

# **Making Large Scale Historic Mapping Available on GPS Equipped Mobile Devices**

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## **1. Introduction**

The National Library of Scotland (NLS) map images website provides access to over a quarter of a million maps as high-resolution, colour, zoomable images. This includes an extensive set of Ordnance Survey (OS) Maps at 25 inches to the mile (1:2500) for England and Wales between 1873 and 1922. For many years these maps have proved invaluable for local historians and archaeologists. This is particularly true for industrial archaeologists where these maps often include a wealth of detail regarding mills, canals, railways, roads, quarries and factories and such like. Where sites have not been built over it can be very instructive to visit the area with a large scale map from say circa 1900, although due to past clearance of the site it may not be easy to relate the map precisely to the location.

Happily, NLS have recently permitted the reuse of selected georeferenced "25 inch" maps making it possible, in principle, to use this mapping "offline" on a mobile device which is equipped with a Geographical Positioning System (GPS) i.e. on a "smartphone" or "tablet" computer. The GPS system will display the user's location on the map with a typical accuracy of 2 to 5 metres.

One limitation at present is that a potential user of the NLS mapping on a smartphone will need to prepare, and install on their phone, beforehand, a file containing the mapping information for the area they are interested in. This file contains what is known as a tileset which is a collection of small image files which combine to form the map at the specified magnification (or zoom) levels.

The user will also need to install a suitable "app" on their phone to display the map and of course be familiar with transferring the tileset files to their phone. Fortunately, both "free" and "paid for" software is readily available to construct a tileset from the NLS georeferenced map layer. Similarly, "free" and "paid for" apps are available for both Android and iOS phones to display the maps.

Various programs, currently available for the creation of tilesets, are described briefly in Section 2 and a small selection of apps which have the required capability of displaying these tilesets as custom offline maps are discussed in Section 3. The focus has been on open source or free versions of available software so that the technique is readily accessible by individuals and voluntary groups as well as professionals. The features available in apps (especially free ones) are always subject to change and thus this section may not fully reflect the present situation.

It is acknowledged that not all potential users will have the interest and knowledge to create tilesets for themselves and Section 4 considers ways in which pre-built tilesets might be made available for users to download or how a dedicated online facility for the creation of tilesets on demand might operate.

## **2. Creating a Tileset for the Area of Interest**

### **2.1 Checking availability of the Source Map**

It is first necessary to determine if the relevant georeferenced layer is available on the National Library of Scotland map images website and obtain its URL.

- 1) Go to the Explore georeferenced maps viewer (<https://maps.nls.uk/geo/explore/>) and from the 'Select a map / map series:' drop-down menu, select "OS 25 Inch, 1892-1914".

- 2) Click on the tab at the bottom of the screen labelled "Overlay" and a panel opens displaying links for the various (historic) counties for which georeferenced layers are available.
- 3) Click on the link for the area of interest and another panel opens with three tabs. Click on the 'XYZ' tab and copy the URL in the box immediately below the tab labels. This is the URL to be used with the software described in Section 3 to access the georeferenced images needed to construct the tileset.

## **2.2 Choice of Format to use for the Tileset**

There are many formats that are in use for tilesets but clearly the format used must be compatible with the app chosen by the user.

Two of the most popular formats both take the form of SQLite databases which contain the map image files (tiles) and the associated metadata. They are MBTiles and the variously named Locus/Rmaps/Galileo/OsmAnd (sqlitedb) formats which use the file extensions '.mbtiles' and '.sqlitedb', respectively. There is software that can convert between these two formats but it is generally best to create the tileset in the required format in the first place. It will be made clear in Section 3 which formats can be used with particular apps. The process for creating both forms of tileset is normally the same except for changing the relevant options in the software.

## **2.3 Creating the Tilesets**

There are several methods that can be used to create tilesets and each has its advantages and disadvantages. In order that the technique is readily accessible by individuals and voluntary groups as well as professionals the focus has been on open source or free versions of available software.

However the basic principles are similar whichever software is used. As a minimum, it is usual to specify the following inputs:-

- Tileset format (MBTiles or OsmAnd sqlitedb)
- Title for the output tileset. (This is likely to be used together with the appropriate file extension - either .mbtiles or .sqlitedb - for the filename for the tileset)
- Map source (use URL previously obtained as described in Section 2.3)
- Area that the tileset will cover. (This is achieved by drawing a box or series of boxes on the map canvas of the georeferenced layer or specifying the left, bottom, right and top coordinates of the area).
- Maximum and minimum Zoom Levels for the output tileset. The former will normally be either 17 or 18. (If it is acceptable to reduce the maximum zoom level by one the size of the tileset is approximately halved.)
- Tile size (normally 256 x 256 pixels)
- Tile Format PNG (4, 8 or 24 bit) or JPG (typical quality value of 75%)

The following is a select list of software which may be used to produce tilesets, which gives the current version number, operating system(s), cost and any special features provided. It is beyond the

scope of the present account to give other than an a brief outline here but links are given where further details may be found for each program.

**(I) Mobile Atlas Creator (Mobac)** [Current Version: 12.2.2, Open source, Java  
[mobac.sourceforge.io/](http://mobac.sourceforge.io/) ]

Mobac creates tilesets in a wide range of formats (which it refers to as atlases) from both online and local sources. It is therefore useful for converting between different tileset formats. It has limited in-app help but comprehensive online documentation.

It has a number of built-in online map sources but to include the National Library of Scotland georeferenced "25 inch" maps (and other custom sources) it is necessary to use a text editor to create an XML file with all the relevant information. This file will include the URL of the map source and must be placed in the specified folder on the user's computer. Thus the program is not as easy to use as some of the alternatives but this is compensated by the wide range of possible custom sources.

**(ii) QGIS** [Current Version 3.22, Free and open source, Windows, macOS and Linux. [qgis.org](http://qgis.org)]

QGIS is a viable alternative to commercial desktop geographic information system (GIS) applications such as Esri's ArcGIS. This means that it contains far more functionality than is necessary to simply create tilesets, including a georeferencing facility. This is reflected in the download size of the program of nearly 500MB and consequently it may take a user longer than with other software to become familiar with creating tilesets. However the program is well documented and there is additional documentation online. Once the user has mastered the basics the program is very straight forward to use.

**(iii) MAPC2MAPC** [Current Version 593, £15 one off fee, Windows, Many output formats [www.the-thorns.org.uk/mapping/](http://www.the-thorns.org.uk/mapping/) ]

This is a Windows program to manipulate digital maps and convert them between different platforms and software. Output formats include maps for the major mobile systems and devices - Android, iOS, Garmin, Magellan, Symbian.

It has extensive documentation both online and in-app and lists a large number of online map sources. However, it does not appear to include, at present, the National Library of Scotland georeferenced "25 inch" maps.

This app is likely to be most useful where one of the less popular output formats is required. A trial version is available that produces output marked with a random pattern of red crosses.

**(iv) MBTilesGenerator** [Open source, PHP Library, MBTiles only,  
<https://github.com/HTML24/mbtiles-generator>]

This is not a standalone piece of software but a PHP library that can form part of a custom application to generate MBTiles files. Preliminary tests have indicated it works well and could be used in a simple online app to generate tilesets without users needing to install and run any of the software listed above. This possibility is explored further in Section 4.

### 3. Choice of App to display the maps

#### 3.1 Introduction to the Apps

Clearly, whichever app is chosen to display the tilesets, it must have the capability of displaying custom offline maps. Some users may already have a paid for app which can display custom maps which they can use (e.g. BackCountry Navigator which is available for both Android and iOS, and uses the OsmAnd sqllitedb format).

Section 3.3 provides a select list of apps, while free, they all have limitations that are removed in the premium version of the app. This list cannot be considered exhaustive and other apps may be available which the present author is not aware of. The features available in any app may change significantly, without warning, so potential users of any of the apps is are advised to check the current features and limitations using the developer's website using the links provided.

#### 3.2 Using the Apps

It is of course necessary to first install the app of their choice, to display custom maps, on their mobile device (either from the Google Play Store or the App Store, as appropriate.)

One of more tilesets, covering the areas of interest, need to be created, as described in Section 2, or by some other means.

The tileset(s) must then be transacted to the device that is to display them using whatever method normally used for file transfers (e.g. cable, Bluetooth, local area network or Internet). It is important to note the location where the tilesets have been transferred to.

Once installed on the mobile device it must be imported into the app and the means of doing this will depend on both the app and the device. All the apps below support importing tilesets using their menu system, providing you know its location.

A more convenient way, that may be available is to use the device's "File manager" to locate the tileset file and tap on it. This will display a list of installed apps that can import the tileset. Tapping the required app will initiate the import process and in some cases immediately display the map in the app.

The user can now open the map (if not already open) and navigate it as normal using the appropriate icons, menus and finger gestures.

#### 3.3 Select List of Apps With Some of Their Strengths and Weaknesses

- (i) **MapTiler Mobile** [Current Version 2.1.8, Free – extra features with a paid for MapTiler account, Android and iOS, [www.maptiler.com/mobile/](http://www.maptiler.com/mobile/)]

This free app is from MapTiler, a large company that provides a software mapping platform for developers building websites and mobile apps. It has relatively few features and controls which makes it much easier to use for the task of displaying custom maps compared to the two other apps in this list. However, online documentation for the app appears to be very limited and only related to integrated use with paid-for versions of the MapTiler Cloud and MapTiler Desktop products.

While there are no advertisements, the user is limited to just five custom offline maps in the free version. However, it is a simple matter to remove tilesets from the app and import replacements from the device. Removal from the app does not delete the tileset from the device storage and so it can easily be brought back into use again later. One very useful feature is that when a custom map is selected it is automatically displayed centred on the device's screen irrespective of where the device is located.

The app combines an online basemap with the custom map overlay. A slider control may be used to alter the opacity of the overlay enabling features on an historic map overlay to be compared with a modern map which forms the basemap. Clearly this is only possible where Internet access (wifi or cell phone) is available.

**(ii) Locus** [Current Version 4.9.0, Free with premium version, Android only, [www.locusmap.app/](http://www.locusmap.app/) ]

This is a well featured app which allows users to download and use offline highly detailed, maps of any region world wide on their device. However, it remains relatively easy to use for the task of displaying offline custom maps. When a custom map is selected there is the useful option of it being initially centred on your screen.

The free version allows users to download up to three pre-built vector maps for use offline. The whole of England is covered by just one of the permitted downloads. It could be extremely useful for a user to have on their phone for general use.

It is not known what limit there is on the number of installed custom maps but it has been found by experimentation to be not less than ten.

Comprehensive documentation is available both in-app and online. The free version of the app displays advertisements in a small area at the top of the screen which are not particularly intrusive. There are two premium versions (silver and gold) that provide extra facilities but these are not essential for displaying custom maps.

**(iii) OsmAnd** [Current Version 4.0, Open Source, Free and premium versions, Android and iOS, [osmand.net/](http://osmand.net/)]

This is another extremely well featured app which provides much more than the present requirement to display custom maps. Unfortunately the resultant multitude of menus can be bewildering to the beginner who just wishes to display their custom map. There is full documentation both online and in-app but it is a steeper learning curve than with the MapTiler and Locus apps.

Furthermore, locating the custom map when loaded is much more difficult than these two apps as OsmAnd lacks the facility to centre the map which the others have.

In the free version, users can download up to seven pre-built vector maps for use offline. The UK is covered by ten such maps and as noted for the Locus app such mapping can be useful for general use. However, it appears that once you have downloaded seven maps you are not able to download more, even if you have deleted some of those downloaded earlier.

#### 4. Possible Future Methods in Obtaining Pre-built Tilesets

It was noted in Section 1 that not all potential users of mapping on their phones might have the interest and knowledge to create tilesets for themselves. Assuming there is sufficient interest in the use of large scale historic mapping to warrant it, there are various ways of addressing this:

**(i) Make available a library of pre-built tilesets for the whole country**

This would occupy a significant amount of server even when limited to single one era (e.g OS 25inch First Edition). Software would need to be written to allow users to select areas of interest to download. It is hard to see who would be prepared to host and maintain such a system. However, the approach has been included here for completeness.

**(ii) Local groups make available pre-built tilesets for selected areas in their region**

In this approach, key areas of interest would be selected within a region such as a county and tilesets created and made available on the Internet. Since the technique is likely to be of particular use for industrial archaeologists it is possible that the local industrial archaeology society might be best placed to identify the key areas to produce tilesets for a given region. Hopefully the group will have among its members someone (or a small team) who could create the tilesets and upload and maintain them to the Internet.

The 15GB "Cloud" storage provided for free by Google Drive may well be sufficient to start with. The links to the various tilesets could be provided on the society's website. Additional areas could be requested and added to the collection. Furthermore, tilesets created directly by individuals could be added, so they can be downloaded by others.

**(iii) Create an online facility to generate tilesets for an area "on demand"**

It is suggested that such a facility would only be considered further, if in due course it became apparent that there was a demand for tilesets that was not satisfied by the approach outlined in (ii) above.

A simple prototype site using the PHP software library referred to in Section 2.3 has been produced to prove the concept. This could be readily extended into an online service where the user specifies, as a minimum, the source map (via a drop-down menu) and the co-ordinates of the centre of the required tileset. Certain safeguards would need to be put in place to avoid overloading the National Library of Scotland server. Once the tileset had been created the user would be provided with a link either on screen or by email to download their tileset.

**(iv) Publish online "simple" guides to creating and using custom map tilesets**

While not directly connected to the provision of pre-built tilesets, it is relevant to include this topic here.

Clearly, the likelihood of the use of historic mapping on mobile phones becoming an established technique is heavily dependant on the ease with which tilesets can be produced and how comfortable the users are with it. Thus the production high quality guidance notes should be seen as a priority.

#### 5. Future Work

While all the software considered here is capable of doing what is required, it is clear that some programs are more convenient to use than others. This is partly because some programs have far more functionality than what is needed in the present application. Most of the programs have

comprehensive documentation available but it can be difficult to find the parts that are specific to creating or using tilesets.

It is therefore considered that the next stage in this project will be to focus on just one program for tileset creation and one program for displaying them. After further investigation of these two programs, comprehensive step by step guides to their use, solely in respect of tilesets, will be produced.

At present the Mobac program for tileset creation and the MapTiler Mobile app for tileset display are seen as the programs to take forward.

In parallel to this activity, a pilot programme will be carried out to investigate making tilesets available for selected sites in a region as discussed in Section 4(ii). This will be carried out for Gloucestershire which has large areas of former industrial activity (such as the Forest of Dean and Leckhampton Hill) which have not been developed since c.1880, this being the date of the mapping that will be used.

The file size of a tileset for a square kilometre is typically about 3MB. Thus, one further piece of work will consider how the file size for a tileset can be reduced while maintaining image quality of the map tiles. This will involve investigating whether to use PNG or JPG format for the map tiles and the number of bits to use per pixel for PNG tiles or the value of the 'quality' factor for JPG tiles. In addition the effect of reducing the maximum zoom level on the appearance of the displayed map will be investigated as such measures can significantly reduce tileset file size.

## **6. Concluding Remarks**

The release of selected georeferenced historic "25 inch" maps by the National Library of Scotland is most welcome and opens up the possibility of using this mapping on a mobile device in the field.

This paper has described a preliminary assessment of software currently available to create and display custom maps on such devices. The focus has been on open source or free versions of available software so that the technique is readily accessible by individuals and voluntary groups as well as professionals.

While it was found that all the software was capable to a greater or lesser degree it is suggested that future work should concentrate on the Mobac program for tileset creation and the MapTiler Mobile app to display the tilesets on mobile devices. Comprehensive step by step guides to the use of these two programs, solely in respect of tilesets, will be produced.

Future work will include a pilot project to create an online collection of tilesets for download and work to determine the optimum compression technique for the images that form the map tiles.

It is hoped that the outcome of this programme will be to encourage the adoption of this potentially very useful technique by simplifying its use by computer non-specialists.

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