Christopher Fleet*, Petr Přidal**

Opening historical maps for community mashups - a case study of the NLS Historical Maps API.

Keywords: Historical maps; Javascript APIs; community mashups; web-services.

Summary: This paper examines the NLS Historical Maps API, launched in May 2010, and its usage over the following two years. The Historical Maps API is a web service allowing historical out-of-copyright maps from the 1920s to the 1940s of Great Britain to be embedded in other websites, and then used as backdrop for other data, or to create derivative work such as OpenStreetMap. The background to the API and the choice of map series is discussed. The technical development of the API, and the use of MapTiler and Tileserver is described, as is the choice of Creative Commons licensing, and the subsequent launch and promotion of the API.

Over the following two years the API has recorded 841,000 visits and 1,462,000 page views. It has been used in a very wide range of websites, including those devoted to outdoor recreation (walking, cycling, climbing, canoeing), archaeology (portable antiquities and metal detecting), family history, local history, railways, photography, teaching, and archives. A number of free and commercial mobile applications have used the API. It has also given very useful publicity to the NLS historical maps, and encouraged the availability of new georeferenced historical mapping.

Introduction

The main aim behind this particular project was to explore the potential for making available historical georeferenced maps as a web service for embedding in other websites. Whereas Google, Bing and Yahoo map APIs focus on present day mapping, our project specifically promoted the use of historical maps in online mashups. We prepared a set of georeferenced historical maps of Great Britain from 1:1 million to 1:63,360 scales, we tiled and compressed them, and then distributed the tilesets across four web servers for more rapid and stable web delivery. A specially-written Javascript API (http://nls.tileserver.uk/api.js) returns a URL for the tile images, delivering these from the most appropriate server. The Historical Maps API was launched in May 2010 at the Project Page: http://geo.nls.uk/maps/api, and in the following 20 months to March 2012, it recorded 841,000 visits and 1,462,000 page views.

The API project between the National Library of Scotland (NLS) and Klokan Technologies GmbH, built upon several years of successful collaboration using historical maps in web applications. The NLS has a large and growing online collection of historical maps at http://maps.nls.uk (numbering 46,000 maps in March 2012), and in recent years has focused on georeferencing parts of this collection (Fleet & Kowal, 2007, Henrie, 2009). Klokan Technologies have provided expertise and a num-

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* Senior Map Curator, National Library of Scotland [c.fleet@nls.uk]
** Managing Director, Klokan Technologies GmbH [petr.pridal@klokantech.com] and Technical Manager for R&D, Moravian Library in Brno [petr.pridal@mzk.cz]
ber of innovative tools to assist with this, including MapTiler, Georeferencer, OldMapsOnline, and customised Geoserver/Openlayers applications. This API project both built upon, and supported these other applications.

**Historical georeferenced series maps**

As this project did not receive any specific dedicated funding, the main initial selection of series maps was limited very much by what NLS could easily provide. The maps had to be out-of-copyright, restricting us to pre-1960s mapping (Crown Copyright in Great Britain lasts for 50 years). For better aesthetics in the API, we were also keen to use coloured maps, effectively limiting us to post-1920s mapping, given our preference for using Ordnance Survey maps. Through previous collaborative projects with the XYZ Digital Map Company, NLS already had two one-inch to the mile (1:63,360) sets of maps covering Scotland and England and Wales. Whilst these were not exactly the same date of series (1920s for Scotland, and 1940s for England and Wales), we did not have the resources for scanning and georeferencing the 1940s series for Scotland (92 sheets), so we compromised and accepted a date range from 1919 to 1947. Quarter-inch to the mile maps in the 1920s cover Scotland in 10 sheets and England and Wales in a further 10 sheets, and so it was just a few days work to scan and georeference these, along with a single-sheet 1:1 million map of Great Britain for the smallest-scale overview. The following series were therefore used in the API (Fig. 1):

- 1:1 million, Great Britain, 1933
- Quarter-inch to the mile, Scotland, 1921-1923
- Quarter-inch to the mile, England and Wales, 1919-1921
- One-inch to the mile, Popular edition, Scotland, 1920-1930
- One-inch to the mile, New Popular edition, England and Wales, 1945-1947

It was appreciated at the outset that these one-inch map sheets at larger scales were already available on the web, including the New Popular Edition Maps website, and the Vision of Britain website,
although not in the same form as a georeferenced web service. The main aim behind the Historical Maps API project was not to release new maps online, but to test the release of mapping in a new way, developing the API technology, and allowing new uses to be made of the maps. 

ArcGIS was used to georeference these maps. Whilst we have used open-source GIS tools, including QuantumGIS/QGIS, we have found so far that georeferencing within ArcGIS has easier functionality for adding control points, and for the dynamic visualisation of different transformation methods. The online service Georeferencer seems to be a viable alternative to ArcGIS when it comes to rectification of scanned maps. For certain sheet joins, due to warping and the variable expansion of the original map sheets over time, many control points were needed, as well as colour-balancing and correction, particularly for seaming together the different series at the Scotland / England Border to create a more pleasing and consistent result.

Tools and standards

Tile Map Service

The maps were prepared as a Tile Map Service (TMS), as described by Pridal & Zabicka (2008), providing access to rendered cartographic tiles at fixed scales. Unlike the Web Map Service which often relies upon software processing to deliver imagery, the main advantage of the TMS is that image tiles are pre-created at a set of zoom levels for a specific projection and datum for more rapid delivery. The tiles were prepared with a customized version of the MapTiler application, creating especially small and optimised .PNG files, and the map was rendered on an Amazon EC2 computer cluster. The total Historical Maps API tileset occupied 10.5 Gb, split up into 200,235 individual files, from zoom levels 1 to 14.

As described by Pridal & Zabicka (2008), the TMS takes advantage of the fact that Google Maps, Microsoft Bing, and other geo-data APIs use the same projection and tiling profile. The coordinates presented to the user are as latitude/longitude using the WGS84 datum (EPSG:4326), whilst internally the applications use the Spherical Mercator projection (EPSG:900913), with coordinates in metres, and treating the earth as a sphere rather than the WGS84 ellipsoid. The extents of all tiles as well as the zoom levels are predefined for the whole Earth on the Spherical Mercator projection, with the only differences being the mechanism by which the individual tiles are described: the Google/OpenStreetMap XYZ, the OSGEO TMS XYZ (with Y coordinates from south to north), and the Microsoft Bing Quadtree format (see also: Tiles à la Google Maps: coordinates, tile bounds and projection for more information). Our API uses the Tile Map Service with the XYZ addressing of tiles also used by OpenStreetMap and Google Maps.

In terms of format, each TMS tile is referenced by a URL, made up of a root server URL, then a zoom factor, then the x and y coordinates. Effectively the zoom and x coordinates are subdirectories beneath the root, with the y coordinate reflected in the tile name. For example:

http://geo.nls.uk/maps/11/1092/1397.png
breaks down into

{server root} / {sub-directory} / {sub-directory}/ {tile image}
The tile model means that map access is rapid: previews and images can be loaded very quickly. Fairly simple Javascript code pulls the correct tiles as an overlay on top of whichever global mapping tiles are in the browser. A Javascript API (http://nls.tileservcer.com/api.js) with an NLSTileUrlOS(x,y,z) function, returns the URL for a tile image at the x,y,z position in the Spherical Mercator.

TileServer

TileServer is a hosting technology for fast web interactive online maps, derived from geospatial data, orthophotos or scanned maps. The maps are distributed on multiple servers, allowing a fast and more reliable service than traditional forms of online publishing of maps from a single server or application, and so the application is able to handle a large number of visitors.

API project page, usage instructions and launch

Basic guidance was written on the Historical Maps API project page (http://geo.nls.uk/maps/api/ - Fig. 2) on the purpose of the API, on how to embed the historic maps in a smartphone, into other websites, and into other API mapping applications. Examples of the exact code that could be copied and pasted into other websites were given, as well as example pages showing the coding for the API running in Google Maps, Openlayers and Microsoft Bing.
The historic maps can be directly viewed in a web browser, as well as on mobile devices such as the iPhone, iPad or Android based tablets by opening the Internet address: http://nls.tileserver.com/. The map is ready for natural zooming and panning with finger pinching and dragging. If users open the address: http://nls.tileserver.com/?q=auto, their mobile will detect their current position, and the map display will zoom to this current location. It is also possible to create an icon for the historic maps in an iPhone, by pressing "+" and then "Add to Home screen" and the historic maps are available, just like other standard iPhone applications.

The easiest way of embedding the historical map in a website is to copy and paste a single line of HTML code into a website page:

```html
<iframe src="http://nls.tileserver.com/" width="500" height="300" frameborder="0"></iframe>
```

It is possible to automatically open the historic map at a particular place or postal address by appending the name as a "q" parameter, for example:

```html
<iframe src="http://nls.tileserver.com/?q=edinburgh" width="500" height="300"></iframe>
```

It is possible to automatically position the historic map to open at particular latitude and longitude coordinates, for example:

```html
<iframe src="http://nls.tileserver.com/?lat=51.5&lng=0&zoom=11" width="500" height="300"></iframe>
```

The map can also automatically detect the geographic location of the visitor to display the place where they are right now, for example:

```html
<iframe src="http://nls.tileserver.com/?q=auto" width="500" height="300"></iframe>
```

We also prepared the precise HTML coding to copy and paste to use the map in other mashups:

```html
<html>
<head>
...
<script type="text/javascript" src="http://nls.tileserver.com/api.js"></script>
...
</script>
```

More detailed and specific HTML page examples were provided at: http://geo.nls.uk/maps/api for using the API with Google Maps (http://nls.tileserver.com/google.html), Openlayers (http://nls.tileserver.com/openlayers.html) and Microsoft Bing (http://nls.tileserver.com/bing.html). The maps were made available as an online service under the Creative Commons Attribution 3.0 Unported Licence (http://creativecommons.org/licenses/by/3.0/) to encourage maximum usage, whilst also giving some publicity to the NLS and project. Users are
allowed to share, copy, adapt and add to the maps, and they can even use the maps in commercial applications, but they must display an attribution to the NLS, together with a link to the NLS website, whenever the API maps are used. In practice, this licensing is more generous than NLS would usually allow for its maps - commercial applications using maps often pay licensing - but for these few maps series, we were keen to encourage greater usage by not restricting access to non-commercial websites only. However, we asked that large users of the API tiles in commercial websites or applications (iPhone apps…) should be confirmed by the hosts, a request which we are pleased to record has been followed.

The Historical Maps API was announced to various map lists in May 2010, and promoted by the NLS and Klokan Technologies through our websites and other media channels. However, we did not attempt more extensive marketing, social media promotion, or advertising of the application, preferring to see usage grow naturally by those with a genuine interest in using the historical maps.

Usage and community mashups

It is only possible to summarise the major trends in terms of usage, based upon some of the limitations of Google Analytics for a site such as this. Statistics were recorded for those using the API correctly with the http://nls.tileserver.uk/api.js file, but those downloading using a local copy of this file, or accessing the tilesets directly were not recorded in Google Analytics. Nevertheless the statistics do allow broad conclusions to be made about general volume and major user communities. For larger users, including mobile applications, we also requested that they monitor and present their own tile usage statistics.¹

During the first year of the project, the usage grew only slowly. We were keen not to overload servers, and there were existing websites which made available the larger scale one-inch to the mile maps, albeit not in the same format. In the first year as a whole (1 April 2011 - 31 March 2012), there were only 94,819 visits, 55,179 unique visitors, and 427,557 pageviews; usually a few hundred visitors per day, and always less than 1,000 visitors per day. However, during the second year, usage more than doubled: 747,929 visits, 600,600 unique visitors, and 1,038,006 pageviews, with more than 1,000 visitors per day oscillating between 1,000 and 4,000 per day. The main reason for this change was the incorporation of the API into Bill Chadwick’s very popular Where’s the Path application (http://wtp2.appspot.com/wheresthepath.htm) in April 2011.

As expected given the mapping, 92% of all visitors were from domains in the United Kingdom, and 2% from the United States. Thereafter, the Netherlands, Australia, Germany and Canada were the highest countries, all with more than 0.5% of traffic. The API registered 1.68% of users as being from mobile devices, a proportion that we expect will grow.

¹ See, for example, Outside Maps tile usage graph for the Historical Maps API at: http://www.haudmeback.com/index.php?option=com_content&view=article&id=65&Itemid=75
From April 2011 until 1 March 2012, the Where’s the Path application registered 388,000 page views, and the publicity within Where’s the Path encouraged much wider usage of the API in other applications (Fig. 3). These are described more fully below, but two particularly important websites that used Permalinks to Where’s the Path including our API, were the Geograph website (http://www.geograph.org.uk/ (4,019 views) - crowdsourced photographs of each Grid Square) and the Nearby ( http://www.nearby.org.uk/ - 2,938 views) location and points-of-interest search website. The selection of websites mentioned below all recorded over 100 page views during the full time period the API has been in existence – 20 months from May 2010 to March 2012.

The main user communities can be broadly defined as those devoted to outdoor leisure and recreation, archaeology, family history, local history, a number of other specialist history websites, photography, teaching, and archives. In addition to Where’s the Path, the API was used by several other walkers websites, including Walkingforum, the Cape Wrath Trail (989 views from May 2010 - March 2012), Outdoors Magic and two newer mobile applications in late 2011 / early 2012, including Outside Maps (Fig. 4) and Otopia’s Leisure maps, both directed to the outdoor leisure user. A range of other outdoor leisure websites included the Stalking Directory (the home of deer stalking), Song of the Paddle (canoeing), SingleTrackWorld (cycling - 1,392 views from May 2010 - March 2012), the Trail Riders Fellowship (trail biking), and Penrith Anglers (fishing).
Perhaps the second largest user community was devoted to archaeology and metal detecting. The Portable Antiquities Scheme was the largest of these (Fig. 5). This website and project encourages the voluntary recording of archaeological objects found by members of the public in England and Wales, with potentially detailed descriptions and images of objects found, including their location. Before 2011, the antiquity location was viewable on a standard modern Google map, but the webmaster was keen to add an ‘Historical’ button displaying the same find location on the Historical Maps API backdrop. There are also related portable antiquity collecting websites that use the API, such as Paul Barford's Antiquity Collecting blogspot. These antiquities are often discovered using metal detectors, and it was quite a surprise to discover how very many metal detecting websites there are in the UK, with very popular postings and active members: the UK and European Metal Detecting Forum (3,189 views), the UK Finds database (1,303 views), detectorist.co.uk (2,518 views), the UK Detectornet Forum (2,297 views), Finding the Past, Roger's Relics (509 views) and DetectingWales.com (434 views).²

² All these Views totals relate to the period from May 2010 - March 2012.
The third largest community, with links to archaeology and outdoor leisure, were a wide range of historical websites. Stravaiging around Scotland (11,470 views from May 2010 - March 2012) is a very popular website devoted to places of historical interest for visitors to Scotland, particularly castles. The Airfield Information Exchange (7,064 views from May 2010 - March 2012) is very popular forum of the Airfield Research Group, with very active postings on old airfields. Secret Scotland shares a overlapping interest, providing a forum where any kind of secret, hidden, or censored places can be discussed; DerelictPlaces is "a forum for people with an interest in the history and documentation of derelict and abandoned buildings to come together and share their experiences, photography and historical findings". WindmillWorld was also a large user (2,209 views) - a site with excellent locations for plotting locations on a map, along with windmill details and photographs. Several local history groups have forums that were also large users: for example, the Kent History Forum, Midlands Heritage Forum and Sheffield History Forum, and there were also good links with route diagrams from historical railway websites (eg. Ffestiniog & Welsh Highland Railway, West Somerset Railway).

Family history and genealogy are considered to be one of the largest user communities for the main NLS website, but were less important for the API. Perhaps where particular Google-maps literate webmasters were involved, the API was used, such as the Scottish Borders Family History Society website (2,333 views - Fig. 6), where every parish page with associated information was accompanied by a relevant API map view. Other Scottish genealogy sites dominated usage (perhaps due to better promotion through NLS) including www.kirkyards.co.uk and kirkcudbright.co.uk, with a scattering across England and Wales.

Formal educational use of the application was quite limited, perhaps reflecting the ready availability of this historical OS mapping through services such as EDINA Digimap, including Digimap for Schools. However, a more innovative learning website that used the API was Juicy Geography, with its ideas and resources for educators about teaching maps using Google Earth and Maps. The Univer-

Figure 5: The Portable Antiquities Scheme website, with the location of archaeological finds displayed on the Historical Maps API mapping.
University of Edinburgh's Carmichael Watson Archive makes available records relating to the Archive of the pioneering folklorist Alexander Carmichael (1832-1912). Each placename attached to contents of the archive is also presented using a Google pushpin against a backdrop of the NLS Historical Maps API.

![Figure 6: The Borders Family History Society website, with the Historical Maps API mapping on individual parish pages.](image)

Whilst we know that the OpenStreetMap community were keen users of the API from direct correspondence, their mailing list and wiki pages, their usage does not reflect in the Google Analytics, as they requested the tiles directly into Potlatch / JOSM. One particular benefit that arose out of the OpenStreetMap community was a collaborative project in 2011 to georeference series maps of Ireland. An OpenStreetMapper from Dublin took scans of two series from NLS - Bartholomew Quarter Inch to the mile (1: 253440) 1940s sheets, and British War Office One Inch to the mile (1:63,360) 1941-43 - G.S.G.S. 4136 - and created georeferenced seamed versions. These were loaded with proper attribution into the Potlatch server and the NLS website in October 2011 and have been well used since then. Up to March 2012, 2700 features have been tagged as originating from these maps.

Of course, the largest institutional user and beneficiary of the Historical Maps API is the NLS. The API has been used as a backdrop in three main applications: Visualising Urban Geographies (Roger et al., 2009), the NLS Georeferencer project, and the NLS Sheet Viewer. This combined usage from NLS amounts to 6,674 views from May 2010 - March 2012. In all cases, the Historical Maps API sheets provided an excellent backdrop for these applications that all focused on historical maps of the United Kingdom, and they were also a natural continuing collaboration between NLS and Klokan Technologies.

3 http://taginfo.openstreetmap.ie/search?q=NLS+Historic+Maps#values
Finally, whilst the primary usage of the API in these websites was simply to refer to a 1920s-1940s historical map of a particular place in the UK, a smaller proportion of the websites above were using the API more imaginatively in a mashup. For example, the Stravaiging Across Scotland, Portable Antiquities Scheme, and Alexander Carmichael Archive illustrate more creative types of mashup using overlays of their own georeferenced data. There is clearly more potential in this type of mashup, especially with other layers of mapping and more guidance and examples from the providers of the API.

Conclusions

The Historical Maps API can certainly claim success in its core objective, of encouraging the use of historical maps in online mashups. Through a modest amount of effort, and very limited funding, the historical maps have been used by a very large and diverse user community over two years. The volume of usage alone is impressive: the API has recorded 841,000 visits and 1,462,000 page views over 20 months, but the range of usage is of more interest. This community is certainly broader and different from the mainstream user community of the main NLS maps website, with more special interest groups, and more serious dedicated users from archaeological and historical subject areas. The API thus encouraged more use of historical maps, illustrating how very large the web “geo” community can be, and also acted as useful publicity for all the other maps on the NLS website. Over two years, the NLS Historical Maps API project page alone (just with information about the API) registered over 3,000 page views, illustrating its role as a catalyst and possible onward referral page for the main NLS map website pages. For NLS, the project encouraged greater familiarity with georeferenced maps and tileservices, which have been taken forward in a more active way during 2012, whilst for Klokan Technologies, the API provided a useful illustration of MapTiler and Tileserver technologies, and the company’s role in supporting the library and open-source geo community.

The Historical Maps API also demonstrated the successful application of georeferencing, tiling and tile serving technologies, one which has a great potential in future. The application is a nice demonstration of Klokan Technologies’ MapTiler and TileServer applications. During the course of this project, MapTiler has been completely re-written in C/C++, and MapTiler Cluster now offers very much faster and much more optimised tile rendering, with tiles up to half the size, so cheaper to host and quicker to download. The TileServer hosting also proved itself to be stable and reliable. In fact, during the course of the project, the NLS tileset DNS address was changed by the NLS IT Department, but the Historical Maps API continued to be available, because the JavaScript API skips the unavailable tile servers and always chooses the fastest for a particular visitor. There is a great potential for other institutions or libraries to make available their maps using these technologies. At the time of writing, the use of modern mapping APIs is in a state of flux with new usage limits for free use on the Google Maps API imposed from early 2012, and a spate of high-level defections from large map users to other modern mapping API providers (including OpenStreetMap). It could be the case that historic mapping will be in greater demand as an alternative to some of the limitations of modern API mapping. Whilst the NLS and Klokan Technologies hope to sustain the API in the future, the growing usage and popularity of the service will require more robust plans, especially if more maps will be added. There is perhaps scope for licensing the service to commercial users, or licensing more detailed scales of mapping when these become available. With possible new income
streams from Google Ads, registration, or licensing of commercial users, the preparation of new tilesets, hosting costs, and maintenance could be properly funded in the future. It would also be possible to develop and promote the service properly, through social media / blogging, etc., and offer greater assistance and examples to help users make best use of the mapping.

**Websites / Products mentioned in the text**

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**References**

