. "2smooth0.2m". This will normally be a large file.

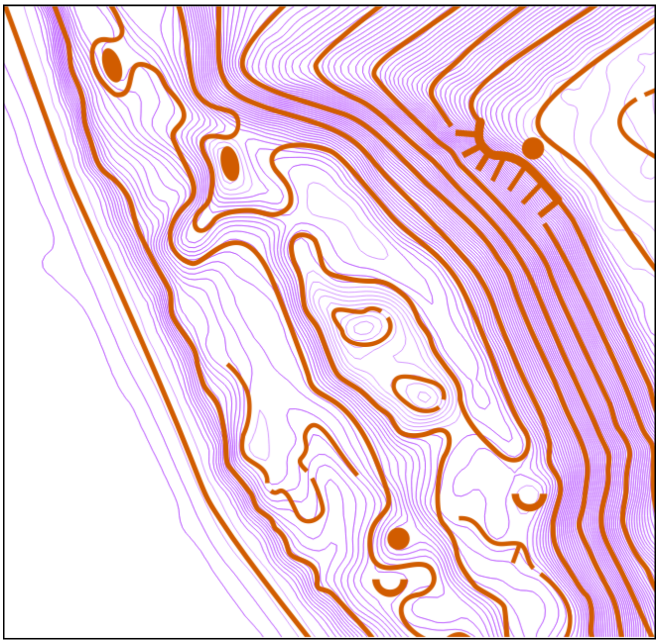
You can then open this OOM file *as a template* in the main map using "Templates"/"Open Template". It will open, correctly geo-referenced, with thin contours which are visible when zoomed in.

The following screenshots show combinations of contours and contour templates to illustrate how the templates assist in creating the base map. The first shows the 2.5m map contours overlaying the 0.5m interval template. I've zoomed in to show detail. I wouldn't on this basis be making many changes to the map contours in this area. The smoothing looks about right. The template highlights a few "between contour" relief features that are worth highlighting on the base map for checking in the field.

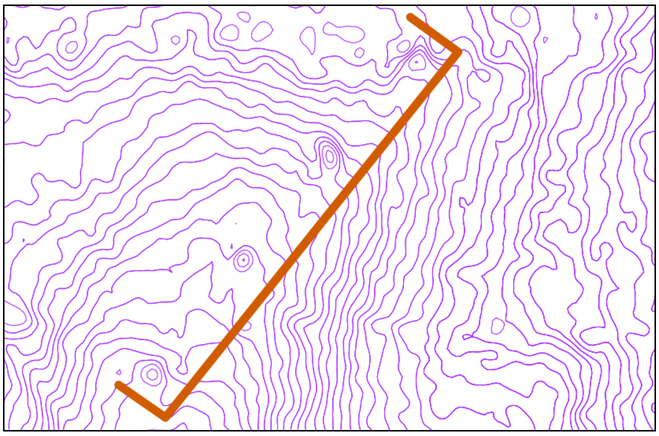


The second pair of screenshots show the map contours and a 0.25m interval template zoomed in to show the most complex part of the map. The left hand screenshot is as obtained from LiDAR. The right hand screenshot shows my attempt to interpret the terrain from the 0.25m interval template, and also benefits from a survey visit which confirmed that the 0.25m contours were remarkably accurate.





The last screenshot shows a small, pretty flat, section of Tunstall Forest where an extreme micro-contour template (0.1m interval) neatly picks out a line of 4 pits, probably left by bombs discarded from a war-time plane returning to Bentwaters airbase. We knew they were there from previous mapping, 15 years ago, but didn't have the positions quite right.



The four pits are clearly defined by several contours in each case. But a lot of the other contour detail apparently revealed here is either “noise” or features which, if they exist, are too small to be shown on a finished map at 1:10,000.

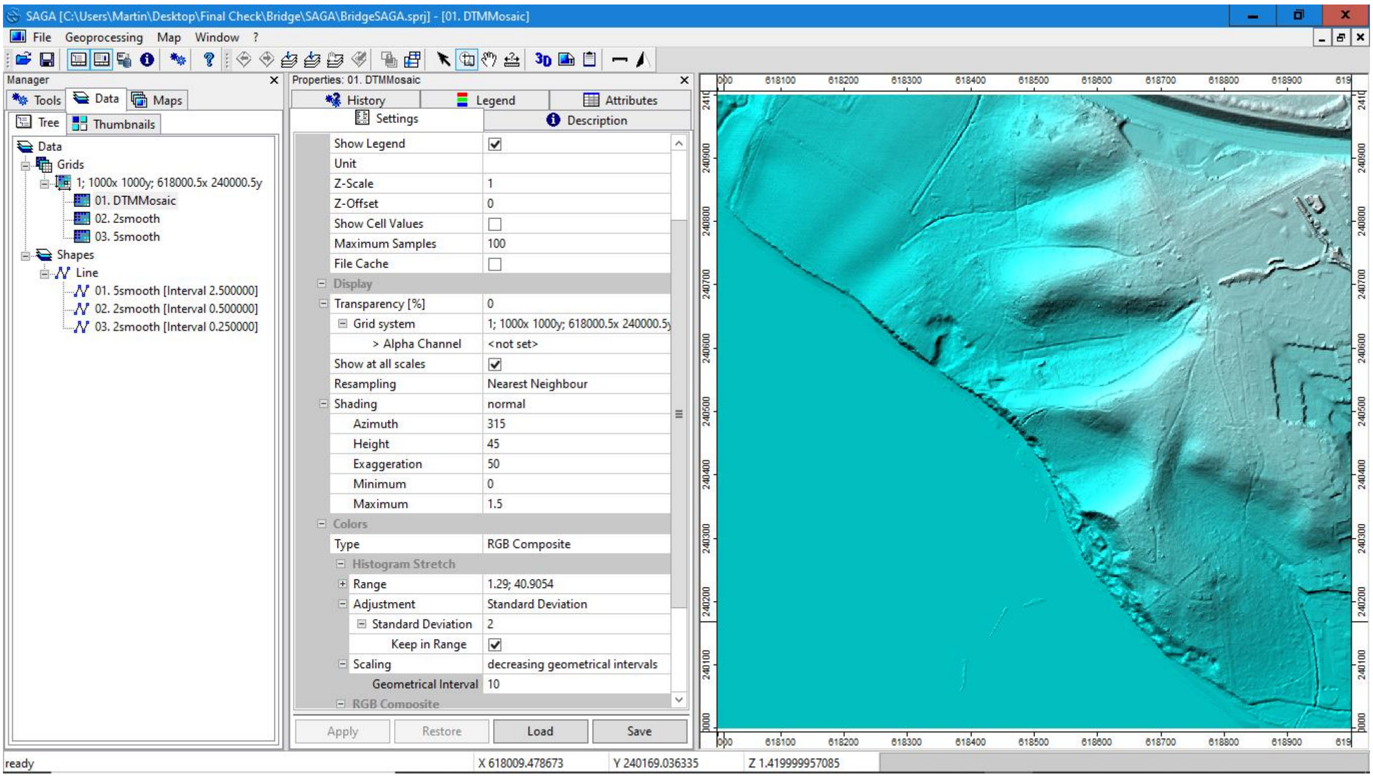
Chapter 5: Obtaining Hillshade and Slope-Gradient Templates from LiDAR

These two types of template are very useful for identifying line features such as ditches and earthbanks. They will also highlight footpaths where the line of the path is slightly raised or sunken compared to the surrounding terrain (which it often is). This is very useful in forested terrain where these features are invisible to aerial photography.

A hillshade template shows darker colours where the terrain is shaded from an imaginary light source. A slope-gradient template shows darker colours (or lighter – you can choose) where the gradient is steeper. They are produced using different methods but the results are quite similar. I generally prefer hillshade templates, and may ignore slope gradient templates which are more complicated to produce. But both can be useful.

Obtaining hillshade templates.

No new SAGA-GIS tool is required to produce simple hillshade templates, just some editing of the properties of the unsmoothed DTMMosaic template.



This screenshot shows the result at Bridge Wood after the appropriate parameters have been set and applied as shown in the Properties window. Some linear features, including paths, are clearly visible. Zooming in displays these more clearly.

The key changes in the Properties window are to “Shading”. Here I’ve set “Shading” to “normal” and Exaggeration = 50. I’ve found values between 30 and 150 work well. It’s a balance between under-shading small features such as ditches and earthbanks and over-shading hillsides. Higher values work best in flatter areas – Bridge Wood is quite hilly (for Suffolk!) and works best with Exaggeration set between 30 and 50. For Tunstall Forest I used 150.

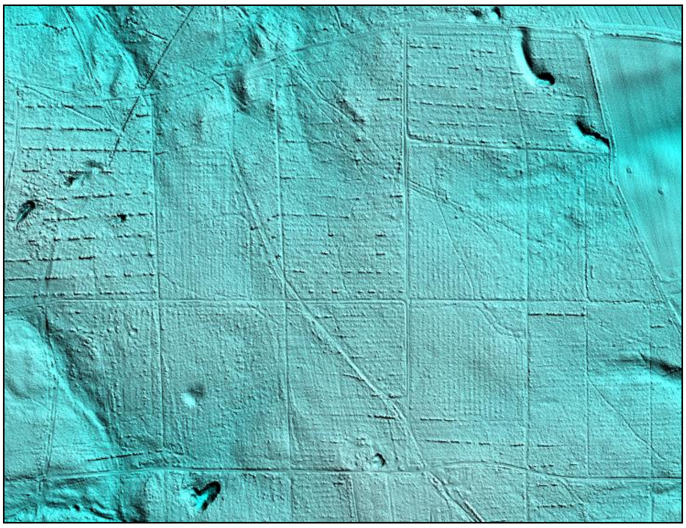
I’ve left “Height” and “Min.” and “Max.” unchanged here from their default values. (Height is the virtual sun’s altitude). It may be worth experimenting with altering the “Max” value a little.

I’ve kept “Azimuth” set at 315 for this template. Azimuth is the direction of the imaginary light source. (I’ll call it the sun!), NW in this case. I normally then repeat the process (quickly done) with Azimuth set at 45 (NE). I’ve also experimented with azimuths at 135 (SE) and 225 (SW). Each resulting template best highlights features running perpendicular to the sun's direction. Hillshade images with SE and SW azimuths display an optical illusion. Our brains are used to seeing images lit from above so in these templates ditches appear as earthbanks and knolls as pits (unless you turn your screen upside down!). But I still find these templates can pick out the line of some features more clearly.

In the above screenshot I've set Color "Type" to "RGB Composite". I've left "Range" as its default, but altered "Scaling" to "deceasing geometric intervals". This reduces the brightness on sun-facing slopes.

You can experiment with the settings to get the results you prefer. If you select "Single Symbol" as the "Type" you can adjust the colour. In "RGB composite" it defaults to cyan. You can set the "Type" to "discrete colors" and adjust the Value Range and the Color window to create a shaded version of the relief template described earlier. It looks very nice, and you might prefer it, but I prefer separate templates – a coloured relief template without shading, and two, or possibly four, cyan versions with shading at different azimuths.

This is now ready to be "Saved as Image" exactly as before. I name my templates "HillshadeNW" etc. For comparison, a section of a Tunstall Forest hillshade template is shown below. It shows the main path grid well, but also many smaller paths, ditches and earthbanks, including rootstock banks. Sometimes the best results can be obtained by overlaying a micro-contour template over this template in OOM.

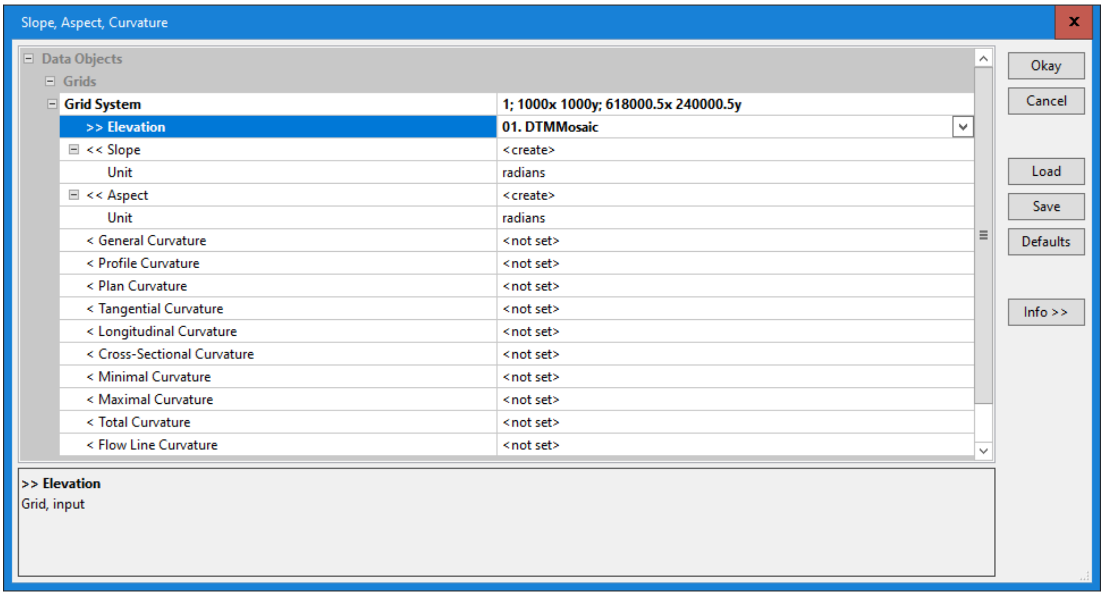


For increased control over look of hillshade templates you can use the SAGA-GIS "Analytical Hillshading" tool rather than the adjustments in the properties window described above. This offers an option to create a composite template from hillshade images with different azimuths. But generally I've not found it particularly useful to do this.

<u>Obtaining Slope Gradient Templates</u>

For a different view of relief features, slope gradient templates can be generated in SAGA-GIS from a DTM LiDAR tile using the "Slope, Aspect, Curvature" tool. These images show darker (or lighter) colouring where the slope is steeper, independent of the direction in which the slope is facing.

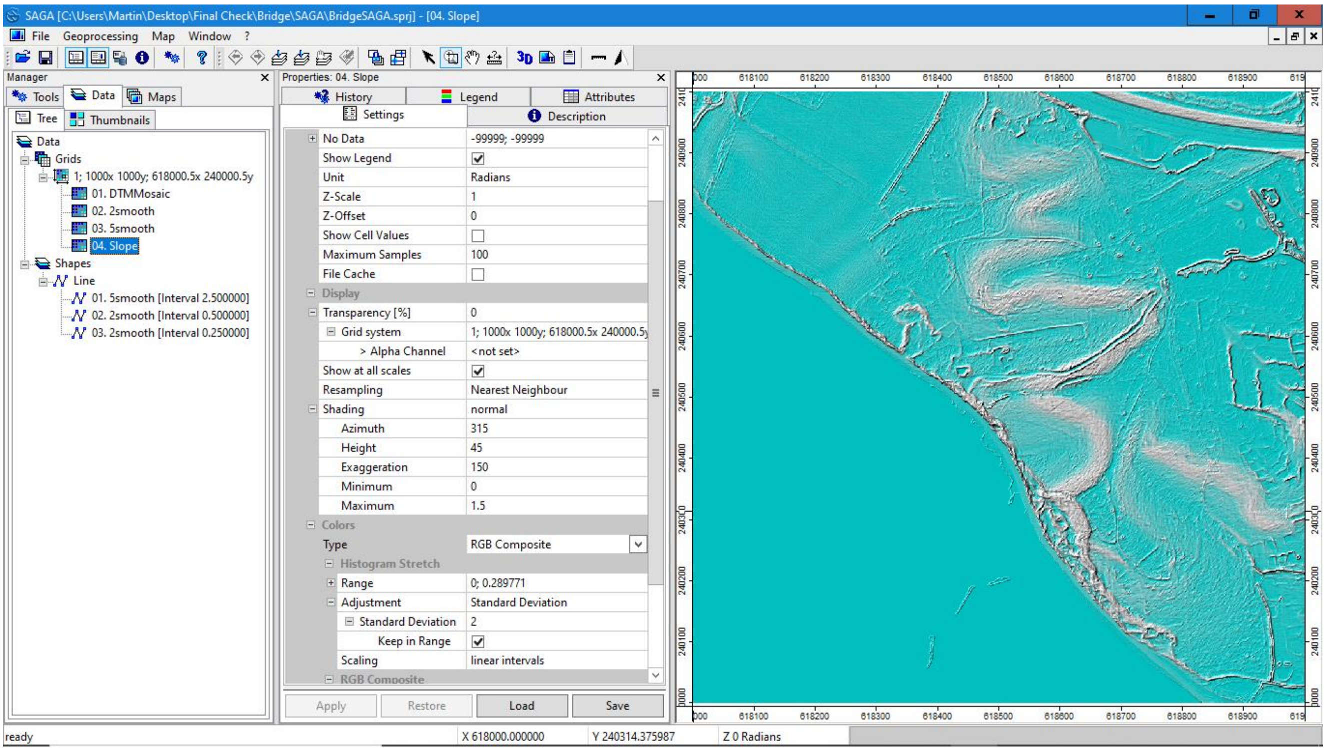
In the screenshot below, I've entered the Grid System and Grid – here called "Elevation" - as normal, and set "Slope" and "Aspect" to "create" to prevent overwriting any other tiles. I've left all the Curvature outputs as "not set".

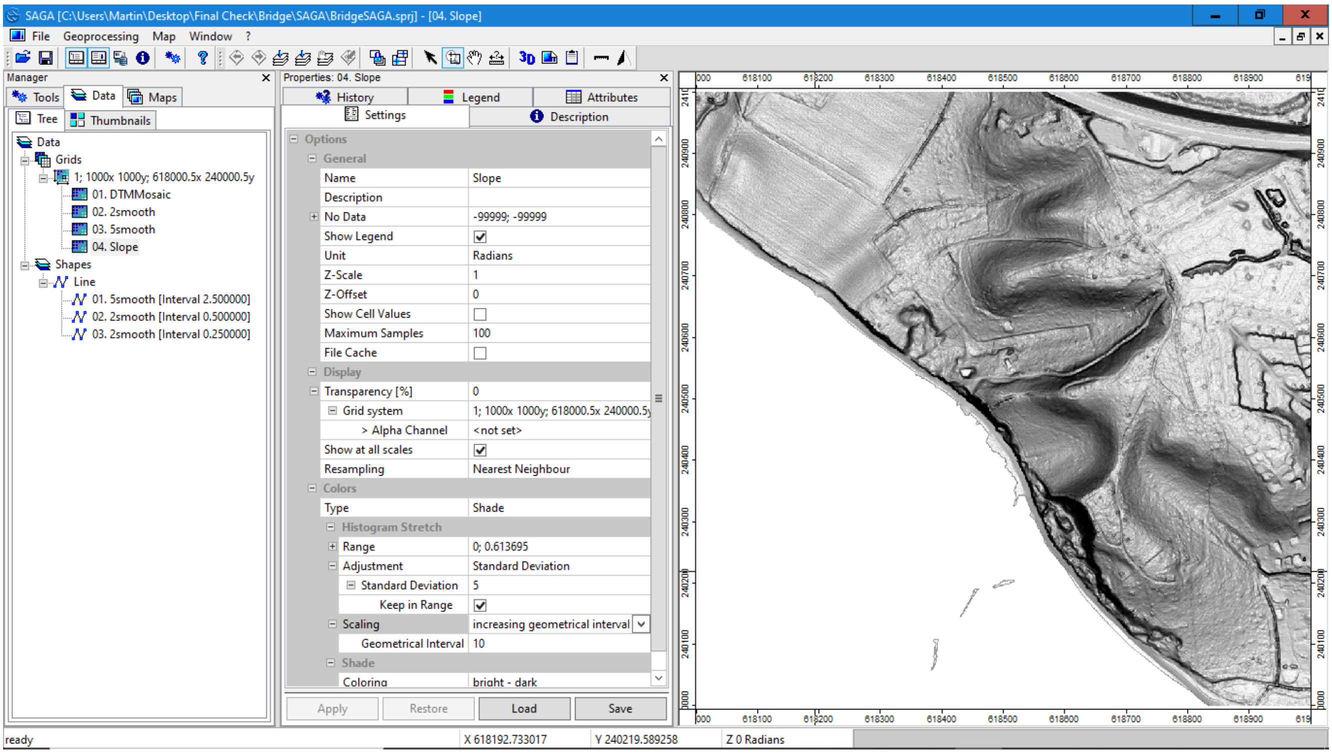


Click "Okay" to produce two new tiles named "Slope" and "Aspect". I've not found "Aspect" useful and normally delete this. "Slope" can be processed in different ways as shown in the next two screenshots.

In the first screenshot I've set the Properties similarly to the hillshade example above, with "Shading" set to normal. I've set "Exaggeration" = 150, "Type" to RGB Composite" and "Adjustment" as shown. In the second example I've set "Type" to "Shade" and "Coloring" to "bright – dark" and "Adjustment" and "Scaling" as shown which produces a greyscale image.

Both images highlight the paths and relief features. There is an almost infinite variety of images that could be produced by adjusting the various properties. Different sets of properties may work better for different map footprints, but I've tended to settle on one set, or ignore Slope Gradient altogether.



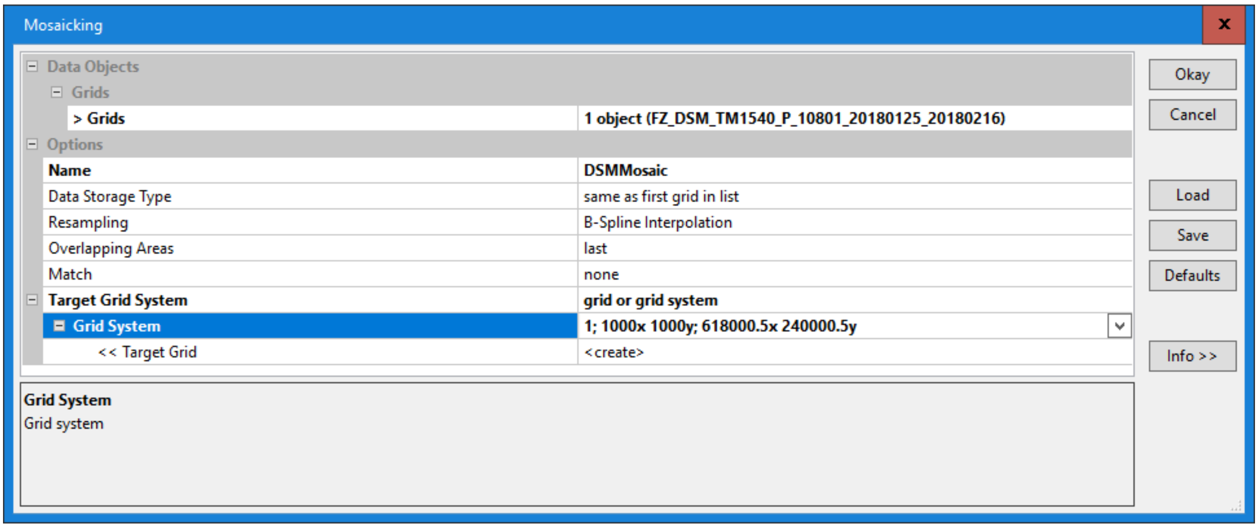

SAGA [C:\Users\Martin\Desktop\Final Check\Bridge\SAGA\BridgeSAGA.sprj] - [04. Slope]
File Geoprocessing Map Window ?
Manager
Tools Data Maps
Tree Thumbnails
Data
Grids
1; 1000x 1000y; 618000.5x 240000.5y
01. DTMMosaic
02. 2smooth
03. 5smooth
04. Slope
Shapes
Line
01. 5smooth [Interval 2.500000]
02. 2smooth [Interval 0.500000]
03. 2smooth [Interval 0.250000]
Properties: 04. Slope
History Legend Attributes
Settings Description
Options
General
Name Slope
Description
No Data -99999; -99999
Show Legend
Unit Radians
Z-Scale 1
Z-Offset 0
Show Cell Values
Maximum Samples 100
File Cache
Display
Transparency [%] 0
Grid system 1; 1000x 1000y; 618000.5x 240000.5y
> Alpha Channel <not set>
Show at all scales
Resampling Nearest Neighbour
Colors
Type Shade
Histogram Stretch
Range 0; 0.613695
Adjustment Standard Deviation
Standard Deviation 5
Keep in Range
Scaling increasing geometrical interval
Geometrical Interval 10
Shade
Coloring bright - dark
Apply Restore Load Save
ready
X 618192.733017
Y 240219.589258
Z 0 Radians

Chapter 6: Obtaining Vegetation Templates from LiDAR

We are currently fortunate in Suffolk in having up-to-date (2018 - 2020) LiDAR surveys available from the DEFRA National LiDAR Programme. Terrain (DTM) detail tends to change little over time and should remain substantially accurate for many years. Vegetation detail, however, changes markedly with the season and noticeably from year to year. But currently I'm finding the templates described in this section very useful – well worth the effort to produce them.

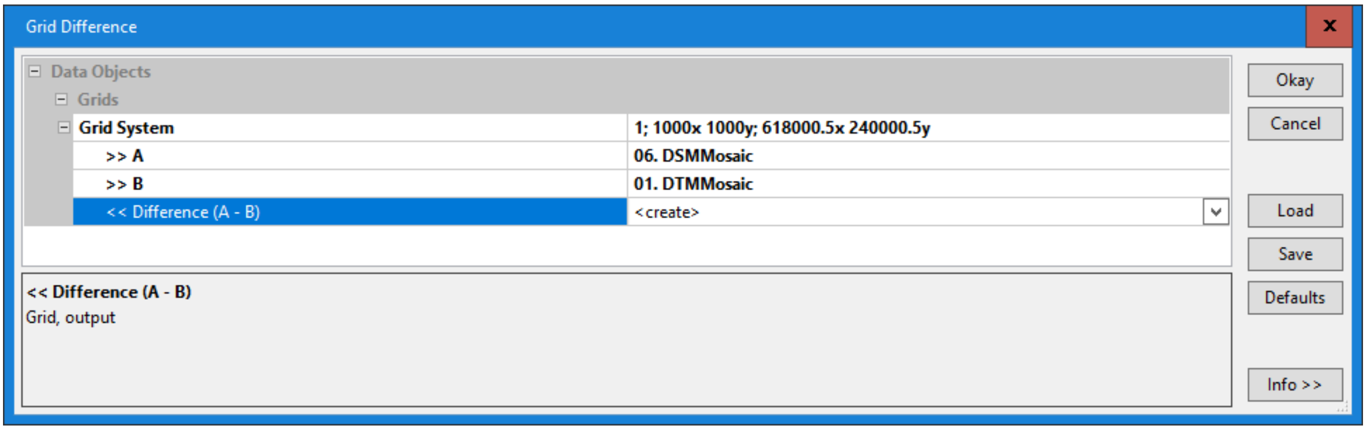
I normally download DSM and Intensity tiles from the DEFRA LiDAR site with my DTM tiles. I can then either merge and crop all three datasets in SAGA-GIS at the same time, or leave the DSM and Intensity tiles to later as I've done here. All three datasets must end up listed under the same Grid System.

For vegetation height templates I use the National LiDAR Programme First Return DSM dataset. The screenshot below shows the Mosaicking tool with this tile for Bridge Wood selected as the input "Grid". As I've already cropped my DTM tile to fit my Bridge Wood map footprint I can just enter "grid or grid system" as my target and select the correct grid system. I don't need to enter the coordinates again. I've named the new cropped tile DSMMosaic. "Target Grid" must be set to "create" as shown.



After merging and cropping, the new tile needs to be "normalised" to show tree height above ground rather than above sea level. This is the difference between the DSM and DTM values for each corresponding cell in the Grid System.

You can normalise DSM data in SAGA-GIS using the "Grid Difference" tool.

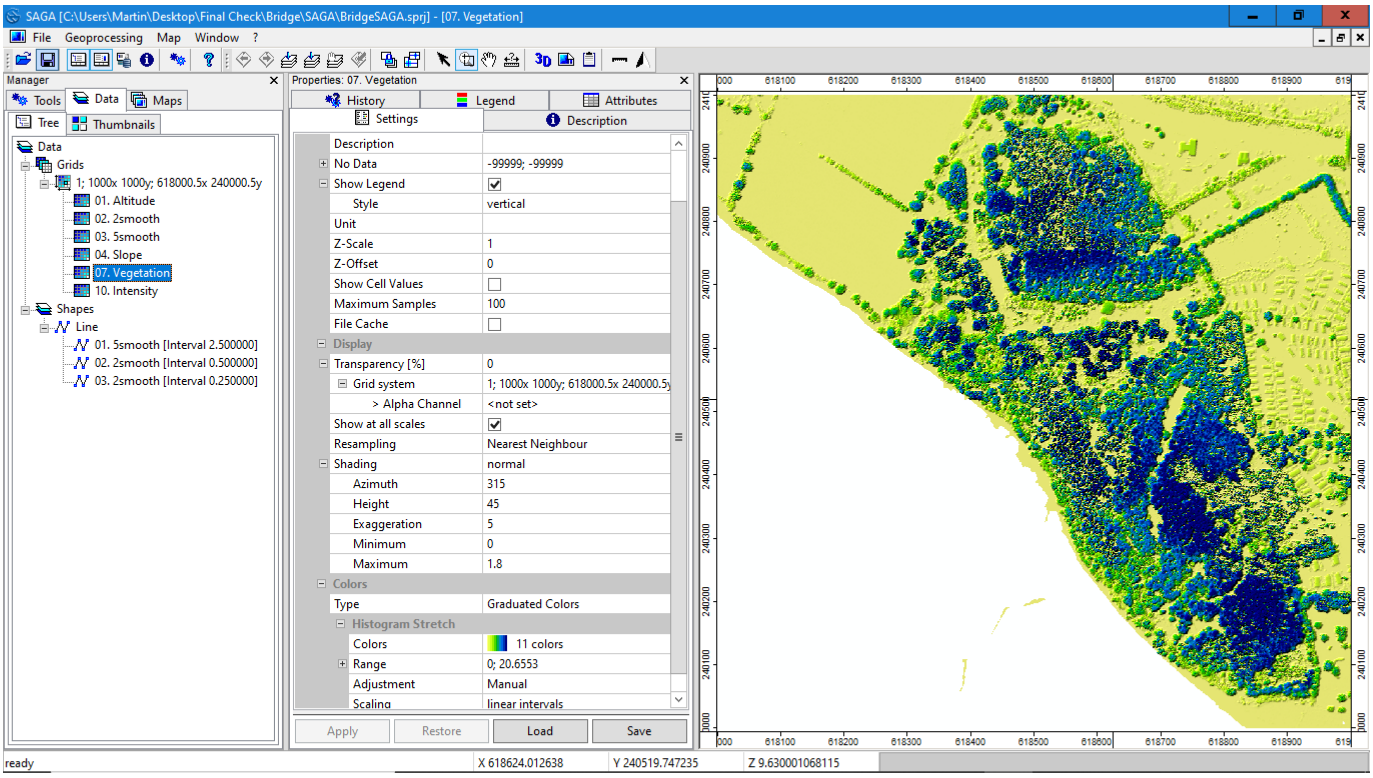


The screenshot shows the Grid System and the cropped DTM and DSM tiles for Bridge Wood already selected. DSM height values are greater than DTM so I've selected the DSM tile as "A" and DTM as "B".

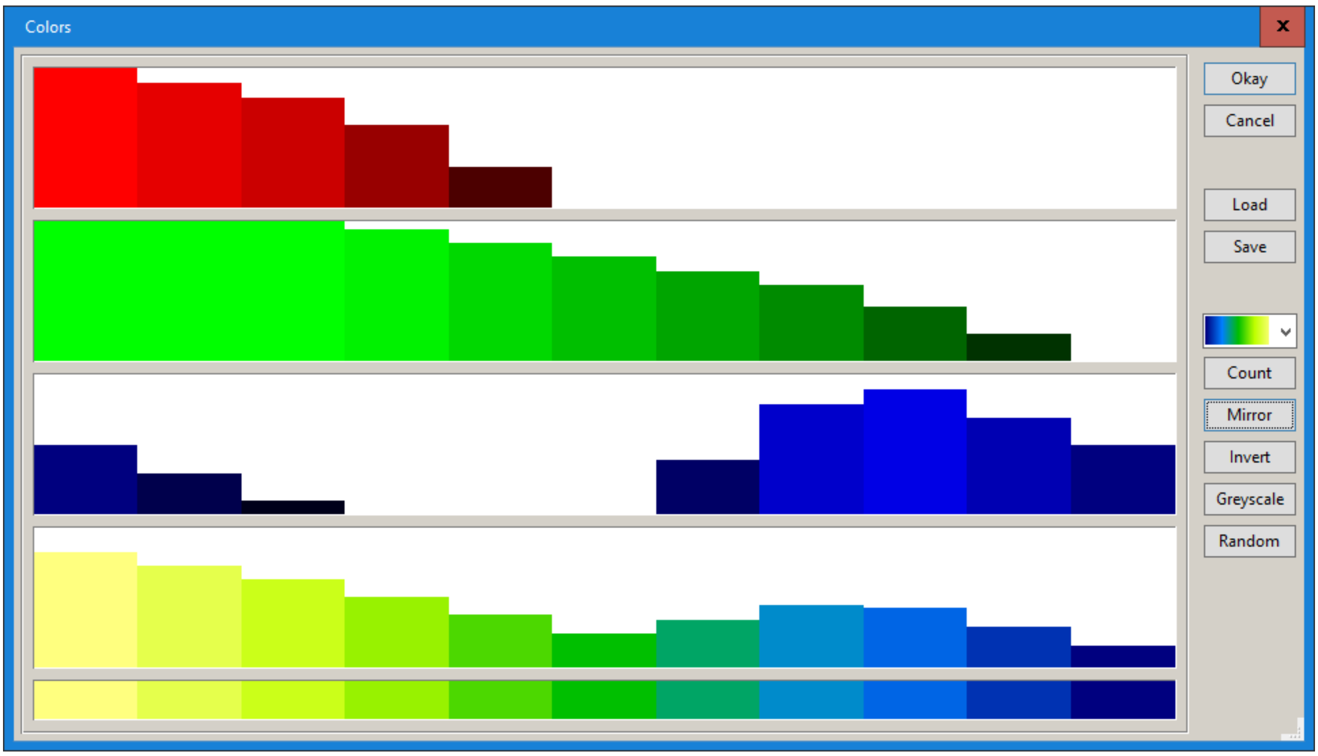
Selecting "create" against "Difference (A - B)" will create a new normalised DSM tile named "Difference (A - B)" under the same Grid System. I've then deleted both the non-normalised and the un-cropped

DSM tiles and renamed the new tile in its Properties window. I've renamed it "Vegetation". I've also, at this point, re-named the DTMMosaic tile "Altitude" – neater, but not necessary.

The Vegetation tile set with its default properties displays in unhelpful colours. The next screenshot shows the new Vegetation tile with its properties edited to produce a more user-friendly template. Note that water - the Orwell estuary in this case – normally displays white.



I first changed "Shading" to "normal" and set Exaggeration = 5, Minimum = 0, and Maximum = 1.8. This adds emphasis to vegetation boundaries. I set the minimum "Range" value to 0, and left the maximum unchanged. I left the Color "Type" as "Graduated Colors" – the default - then clicked in "Colors" and clicked the ellipsis (…) to open the Colors window.



The screenshot shows the Colors window after I've clicked the rainbow dropdown, scrolled down, and chosen the bottom but one colourway from the palette (blue – green – yellow),. I then clicked "Mirror" to reverse the colours so we have yellow for open land and shades of green/blue for the trees – a very rough approximation to what we expect as orienteers. I've left "Count" as 11. Then click "Okay".

Finally, back in the Properties window, I clicked Apply to display the adjusted template. I then saved the template as normal.

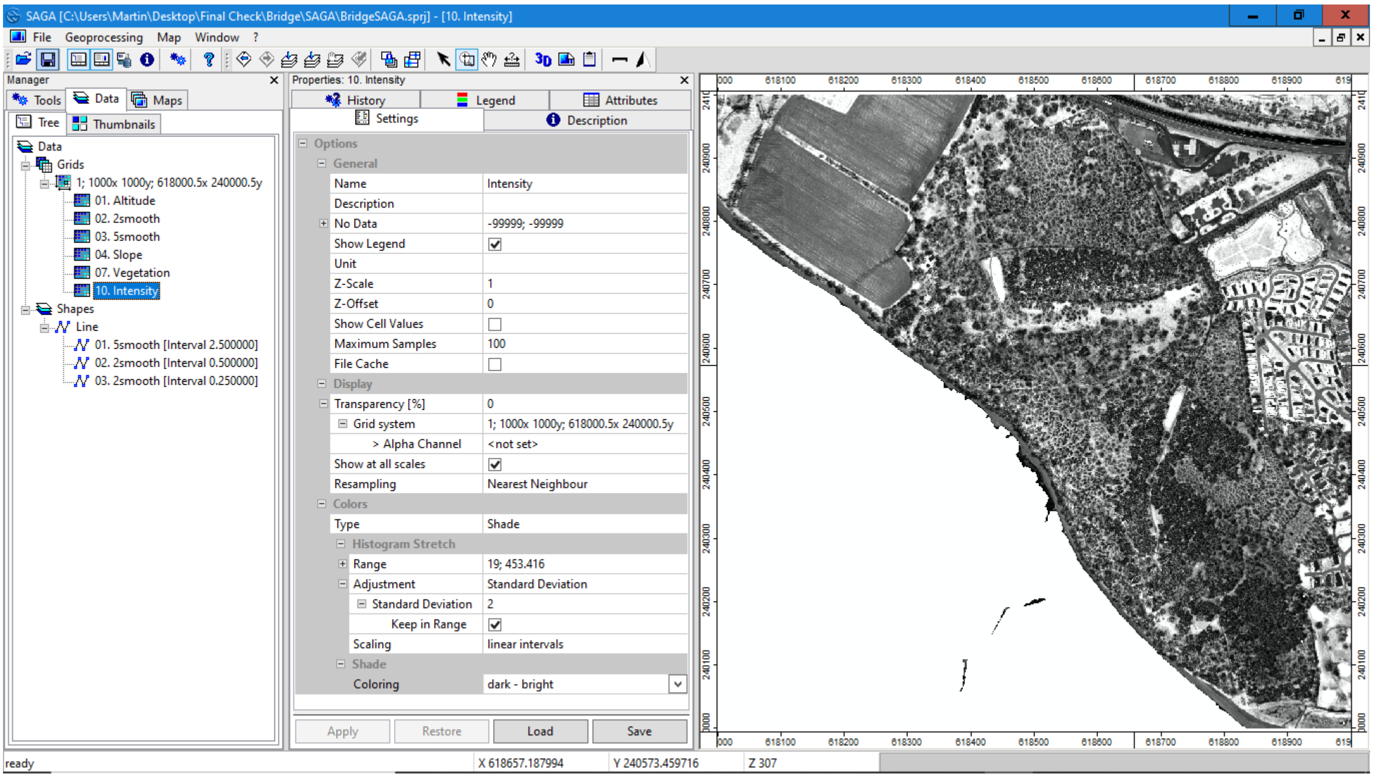
Experimenting with different shading properties and colours creates a myriad of different effects which may or may not improve the "readability" of your template in OOM. I've settled on the above parameters for now.

This is a February survey and some of the apparently open areas proved in the field to be leafless deciduous trees which the laser pulses missed. I actually got a more accurate vegetation template for Bridge Wood from the composite DSM LiDAR dataset which has survey data from a different season.

LiDAR Intensity Data.

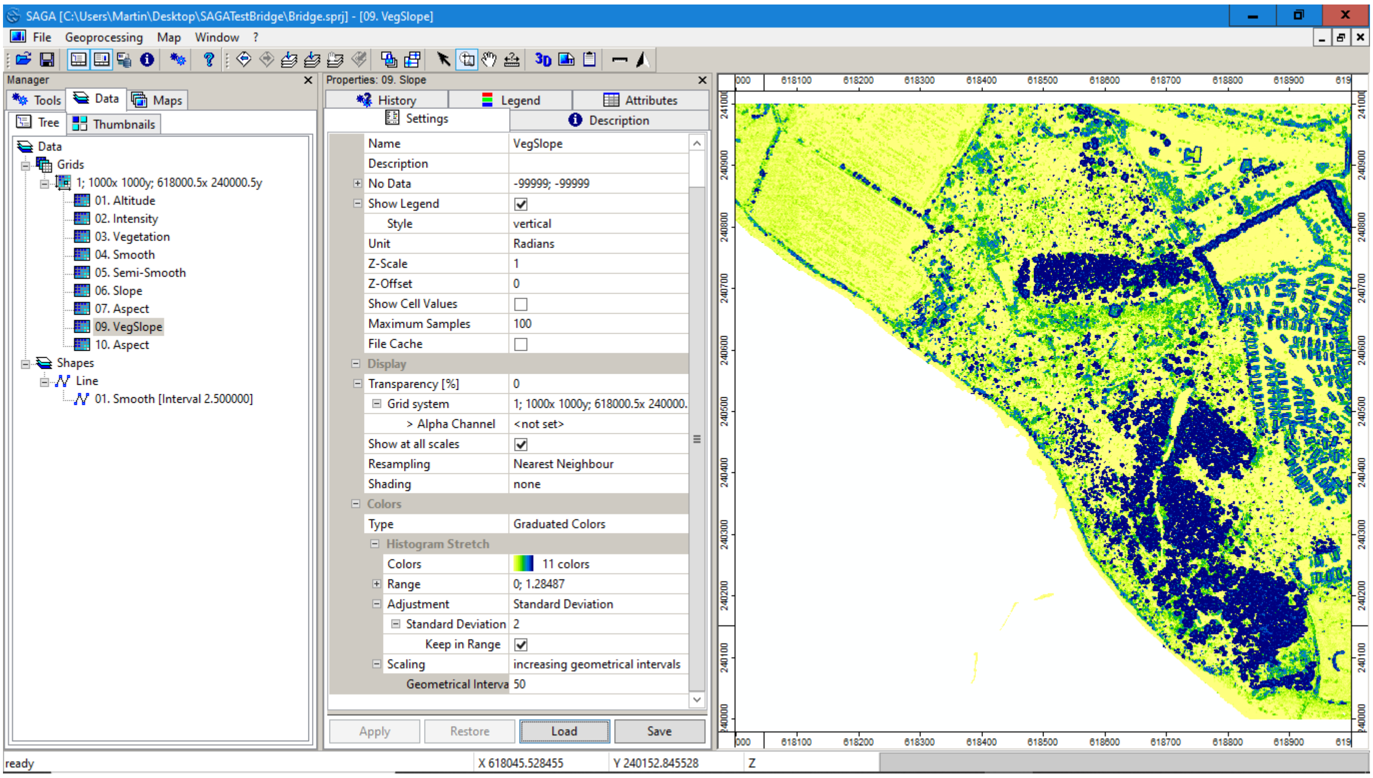
The Intensity dataset records the intensity of the laser return, independent of altitude, so the tile does not need normalising. Merging and cropping can be done with the Mosaicking tool as normal. The screenshot below shows a greyscale image obtained from the Intensity tile with the Properties set as shown. I've set the colour "Type" to "Shade" and "Coloring" to "dark - bright". All other parameters are left at their default values. Many other colour and shade options are possible, as always.

I've found this template quite useful in identifying boundaries between different types of vegetation of similar height. It also shows paved areas and buildings well and picks out paths in open areas, and even under light tree cover, sometimes better than an aerial photo.



Vegetation Slope Template

A different, sometimes useful, impression of vegetation height, and hence vegetation boundaries, can be obtained by applying the "Slope, Aspect, Curvature" tool to the Vegetation tile. I rename the output tile "VegSlope". The screenshot below shows the result with the properties as set. Again, infinite variation is possible. This is not a template I've used much, but you might find it useful. It's one that's offered in the latest version of OCAD.



All the vegetation and intensity LiDAR templates described in this chapter suffer from the disadvantage of not "seeing" well through the tree cover. In this respect they are no improvement on aerial photographs. However, in contrast to aerial photographs, they "see" vertically downwards so they don't distort the position of treetops and roofs of tall buildings relative to the ground. And they also have no shadows. Because of the way it's surveyed LiDAR data is usually more accurately geo-referenced than standard aerial photography.

To display vegetation below the tree cover, you need to process LiDAR point cloud data. This is described in the next chapter.

Chapter 7: Obtaining a LiDAR undergrowth template using LAStools and SAGA-GIS

Most of the useful LiDAR data to create templates in OOM is obtained from DTM and DSM tiles. But these models ignore any intermediate laser returns between the first return (the tree tops) and the last return (the ground). For an estimation of runnability we need to consider these intermediate returns.

To achieve this we must process the raw LiDAR point cloud data which stores all of the returns for each laser pulse. Each individual return has “x, y” horizontal coordinates and a “z” value, denoting altitude. The DEFRA National LiDAR Programme provides point cloud data in which each x, y, z point in the cloud is also accompanied by several “attributes”. The “intensity” attribute records the strength of the laser return. The “classification” attribute groups the z values by height above ground. Classification “4” includes z values whose height above ground is between 0.15m and 5.0m. So this classification covers most of the vegetation height range we are interested in when checking runnability. But a tighter range such as 0.2m to 2.0m more accurately reflects the sort of undergrowth and body-height vegetation that slows us down as orienteers.

Mappers with the latest OCAD version can analyse point cloud data and produce templates showing undergrowth density using OCAD’s in-built tools. It’s also possible to analyse point cloud data with the Karttapullautin application, but I’ve not myself found that especially helpful for producing base maps. The process described below uses LAStools software together with SAGA-GIS to produce an equivalent result to the latest OCAD for those using OOM or earlier OCAD versions.

It may be questionable whether the result is worth the additional time spent. I’ve used this method with five maps so far, and my initial impression is that, on balance, it is. The resulting templates should be reasonably accurate for the date of the survey flight. Undergrowth will of course change with the season and from year to year, but checking in the field in Tunstall Forest exactly one year after the DEFRA survey flight, I found the template gave a reasonably accurate picture of the undergrowth and low level vegetation under tall tree cover. In many areas, a quick check in the field was all that was required to confirm this, rather than a detailed survey of each undergrowth boundary. One might hope that orienteers wouldn’t expect to rely on too precise undergrowth boundaries for navigation anyway, just for an indication of best route choice.

SAGA-GIS can import point clouds and has tools to merge and crop them to your map footprint. It can also extract subset point clouds (eg retaining only Class 4 data points). But I’ve not yet found a way in SAGA-GIS to “normalise” a point cloud’s z values - ie convert from altitude above sea level to height above ground. LAStools is dedicated software for point cloud processing and will achieve merging, cropping, normalising and subset extraction in one or two steps.

LAStools downloads as a folder and sub-folders with all the necessary files. The download site is at http://www.cs.unc.edu/~isenburg/laszip/ I only use the files in the “bin” (binary) sub-folder, but you probably need to keep the other folders for the application to work.

First you need to download from the DEFRA site the National LiDAR Programme Point Cloud tile or tiles that cover your map footprint. See Chapter 1 for details. These are 5km square tiles, so for many map footprints, including Bridge Wood, one tile will suffice - but Tunstall Forest needed its usual three.

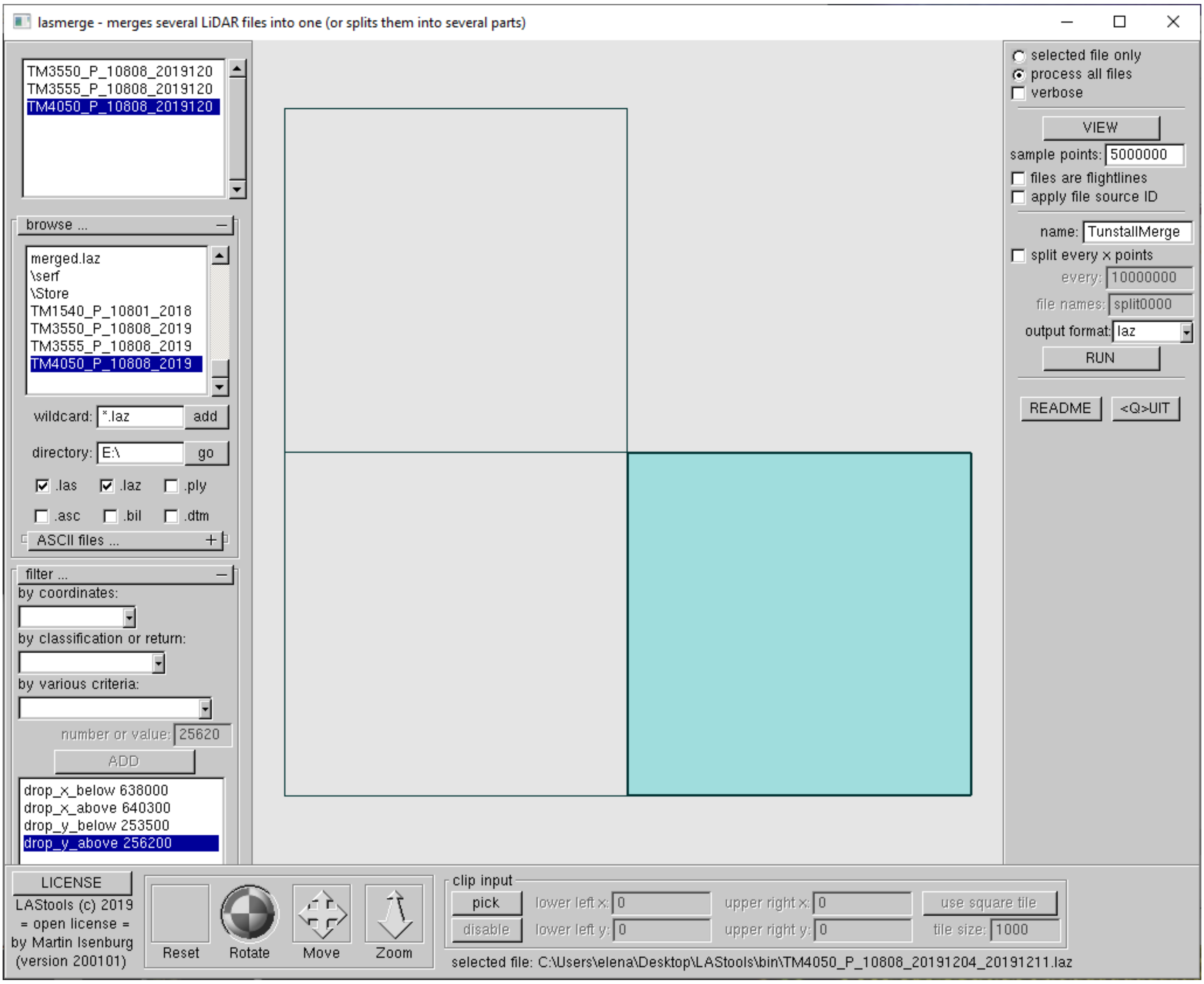
For each 5km square, a zipped folder will be downloaded containing one sub-folder which contains just one .laz file. .laz is a zipped version of the .las format which is the standard format for point clouds. Each .laz file will normally be more than 100Mb.

You can extract a downloaded .laz file directly into the “bin” (binary) sub-folder in LAStools just by moving it across. Saving it in the “bin” folder makes it easier to work with. Note that LAStools requires files to be named without spaces. Also be careful when moving files across into the “bin” folder. If you release the mouse over a tool file, the tool may be automatically executed – not what you want.

If you have a single .laz tile you can complete all the processes required using the “lasheight” tool alone.

If you have more than one tile you first need to use the “lasmerge” tool to merge and crop the tiles. First click on the lasmerge application file in the “bin” folder. It will open initially as a command line window followed by a user interface as below. All the processes required can be executed in the user interface. It's a little clunky, but the better option for those, like me, who are unfamiliar with using the command line. The alternative "lasmerge64" version appears to work in the command line only.

The following screenshot shows the lasmerge user interface. The left panel is for selecting and cropping your point cloud tiles. The "browse" button opens a list of .laz files in the "bin" folder. Double click each of your downloaded files and they will display in the top left window. Then use the "filter" button to open the options as displayed. Click the "by coordinates" dropdown, select "drop x below" and enter the x coordinate of the SW corner of your bounding rectangle in the "number or value" box. Click "Add" to add it to the window below. Repeat for the other three coordinates, as shown below for Tunstall Forest.

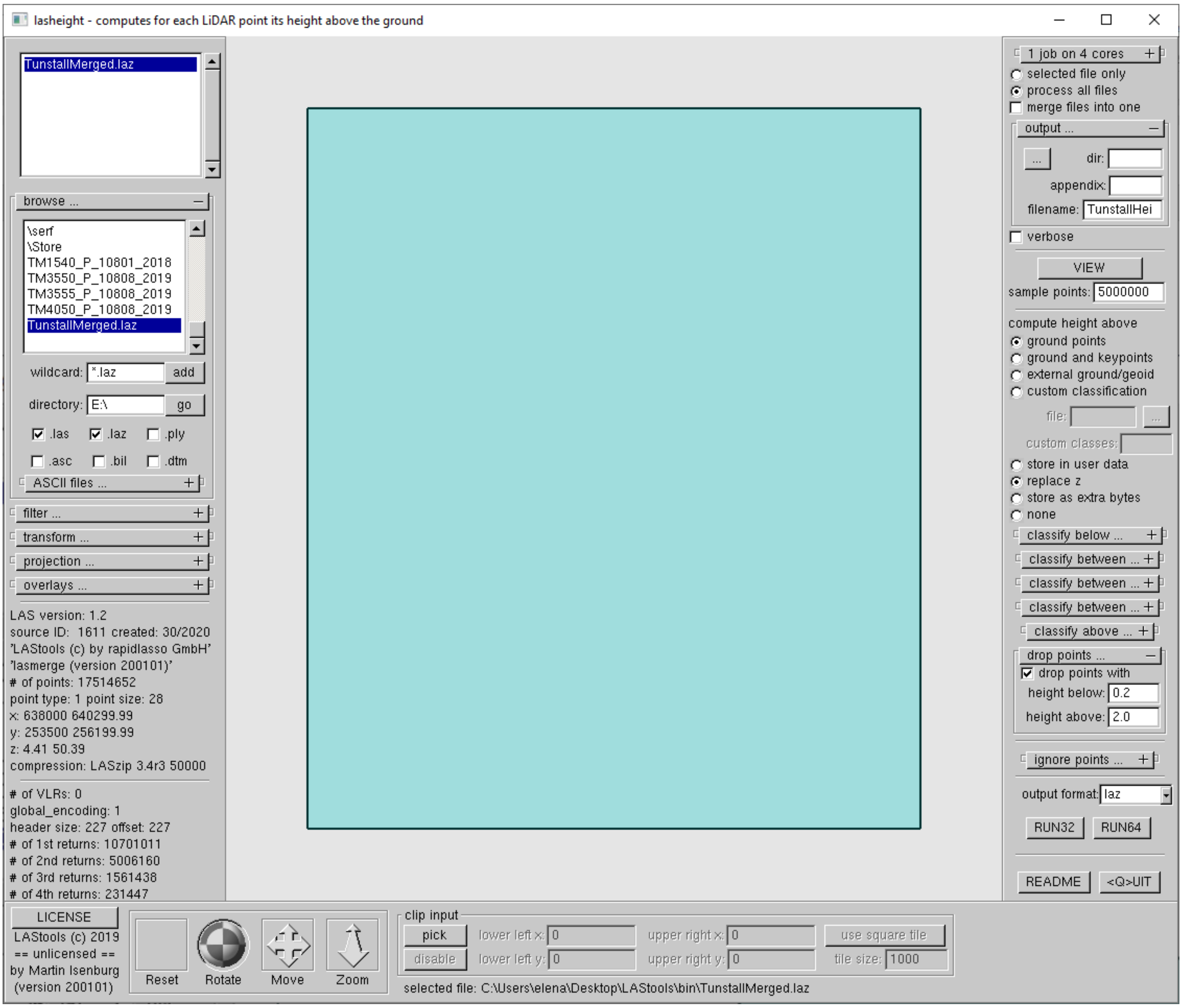


In the right panel you just need to give your merged file a name and click "Run". A "Run" dialogue box will appear. Click the "Start" button, and wait. There is no progress indicator, but the "Run" box will close when the task is finished, which may take a while. Your merged file will be saved in the "bin" folder.

The "lasheight" tool will clip a single input tile to match your map footprint if required. It will then normalise all z readings to height above ground and filter out all cloud points outside a range of values for z which you specify.

The "lasheight" tool opens similarly to "lasmerge" and its user interface is also very similar. You may see a licence notice on opening lasheight which you can accept – LAStools only requires licence payments for commercial use. This licence notice will sometimes be hidden under the user interface. If lasheight fails to run, try minimising the user interface to see if an un-ticked licence notice is the problem.

I've shown the "lasheight" interface below with the merged tile "TunstallMerge" opened in the top of the left panel via the Browse button. If I'm working with an already merged and cropped tile, as at Tunstall, there is nothing else to enter in the left panel. But if the map footprint only requires a single LiDAR tile, as at Bridge Wood, there is no need to use "lasmerge". You can crop a single tile in "lasheight" by clicking the "Filter" button and entering the bounding coordinates exactly as in the "lasmerge" screenshot above.



The right panel is for filtering the point cloud for the points you want to retain. Selecting "ground points" will normalise the z readings. Selecting "replace z" replaces the old, above sea-level, readings with the new normalised readings. Then click the "drop points" button to set the range of z values to *reject*. I've rejected ("dropped") those outside the range 0.2m – 2.0m. You can choose whatever range you prefer.

You can specify an output file name in the "output" dialogue. I've named it "TunstallHeight". Or you can just allow lasheight to save the output in the "bin" folder with the original filename but with ".1" added.

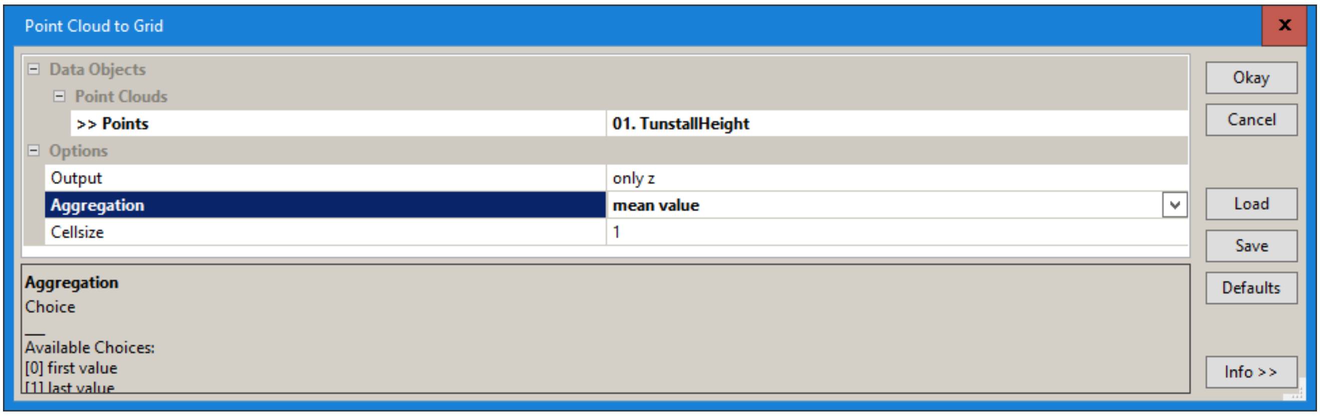
Then click "Run 64" (assuming your Windows version is 64 bit). The Run buttons are at the bottom of the right panel but may not be visible without first minimising the "output" and "drop points" dialogues. A "Run" dialogue box will appear. Click the "Start" button, and wait. The "Run" box will close when the task is finished. This may take a while.

You are now left with a very much smaller and more easily handled output point cloud file. The remainder of the task now works best in SAGA-GIS.

You can load .laz files into SAGA-GIS v.7.9.0 by simply dragging and dropping as you can with DTM and DSM tiles. But for more options you can click the "Find and Run Tool" icon in the toolbar to search for and select the “Import Point Cloud” tool. Using this tool is straightforward. It will import your processed .laz file from the LAStools “bin” file with its new normalised and filtered values. You can also import additional attributes, such as “intensity”, but I’ve not needed to do this – I’ve left them unticked. With large or multiple point clouds, “lasheight” will zero all the intensity values anyway, unless you pay for a licensed version!

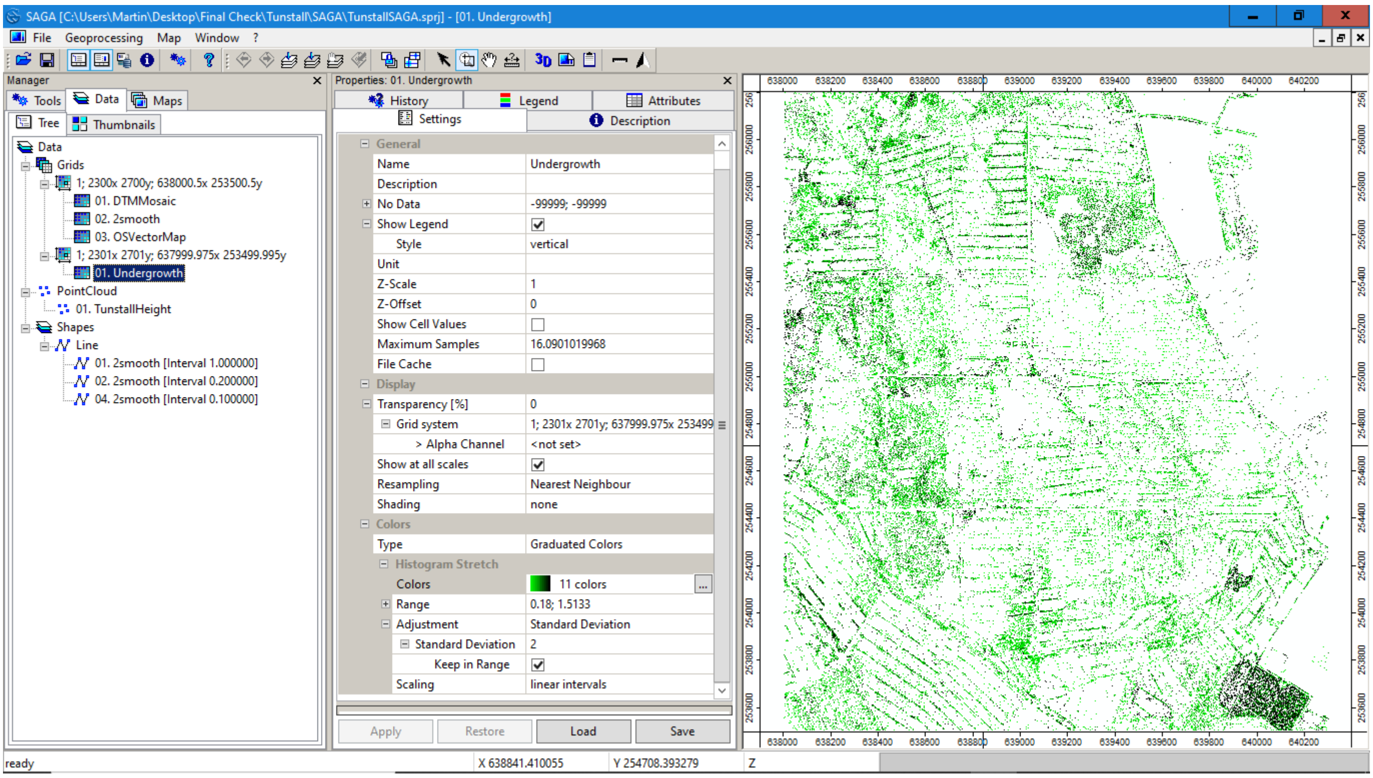
The new point cloud tile, “TunstallHeight” in my case, will be listed under “PointCloud” in the Data window.

Then use the “Point Cloud to Grid” tool below to convert the point cloud into a normal grid of 1m cells. This tool will resample the cloud points and average the z values where there is more than one cloud point per cell - provided you choose “mean” as the “aggregation” option. 1m is the default cell size.



Clicking “Okay” will generate two new tiles listed under a new grid system: “TunstallHeight (Z)” and “TunstallHeight (Points per Cell)”. The grid system should be similar to the one under which your other template tiles are listed, but may not be identical. This doesn’t matter. I deleted the “Points per Cell” tile, and renamed the “(Z)” version “Undergrowth” in the Properties window.

The last step is to adjust the properties of the “Undergrowth” tile and save as a .png template as per normal. For the Tunstall example I chose parameters as per the screenshot below. For the colour palette I chose an all green version. It’s 5th on the list in the rainbow dropdown in the “Colors” window. It needs mirroring to show the best result.



Every green cell in the resulting template represents one or more laser returns at that x, y co-ordinate from a height between 0.2m and 2.0m above the ground regardless of whether there is higher tree cover above. Provided the colour palette has been “mirrored”, lower undergrowth (more likely to be drawn with the green striped IOF symbols – 407 and 409) will be displayed in lighter green, and taller undergrowth (more likely to be drawn with the area green symbols – 406, 408, 410) in darker green. The denser the pattern of green dots, the denser the undergrowth. Varying the parameters produced different intensities of colour, but I think the chosen parameters produced the best image overall.

As you can see, there’s quite a lot of undergrowth at Tunstall at present. But much of it is directional (rootstock banks or brashings) allowing fast running with the grain. It creates a challenge for the planner though.

Chapter 8: Creating geo-referenced aerial photo templates

Using SASPlanet and SAGA-GIS (with acknowledgements to Alex Finch and Simon Starkey)

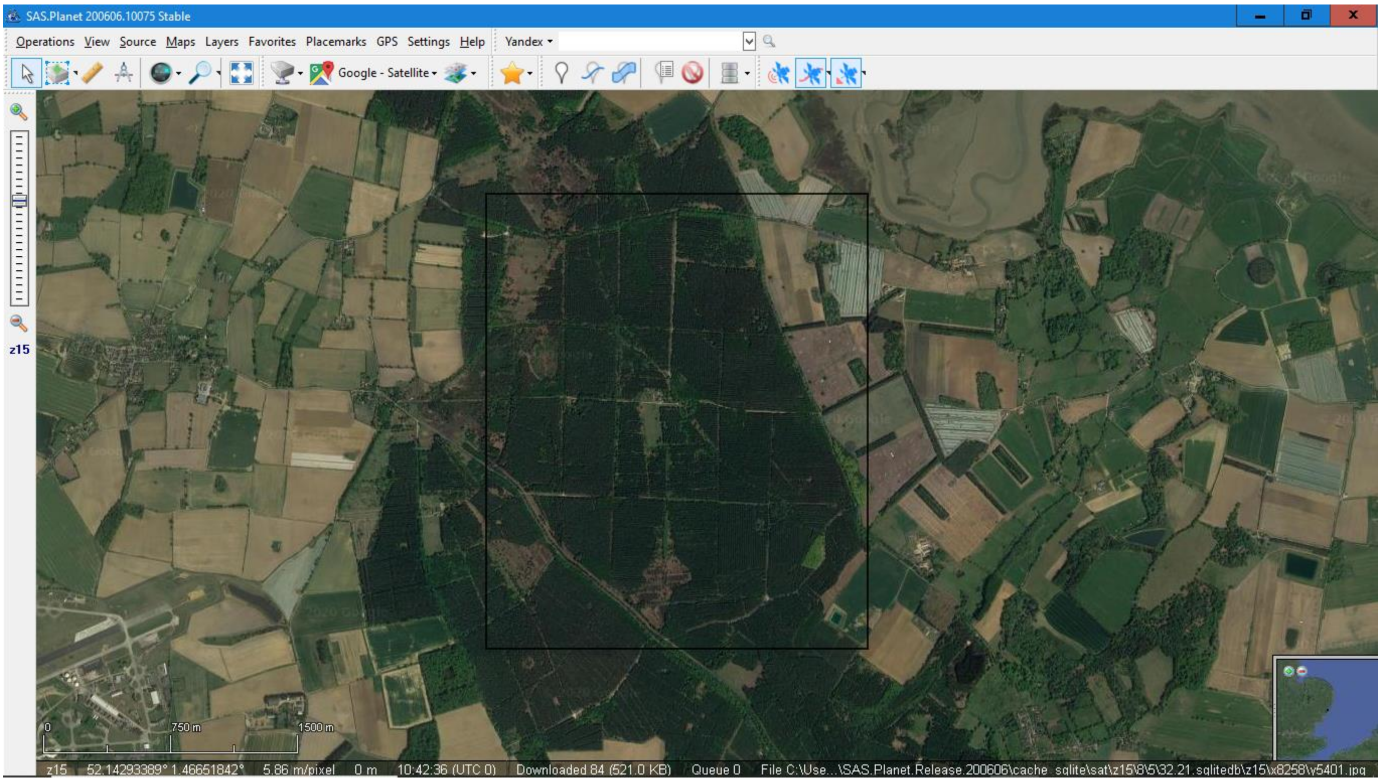
SASPlanet offers a choice of high resolution aerial photographs of your whole map footprint in one download. The photos are not aligned to the OS Grid and require conversion to the Ordnance Survey OSGB36 map projection before they can be used as geo-referenced templates in OOM. The latest OOM version makes this conversion automatically.

SASPlanet downloads directly here. I'm using this 06/06/20 version. It downloads as a folder with various sub-folders. The SASPlanet application (.exe) file is in the main folder. I created a shortcut to it.

SASPlanet links to an extensive catalogue of maps and aerial photos – though many are not relevant to the UK. SASPlanet appears to be Russian software. I've looked at the photos in SASPlanet sourced from Google, Bing and ESRI ArcGIS. Which of these provides the best template may vary from area to area. I've found that Google offers the clearest and most recent aerial photographs of East Suffolk.

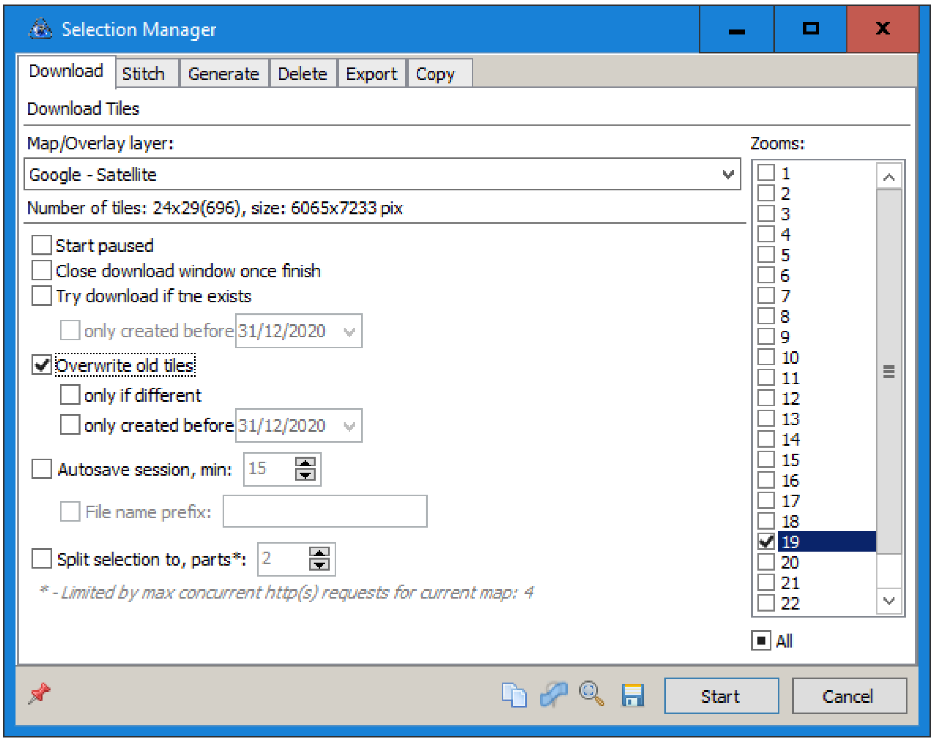
To extract a photo from SASPlanet open the application and navigate to your area. You will need to have "selected basemap" set in the top toolbar to a source that has coverage in your area. "Google Satellite" gives Google Earth's worldwide coverage and so is a good starting point.

Then press alt + R to draw a rectangle around your map footprint. Click one corner, then move and click the opposite corner. The screenshot shows this completed for Tunstall Forest.



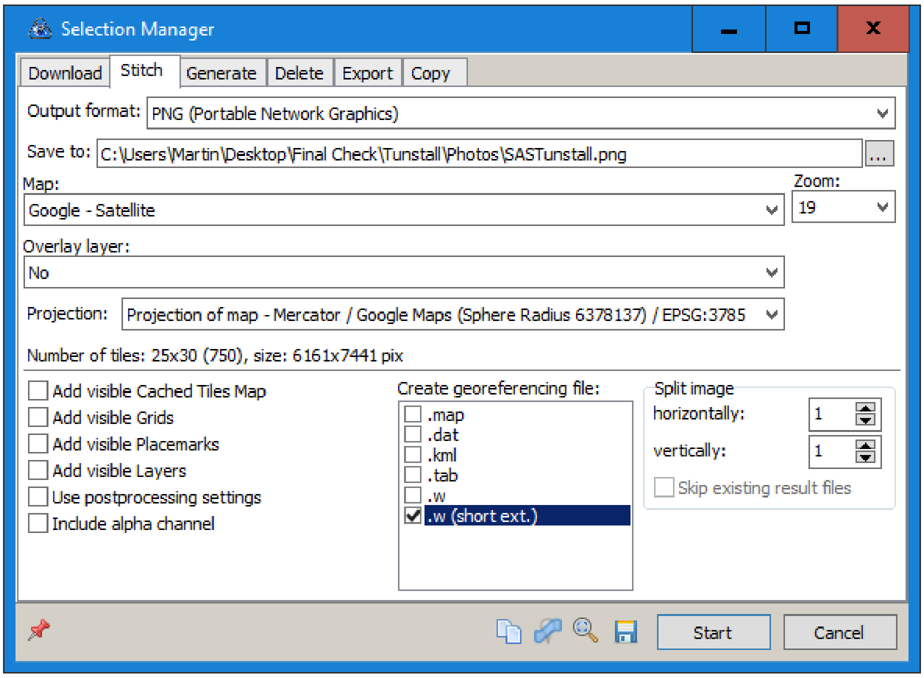
You can zoom in further to compare the various photo sources available for your footprint and select the optimum zoom level for your download (indicated on the left side of the screen). I've found that z19 is best with Google photos for large map footprints such as Tunstall. z20 is good for smaller footprints such as Bridge Wood. Greater zoom levels than 20 can exceed the maximum definition of the photo and therefore fail to add clarity, while slowing the process and adding greatly to the downloaded file size.

Now press ctrl + B to bring up the next screen and click the "Download" tab (normally the default).



I've set the zoom at 19 and ticked "overwrite old files". Then press "Start". You'll see a progress window which shows how many files (tiles) are being downloaded – a surprisingly large number. On completion click "Quit" to close the progress window.

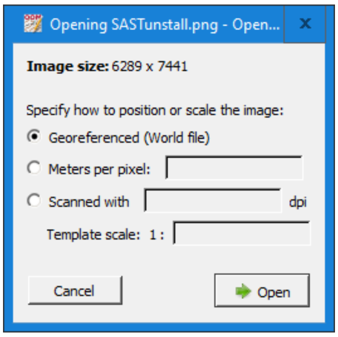
Now press ctrl + B again. And click the "Stitch" tab.

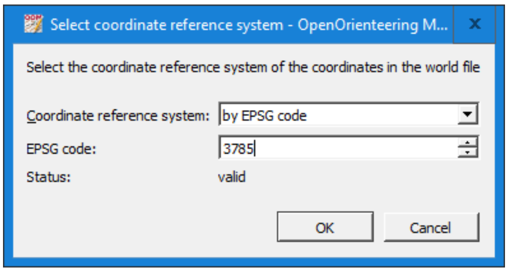


I've set "Output format" to PNG. SASPlanet will download in various formats including ECW and GeoTIFF, but I've found PNG gives the best result in OOM. In the "Save to" line click the ellipsis (…), navigate to a suitable destination - eg a "photos" subfolder of your map project folder - and enter a filename. I've then set "Zoom" to 19 again, and left "Projection" as "Projection of map" and noted the EPSG number – 3785 in this case. The dropdown gives alternative projections, but OSGB36 (EPSG 27700) is not available. I've also ticked ".w(short ext.)" in the geo-referencing table. This will save a small .pgw file which SAGA-GIS will read alongside the not so small .png image file (83Mb in this case).

Click “Start” again and watch progress – or take a break! Two additional files will be saved as well as the .png and .pgw files. I keep these, although I’m not certain they are required. SASPlanet can now be closed. It will re-open in the same place.

Then, with my geo-referenced OOM file open, I click “Open Template” and navigate to and open my saved SASPlanet photo. Click “Open” in the first dialogue window below as usual. In the second dialogue window select “by EPSG code” and enter “3785” as shown.



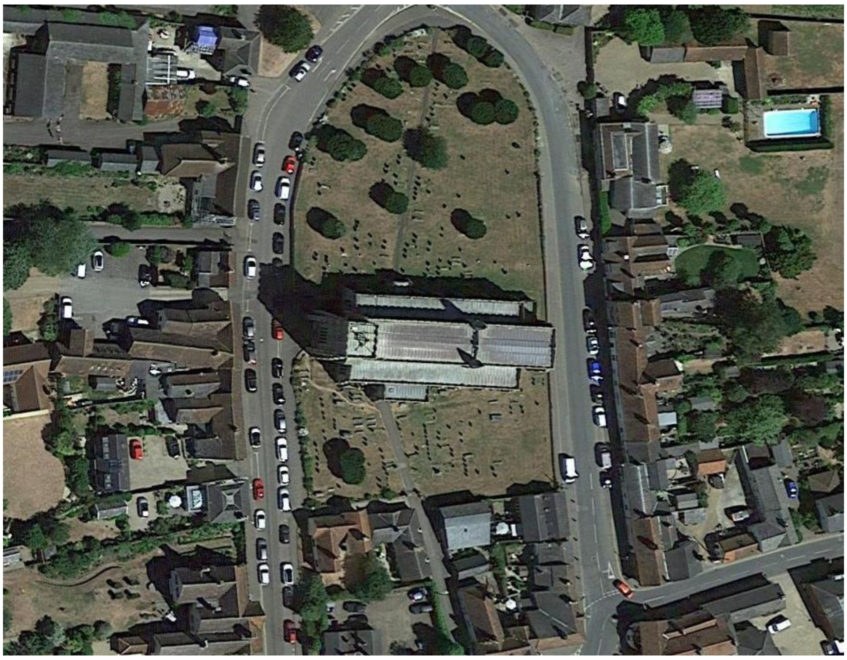


OOM will now convert the image from its native co-ordinate reference system (EPSG 3785) to the co-ordinate reference system of your map (EPSG 27700), and then open the photo template which should open correctly geo-referenced. It will be skewed on the screen as its native projection has been altered.

Errors in aerial photography

When using aerial photographs as templates it’s wise to be aware of potential errors. Most aerial photographs I use (eg from Google) will have been taken from aircraft, despite the “Google Satellite” tag in SASPlanet. While the centre of each camera frame should be a vertical view the edges will be an oblique view. Any lens distortion and stitching errors will hopefully have been largely corrected. But oblique errors in sections of the frame which were not shot vertically cannot be corrected for.

In the example below, the shot is noticeably oblique. The top of the church tower is several metres out of line with its base and the rear end of the church roof appears to overhang the road. This is easily spotted and allowed for, but the same distortion applies to tall trees and even, logically, to higher ground, where it’s not so obvious. So, in general, if the position of a feature on a photo template is out of line with the same feature on a LiDAR template, I tend to favour the LiDAR evidence.



A SASPlanet photo obtained as above should open correctly geo-referenced. But it may not be quite correctly positioned. OOM uses the Proj4 suite of coordinate reference system transformation algorithms. No CRS transformation algorithm is 100% accurate – all are better or worse approximations. A displacement of a few metres can be expected. The error will vary across the UK, but should not vary noticeably across a single O-map footprint, or indeed across your local area. It may be small enough to ignore, but in my part of Suffolk it's approximately 3m south and 2m west, so I normally correct for it.

The simplest way to correct the error is to make a small adjustment in OOM using the "Move by Hand" tool at the bottom of the Template Setup window. You may first need to click the adjacent "Edit" button to unlock the geo-referencing. Just move the photo slightly to match one of the other geo-referenced templates and thus correct the error. This could be an OS map template if you've already produced this. The "Intensity" LiDAR template also works well. The adjustment is easiest with the photo above the other template in the template list. You may want to set its "opacity" temporarily to 50%.

Having established, by trial and error, that this displacement is close to being the same for all the maps in my area, I now prefer instead to pre-adjust the coordinates by that amount in the photo's associated .pgw file before opening the template. To do this you need to multiply the "x" and "y" displacement values in EPSG 27700 co-ordinates by the correct co-ordinate "scale factor" for EPSG 3785. This scale factor is most easily found by geo-referencing a dummy blank map to EPSG 27700 for a location in your area and then re-setting the co-ordinate reference system in the geo-referencing dialogue window to EPSG 3785. The scale factor can be read at the bottom of the window. You may have to close and re-open the dialogue window to see this. As with the error itself, the scale factor seems to be close to constant across my local area at about 1.6 – there's no need for greater accuracy than that.

Another reason for making a note of the value of this displacement error in your area is that you can then make a reverse correction when using the facility in OOM to export a KMZ version of your finished map to use in MapRun. I've found that this displacement, in the reverse direction, is the amount I need to temporarily move my map origin in order for the KMZ file to open exactly aligned in Google Earth, presumably because OOM uses the inverse algorithm to achieve this. Because your map origin is measured in EPSG 27700 co-ordinates there's no scale factor to apply in this case.

Obtaining vertical aerial photo tiles from the DEFRA LiDAR site

The aerial photographs on the DEFRA LiDAR site have the advantage of being sourced from vertical photography which does not displace the tops of trees and buildings relative to the ground. They are also already geo-referenced to the OS Grid. But the coverage is currently very sparse, mostly of coastal areas. And I don't find the photo definition, at least in Suffolk, quite as clear as those from SASPlanet. The process of obtaining useable templates is also not as straightforward.

To obtain these photos from the DEFRA site you need to select your map footprint and "Get available tiles" (See Chapter 2 for details). If vertical photo coverage is available you can select "Vertical Aerial Photography Tiles" either "RGB" or "RGBN". The more recent photos are in "RGBN" format.

If there is photo coverage across a whole 5km square your download will be a zip file containing one folder with 25 files, one for each 1km tile. Unfortunately the files are not identified by grid reference but by a serial number. This is not, as far as I can tell, linked in any way to the grid reference - rather it refers to the date and sequence of the flight.

It's possible to resolve this problem by visiting DEFRA's separate data index site here. Select the layer list and tick "vertical photographs" (un-ticking everything else). Clicking on a 1km grid square reveals the file name for the vertical photo tile for that square, if it exists.

You can then drag and drop the photo tiles you need straight into the SAGA-GIS data window. They are .ecw files which can only be opened in GIS software.

If you need more than one tile these can be merged in SAGA-GIS using the "Mosaicking (Grid Collections)" tool rather than the simple "Mosaicking" tool. Single .ecw tiles can also be clipped with "Clip Grids". However, I've not found either tool works very satisfactorily with these photos - some definition is invariably lost. So it may be better to simply save the .ecw tiles as separate 1km square .png templates in the normal way, and make do with multiple templates in OOM.

Chapter 9: Obtaining and Processing Ordnance Survey Mapping to use as Templates.

In the UK, Ordnance Survey mapping is an obvious source of base map material. Unfortunately, the best OS mapping is only available at significant cost or via quite time-consuming processes. Free OS mapping is available through OS OpenData but what is available as OpenData is less accurate and less detailed.

When using any OS mapping it's important to check that your finished map will conform to OS copyright requirements. All OS mapping is subject to copyright, which must be acknowledged, even where the OS mapping is only employed at base map level and is not evident on the final map. The British Orienteering Ordnance Survey Licence covers the creation of printed orienteering maps which use printed OS maps or digital OS OpenData as basemap sources. Mappers should not assume it covers the use of more detailed digital OS mapping obtained from the government's "MagicMap" or other commercial sites. These generally have a copyright statement in the terms and conditions on the site.

OS copyright must also be acknowledged if DEFRA LiDAR data is used for your map as this is based on the OS National Grid. This *is* covered by the British Orienteering OS Licence.

In this chapter, I'll look first at OS OpenData and then at how I obtain and process better quality OS mapping.

OS OpenData

OS OpenData is available here. I've found that "OS OpenMap - Local" is the best source. OS VectorMap – District is similar.

To obtain OS OpenMap – Local you must first select a 100km tile. You have to be very unlucky to have a footprint which overlaps two or more tiles! The whole of Suffolk, and much of the surrounding counties, is covered by TM and TL.

Downloading in GeoTIFF (raster) format creates a Zip folder which contains a "data" subfolder. This opens to display four hundred 5km tiles which are named as per 5km LiDAR tiles. These will open as templates directly into OOM. They can be merged and cropped in SAGA-GIS but it's tricky to retain the original colours. I've not tried hard to resolve this, as I don't find OpenMap Local, or any other OS OpenData mapping, sufficiently detailed to be very useful, particularly when the more detailed OS VectorMap - Local is freely available via the UK Government MagicMap site.

Downloading OS OpenMap - Local in vector format as an ESRI shapefile is also possible. It downloads as separate layers for different features – roads, buildings etc. Potentially, these can be imported straight into OOM, but in practice I've not found it worthwhile to do this.

The latest OCAD has in-built tools to access and process OS OpenData, but I don't think this applies to more detailed OS mapping.

More detailed OS Mapping

The remainder of this chapter explains the methods I use to create geo-referenced templates from OS VectorMap – Local and OS MasterMap. The processes are relatively time consuming, and not worth considering if you can obtain detailed OS mapping from other sources such as a Local Council or School.

OS VectorMap – Local is free to download in raster format from the UK Government MagicMap (MAGIC) website. Unfortunately the downloads are not geo-referenced. I've described below a method to merge and geo-reference MAGIC downloads in SAGA-GIS. Unlike mapping from OS OpenData, OS VectorMap - Local provides templates that I've found sufficiently detailed to serve as base map material, at least for forest mapping at 1:15,000 or 1:10,000, alongside LiDAR data and aerial photography.

The best quality OS mapping is OS MasterMap. OS MasterMap is substantially more detailed, with accurate property and field boundaries, and roads and pavements drawn to scale. This is potentially very useful for Urban Orienteering and Sprint-O maps. OS MasterMap can be purchased, geo-referenced, through commercial sites such as Promap, but this is prohibitively expensive for most orienteering club mappers. I've described below a process I use to merge and geo-reference OS Mastermap tiles obtained from Promap screenshots. Though not free to view, OS MasterMap views in Promap are inexpensive. The process is realistically too long-winded for forest maps where too many screenshots would be required.

Processing OS VectorMap - Local Downloads from MAGIC

The UK Government (DEFRA) MAGIC site is [here.]()

OS VectorMap Local tiles can be obtained from MAGIC as A3 or A4 downloads at a range of scales, the most useful of which produces a 1km tile on an A3 portrait page. The downloads are not geo-referenced and the page includes margins which are best cropped. It's possible to load the pages directly as templates in OOM using OOM's template adjustment tool with two passpoints. But for a map footprint like Tunstall, which covers nine 1km OS grid squares, I prefer to merge the tiles into one template.

It's possible to use imaging software such as Photoshop, or the open source alternative, GIMP, to crop and merge MAGIC downloads. Until recently I used Photoshop, which I found a little "hit and miss". I now prefer the following method using SAGA-GIS. It's not quick, but it does also geo-reference the template.

You first need to note which 1km map tiles you need to cover your map footprint. If you've not already done so, these can be checked on the MAGIC screen. I've found it best to write these down as a 12 figure (1metre) grid reference defining the SW corner of the tile. So for the 1km tile TM 3853, I write "638000, 253000", or just "638,253" as a shorthand. This is the first of nine tiles I require for my Tunstall Forest map footprint. You also need to prepare a "Maps" sub-folder to receive your downloaded tiles.

Next you need to note three numbers:

- Scale = 1:3780
- X = 46
- Y = 412

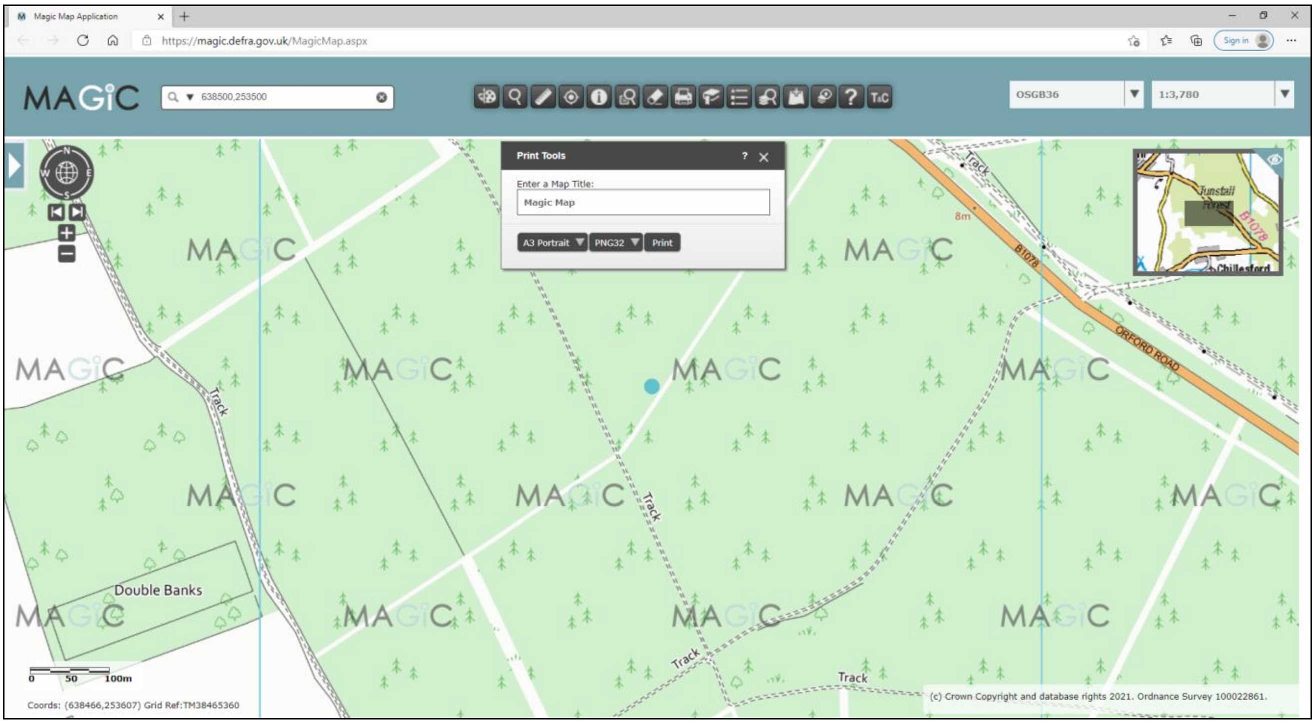
1:3780 is the scale that most closely equates to 1 pixel per metre on an A3 portrait downloaded MAGIC image. Only whole number scales can be entered in MAGIC so this is the closest that can be achieved. Conveniently, at this scale a 1km tile neatly fits onto an A3 portrait MAGIC download.

Before download, I set my 1km tile dead centre on the MAGIC screen, as below. X and Y are then the co-ordinates, in pixels, of the SW corner of the 1km tile relative to an origin at the SW corner of the downloaded A3 portrait page. This sets the parameters to crop and remove the margins in SAGA-GIS.

These three figures work for both our home computers, set to any screen resolution. They give a result accurate to 1m across the final merged template. It's possible, though I think unlikely, that different computers might require different figures. Some trial and error was required to fix these. If you do experience a problem please see appendix 1 to this chapter below.

I then create my first tile in MAGIC. The next screenshot shows the result after the following steps. First check that "OS Colour Mapping" is ticked in the left side panel, which can then be minimised. Then change the search type in the search bar to "Grid Ref. or coordinates" and enter the 12 figure grid reference of the **midpoint** of the first 1km tile. Mine is 638500, 253500. The screen will zoom in to 1:10,000 scale, in Vectormap Local format, with the midpoint marked with a blue dot dead centre on the screen. **Be careful not to pan the screen from this position or the tiles will not merge properly.**

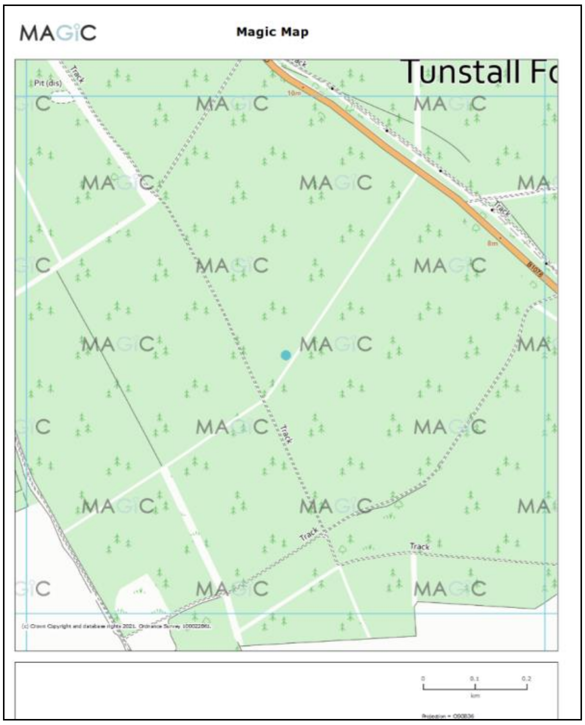
Now, make sure the map projection is set to OSGB36 and amend the scale manually to 1:3780. You may have to temporarily select a different scale using the dropdown first before you can amend the figures in the box to 1:3780. Click the print icon, select "A3 Portrait" and "PNG32" in the dialogue box. Your screen should then look like this:



Click “Print” to create your image and then “Printout” to show the result on a new screen as shown opposite.

Check that your full 1km tile is displayed on the printout (which it should be if you’ve not accidentally panned the MAGIC screen) then right click and “save image as” a .png file in your “Maps” sub-folder, with an identifying name - I use the abbreviated grid reference, eg 638,253. This is really helpful later if you have many tiles.

Close the printout screen which will return you to the MAGIC screen. For the next tile, just enter the new grid-reference - often just one figure needs adjusting for adjacent tiles - and set the scale to 1:3780. The scale will have become reset to 1:10,000 when you changed the grid reference and may need resetting again using the dropdown before it will allow you to enter 1:3780 in the box. Click “Print” and “Printout” as before, and save with the new name. Repeat for the remaining tiles



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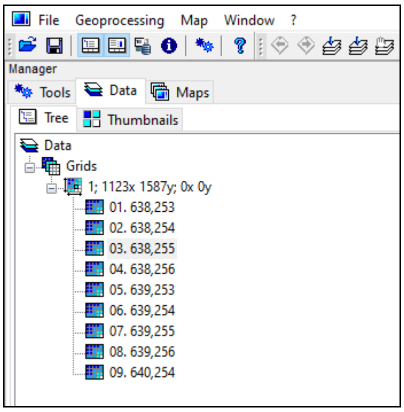
Now open your SAGA-GIS project. If you start the project with this process you will need at this point to determine the coordinates of the SW and NE corners of your final map footprint (the closest round 100m that contains your map footprint is best). The MAGIC screen is good for doing this, using the grid reference of the cursor displayed in the bottom left corner. If you have already processed LiDAR tiles in your SAGA-GIS project, you will have set your footprint previously and don’t need to repeat.

You can then drag and drop all your MAGIC 1km tile images in one go from your folder to the SAGA-GIS Data window. They will all list under the same grid system as per the screenshot below. If you have already created LiDAR templates in this SAGA-GIS project you will have additional tiles in the Data window to those shown.

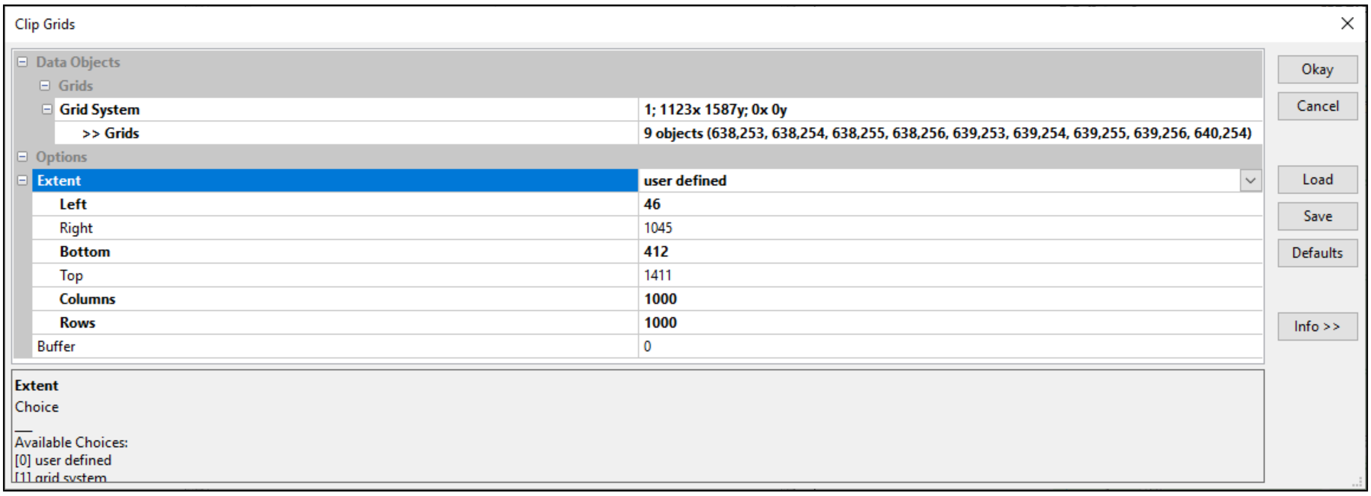


Now all the tiles can be cropped ("clipped") in one action. Find and open the "Clip Grids" tool. The next screenshot shows the correct tiles selected and the correct extent values entered.

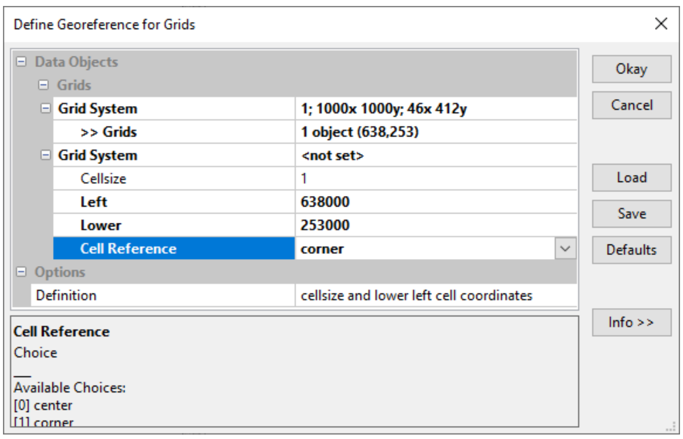
To crop the tiles to remove the margins you must enter 46 and 412 as the "Left", and "Bottom" values, and 1000 as each of the "Columns" and "Rows" values. If you enter the values in that order it prevents later entries wrongly auto-correcting earlier ones.

Note, with "Columns" and "Rows" correctly set to 1000, this automatically sets the Left-Right and Bottom-Top differences to 999 which is correct as they are measured centre-cell to centre-cell.

Click "Okay" (possibly twice) to run the tool. This will create a new grid system in the data window (above the old one) with all the tiles listed beneath. I check I have all the cropped tiles on the list and then delete the original uncropped list from the Data window – simplest by just deleting the old, un-cropped, grid system. The un-cropped tiles are still in your folder if you need them again. Retaining the old tiles can confuse, though new tiles with the same name should display in tool screens with eg "_1" suffixes.



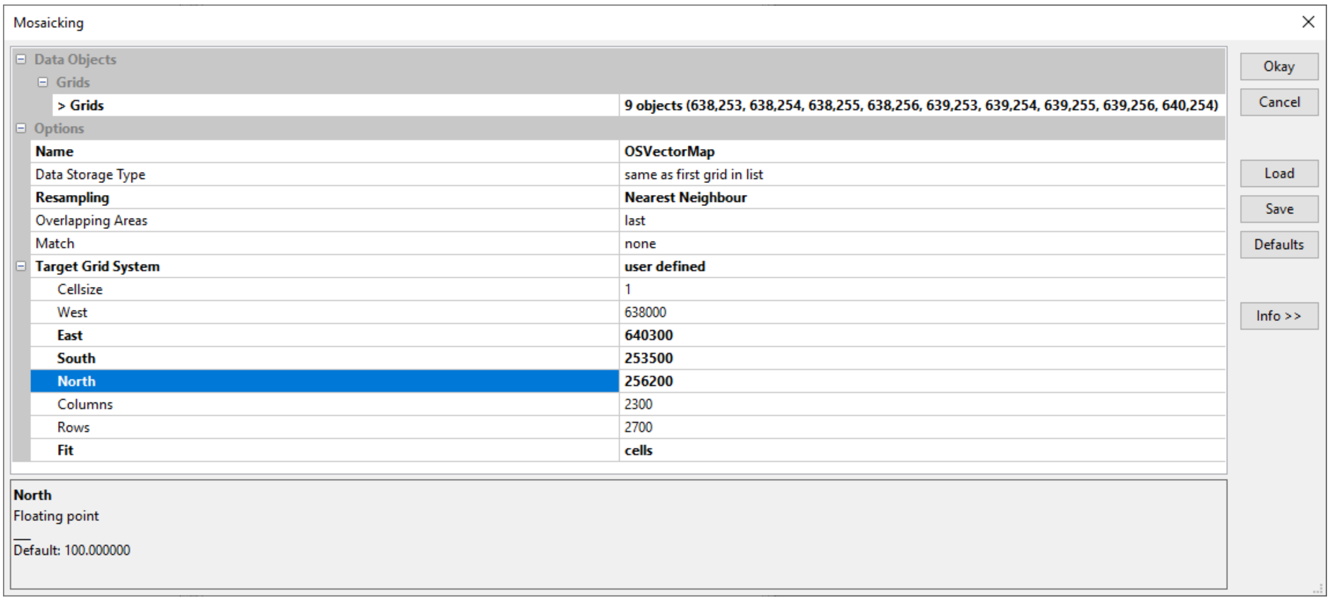
The next task is to assign the correct grid references to each tile which must be done individually. Find and Run the "Define Geo-Reference for Grids" tool. The screenshot opposite shows the first tile selected and the correct coordinates for this tile entered – easily found from the name of tile. **Note that "Cell Reference" must be set to "corner".** When re-running the tool for subsequent tiles the default values will be those set for the previous tile. So you must first select the new tile on the "Grids" line – easily forgotten. There is then often only one digit to change in the "Left" and "Lower" values.



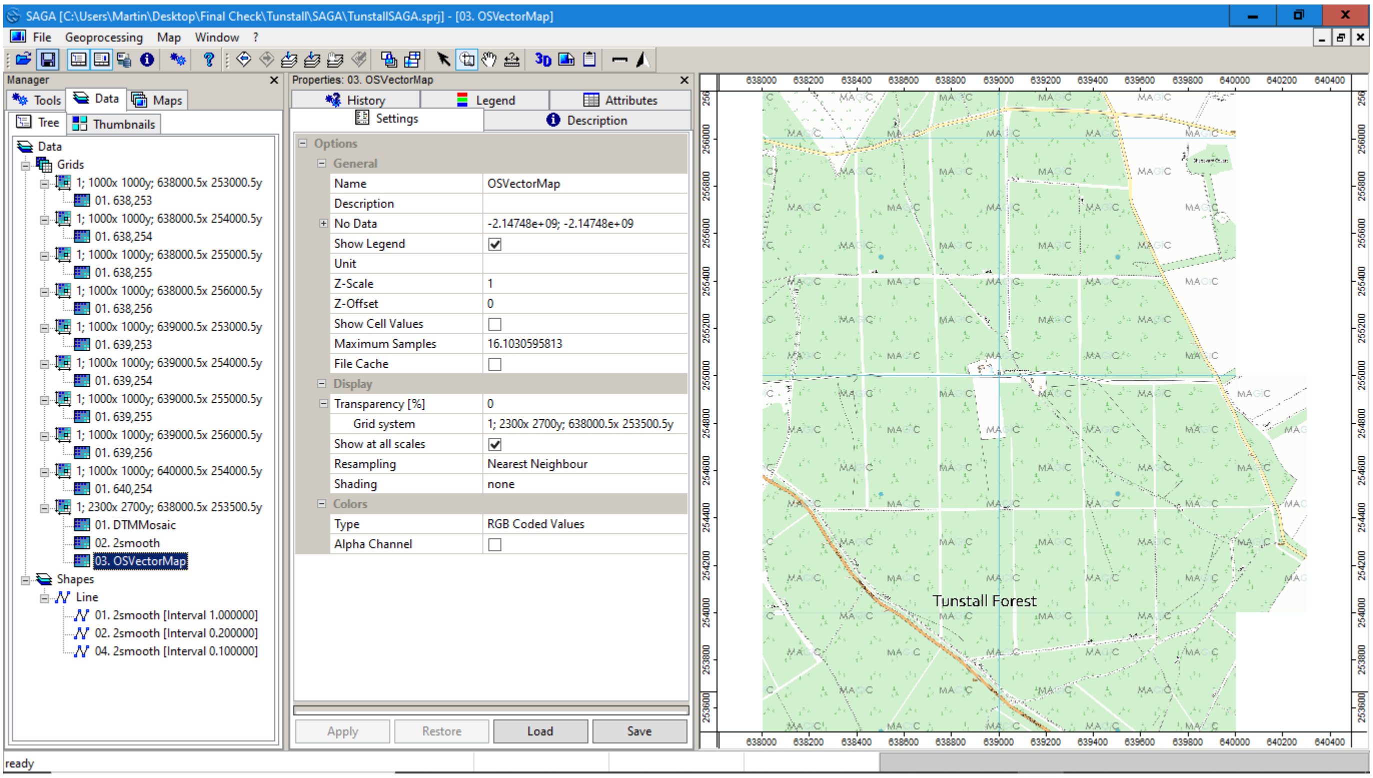
Once complete, each tile will be listed under its own grid system. Quickly check they're correct - the ".5"s which are added to each x and y value *are* correct - and then delete the previous list.

The last stage is to merge the tiles. Find and run the "Mosaicking" tool. Select all the tiles, as shown below, and adjust the "Target Grid System". If this is your first SAGA-GIS task with this project, select "User-Defined" and set "Fit" to "cells". Reset the "West", "East" etc, values to match your map footprint as shown. I've then named the output merged tile "OSVectorMap", and changed "Resampling" to "Nearest Neighbour". The other options don't work for images.

If you've already processed LiDAR data in this SAGA-GIS project you will already have the correct target grid system set. So select "Grid or Grid System" instead of "User Defined", select the correct grid from the drop down, and set "Target Grid" to "create".



Click "Okay" and you should see the job done, as below. I've double clicked the new tile to display the image in the Map window.



If the colours are wrong, reset “Type” in the Properties window to “RGB Coded Values”. On one occasion that failed to work for me, probably because I’d left one or more individual tiles with different colour types earlier on. I’ve not had a problem working systematically as above and leaving adjusting the “Type” setting till right at the end.

If there is any misalignment between the original tiles in the merged image, it may be because one or more were corrupted by panning the image in the MAGIC screen before downloading. If so, you can just redo the offending tile and reprocess.

Finally, delete the separate unmerged tiles leaving just the merged OSVectorMap tile and its grid system, plus, as in this screenshot, any other tiles generated previously. Then right click the OSVectorMap tile and “save image as” a .png file in your templates folder for this map. It will open in OOM as a correctly geo-referenced template.

Processing OS MasterMap Screenshot Images from Promap

The process described here will produce merged and geo-referenced base map templates in SAGA-GIS from a set of screenshot images from sites such as Promap. Once set up, I’ve found this process a little quicker and more reliable than the method I previously used which involved cropping and merging screenshots in imaging software such as Photoshop or GIMP, especially as I’m already using SAGA-GIS to process LiDAR data.

I currently only use this process for obtaining OS MasterMap templates from Promap. MasterMap screenshots are not free to view on Promap but are relatively inexpensive to purchase from the site. Some similar sites (eg MapServe) advertise free MasterMap views, but my experience is that the “free” offer expires after a limited number of views.

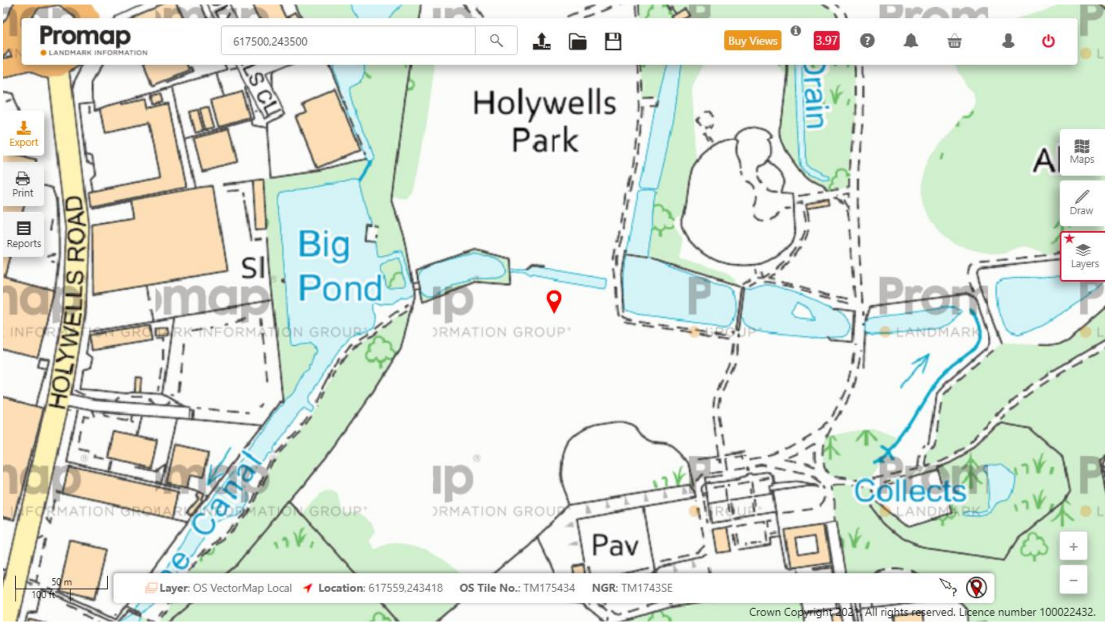
The process described here is not quick, and is probably only worth the effort if OS MasterMap offers detail that cannot be obtained from other sources and will save significant time in the field. This may well be the case when mapping for urban or sprint orienteering events. Because of the large scale of OS MasterMap the number of screenshots required escalates as the map footprint increases. I’ve used as my example for this chapter Holywells Park, a typical small urban park in Ipswich, where MasterMap offers helpful detail not available from other OS mapping. NB: Before using the method described here, it’s important to check that your final map will comply with OS copyright requirements.

There are a few preliminary tasks to set things up for your computer. These only need doing once. Readers are welcome to use my settings which should work for most laptops. The same settings can be used for larger-screen desktops, but you should be able to exploit the larger screen to reduce the number of screenshots required. I complete these preliminary tasks in Promap set to OS VectorMap Local view rather than MasterMap view. This avoids any unnecessary charges.

The first task is to confirm your computer’s screen display resolution – usually by accessing “Settings” from the Windows “Start” icon. Mine is currently set to its maximum resolution of 1366 x 768 pixels.

Then open Promap here – you may need to register - and enter appropriate coordinates in the rough vicinity of your map in the search bar. Alternatively, zoom out, pan to your map area and zoom back in. Use the mouse wheel to zoom.

Next select OS VectorMap - Local from the map layers list in the right side panel. The image can then be zoomed to show the 50m scale bar bottom left as in the first screenshot below. I’ve also set the image to Full Screen (Fn + F11 on my laptop) and minimised both side panels. If you see a text bar advising you to read the terms and conditions you should “accept” to remove the bar and increase the useable screen to its maximum.



Now, using the cursor and reading the cursor position off the bottom bar, I can confirm my "useable" screen dimensions in metres (allowing for cropping the redundant information in the margins). For my laptop screen at this zoom factor my useable screen area is 500m x 250m. On my wife's desktop I can get 700m x 350m. Round figures like this are useful. I've used 500m x 250m in my working below.

It's important to get the zoom factor right. Other map formats in Promap zoom through a different set of scales – this "50m" zoom scale is displayed in OSVectorMap and can be transferred to MasterMap when you're ready just by switching to MasterMap from VectorMap with the correct zoom factor set. I find this the most useful zoom factor, giving reasonably clear – not over pixelated – MasterMap templates, without needing too many screenshots to cover an average 1:4000 scale Sprint-O map footprint.

I now need to ascertain the scale factor of the on-screen image in pixels per metre. I've shown my working in appendix 2 at the end of this chapter. The correct value for this "50m" zoom setting is 2.30 pixels per metre. It appears to be set by Promap, and is independent of your screen's resolution.

A further piece of preparation, which only needs doing once, is to create a spreadsheet as in the following screenshot. I've included this as an attachment. It should need little adjustment. This should work for images on different computers, provided the screen display resolution is entered correctly.

Microsoft Excel - ScreenshotMerge

	A	B	C	D	E	F	G	H	I	J
1	Footprint	Min (m)	Max (m)	Tile Size (m)	Tiles	Screen (px)	Scale Factor	Tile size (px)	SW Corner of Clip	SAGA-GIS
2	X	617100	618100	500	2	1366	(pixels/metre)	1150.00	108	Cell Size (m)
3	Y	243100	243850	250	3	768	2.30	575.00	97	0.434782609
4										
5										
6	Centres of Tiles (Grid reference m)					SW Corners of aligned clipped tiles (px)				
7										
8	7	617350, 244975	617850, 244975	618350, 244975	618850, 244975	7	108, 4122	1258, 4122	2408, 4122	3558, 4122
9	6	617350, 244725	617850, 244725	618350, 244725	618850, 244725	6	108, 3547	1258, 3547	2408, 3547	3558, 3547
10	5	617350, 244475	617850, 244475	618350, 244475	618850, 244475	5	108, 2972	1258, 2972	2408, 2972	3558, 2972
11	4	617350, 244225	617850, 244225	618350, 244225	618850, 244225	4	108, 2397	1258, 2397	2408, 2397	3558, 2397
12	3	617350, 243975	617850, 243975	618350, 243975	618850, 243975	3	108, 1822	1258, 1822	2408, 1822	3558, 1822
13	2	617350, 243725	617850, 243725	618350, 243725	618850, 243725	2	108, 1247	1258, 1247	2408, 1247	3558, 1247
14	1	617350, 243475	617850, 243475	618350, 243475	618850, 243475	1	108, 672	1258, 672	2408, 672	3558, 672
15	0	617350, 243225	617850, 243225	618350, 243225	618850, 243225	0	108, 97	1258, 97	2408, 97	3558, 97
17		0	1	2	3		0	1	2	3
19										
20										
21										
22										
23										

Sheet1 / Sheet2 / Sheet3

I've entered details for my computer in the green cells. The tile size, screen resolution and scale factor in pixels/metre are as obtained above. I've also entered the bounding coordinates of my map footprint. If you've not already established those, this can easily be done in Promap in OS VectorMap - Local view.

The number of tiles required and size of each tile in pixels are calculated in the orange cells.

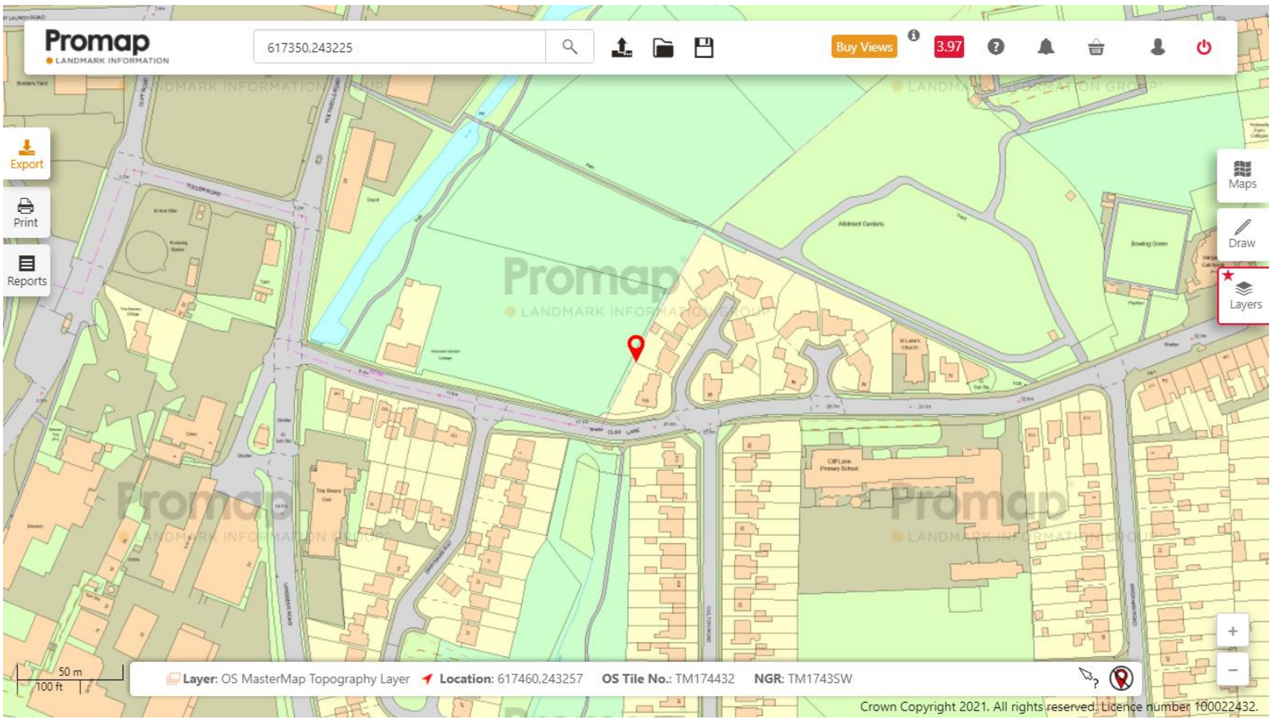
The remaining orange cells show the calculated coordinates in pixels of the SW corner of each cropped tile which is the same in each case – rounded up to whole pixels - and the cell size of the final template which is equal to the size of a pixel in metres. This is equal to the reciprocal of 2.30. It needs to be set accurately – hence the 9 decimal places.

The lower left hand grid then displays the centre points of each tile. I only require the 6 tiles I've shaded purple for this map footprint (1000m x 750m), but I've set up the spreadsheet to work with larger footprints if required – up to 2km square. This method is really too time-consuming to use with larger footprints. You can copy and paste the co-ordinates from the left hand grid to the Promap search box for each tile. The right hand grid is used in later in SAGA-GIS. That's the preliminary tasks complete, which only need doing once (unless you change computers).

To get my first screenshot from Promap (below) I've entered the 12 figure grid reference of the centre of my SW-most tile – as copied and pasted from my spreadsheet. I've then chosen OSVectorMap - Local in the right side panel, zoomed to the "50m" scale and checked I have the right tile. Use the mouse wheel to zoom. Only then have I selected OSMasterMap in the right side panel.

At this point you may be asked to pay for Promap screen views. You must register first, if not registered already, and then pay for a number of MasterMap "views". You don't require a new "view" for each screenshot – you may need a new paid view when you cross a 1km gridline, but I've not checked this for certain. The 6 screenshots I needed for Holywells Park required two paid views – approximately £2.00. This compares to a price of over £300.00 for a geo-referenced download of this footprint from Promap. The download price varies between urban and rural areas, urban being more expensive.

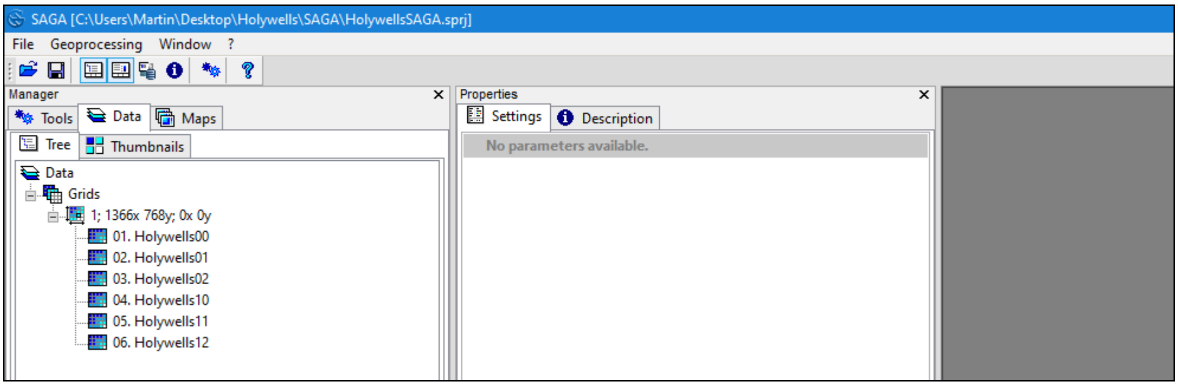
MasterMap should now open with the correct "50m" zoom factor, provided you've first selected OS Vectormap Local and zoomed to this scale. The red locator pointer should still be dead centre in the screen (provided you've not panned the map by mistake). The screenshot below shows the first tile, set up ready for copying, with both sidebars minimised, "Full Screen" set, and the terms and conditions bar closed. MasterMap displays the image slightly feint as shown, but for our purposes that's no issue.



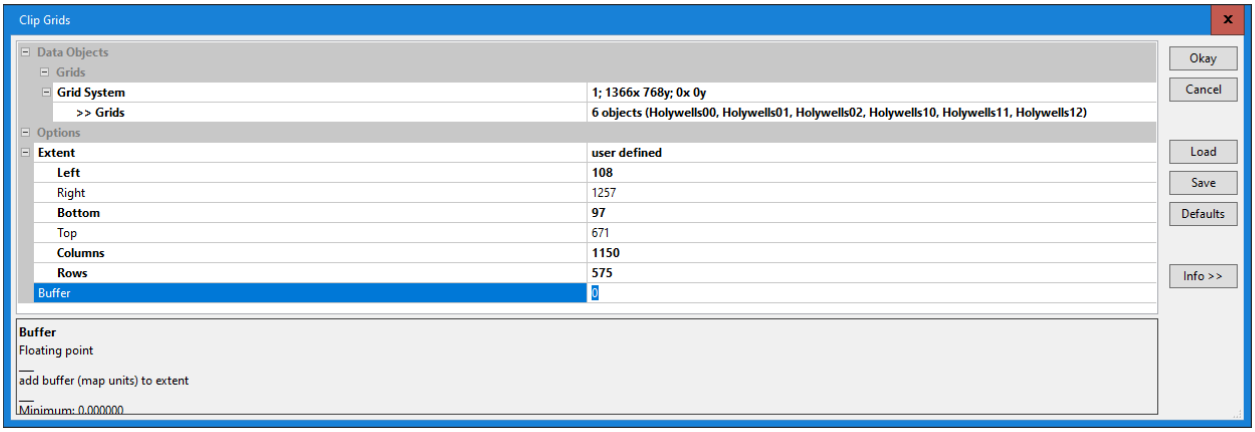
I repeat this process for each screenshot, copying the centre coordinates from my spreadsheet each time. After taking each screenshot (Alt + PrtSc) I save it in my “Maps” sub-folder in my current project folder. I do this by pasting the image into Microsoft Paint and then saving it as a .png file with an identifiable name ending 00, 01, 02, 10 etc. I understand GIMP can be used instead of Paint for pasting and saving. You may need to exit “Full Screen” in order to do this but don’t forget to return to “Full Screen” before each screenshot.

For this footprint I now have six .png files in my “Maps” sub-folder. Check that they are all different as it’s rather easy to create the same one twice by mistake. I then drag and drop these in one go into SAGA-GIS. I keep my spreadsheet open as I will need figures from the sheet to enter as parameters in SAGA-GIS. It’s worth keeping Promap open as well. Otherwise you may be deducted a further payment if you have to open Promap again later and re-enter MasterMap view.

The first SAGA-GIS screen is shown below.



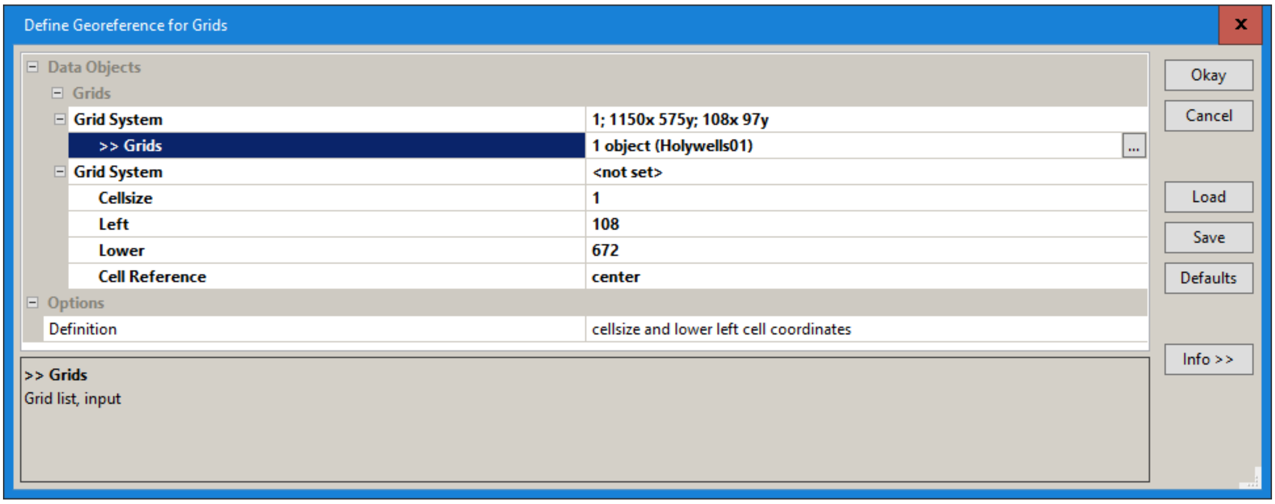
All 6 tiles have the same grid system (corresponding to my screen display resolution with the x, y origin at 0, 0). I can therefore clip (crop) them all in one go to remove the margins and leave my 500m x 250m tiles. This is analogous to the process described for MAGIC downloads above. To do this “Find and Run” the “Clip Grids” tool:



The screenshot shows all 6 tiles loaded. I’ve set a new user defined “Extent” with the “Left”, “Bottom”, “Columns” and “Rows” values (108, 97, 1150 and 575) entered from the spreadsheet. These are all measured centre cell which is why the automatically completed “right” and “top” values appear out by 1 in each case – the cropped tile will be centred correctly.

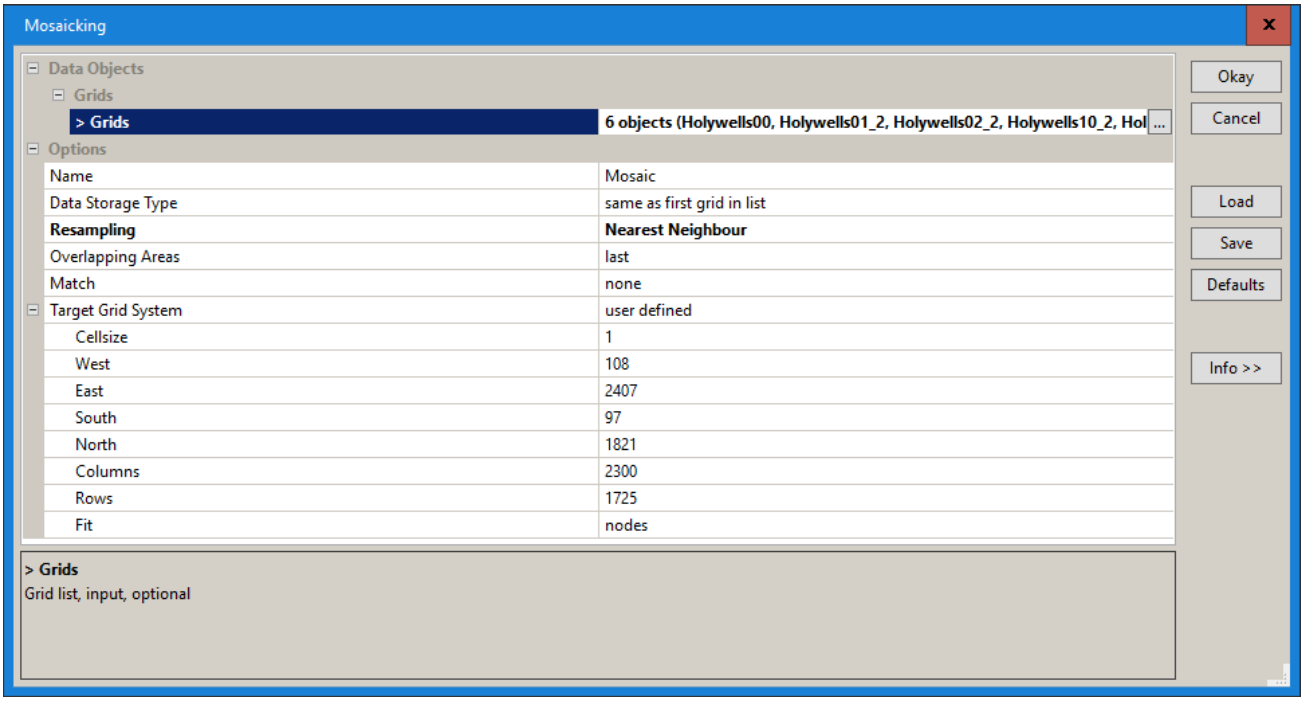
Click “Okay” and a new grid system will be generated in the Data window with the six cropped tiles listed. I delete the six un-cropped tiles from the Data window at this point - easiest by deleting their grid system - as it’s helpful not to keep tiles with the same name. They are still in my “Maps” folder if I need them.

It’s easiest now to merge the 6 cropped tiles while they still have their grid systems in pixels. But all except tile 00 need first to have their grid systems re-referenced so they merge in the correct relative location. Currently they will merge on top of each other. Do this with the “Define Geo-reference for Grids” tool. The screenshot below shows this set up for tile 01 (which may appear with a "_1" suffix). The "Left" and "Lower" values come from the right hand grid on the spreadsheet. The "Cell reference" should be left as "center" this time.

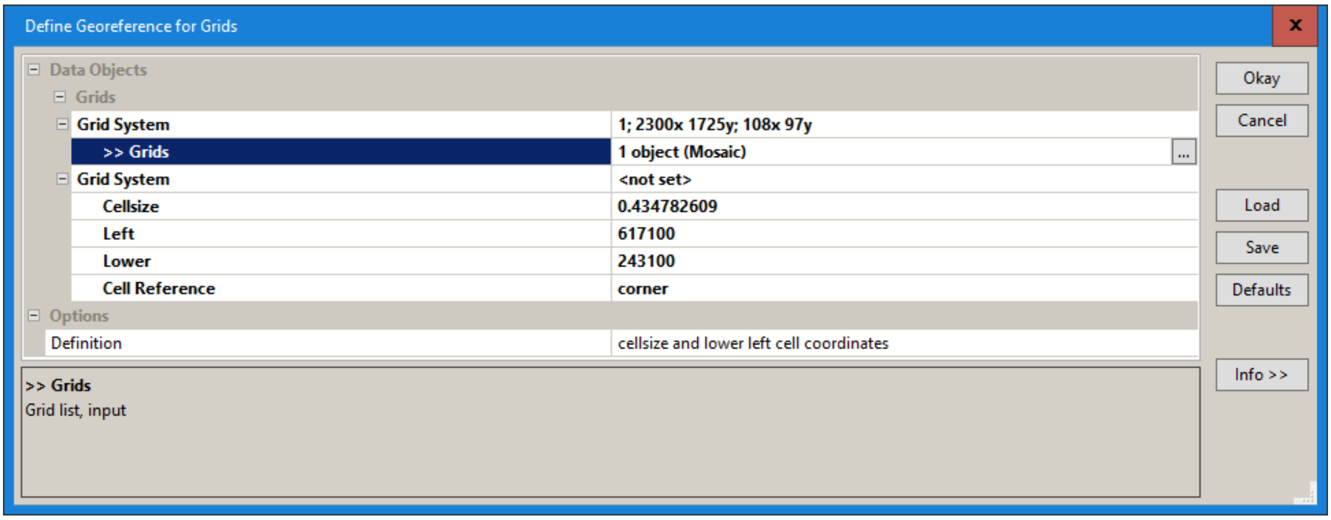


Repeat for the remaining tiles. The previous values show as default each time so some are preset for you. It's easy to forget to replace the previous tile in the "Grids" line though, which you need to do each time.

You can now use the "Mosaicking" tool to merge the six tiles. See the screenshot below. You first need to enter your six tiles – the five newly defined ones plus the "00" tile which hasn't required re-defining. SAGA-GIS has added a "_2" suffix to the names of the new tiles. Then, provided the above stages have been completed correctly, all the other parameters should be correctly entered as default. There should not need to be any resampling as all cells should match up along the tile borders, but I've changed the "Resampling" parameter to "nearest neighbour" just in case. The other options fail to work for images. "Fit" can be left set at "nodes" as all measurements are still in pixels. I've left the name as "Mosaic".

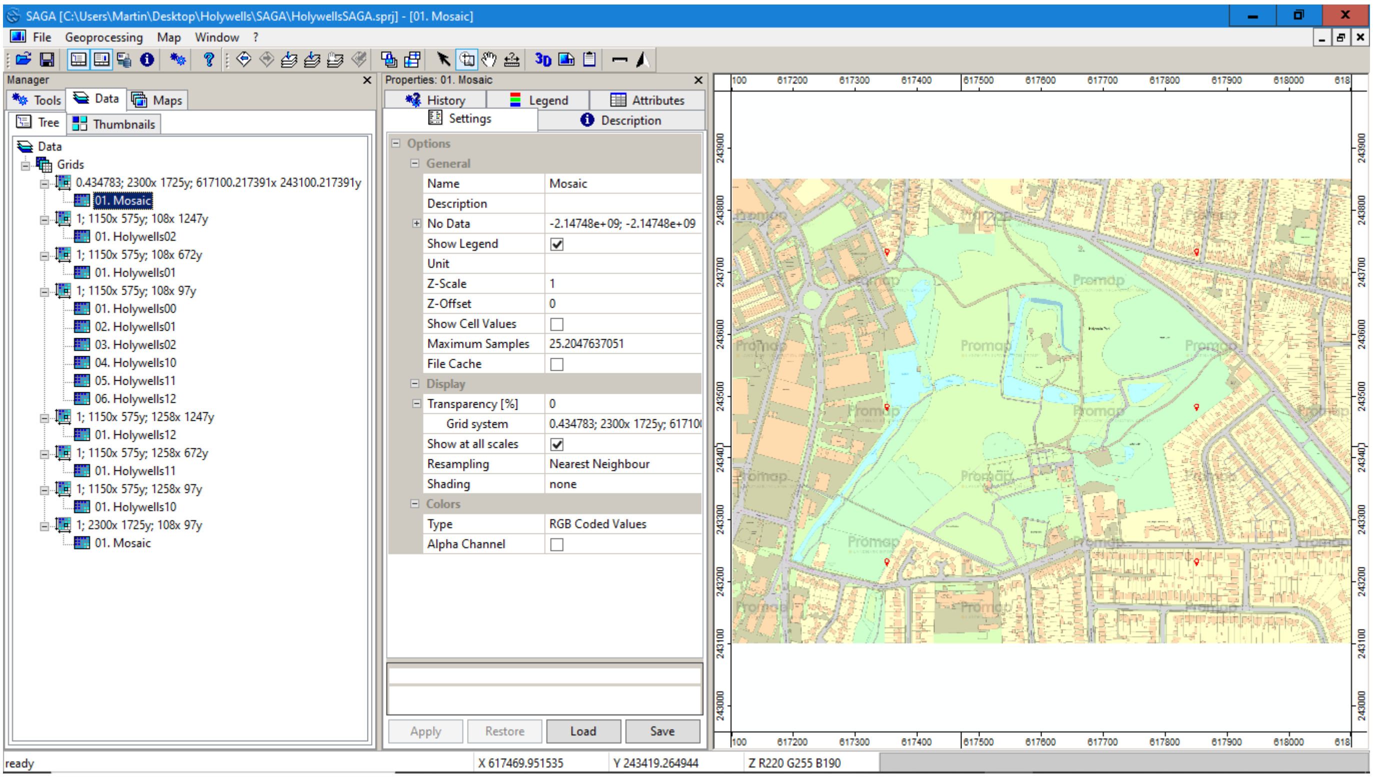


The final task is to geo-reference the new merged tile using the "Define Geo-reference for Grids" tool again.



I've selected the "Mosaic" tile in the "Grids" line. The "cellsize" must now be changed to metres using the accurate (9 decimal places) pixel to metre conversion value from the spreadsheet. The "left" and "lower" values are the grid reference of the SW corner of the footprint. This time "Cell reference" must be changed to "corner".

The next screen shows the new, geo-referenced, "mosaic" image displayed in the map window. I've changed "Type" to "RGB Coded Values". The default "Graduated Colours" displays the colours incorrectly. The new grid system has the new cellsize, and displays the x, y coordinates of the SW-most cell correctly as their centre-cell values.



You can then save the image as normal in the project's template folder. It will open correctly geo-referenced as a template in OOM. If there is any misalignment between the original tiles in the merged image, it may be because one or more were corrupted by panning the map before taking the screenshot. If so, you can take just the offending screenshot again and reprocess.

Appendix 1: Checking the Scale and X, Y coordinates are correct for your computer when processing OS VectorMap – Local downloads from MAGIC.

I'm fairly confident the X, Y values of 46 and 412 will work for all computers and all screen resolutions provided the scale is set to 1:3780 in MAGIC and the map tiles are downloaded in "A3 Portrait" format. That might cease to apply, of course, if the MAGIC site updates its download formats.

To check this you can load one downloaded A3 Portrait tile into SAGA-GIS, double click it to display its image and zoom right in to show just the SW-most grid line intersection. Best to zoom in so the axes show whole number coordinates. The gridlines will display more than one pixel wide at this magnification. For best results, the coordinates of the SW corner of the 1km tile should each be taken as the higher of the possible whole number values – these should read 46, 412. Checking the NE gridline intersection as well will confirm that you have the correct scale (1 pixel per metre or 1000 pixels per km). This time, the lower or middle whole number value is fine, and the differences with the SW corner should be 999, not 1000, because they are measured centre cell to centre cell. So 1045, 1411 is correct.

If this is not correct, a first possibility to check is that you might have unwittingly panned the image slightly in the MAGIC screen and moved the blue dot off-centre. So check a different download. If still not correct you may need to adjust the figures by trial and error. Or, of course, you can try merging in Photoshop, GIMP, or similar, or accept multiple templates.

Appendix 2: Obtaining the Scale Factor (pixels/metre) for use with MasterMap screenshots from Promap.

You should only need to read this appendix if you find that a scale factor of 2.3 does not work on your computer (for example if Promap updates its site). This note explains how I arrived at this figure.

A quick way to do this is to record the x coordinates of the left and right edges of the on-screen Promap image to obtain a measurement of your full screen width in metres at the chosen zoom factor. This is best done with Promap displaying OS VectorMap Local which zooms to show the correct 50m scale bar. On my laptop the screen width at this zoom factor is 593m. Dividing my horizontal screen resolution (1366 pixels) by this figure gives an approximation of the scale factor, in this case 2.3035 pixels/metre.

For extra accuracy I halved the Promap zoom factor to "100m" on the scale bar. The screen width was now 1187m, suggesting a truer result at the "50m" zoom factor would be 593.5m (only whole number coordinates are displayed in the bottom bar). That gives a better approximation for the scale factor of 2.3016 pixels/metre. Further accuracy is not relevant as the limiting factor governing how accurately the screenshot images can be processed is the fact that the width and height of the cropped screenshot must be a whole number of pixels. A value of 2.30 for the scale factor gives 1150 pixels for the 500m tile width and 575m for the 250m tile height. There's no need to be more accurate, even if it was possible. In practice these figures produce templates without noticeable joins and with an accuracy better than 1m across the map.

I've checked this at other screen resolutions by adjusting my laptop's display settings and also by repeating the exercise on my wife's desktop. The scale factor varies with the Promap zoom factor, as expected, but is independent of your screen resolution.

With a scale factor of 2.30 pixels per metre, you could increase the tile dimensions from 500m x 250m, for example to maximise tile size on a larger computer screen, and still retain whole number values for the tile dimensions in pixels, provided your tile dimensions in metres are both multiples of ten.