Hydrography Professional Stream

Kaikōura – Getting Back to Sea

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Kaikoura Boat Club Channel Post-Quake

Introduction

Monday, 14 November 2016, was a devastating day for the Kaikōura and Waiau districts when a massive Magnitude 7.8 earthquake struck the region causing tectonic uplift, which triggered huge slips to effectively isolate the Kaikōura township from the north, south and west.

The coastline lifted approximately 1.0 metre around Kaikōura, exposing kelp and paua alike to the drying effects of the sun. It also left the Marine Tourist industry high and dry and stranded hundreds of tourist rental cars and vans all-round the district.

The Royal New Zealand Navy (RNZN) was able to deploy its emergency response units and bring immediate relief to the town and its temporary visitors.

From a surveying perspective, the earthquake dislocated the whole region, both horizontally (1.35m SE) and vertically (0.3-0.94m) which, effectively, destroyed the existing coordinate and vertical survey infrastructure.

Project

We were tasked to re-establish Chart Datum and survey the South Bay Marina and North Harbour using topographical and hydrographic techniques.

GNS and LINZ were able to establish Continually Operating GNSS Reference Station (CORS) and determine new precise coordinates and NZVD16 heights on a number of sites in the Kaikōura region.

Methodologies

We had two priorities after negotiating the only open road (Inland Kaikōura-Waiau Road) in true convoy fashion, vehicle No '200' going in and '18' coming out a week later, and these were to set up our CORS on the old reservoir with a precise Marlborough 2000 Latitude Longitude E Height in terms of NZV16 Geoid and also to set up a tide pole and gauge in the Whale Watch Marina.

So, while Liam and Quentin, my two Survey Graduates, set up the GNSS Receiver up the hill, I was establishing my acoustic tide gauge on the wharf edge.

CCPRS GNSS receiver set up on the old reservoir.

Establishing acoustic tide gauge on the wharf edge.

LINZ had supplied us with detailed tide prediction data which allowed us to determine the reduced level of the wharf and the probe height of our acoustic sensor which measured downwards (Nadir) to the water surface.

We were able to establish a tide pole on some bulwarks and synchronise the gauge to the pole.

We were also able to survey the position and height of the GNS occupied trig along the Kaikōura Peninsula which had a new post-quake precise position and back calculate a position for our CORS.

By applying the offsets to Lyttelton Datum and the Chart Datum, we discovered that I had established the tide pole and gauge about 100mm in error. This became more obvious after a week of tide recording to match the predicted tides. Later we requested the LINZ Recorded Tide Data from their gauge in North Wharf and found that we had all the heighting within about 30mm.

Surveys

Of course, time was of the essence and we made sure our survey methods were consistent and in terms as we would adjust them when we had more data.

We had perfect weather, a light northerly, while we sounded South Bay and a southerly when we sounded North Wharf and Ingles Bay as each wind shift left the survey area in a wind shadow and calm conditions. We used our RHiB for the South Bay area and agreed to survey the Kaikōura Motorboat Club Ramp and Channel too.

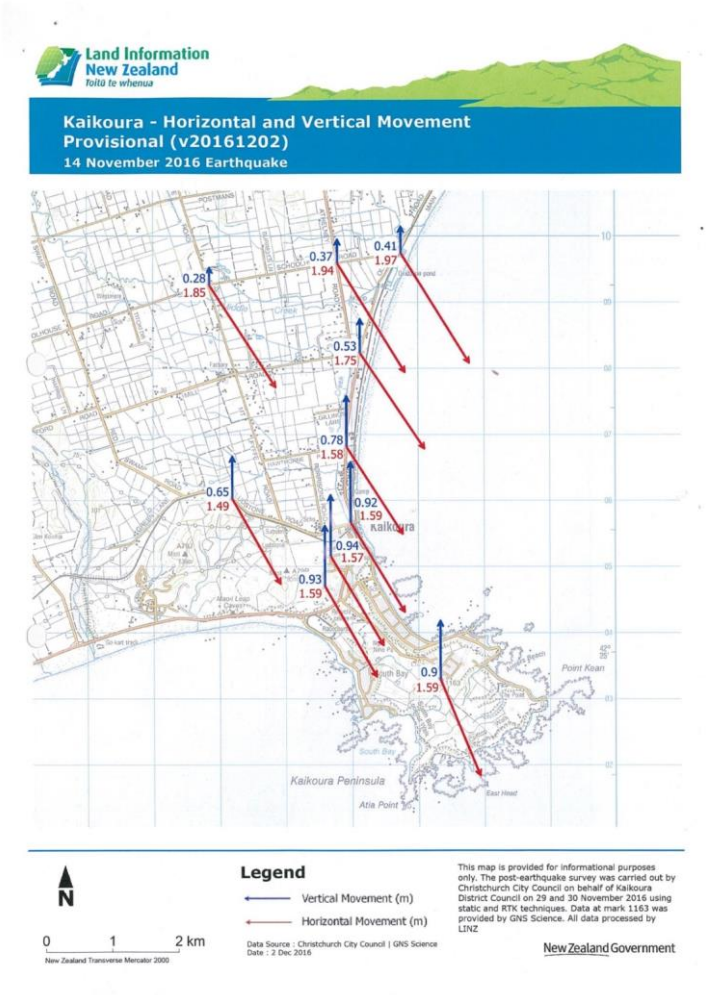
By New Year's Day, they had excavated their channel and will make it available to the general public until the Marina excavations are complete.

Tectonic Uplift

With so much seabed now exposed above low tide. we were tasked to survey an area between the Marina and the Coastguard Channels, both of which had limited navigable depths. We surveyed this area using our DJI Drone after marking prominent rocks with black crosses sprayed onto a white background. This proved very effective on the white limestone.

When we arrived in Kaikōura on Monday, 5 December 2016, we immediately sought out the local fixed wing and helicopter operations at the airport and obtained contact names, phone numbers and advice on what operations were continuing around the Kaikōura Peninsula and what restrictions were in place. We learnt that the restricted flying zone had, by this time, been revoked.

We were satisfied that we could operate legitimately under Civil Aviation Rule 101 and could operate in conjunction with the local flying operations. However we restricted ourselves to a maximum flying height of 80 metres (250 feet), but this meant that some of the other shoals photography didn't knit into our orthophoto solution.



Quarry Sites

The excavation of the marina and approach channel require the removal of limestone rock to reinstate the current depth from 1m to 2m below chart datum. This rock requires disposal locally, and to this end we surveyed an existing quarry and a new site over by the state highway using our drone and a Trimble SX-10, an integrated total station and scanner, to determine the volumes available.

CORS – COMS

Our CORS was able to take advantage of the surviving cellular telecommunications system and feed data back to our server in Christchurch and LINZ in Wellington. This data is received by our Trimble 'Pivot' system which makes it available to all our GNSS rover receivers. We have ten nodes, or CORS, available to us continuously anywhere in the country independent of the commercial companies.

We have UHF transmitters coupled to our NetR9 receiver in our CORS and this is used primarily for our hydrographic operations at sea and has an RTK range in excess of 25km from the base receiver. We can connect our radios to our TSC3 data recorders if cellular coverage is marginal for our GNSS control and topographic surveys.

In January 2017 we again used it for surveying the coastline north of Ohau Point at the Seal Colony, a distance of 22km from the base.

Ohau Point Coastline and Slip No 6

LINZ – Fast Static

We spent a day carrying out twin observations of a number of marks around the Kaikōura township as well as picking up the original Navy bench marks they had established chart datum in Kaikōura years before.

North Wharf & Ingles Bay

While I hired a local fishing boat for this deeper more open sea survey, Liam and Quentin carried out onshore surveys and checks on tide levels and the coastline.

Ingles Bay is often seen in postcards with fishing vessels on their moorings wallowing up and down. It is now full of shoaling rocks as it is much shallower with the recent uplift.

The locals tell me that aftershocks in the realm of magnitude 4.5-5.5 are still happening. Maybe I was becoming immune or just too tired at night and was fast asleep and not aware.

Post Processing & Plans

The benefits of a good cellular network are many fold, but for us being able to remotely access the fast computers back in our Christchurch office, was exceptional. The transfer of data using 4G modems was

reasonably fast but once there, it was immediately archived by the office system and then processed. We were able to use Trimble TBC and RealWorks, 12d, Trimble Hydro-NavEdit.

We had laptops, Trimble tablets and Trimble TSC3 Recorders to record the local field files and process as we needed to on site.

Seabed Flora

The Kaikōura coastline is very rich in flora and fauna which makes it a tourist and conservator's delight. However for the hydrographic surveyor it confuses the water column with false echoes and noise in the depth measurement. This makes editing of the survey depth data long and subjective.

Navigable Depth & Engineering Depth

Hydrographic processing software is a little unique as it can thin the density of data by depth bias, shallow or deep. Thus, for safe navigable depth we use a shoal bias to best represent the shallowest depth that a mariner is likely to encounter, but from an engineering perspective we want the deeper depth as we want volumes of bedrock to be excavated.

We created two surfaces to represent these two situations and overlaid our orthophoto to confirm the shoal location.

This methodology gave a better appreciation of the engineering scope of works as it reduced the calculated volume to be excavated and allowed initial excavation to proceed.

Launching Pool

We understand the area of the foot of ramp was deepened to allow the large dolphin watch boats to launch and give them a six hour sailing window about high tide, i.e. mid to mid-tide instead of a three hour window. They could negotiate the shallower channel as their draft is not excessive, but need the deeper pool depth because of their lengths.

Excavation Method

A simple and straight forward method in shallow water is to create a bund, or embankment, and then excavate to the design depth and remove the bund as you withdraw.

The limestone seabed can be ripped with a single ripper tooth and excavated with a 35 Tonne digger. The material can be used to extend the bund and can be immediately driven on. The low tide bund maximised the reach of the digger and their efficient removal of seabed rock.

Note the amount of exposed seabed behind the digger.

Whale Watch Marina

The future of the marina and concrete wharf infrastructure is not known at this time and may be removed if uneconomic to excavate.

The boat pens have shallowed by 1.0 metre, which, during a Spring Low Tide of 0.3 metres, means that they would touch the seabed instead of floating. They (the whale watch vessels) were moved to Wellington marina during the spring tides in mid-December, so there is an incentive to have their berth deepened.

We understand that a barge may be brought up from Christchurch to carry a digger into the marina. Barge vessels in this type of operation need spuds (piles) to constrain the barge's movement when the digger is mechanically breaking up the seabed with its pick and excavating with its bucket.

New Technology

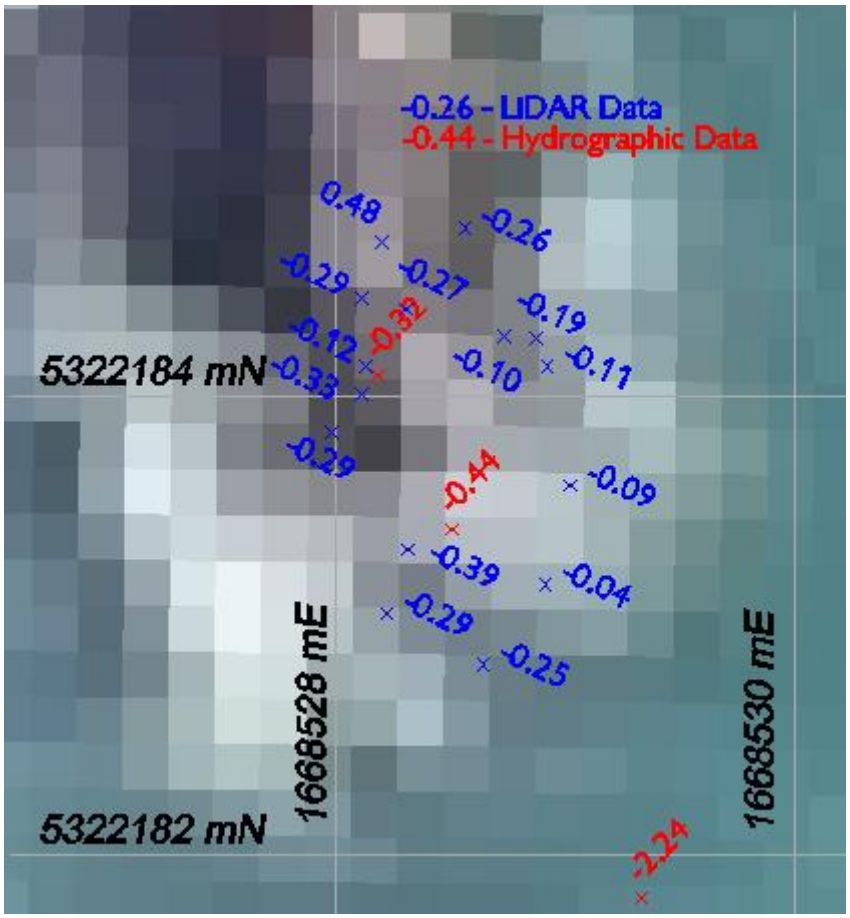
Airborne LiDAR is very effective on hard surfaces and has been used along the coast north and south of Kaikōura to provide the data for evaluating various roading options there.

The new LINZ orthophotography is a great resource for imagery.

The NZVD2016 ground truthed geoid is and will become an accepted tool for surveyors, engineers and those involved with the third dimension.

We were able to prove the datasets from each of the technologies were consistent as we sounded over a shoal at high tide which had been exposed at low tide to the LiDAR aircraft. The results are impressive.


WHALE WATCH
PAIKEA
Orion-Rib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Conclusion

This project provided us with a unique opportunity to assist in the recovery of the town's marine tourism and roading network.

The best technologies available were used for the task of surveying in shallow water.

The support from the government departments of LINZ and GNS was exceptional. They provided precise coordinates, heights and tides for re-establishing position and chart datum which enabled the engineers of Tonkin & Taylor Ltd to assess the damage and solutions to recovery. The new NZVD16 geoid model proves to be invaluable when re-establishing vertical datums and the open source data available from LINZ was essential in proving our survey measurements and calculations.

Our integration of equipment, methodologies and datasets proved very effective as each complimented the other and made whole.

We wish to thank Tonkin & Taylor, Tony Fairclough and Brian Davis and Opus, Scott Becker, for inviting us to do this work.

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