ARCTIC BASEMAPS IN GOOGLE MAPS

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ABSTRACT:

The Ocean Mapping Group has been collecting data in the Arctic since 2003 and there are approximately 2,000 basemaps. In the current online storage format used by the OMG, it is difficult to view the data and users cannot easily pan and zoom.

The purpose of this research is to investigate the advantages of the use of Google Maps, to display the OMG's Arctic data. The map should should load the large Artic dataset in a reasonable time.

The bathymetric images were created using software in Linux written by the OMG, and a step-by-step process was used to create images from the multibeam data collected by the OMG in the Arctic. The website was also created using Linux operating system.

The projection needed to be changed from Lambert Conformal Conic (useful at higher Latitudes) to Mercator (used by Google Maps) and the data needed to have a common colour scheme.

After creating and testing a prototype website using Google Ground overlay and Tile overlay, it was determined that the high resolution images (10m) were loading very slowly and the ground overlay method would not be useful for displaying the entire dataset.

Therefore the Tile overlays were selected to be used within Google Maps. Tile overlays used for this project proved to be useful for large datasets because they cut the image into many different tiles and load only the part of the image (tile) within the map window bounds.

1. INTRODUCTION

The Ocean Mapping Group (OMG) at the University of New Brunswick is working in the Canadian Arctic as a part of ArcticNet. ArcticNet is a funded program that brings together scientists and managers from a number of different backgrounds to study the impacts of climate change in the coastal Canadian Arctic. The OMG "will map the bottom topography and geological structure of the Northwest Passage and other regions of the Canadian Archipelago..." (Beaudoin, 2008). The data collected by the OMG will aid the first step towards the management of increased intercontinental ship traffic and resource exploration as ice conditions change.

1.1 Arctic basemaps

The OMG has been collecting data in the Arctic since 2003, on board Canadian Coast Guard vessels and their survey launch, the C.S.L. Heron, which is on loan from the Canadian Hydrographic Service (Brucker, 2008). This has resulted in the OMG having a very large dataset with approximately 2,000 15' x 30' Arctic basemaps. The OMG will continue to build up their coverage of the Arctic with each transit through the North West Passage.

Geographic information systems (GIS) have been around for decades, although they were expensive which limited their use.

In the past few years, with the introduction of simple, and mostly free or inexpensive web-based geographic information systems (e.g. Google Maps, Yahoo Maps, Microsoft's Virtual Earth), there have been thousands of maps published online (Elias et al., 2008). These web-based systems have a small set of GIS tools, however many third-party "mash-ups" have been related to these GIS tools, allowing users to add more functionality to their maps (Elias et al., 2008). These simple online GIS programs allowed users and companies to display their data to anyone with access to the Internet. In order for the OMG to stay up-to-date with the evolving online GIS industry, it was important for the OMG to be able to display their data on the Internet and allow users to download their high resolution data in the current 15' x 30' map format.

1.2 Overview of the Current Arctic Basemap

Currently, the OMG have created their own methodology for displaying their data online, although it can be seen from its functionality that is not very user friendly. Its functionality is described in the next section.

The online data storage and viewing of the OMGs data begins with a simple map of Canada in the background and squares outlining the different areas where they have data (see Figure 1). After clicking on an area, a new page opens with the large overview map, a smaller scale overview map which contains the

15' x 30' basemaps (shown in red squares), the actual data (sun illuminated and colour shaded bathymetry) and links to download the data (see Figure 2). If users click on the box with the data, a new page opens with the users having the ability to see the 15' x 30' basemap in high resolution (approx. 10m resolution, see Figure 3).

Users must then click the back button and click a new area in either the small scale overview map or the large overview map and repeat the process. It is difficult for users to know where the data is spatially as there is no background for the actual data and the only reference to its location in Canada is on the overview maps. It is also difficult for users to pan to different areas of the dataset because they have to click on the area in the overview maps.

The last difficulty is with the user's ability to zoom in and out on the data. There are only 2 zoom levels that alow to the users to see the data, the entire 15' x 30' basemap and a high resolution image of the basemap.
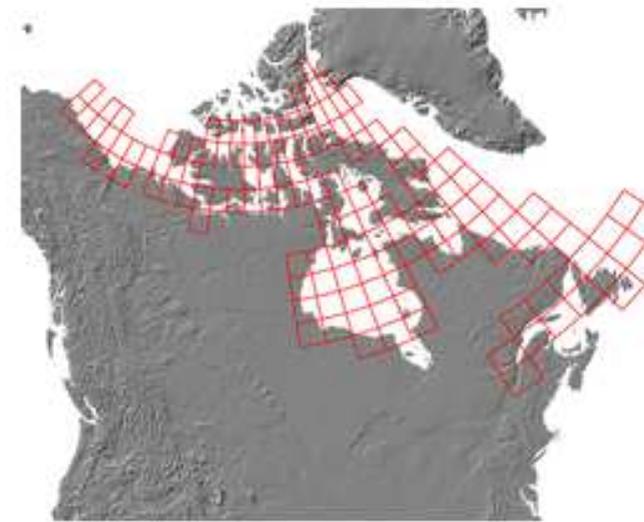

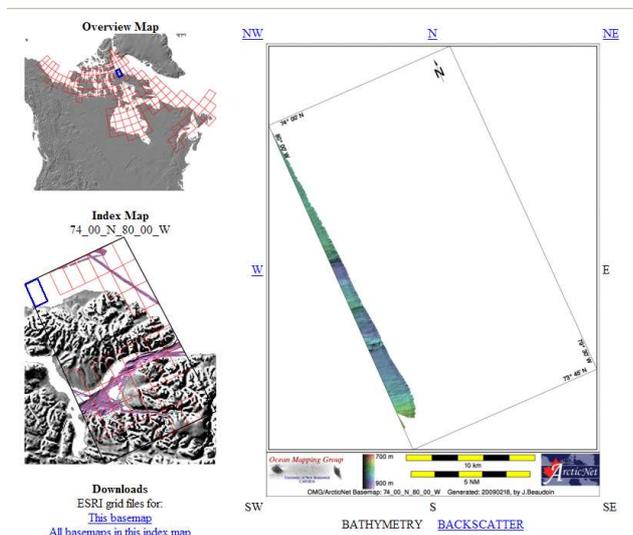Figure 1. The overview map of the OMG's Arctic Dataset.

Figure 2. Showing the overview map (a smaller scale overview map and links to download the data is shown on the left and the data is visible on the right).
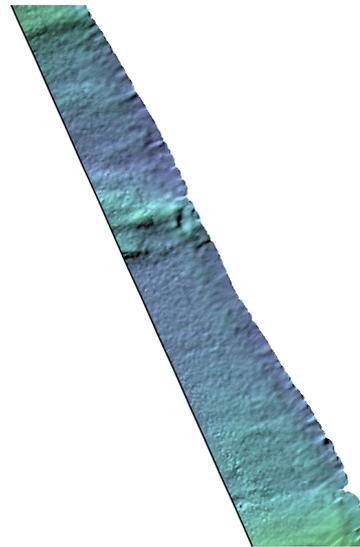

Figure 3. Showing a high resolution image of the bathymetry.

1.3 The user requirements for new Arctic Basemaps

The purpose of this research project is to investigate the use of an open-source GIS program to display the OMG's Arctic dataset on the web. The objectives for this research are to have a background map with the OMG's data overlaid, allowing users to have some sense of where the data is located spatially. Users should also be able to pan and zoom to any area they choose. For the creation of images from the OMG's data, the projection needed to be changed from Lambert Conformal Conic, to Mercator which is used by Google Maps.

The images needed to have a common colour scheme for depth, have a transparent background, and the latitude and longitude for the corners of the images to properly georeference them. A legend for the depth colour scale and an opacity slider bar were added to the map. The last objective is to display the large dataset without long delays from loading the dataset.

2. ARCTIC BASEMAPS WITH GOOGLE MAPS

The program we decided to use in this research project was Google Maps, which is freely available to the public after registering with Google for a Google Maps API key. Google Maps is a program created by Google that allows users to embed a map directly into their website. Google provides the source code to users as well as an API reference that allows developers to add functionality to their maps. With Google maps, developers can perform simple GIS tasks, for example, adding points, lines and polygons, geocoding, and image overlays.

The methods used to fulfil the research project's objectives are discussed below. The first step was to research the documentation about Google Maps from the Google Maps developer website (Google, 2008). The documentation provided steps for embedding Google Maps into a website.

Users must register and open an account with Google and obtain a Google Maps API key. The API key registers the user website with Google and allows Google Maps to be embedded in that website. The next step is learning the syntax for HTML and Javascript which is used for the creation of a website. A useful website for learning HTML and Javascript is from w3schools (Refsnes, 2008). Javascript is used to embed Google Maps into the website and perform the simple GIS tasks. After creating the website with Google Maps displayed (see Muggah, 2008), the map controls, map type, map center and zoom level can be set.

2.2 Data preparation

For this research project, the satellite map type was chosen because within Google the new low resolution bathymetry was added to the existing satellite map. In areas where the OMG did not have data, users would be able to see the only low resolution bathymetry. The map was centered near Pond Inlet, on Baffin Island and a low zoom level was set so users would see the entire OMG dataset. An overview map was added to allow users to see the location of the map bounds on a larger scale (see Figure 5).

2.3 Data conversion

The next step was to determine how to get the OMG's data onto Google Maps. Google requires image files for their image overlays. In order to set and change the opacity for the image overlay, a PNG file was chosen for the image file. The PNG images were created from the OMGs multibeam data using open source software and software written by the OMG. The following data processing workflow, created by Ian Church from the OMG, outlines the procedure used.

The multibeam data was converted to the OMG's r4 file format. The r4 file was sun illuminated and then converted to an 8-bit file with different colours for depths. A PNG image was then created of the sun illuminated colour coated image. Thirty blank map sheets in the Mercator projection were made to cover the extent of the OMG's dataset in the Arctic. The PNG files were patched into these blank map sheets, creating thirty map sheets containing the OMGs data from the Arctic. Transparency was added to these map sheets where there was no data so when they were added to Google Maps, users would see the background image from Google where there was no OMG data.

3. PROTOTYPING

After creating the PNG images, the right type of image overlay needed to be determined.

3.1 Ground Overlay

In this research project, two types of image overlays were used. The first type of image overlay was the Ground Overlay. This overlay was easy to implement, only requiring the PNG image and its Southwest and Northeast corner coordinates. When this type of overlay was used, the image was properly georeferenced and displayed the data, however when the image was zoomed it became pixelated.

The main reason this type of overlay was not used, was because of the loading time for the overlay. The overlay was extremely slow and sometimes did not load at all. This was because the ground overlay was designed to display an image in a small area at one or two zoom levels.

3.2 Tile Overlay

The second type of image overlay that was used in this research project was the Tile Overlay. The tile overlay was useful for large datasets because the large images, unsuitable for other methods of online publishing, were pre-cut into tiles (many smaller images that were 256 pixels by 256 pixels) and only the images which were present within the map bounds would be loaded (Pridal and Zabicka, 2008). This type of overlay is more difficult to implement, however it is extremely efficient and will be used to display the large dataset.

Microsoft's Map Cruncher for Virtual Earth was used to create the pre-cut tiles (Elson, 2007). Google requires a pyramid format for cutting the image into tiles. This means that at zoom level zero (showing the whole world) one tile is used. At each subsequent zoom level, each tile is divided by four (zoom level $0 = 4^0$, zoom level $1 = 4^1$, ... , zoom level n = 4^n). Microsoft's Map Cruncher required the latitude and longitude of each corner of the thirty images so they could be properly georeferenced. The new tiles (~600,000 images) for 12 zoom levels were overlaid in Google Maps using the tile overlay method.

4. TESTING

After testing the website for loading time and the ability for users to pan and zoom to any area of the world, it was determined that Google Maps, and its tile overlay method, was a suitable program to display the OMGs dataset. The images were georeferenced properly and the objectives of the project were met (see Figures 5, 6 and 7).

The use of PNG files in this project allowed that the opacity of the image could be set. Using some Javascript programming, a slider bar was added to Google Maps to allow users to change the opacity of the image (see figure 5). The opacity of the images could be changed from 0% to 100%, from no opacity to full opacity (transparent image).

5. CONCLUSIONS

There are many benefits for creating a website that displays Google Maps and the Arctic data on the OMG's website. The first benefit is that it was an easy way of displaying their data with a background image for areas where they do not have data. It allows users to pan and zoom continuously which replaced the OMG's old method of displaying their data and made it more user friendly. Another benefit of using Google Maps is that it is a free, open source service, where other proprietary software can be expensive to display the same data. The open source software allowed for customization of the website and the map.

Google Maps support data retreival and display in many different formats. It has proven that it can display large datasets with minimal load time and it has the ability to handle the future objectives for this project. Google Maps is fairly easy to use and their API documentation is very useful (Lewis et al., 2007). We have showh that this research project helped the OMG to fulfill their end users needs.

6. FUTURE WORK

There are many possibilities to future work on this project. The first objective for future work is to have a link to download the high resolution imagery in the OMG's 15' x 30' basemap format. This is useful for the OMG because they want to be able to distribute their data to interested parties or clients. The next objective is to get the multibeam backscatter images onto Google Maps.

This is another feature that is useful for the OMG because it is important aid for interpreting the bathymetry and seaflor geology type. The backscatter images should also have a link to download the imagery.

A final possibility is to show the location of MVP or CTD casts. These casts are important for oceanography and hydrographic surveys because they show the temperature, salinity, density, and sound speed profiles at each location. More objectives will surely follow these objectives because of the evolving ocean mapping industry.

Using Google Maps to display data will be useful for future work because it is an easy way to visually display data to clients. It allows clients to see the progress of a hydrographic or oceanographic survey by simply providing them a link to a website where the data is overlaid on Google Maps.

With the evolving web GIS industry, it will become more important to display data online, using similar methods to the ones used in this project.

Figure 4. The website created for the Ocean Mapping Group with labels showing what was added to Google Maps.

Figure 5. The website showing bathymetric data zoomed in near Pond Inlet, in Northern Baffin Island.
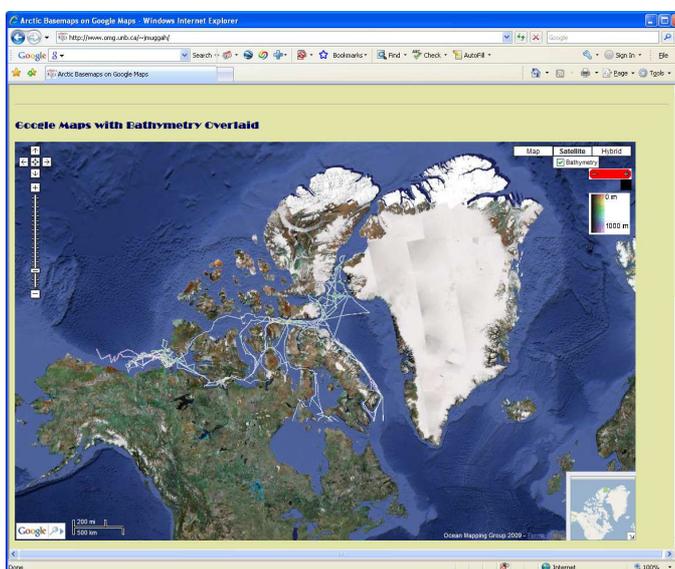

Figure 6. An overview of the website (www.omg.unb.ca/~jmuggah).

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8. ACKNOWLEDGMENT