Large-scale Regional Topographic Mapping Based on LIDAR Survey Data

John R. Gibson
Greater Wellington Regional Council
Wellington, New Zealand
john.gibson@gw.govt.nz

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Introduction

This poster describes the creation of a new set of large-scale topographic maps for the Wellington Region, NZ. These maps have been created at approximately 1:1,000 to 1:4,500 scales with 1m and 5m contours, and are intended to augment the existing national standard 1:50,000 mapping series. The maps are supplied as a tile-cached map service. They are based upon topographic data from broadscale high-resolution LIDAR surveys, plus other digital data from a variety of sources in a form of content "mash-up".

Background

The standard NZ topographic mapping series is the LINZ 1:50,000 scale NZTopo50 maps series. These maps have a lineage dating back to the first "Series 1" maps from about 1945 onwards, initially at 1:63,360 and later migrated to 1:50,000. They are in a state of continuous maintenance and are the mainstay of NZ's national topographic mapping. In addition to the paper-based maps, the source data is freely available from LINZ as both vector layer datasets as well as raster images.

In recent years, some components of topographic mapping have been massively improved, such as cadastral boundaries, road centrelines, and address points. High resolution colour aerial imagery has become readily available, typically 0.3m pixel imagery for national coverage. Google maps and similar products have set new expectations for interactive mapping at large scales. However, topographic basemaps have generally not shown a matching improvement in terms of content or higher resolution.

The causes of lack of major improvement in topographic mapping can mostly be traced to a lack of improvement in hypsometric (land elevation) datasets. This situation is now changing with increasing availability of broadscale LIDAR data. The new Wellington Regional maps are based on the outputs of a 2013 broadscale LIDAR survey of the entire region.

What Was Done

In 2013 a broadscale LIDAR survey was performed covering approx. 8,000 km^2 of the Southern North Island, NZ. Specifications were a minimum LIDAR point density of 1.3 points per square

metre, to a vertical accuracy of +/- 0.15m (1 sigma). The survey was commissioned for the WAGGIS (Wellington Area Government GIS) Consortium, for flood modelling and land management purposes.

A joint research project with Landcare Research (LCR) enabled production of a 1m cell-size digital elevation model (DEM), canopy height model (CHM) and Hillshade grid. LCR processed the LIDAR data free of charge in return for a period of exclusive access to the data, using innovative algorithms in the SPDLib software library. This allowed fully-automated production of point classifications and surface models, in contrast to the conventional semi-manual methods usually used.

The DEM was then processed to create a set of 1m and 5m interval contours for the region. At this point we realised that it would be possible to use the LIDAR data products as the basis for some large-scale topographic maps. The data layers were assembled in ESRI ArcMap 10.1, symbolized as appropriate, and a set of tile-cache topographic basemaps was created and published.

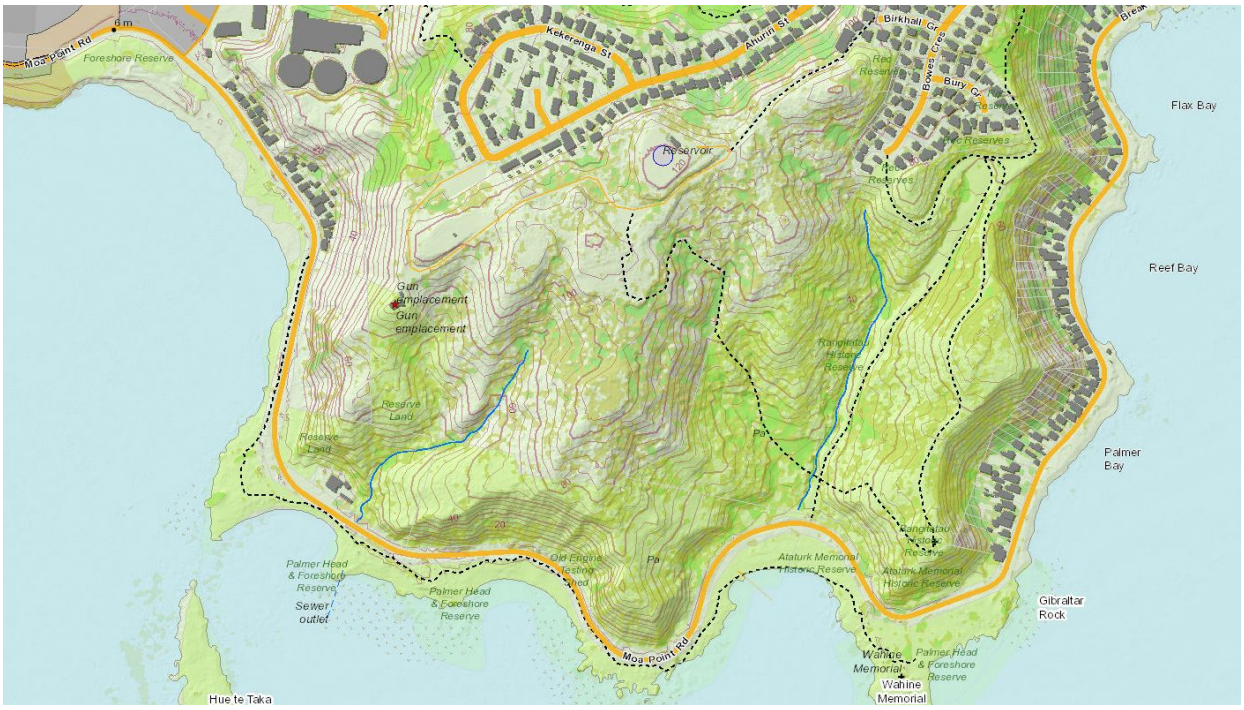

Figure 1. Example of a new map.

Sources

The final mapping product is a "mash-up" of many different digital data products which are in the public domain.

— LIDAR-derived hillshades, contours (1m and 5m), Canopy Height Model (WAGGIS,LCR,ASL)

— Topo50 vector layers including cadastral parcel boundaries (LINZ)
— Road centrelines - (OSM and NZTA)
— Building footprints - (TAs and GWRC)
— Streams, coastline (GWRC, from LIDAR interpretation)
— Vector river bdys (GWRC from aerial and LIDAR)
— Tracks - (LGGA)

Challenges

The actual cartographic methods used are relatively simple, e.g. symbolisation, representation, transparency and scale-dependancy. Nevertheless we considered the result to be fit-for-purpose and we released the basemap to the public in February 2016 following a period of internal use at GWRC.

The main challenges were to source or create a consistent set of vector overlay layers which were suitable for use at large scales. Many existing LINZ Topo50 vector layers are suitable for reuse at larger scales, but other layers needed to be sourced elsewhere or captured off aerial imagery or LIDAR sources.

Challenges are summarised below:

— various map layers required recapture at suitable accuracy levels, e.g. streams, river boundaries, bridges, coastline;
— new stream centrelines are being extracted from the DEM using mainly automated algorithms, but this requires a reasonable amount of effort and manual intervention.
— other layers were sourced from other open data sources, e.g. road centrelines (OSM and NZTA). We were fortunate that building footprints were available for many Territorial Authorities in the region, and GWRC could capture most of the remainder.
— the LIDAR sensor available at the time had limited ability to penetrate the forest canopy in areas of native bush, leading to poorer results for the DEM in these areas. This shows notable contrast with the results over pasture etc which is visible in the map in places. (The survey contractor has since acquired a LIDAR device which much-improved ability in this type of terrain).
— we had limited prior experience in digital cartography of this type, and struggled to find standards to align to.
— The LIDAR processing algorithms have limited abilities in eliminating medium sized buildings (e.g. warehouses) from the bare-earth DEM. This is being rectified by use of existing building footprint data & algorithm improvements.

Results

The new maps were created at scales of 1:4,513, 1:2,256 and 1:1,128 (Google/Bing standards for tile-caches) using the NZTM projection. This ensured compatibility with other basemap products available in NZ (e.g. Eagle Community Basemaps). Above 1:4,513 scale, the map

service uses LINZ raster topo imagery layers (Topo50 and Topo250).

The maps are available as WMTS tile services through GWRC web mapping applications e.g. http://mapping.gw.govt.nz/ and as services at http://mapping.gw.govt.nz/arcgis/rest/services.

Advantages

The new maps provide a level of topographic context which was previously unavailable for most areas in the region. For example, drainage and tracks that were previously invisible on topographic maps are clearly defined. Landowners, farmers, engineers, trampers and mountain bikers etc. can all take advantage of the improved information. New vector datasets have been created which are suitable for reuse elsewhere. Data is released under Creative Commons CC-BY terms to maximize reuse.

Figure 2. Map example from around Mount Victoria tunnel.

Future

We anticipate the continuous improvement of these map products in the future. Supporting vector layers will be enhanced, including stream centrelines and coastal tidal limits. Emerging cartographic standards will be studied and learnt from, in order to align the maps with other large-scale products.

At some point a re-fly of regional LIDAR will resolve some of the issues we experienced with vegetation canopy, and allow change detection in the landscape. The initial vertical datum for the data was specified as Wellington Datum 1953. The DEM will be reprocessed to align with the new national standard, NZVD2009.