# LiDAR Data Extraction

### Contents

QGIS Installation1
2 Dbtaining LiDAR data
Processing the Data
solate the data for your map area6
Merging tiles
Cropping the map7
Select by name
Select by cursor
Extract the contours
Extracting Vegetation Boundaries13
mporting the contours into OOM14
Creating a new OOM map15
Appendix 1 – Creating/Editing a shape file18

### **QGIS** Installation

To start with you need QGIS. This is a free download. https://qgis.org/en/site/forusers/download.html

The current version is 3.12 and is the one used for this document.

Once you have QGIS loaded you should set up some plug-ins. These are extra features which will help you as you review the data. Start QGIS and click on the 'Plugins' option of the main menu and select 'Manage and Install Plugins...'. This dialog box will appear.

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	🍅 Mappia Publisher		OuiskMan Comisson 🍈
Installed	net State American St		QuickMapServices 🕕
Not installed	Physiocap3		Collection of easy to add basemaps
	Planet_Explorer		collection of easy to and basemaps
Invalid	Quick Attribution		Convenient list of services + search for finding
install from ZIP	✓ ⊕ QuickMapServices	_	datasets and basemaps. Please contribute new services via http://gms.nextgis.com! Built by
	QuickMultiAttributeEdit3		NextGIS.
Settings	V 🔝 QuickOSM		
	QuickPrint		
	QuickWKT		Tags service, internet, tms,
	sectanglify		wms, qms, wfs, geojson,
	sed Layer		openstreetmap, osm,
	Species Explorer		4 >
	VoGIS-ProfilTool		Upgrade All Uninstall Plugin Reinstall Plugin

Scroll down the list and install QuickMapServices and QuickOSM.

## Obtaining LiDAR data

Go to the DEFRA website - <u>https://environment.data.gov.uk/DefraDataDownload/?Mode=survey</u>

DEFRA DAT	A SERVICES I	PLATFORM	APIs	APP GALLE	RY SUR	VEYS C	ONTACT US	•			
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sk!	50ne	031	XQW	SK3 INE	SK41NW	SK41NE	SK51NV	Download your data		*	
Sho	SK21SW	SK21SE	SK31SW	SK3 1SE	SK41SW	SK41SE	SK51SV	Select your	area		
ed SK10NE	SK20NW	SK20NE	SK30NW	SK3 ONE	SK40NW	SK40NE	A50 SK50NV M1	Drag a .zip shapefile her	re or use	the	
SK10SE	Tamworth SK20SW Fazeley	SK20SE	SK30SW	SK3 0SE	Market SK405W	SK40SE	SK50SV	"Click to Upload" button			
SP19NE	SP29NW	SP29NE	SPSSNW	SP39NE	SP49NW	SP49NE	M69 SP59NV	Zip must include .shp, .shx	, .dbf, .p	rj files	

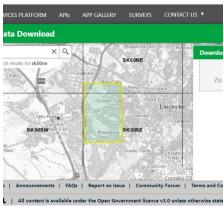
Use your mouse to navigate to the grid square containing the area of interest.

In the 'Download your data' window scroll down and locate the drawing tool. I normally use the polygon tool.



#### Download your data

In the map window draw a shape round the area of interest (here I am looking at Western Park in Leicester).



In the 'Download your data' window click on 'Download data'.

The window will display a list of available files.

In the product box select 'National LiDAR Programme DTM', select the latest year and 1m resolution.

Download your data	*	>
Download your data		
Product:		
National LIDAR Programme DTM	•	
Year:		
2018	•	
Resolution:		
1M	•	
Available Tiles		
National-LIDAR-Programme-DTM-2018-SI	<50ne	
National-LIDAR-Programme-DTM-2018-SI	K50se	

The National Programme is the latest data.

The available tiles appear at the bottom of the box. You need all the tiles for your area. For example Western Park is in 2 grid squares so two tiles are required. Click on each tile to download it. These files are large so ensure you are not using mobile data.

Repeat with the DSM files.

The downloaded files are zip files each containing a large TIF file containing the LiDAR data. Extract the files into your working folder

Name	Date modified	Туре	Size
DSM_SK5500_P_10723_20180126_20180207.tfw	02/08/2019 20:26	TFW File	1 KB
DSM_SK5500_P_10723_20180126_20180207	02/08/2019 20:26	TIF File	46,228 KB
DSM_SK5505_P_10723_20180126_20180207.tfw	02/08/2019 20:26	TFW File	1 KB
DSM_SK5505_P_10723_20180126_20180207	02/08/2019 20:26	TIF File	44,846 KB
DTM_SK5500_P_10723_20180126_20180207.tfw	02/08/2019 20:27	TFW File	1 KB
DTM_SK5500_P_10723_20180126_20180207	02/08/2019 20:27	TIF File	39,044 KB
DTM_SK5505_P_10723_20180126_20180207.tfw	02/08/2019 20:26	TFW File	1 KB
DTM_SK5505_P_10723_20180126_20180207	02/08/2019 20:26	TIF File	38,775 KB

### Processing the Data

#### Start QGIS

Start a new project and save the project file (e.g. with your data).

Click 'Project/Properties' in the top bar and this dialogue will open ...

	Project Coordinate Reference System (CRS)	
General	No CRS (or unknown/non-Earth projection)	
Metadata	Filter Q	
CRS	Recently Used Coordinate Reference Systems	
	Coordinate Reference System	Authority ID
Default Styles	OSGB 1936 / British National Grid	EPSG:27700
Data Sources	WGS 84	EPSG:4326
	* Generated CRS (+proj=tmerc +lat_0=49 +lon_0=-2 +k=0	USER:100026
Relations		
Variables	Predefined Coordinate Reference Systems	Hide deprecated CRS
Macros	Coordinate Reference System	Authority ID
OGIS Server	OCRS Salem NAD 1983 CORS96 TM Meters	ESRI:102548
QOIS SEIVEI	OCRS_Santiam_Pass_NAD_1983_CORS96_TM_Fe	ESRI:102519
	OCRS_Santiam_Pass_NAD_1983_CORS96_TM_M	ESRI:102549
	OSGB 1936 / British National Grid	EPSG:27700
	4	Þ
	OSGB 1936 / Mrithh Hatonal Gnd WKT GRAL 1026 / Mrithh Hatonal Gnd GRAL 1026 / Disk / Frisinh Hati GRAL 1026 / Disk	
	▼ Datum Transformations	
	Ask for datum transformation if several are available (defined in glo	obal setting)
	Source CRS Destination CRS Operation Allow Fallback Tran	nsforms
	EP5G:4326	

Select 'OSGB1936/British National Grid – ESPG:27700' and click on 'OK'.

Bring the first DTM layer in as a raster layer. Click 'Layer/Add Layer/Add Raster Layer' in the top bar or Ctrl + Shift + R.

This dialog box will appear:

Q Data Source Manager   Raster	×
🛅 Browser	Source type
V. vector	File      Protocol: HTTP(S), cloud, etc.
Raster	
Mesh Mesh	Source
🤊 Delimited Text	Raster Dataset(s) var Leicester (NationalData \P_10723 \DTM_SK5500_P_10723_20180126_2018 207.tif
🍄 GeoPackage	
📿 SpatiaLite	
🗣 PostgreSQL	
MSSQL	
📮 Oracle	
DB2 DB2	
🌠 Virtual Layer	
🧟 WMS/WMTS	
🚑 wcs	
🙀 WFS	
🚒 ArcGIS Map Server	
ArcGIS Feature Server	
👫 GeoNode	Close Add Help

Use the '...' box to bring up the file selection dialog. Select one of the DTM TIF files.

Click the 'Add' button

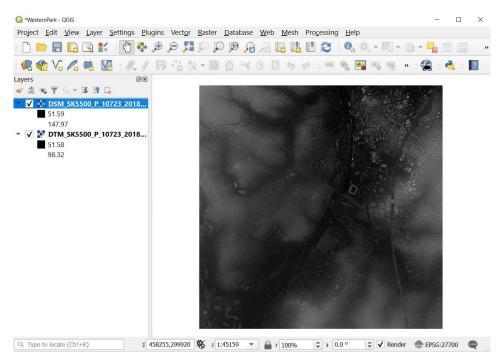
The Grid transformation window will open. Accept the transformation offered and click OK

Watch the progress bar at the bottom as the data is processed.

Repeat the 'Add' process to add the DSM layer.

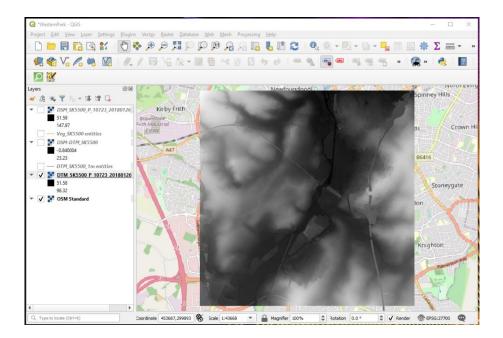
You now have two raster layers in the QGIS tool.

Note that you can also 'drag and drop' the TIF file into the QGIS window and it will open and create the raster layer. You may also be able to do this with the uploaded zip file.



Try unticking the layers to see the monochrome image.

To see a map of the area under your image select 'Web' from the top menu followed by 'QuickMap Services' then 'OSM' and 'OSM Standard'. This enables the OpenStreetMap layer which can be switched on and off as any layer as shown below.



### Isolate the data for your map area

To save repetitive operations and lengthy operations it is advisable to join the tiles together and then crop to the area you are working on.

#### Merging tiles

For example, Bradgate spans two tiles. From the top menu select 'Raster', 'Miscellaneous', 'Merge'.

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ayers 🛛 🗶			
· @ ≪ ▼ % × II II □	Q Merge	×	
DSM SK5010 P 10723 201			
52.15	Parameters Log		
252.85	Input layers		
— <u>Contours</u>	0 elements selected		
DTM_SK5010_SK5510_Merged	o elements selected		
-48.5	Grab pseudocolor table from first layer		
248.14	Place each input file into a separate band	Q Multiple selection	×
V DTM_SK5510_P_10723_201		Multiple selection	^
-48.52	Output data type	DTM_SK5010_SK5510_Merged [EP	Select All
110.82	Float32	DSM SK5010 P 10723 20180126	Select All
- SK5010 5m SS entities	Advanced parameters	✓ DTM_SK5010_P_10723_20180126_	Clear Selection
SK5010 1m SS2 entities	Merged	I DTM CKEE10 D 10700 0010010C 1	Toggle Selection
✓ ▼ DTM SK5010 P 10723 201			oggie selection
52.18	[Save to temporary file]		Add File(s)
249.08	✓ Open output file after running algorithm		Add Directory
215.00			Add Directory
	0%		ОК
	0%0	-	Cancel
	Run as Batch Process Run Close		Cancer
		•	

In the 'Input Layers' click the '...' button to open the 'Multiple selection' dialog. Select the raster layers you wish to merge.

Set the 'Merged' output file you wish to use. (if you don't do this the merged file will go as soon as you close the QGIS session.

Click on the arrow to the left of 'Advanced Parameters' to show the extra settings. Set the 'nodata' value to 0 as shown below.

Not set	٢
	V
Assign specified "nodata" value to output [optional]	
0	
Additional creation options [optional]	

Click the 'Run' button and wait for the processing to complete before clicking the 'Close' button.

Repeat this process for the DSM layer tiles. It helps to give the new merged layers meaningful names in the list on the left hand side. You will now have a merged DTM layer and a merged DSM layer. Save the project.

### Cropping the map

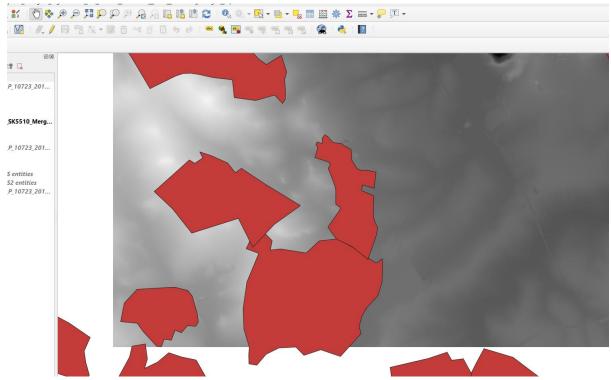
Obtain the area files from the LEI mapping group. These are vector files of LEI orienteering areas. (All files need to be in the same folder - .shp is the shape file but the .dbf & .shx are needed to make it work).

		V 🖸 Search LiDA	ik Bradgate	Q
Name	Date modified	Туре	Size	
LEI_Areas.dbf	11/10/2019 20:46	DBF File	7 KB	- 1
LEI_Areas.prj	11/10/2019 20:46	PRJ File	1 KB	- 1
LEI_Areas.shp	1 <b>1</b> /10/2019 20:46	DWG TrueView Shape Source	28 KB	
🙆 LEI_Areas.shx	11/10/2019 20:46	DWG TrueView Compiled Shape	1 KB	

Open the LEI\_Areas.shp file as a new vector layer

🛅 Browser	Source Type		
Vo Vector	File      Directory      Database	e 🔿 Protocoj: HTTP(S), cloud, etc.	
Raster	Encoding	UTF-8	*
🎬 Mesh	Literoning .		
Delimited Text	Source		
🙀 GeoPackage	Vector Dataset(s) C:\Users\Simon\I	esktop\LiDAR Bradgate\LEI_Areas.shp	G
尾 SpatiaLite			
RostgreSQL			
MSSQL			
Q Oracle			

This screen shot shows the 'Bradgate' example overlaid with the LEI\_Areas shapes



As you can see all the areas are shown.

Ensure the LEI Areas is the currently selected layer (highlighted in the layer list on the left). From the 'View' top bar menu select 'Show Map Tips' (also available as an icon on the next menu bar down). Now when you hover the mouse cursor over an area the area name will appear. If this does not occur right click on the layer in the list on the left and select 'Properties'. Select the 'Display Name' page (The page (The page (The page to bottom left)) and ensure the field 'Name' is selected to display. See below.

Q Lay	r Properties - LEI_Areas   Display ×
Q	Display Name
<b>()</b>	abc Name v E
્રે	The feature display name is used in identify results, locator searches and the attribute lable's dual view lab.
*	HTHL Hep Tip
-	[% "Name" %]
ഞ	
۹.	
<b>*</b>	
<ul> <li></li> <li></li></ul>	
•	( )
a)	v E Inset
٢	The HTML map tips are shown when moving mouse over features of the currently selected layer when the 'Show Map Tips' action is toggled on. If no HTML code is set, the feature display neme is used.
Ψ.	Style * OK Cancel Apply Help

If you feel so inclined you can have a each area permanently displayed. In the same properties screen go the Labels page (\_\_\_\_\_\_). Set the 'Value' field to 'Name'as shown below.

(etc. Single Labels					Ŧ
Value abc Name					Ŧ
▼ Text Sample					
Lorem Ipsun	n				
Lorem Ipsum			<b>5</b> 1:9616	- 12	
abo Text	Placement				
<pre>*ab Formatting</pre>	Offset from centroid	Horizontal			
abo Buffer	Around centroid	Free			
Background	O Using perimeter	O Using perimeter (curved	)		
Shadow abo Callouts	Centroid   visible polygon	whole polygon			€
Placement	Force point inside po	olygon			
🖌 Rendering	Distance 0.0000			\$	€
	Milimeters			•	¢
	Geometry generator				
	<ul> <li>Geometry generator</li> </ul>				

The next step is to select the area shape you wish to use.

Two methods are available:

#### Select by name

Each area has been named. In the left hand QGIS window right click on the 'LEI\_Shapes' layer and select 'Open Attribute Table'. This brings up a dialog box with the area names. Scroll through the list to find the area you require and left click on the line number. The example below shows the selection of the Bradgate area which is now highlighted in yellow.

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\$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$					
LEI Areas					
DSM_SK5010_P_10723_201	Q LEI_Area	as :: Features Total: 68, Filtere			
52.15 252.85	/ 🛛 🖶 🕻	3 1 🖷 🗇 🕜 🖄 1 🗞 🗮 🖸	🖕 🝸 🖀 🌺 🗩 »		
- Contours	id	d Name	<b>^</b>		
DTM_SK5010_SK5510_Merg	28	Leicester Gram			
-48.5					
248.14 DTM_SK5510_P_10723_201	29	Ambion			
-48.52	30	Spinney Hill			
110.82 — SK5010_5m_SS entities	31	Elizabeth			
SK5010_1m_SS2 entities	32	Sence Valley			
DTM_SK5010_P_10723_201 52.18	33	Swithland			
249.08	34	Bradgate			
	35	Johns Lee			
	36	Beacon Windmill			~~
	Show All F	Features	3		-
				•	
				r	

Select by cursor Left-Click on the select using cursor icon



Click on the area you wish to use and it will be highlighted. (if you open the attribute table as described above the name of the area you have highlighted will be selected)

The area you wish to use should now be highlighted. If the area you wish to use is new or not defined refer to appendix 1 on creating/editing a shape file

🔇 Clip Raster by Mask Layer				×
Parameters Log				
Input layer				-
TTM_SK5010_SK5510_Merged [EPSG:27700]		-	…	
Mask layer				
C LEI_Areas [EPSG:27700]	-	…	)	
✓ Selected features only				
Source CRS [optional]				
		-	-	
Target CRS [optional]				
		-	-	
Assign a specified nodata value to output bands [optional]				
Not set			\$	
Create an output alpha band				
$\checkmark$ Match the extent of the clipped raster to the extent of the mas	sk layer			
<u> </u>				•
0%			Cance	
Run as Batch Process Run	Close		Help	
		-	-	-

From the QGIS menu select Raster / Extraction / Clip Raster by Mask Layer. The dialog box below will appear.

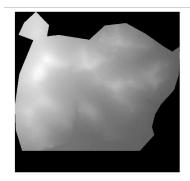
Pull down the Input layer list by clicking on the arrow at the right end of the dialogue box. Select the merged layer you wish to crop (It is here that sensible layer naming becomes and advantage).

Pull down the Mask layer list by clicking on the arrow at the right end of the dialogue box. Select the LEI-Areas layer. Double click this dialog box to allow you to select the 'selected features only' tick box.

Finally scroll down to 'Advanced Parameters' and set the output file. Click on the '...' button on the right and select 'save to file'. In the standard file dialog you will name the TIF output file.

Click the 'Run' button and allow the process to complete (it may take some time).

Click 'Close' when the process finishes. The cropped TIFF file will be shown as a new layer. Give the new layer a descriptive name. Untick the other areas to show the new cropped layer. The areas outside the selected area may show as black.



Repeat the process for DTM and DSM layers.

As an alternative see Apendix A – Creating Your own Shape file

### Extract the contours

In the layer list on the left of the QGIS desktop select the merged and cropped DTM layer.

From the 'Raster' menu select 'Extraction' / 'Contour'. The following dialogue will appear:

Parameters Log
Input layer
<pre>PTM_SK5500_P_10723_20180126_20180207 [EPSG:27700]</pre> <pre></pre>
Band number
Band 1 (Gray)
Interval between contour lines
1000000 🖾 :
Attribute name (if not set, no elevation attribute is attached) [optional]
ELEV
Offset from zero relative to which to interpret intervals [optional]
0.000000 🚳
Advanced parameters Contours
[Save to temporary file]
✓ Onen output file after running algorithm

Set the interval between contour lines. It is suggested that you use a smaller gap that the final map so that intermediate detail can be mapped using form lines. I tend to use 1m contours.

Scroll down to the 'Advanced Parameters' and click the small arrow to show the extra features. Set the 'Input pixel value to treat as "nodata"' to 0. This prevents a border round the contour plot.

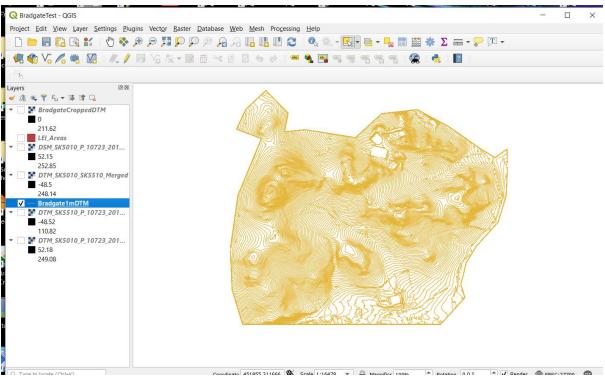
Move down to 'Contours' and set the output file. It is recommended that the file is stored as a '.SHP' file. This file can be read directly by OpenOrienteer Mapper.

Click 'Run'. Allow the process time to run:

Execution completed in 7.66 seconds Results: ('OUTPUT': 'C:/Users/Simon/App processing_3ca06b94e82d4b01914 OUTPUT.shp')	Data/Local/Temp/ 1009024420afdb/f21bbcf7425248fa929b4b77174208	d1/
Loading resulting layers Algorithm 'Contour' finished		
	6	8
	0%	Cano

You will now see the contours added to the list of layers. Give the layer a sensible name.

NB for use in older versions of Ocad you will need to export as a DXF file. Ensure the 'Attribute name' field is clear before running conversion.



Switch off the other layers to see the generated contours.

The resulting georeferenced SHP file can be imported into Ocad or used as a template in OOM.

## Extracting Vegetation Boundaries

The vegetation can be deduced by subtracting the DTM layer from the DSM layer leaving a result that shows the height above the ground level.

Result Laye Raster Bands DSM\_SK5500\_P\_10723\_20180126\_201802 Output laver alData\DSM-DTM\_SK5500 @ Output format GeoTIFE Selected Layer Extent X min 455000.00000 🗘 X max 456900.00000 \$ Y min 302500.00000 Y max 305000.00000 \$ \$ Rows 5000 Columns 5000 \$ Output CRS EPSG:27700 - OSGB 1936 🔻 🏾 🌍 ✓ Add result to project 4 Operators 
 cos
 sin
 tan
 log10

 acos
 asin
 atan
 In
 ( sqrt <= >= != "DSM\_SK5500\_P\_10723\_20180126\_20180207@1" "DTM\_SK5500\_P\_10723\_20180126\_20180207@1" Expression valid OK Cancel Help

Select 'Raster' / 'Raster Calculator'.

To set up the process use the '...' button to setup an output file.

The X/Y values have been set up to process only the area of interest. Theses value can be worked out from the main screen before initiating this window (move the cursor and observe the coordinates bar at the bottom of the screen). In this instance the Western Park area has been selected.

To set up the expression first in the 'Raster Bands' window double click on the DSM layer, then click on the '-' button, finally double click on the DTM layer. This will generate the expression as shown in the screen shot above. Click 'OK' to generate the output as a new raster layer.

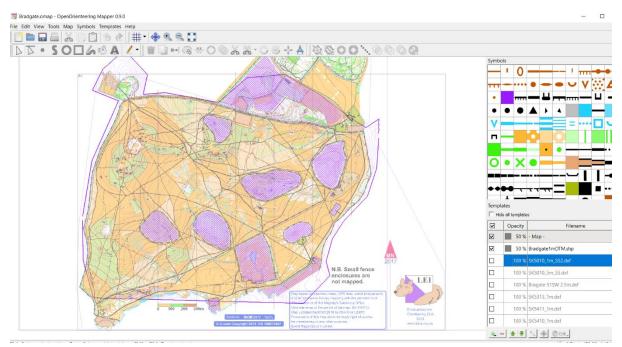
Once the raster layer has generated extract the layer contours as before to generate a SHP file that can be brought into the mapping program.

### Importing the contours into OOM.

This method assumes you already have a georeferenced OOM map of the area and are going to use the LiDAR data to update/correct the map.

Open the map and open the template setup window (Templates/Open Template Setup Window from the main menu or Ctrl+Shift+9.

From the main menu select Templates/Open Template (or click the icon in the template window). Select the .SHP file created earlier. Accept the default settings offered by the dialogue box. The contours will now appear as a template beneath your map. When working with templates set the opacity in the Template Setup Window to 50% so you can see the contours through the map.



Note that we have imported contours here at 1m intervals and the final map only needs 5m contours. This allows the mapper to select the contour lines that best express the landscape. The mapper can also use the intermediate contours to create form lines to fill in missing detail. It is permissible to slip up or down a contour across the map if it helps paint a better picture for the orienteer.

Make sure the final map has the environment agency copyright notice acknowledging the use of the LiDAR data.



Use the date of the data in the copyright notice. (Up to date copyright symbols are available in the Mapping Resources on the BOF website <a href="https://www.britishorienteering.org.uk/mapping\_resources">https://www.britishorienteering.org.uk/mapping\_resources</a>)

Page 14 of 18

### Creating a new OOM map

Once you have generated the LiDAR extract for your area it can be used to create a georeferenced OOM map.



Start your OOM application. From the opening screen select 'Create a new map'.

This dialog box will now open.

🗱 Create new map - OpenOrienteering M $ imes$
Choose the scale and symbol set for the new map.
Scale: 1 : 10000
Symbol sets:
Empty symbol set
Course_Design_10000
ISMTBOM_10000
ISOM 2017-2_10000
ISSkiOM 2019_10000
Load symbol set from a file
$\overleftarrow{\mathbf{\nabla}}$ Only show symbol sets matching the selected scale
🔶 Create Cancel

Choose the map scale you wish to use and the symbol sets available for that scale will be displayed. So in this example we are setting out to draw a map at 1:10,000 using the ISOM2017-2 symbol set. The symbol sets have been drawn in conjunction with the IOF mappers so the symbols and colours are to specification. Select 'Create' to open your new map.

10 Unsaved file - OpenOrienteering Mapper 0.9.2											-			×
File Edit View Tools Map Symbols Templates Help														
🗋 🖿 📇 🗇 🗊 🗐 🗇 🖉   # • 🔶 🔍 🕰 🎦														
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			۷	٨		•					11	4	4	籢
Ready to draw!	1	•				8	F							
Start drawing or load a base map. To load a base map, click		•	~	,		8	88		8			-	Π	Ш
Templates -> Open template		-			 c	) •	×	: [		μ		<u></u>		-
Hint: Hold the middle mouse button to drag the map,				-				_	-	• •	+		ŧ.	_
zoom using the mouse wheel, if available.	v	I	-	•	• •	• •		• •	- 11			Ш	<u> </u>	
				E	-		H		0	+	т	0	Ť	<b>→</b>
	<b>→</b>	0	×	-		-	-1	-	-1	÷	•	321	5	ÞOC
	-													-
Click: Select a single object. Drag: Select multiple objects. Shift+Click: Toggle selection.										9,	1x	71.31	18.07	(mm)

Here you can see the symbol set and some hints to get going. The next step is to use your LiDAR extract as the base map.

Click on 'Templates' and select 'Open Template'. Select the .shp LiDAR contour file that you created earlier.

OOM recognised that this is the first base map and uses it to derive the georeferencing. This screen will open:

3 Map Georeferencing	- OpenOrienteering Mapper master v20200411.3
Map coordinate referen	ce system
Coordinate reference system	m: by EPSG code
EPSG code:	27700
Status:	valid
Reference point	
Map coordinates:	0.00 mm X 0.00 mm Y Pick on map
EPSG 27700 coordinates:	473178.39 m 🔹 E 334725.29 m 🔹 N
Geographic coordinates:	52.90499032 ° · N -0.91342796 ° · E (Datum: WGS84
Show reference point in:	OpenStreetMap   World of O Maps
On CRS changes, keep:	O Projected coordinates
	Geographic coordinates
Map north	
Declination:	0.00 ° Lookup
Grivation:	-0.87 °
Show scale factors	
Reset	OK Cancel Help

Ensure the 'Coordinate Reference System' and the 'ESPG code' are as shown above

Versions of Mapper up to and including 0.9.2 require a correction. The 'Coordinate Reference System' should be set to 'Custom PROJ.4'. The 'Specification' field should be replaced with the one below (include all the text in italics).

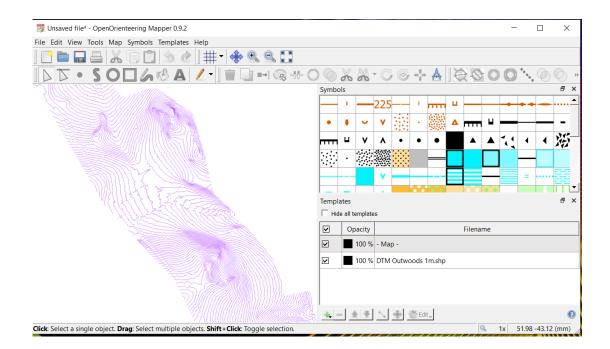
+proj=tmerc +lat\_0=49 +lon\_0=-2 +k=0.9996012717 +x\_0=400000 +y\_0=-100000 +ellps=airy +datum=OSGB36 +units=m +no\_defs

2 Map Georeferencing - OpenOrienteering Mapper 0.9.2					
Map coordinate reference	system				
Coordinate reference system:	Custom PROJ.4	•			
Specification:	00000 +y_0=-100000 +ellps=airy +datum=OSGB36 +units=m +no_d	lefs			
Status:	valid				

Move onto the *Map North* settings. In the Declination field the angle between true north and magnetic north at the position of the map has to be entered to make magnetic north be at the top. Your map should be orientated to magnetic north, not grid north. Click the 'Lookup' button. This uses the current georeferenced coordinates to find out the magnetic deviation from grid. This opens a page in your web browser. Copy the value displayed into the 'Declination box'.

Declination positive values are east of true north and negative values are west of true north.

Click 'OK' and you are ready to start drawing your georeferenced map.



### Appendix 1 – Creating/Editing a shape file.

Shapefiles describe vector features. Vector data provides a way to represent real world features within the GIS environment. A vector feature has its shape represented using geometry. The geometry is made up of one or more interconnected vertices. A vertex describes a position in space using an X, Y axis.

First, zoom in to the area where your area of interest. Choose Layer  $\rightarrow$  Create Layer  $\rightarrow$  Vei New Shapefile Layer from the Layer menu (or the same button on the toolbar). The New Vector Layer dialog will be displayed. Choose the type of layer "polygon". In the Fields List, select "id", and click the button [Remove Field]. Under New Field, type a name (e.g., "my\_polygons"), click on [Add to Fields list], and then click [OK]. You will be prompted to the Save as dialog. Type the file name ("my\_polygon") and click [Save]. You will be able to see the new layer in the Layers list.

Click on the layer name to select the layer you have just created. All editing sessions start by

choosing the *F* Toggle editing option (either on the toolbar or under the Layer menu). Select this option and note that the little pencil symbol will show up beside the name of the layer, indicating

that the layer is now editable. Now, click on the O Add Feature icon (or select Edit  $\rightarrow$  O Add Feature). When you do this, the cursor will look different (not an arrow head). Left-click on the map area to create the first point of your new feature. Keep on left-clicking for each additional point you wish to include in your polygon. When you have finished adding points (i.e., the polygon represents the desired operational area), right-click anywhere on the map area to confirm you have finished entering the geometry of that feature. The attribute window will appear. Input the name you want

for your polygon (e.g., "polygon1"), and click **[OK]**. Then, click on Save Layer Edits (either on the toolbar or under the Layer menu).