NZIS
POSITIONING AND MEASUREMENT

September 2016

NZIS Positioning & Measurement Stream Articles

This month we have a bumper column split into three sections: information about LINZ's new NZVD2016 & NZGeoid2016; tips on how to receive group digests from the stream LinkedIn group; and a roundup of recent articles and other resources.

NZVD2016 & NZGeoid2016 – a brand new vertical datum and geoid model for NZ

On 27 June 2016 LINZ released the New Zealand Vertical Datum 2016 (NZVD2016) and the New Zealand Quasigeoid 2016 (NZGeoid2016). In LINZ's words:

> *"The purpose of the Vertical Datum Improvement project was to improve the accuracy of the national vertical datum. This was done through the collection of a national airborne gravity dataset, as well as on the ground surveys, and data analysis.*
>
> *[NZVD2016] provides a national vertical datum with consistent coverage across the country, including the seamless transition from land to sea."*

NZVD2016 & NZGeoid2016 offer considerably improved accuracy for GNSS-derived heights over those derived in terms of the NZVD2009 & NZGeoid2009 which they supersede. NZVD2009 & NZGeoid2009 themselves offered considerably improved accuracy for GNSS-derived heights over what was previously achievable (by either utilising the prototype NZVD2005 & NZGeoid2005 combination, or other geoid models such as the EGM96). However the usefulness of NZVD2009 & NZGeoid2009 were constrained by a number of limiting factors: irregular density of the dataset of gravity readings from which NZGeoid2009 was derived; incomplete coverage of gravity readings in near-shore areas; the somewhat large standard deviations of the constant datum offsets between NZVD2009 and the thirteen local Mean Sea Level datums still commonly used (note LINZ terminology has been revised to now refer to these as Local Vertical Datums, or LVD's); and the growing need by surveyors and others to be able to determine heights by GNSS in applications with tighter error budgets than the specified accuracy parameters of NZVD2009 & NZGeoid2009. NZVD2016 & NZGeoid2016 represent a significant improvement upon these shortcomings.

In order to improve the accuracy of the vertical datum it was necessary to generate an improved geoid model, derived from a sufficiently uniform and accurate nationwide coverage of gravity readings. As no such dataset was already in existence, a major airborne gravity survey was undertaken covering all of the mainland New Zealand landmasses and near-shore waters. Two campaigns of airborne surveys were undertaken in 2013 and 2014, consisting of a total of 75 flights and 425 flying hours spread over 50,000 km of flight lines. Additional gravity readings were collected by terrestrial observations, ship track data and satellite altimetry. The resulting NZGeoid2016 covers the New Zealand continental shelf with a grid resolution of approximately 1.8km (one arc minute). According to LINZ information, NZGeoid2016 has an expected accuracy of better than 3 centimetres based on comparisons with GNSS-levelling in urban areas.

A new feature of NZVD2016 is the thirteen LVD relationship grids which have also been published to transform heights between NZVD2016 and the thirteen LVD'S. These relationship grids effectively combine the NZGeoid2016 model with datum offset models in composite models. This is because the datum offsets from NZVD2016 to the LVD's are no longer constant for each LVD (as they were for NZVD2009).

The Vertical Datum Improvement project was completed as a collaboration between LINZ, GNS Science and Victoria University of Wellington in the collection, analysis and computation of the data. The project was allocated a budget of $1.9m, and was completed significantly under budget at a total cost of $1.5m. A very reasonable cost to the nation for the utility of being able to determine orthometric heights by GNSS to a significantly greater accuracy than previously.

LINZ has a number of on-line information resources about NZVD2016, NZGeoid2016, and the LVD relationship grids:

The downloadable *Standard for New Zealand Vertical Datum 2016 - LINZS25009* http://www.linz.govt.nz/regulatory/25009.

http://www.linz.govt.nz/data/geodetic-system/datums-projections-and-heights/vertical-datums/new-zealand-vertical-datum-2016-nzvd2016

http://www.linz.govt.nz/data/geodetic-system/datums-projections-and-heights/vertical-datums/new-zealand-quasigeoid-2016-nzgeoid2016

http://www.linz.govt.nz/data/geodetic-system/datums-projections-and-heights/vertical-datums/vertical-datum-relationship-grids

See also presentations by LINZ's Matt Amos and Rachelle Winefield from the May 2016 FIG Working Week in Christchurch:

http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/ppt/ts08d/TS08D_amos_8103_ppt.pdf

http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/ppt/ts08d/TS08D_winefield_amos_8081_ppt.pdf

The NZGeoid2016 and the thirteen LVD relationship grid datasets are available for download from LINZ Data Service (https://data.linz.govt.nz/).

NZGeoid2016 and LVD relationship grid data files for surveying equipment should also be already available in equipment specific formats from all major equipment vendors.

The 25 June 2016 version of SNAP software also includes NZGeoid2016, along with NZGeoid2009, NZGeoid2005 and EGM96 (all embedded in software installation). Download SNAP from: http://www.linz.govt.nz/data/geodetic-services/download-geodetic-software/snap-concord-downloads.

This month's image is a photo of the gravity meter console setup for LINZ's 2013/2014 airborne gravity survey. The gravity meter is a LaCoste & Romberg S-meter, which has been modified for use in an aircraft (previously used for ship-borne gravity collection). Image credit: LINZ.

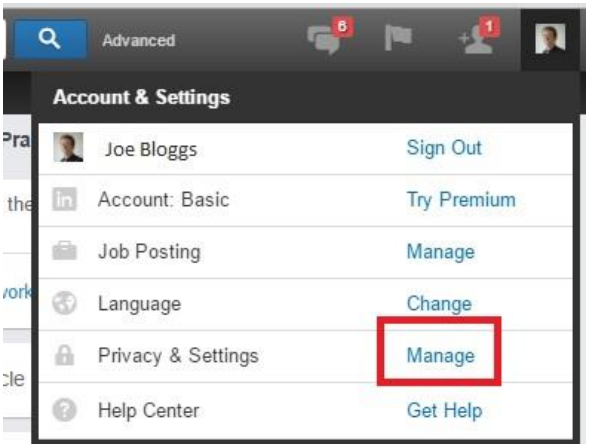
How to receive group digests from our stream LinkedIn group

As many of you will already have discovered, LinkedIn can be a great way to maintain your professional network, find employment and business opportunities and stay engaged with what is happening in the profession.

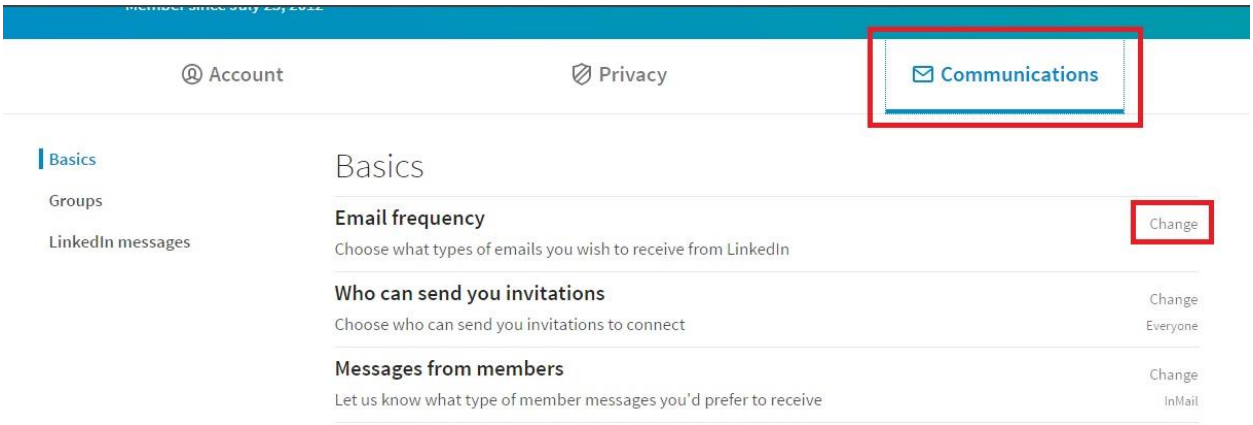
Several of the NZIS Streams and Divisions and NZIS Head Office use LinkedIn groups to disseminate information and encourage discussion on items of interest to the community. This month for example the Positioning and Measurement Stream group includes articles about maps for Driverless Cars, a piece on the NZ Spatial Excellence Awards and another on NZVD2016, and a link to a podcast on the development of the Galileo Satellites.

To join these groups log in to LinkedIn and search for 'NZIS'. It is a nuisance to have to log in to check the latest updates in each group, so instead we recommend receiving a daily or weekly digest from each group. To do this:

1. Log into your LinkedIn account and hold the cursor over your profile picture at the top right of the screen to see the **Account and Settings** menu.
2. Under **Privacy and Settings** click **Manage**.

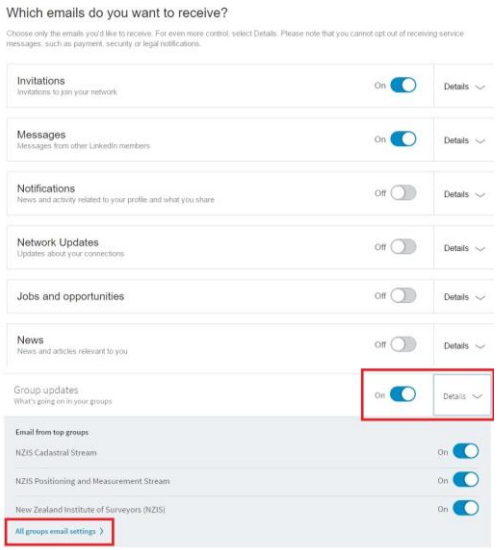


3. Go to the **Communications** tab and under **Email frequency** click **Change**.



4. Scroll down to **Group Updates** and make sure this is turned **On**.

5. Click the **Details** drop down to change settings for individual groups. Then under **All groups email settings** you can specify how often you receive group emails, and whether you would like to see a Weekly or Daily digest of activities in your group. Getting this digest is the best way to ensure you stay in touch with all of the news items and discussions that appear in your group.



Lastly, don't be afraid to get involved in the discussion! We look forward to seeing you there.

Recommended Reading

In July Stuff had a piece *GeoNet turns 15 - what have we learned about earthquakes in that time?* heralding 15 years of GeoNet operation. Article and video at: http://www.stuff.co.nz/national/82329250/geonet-turns-15--what-have-we-learned-about-earthquakes-in-that-time.

The feature article of the July 2016 issue of Coordinates magazine, *The prediction and validation of the Kumamoto earthquake*, outlines how data from an array of GNSS sensors (i.e. similar to GeoNet) in Japan provided scientists with sufficient confidence to predict an earthquake that did actually eventuate. The authors acknowledge the prediction was only a partial success, but their report shares some valuable findings from this study. Read the full article at: http://mycoordinates.org/the-prediction-and-validation-of-kumamoto-earthquake-with-gnss-data/.

The August edition of GeoDataPoint has a focus on BIM, including a compelling article *BIM by way of backpack* which describes the advantages backpack-based mobile data capture systems offer for the rapid capture of large and complex assets. Read the full story at: http://view.ceros.com/orange-tap/gdp-august-2016/p/5.

The August issue of POB magazine has *Machine Impossible – New air/water drone development could be a geospatial game changer*, which profiles a multi-rotor drone platform currently being developed by researchers at Rutgers University in the USA. The team has developed a drone that can operate both airborne and underwater and transition from one medium to the other in less than a second, which they are now looking to commercialise. More at: http://www.pobonline.com/articles/100510-airwater-drone-could-simplify-surveying.

POB also continue their series focussed on deformation monitoring networks, with part 2 discussing network simulation and balancing accuracy and redundancy: http://www.pobonline.com/articles/100513-guest-column-more-on-deformation-monitoring-networks.

Spatial Source has *Locata leads revolution in positioning* which describes how pioneering Australian positioning technology company Locata has recently completed successful trials for the US Air Force to the stage where USAF has declared the technology operational. In conjunction with other commercial partners, Locata had already proved the effectiveness of its positioning technology as an alternative/augmentation to GNSS at large mining test sites. Locata is now looking to commercialise their technology for mass market applications, and it is easy to see how it might be able to be utilised by surveyors. More at: http://www.spatialsource.com.au/2016/08/locata-leads-revolution-non-gps-positioning/. Locata's achievements with the USAF is big news at present and is also mentioned in *Air Force upgrades to better field reference system for testing GPS denial,* the feature article in the current issue of GPS World magazine: http://gpsworld.com/air-force-upgrades-to-better-field-reference-system-for-testing-gps-denial/.

Another piece on Inside GNSS's website magazine notes:

> *"The U.S. Secretary of Defense has said "I hate GPS" and "I want to unplug the military from GPS." Senior officials at the Department of Homeland Security (DHS) have called GPS "a single point of failure for critical infrastructure.""*

This illustrates why the USAF designation of alternative positioning technology (such as Locata's) as operational is such a big deal. Read more at: http://www.insidegnss.com/node/5078.

Readers may have a chuckle at another Spatial Source article *Australia on the move? Geodetic surveyors dispel GDA2020 confusion* which describes how international media outlets managed to generate sensational headlines from the planned Geocentric Datum of Australia 2020. Read the story at: http://www.spatialsource.com.au/2016/08/australia-move-geodetic-surveyors-dispel-confusion/. Inside GNSS also has an article on this subject at: http://www.insidegnss.com/node/5082. Detailed information about Australia's datum modernisation programme from one of the agencies responsible is available at: http://www.icsm.gov.au/geodesy/modern.html.

In GNSS news, the two Galileo satellites which were originally inserted in incorrect orbits are set to commence broadcasting navigation signals from their improved but still unintended orbits. Read more at: http://gpsworld.com/salvaged-galileo-satellites-to-broadcast-test-signals/ and http://www.insidegnss.com/node/5076. For a technical insight on Galileo development work, Omega Tau has a podcast featuring interviews with the staff of OHB System AG in Bremen including discussion on the development of the Galileo satellite vehicles: http://omegataupodcast.net/209-satellite-development-at-ohb/. GPS World have an update to their regular stocktake of all GNSS constellations at: http://gpsworld.com/the-almanac/.

To submit material for inclusion in future Positioning & Measurement stream Newslink columns please contact us via the stream LinkedIn group (http://tinyurl.com/njbpejn), or post material directly there.

October 2016

This month's column features information about: RTCM3.2 implementation at PositioNZ-RT reference stations; and some additional NZVD2016 resources to supplement the material in our September piece.

We encourage stream members and other readers to submit anecdotes and photos of their work in this column. To submit material for inclusion in future Positioning & Measurement stream Newslink columns please contact us via the stream LinkedIn group (http://tinyurl.com/njbpejn), or post material directly there.

This month's photo is an old one but a good one from one of our readers. It shows a Kea checking out a GNSS antenna during a deformation survey being undertaken by Energy Surveys in the upper South Island. Credit: Marcel Abele, Oct 2006.

PositioNZ-RT & RTCM3.2

In the last few years LINZ has upgraded the GNSS hardware at its PositioNZ permanent GNSS reference station sites from GPS+GLONASS hardware to new multi-GNSS hardware. The new multi-GNSS units are capable of tracking satellites from GPS, GLONASS, Galileo, Beidou & QZSS constellations. However in order to utilise full multi-GNSS functionality for real-time applications it is necessary to also implement firmware upgrades which have only become available more recently. The necessary firmware upgrades have been implemented and are already operational at Warkworth (WARK), Mt John Observatory (MTJO), Taupo Airport (TAUP), Whangarei (WHNG), Waiarapa (WRPA) & Puysegur Point (PYGR).

Real-time corrections for multi-GNSS are not supported in the RTCM3.0 format in which corrections from all PositioNZ-RT sites were streamed until just recently. In order to utilise the PositioNZ-RT service for multi-GNSS positioning, corrections must be streamed in the RTCM3.2 format. Users must also configure their GNSS receivers to receive corrections in the RTCM3.2 format.

As the RTCM format has evolved it has been refined to contain correction messages in more compact data packets. This has resulted in more efficient and accurate positioning by end users whilst also freeing up valuable bandwidth for the expanded amount of message information required to support a growing number of GNSS signals. The RTCM3.2 format incorporates Multi

Signal Messages (MSM) into the RTCM format, and is an open and standardised format designed to support real-time GNSS correction messages streamed from reference stations observing any or all of the GNSS constellations already or soon to be available.

Most modern survey-grade GNSS receivers with up to date firmware should be able to be configured to receive corrections in the RTCM3.2 format, but the users of legacy GNSS equipment might find that their equipment does not support it.

Only some PositioNZ-RT sites are readily capable of supporting dual RTCM3.0 & RTCM3.2 streams, and LINZ has signalled its intention to eventually migrate corrections at all PositioNZ-RT sites to the RTCM3.2 format, and possibly cease support of the RTCM3.0 format. In order to gauge when or if this should occur, LINZ currently has a trial in progress whereby both RTCM formats are being provided for streaming corrections from stations WARK, MTJO, TAUP & WRPA. LINZ also has yet to finalise a programme for upgrading all sites to RTCM3.2. To assist in its decision making, LINZ is now requesting that users of the PostioNZ-RT service experiment with their GNSS receivers to determine if they can be configured to operate receiving the RTCM3.2 format. Users are encouraged to provide feedback to LINZ in the form of an on-line survey (https://goo.gl/forms/0wVvm7o4mzt4T0Oh2). For additional information refer to LINZ's recent RTCM notice: http://www.linz.govt.nz/news/2016-08/preparing-positionz-rt-for-multi-gnss-%E2%80%93-can-you-connect.

Subscribers of commercial real-time correction services (comprised of reference station networks which include the PositioNZ-RT sites and other private reference stations) should contact their correction service providers to inquire which RTCM formats are supported by those services.

For some background about RTCM, refer to XYHT magazine's November 2015 article *RTCM – Real Time Correction Messages: Why this is important and where it is going* (http://www.xyht.com/gnsslocation-tech/rtcm/). [Note that the acronym RTCM does not stand for real time correction messages, but for the Radio Technical Commission for Maritime Services which is an international communications standards organisation. More detail at: http://www.rtcm.org/].

NZVD2016 & NZGeoid2016

In our September column we previewed the new NZ vertical datum and geoid model, including links to some useful resources. The Lincoln University based GIS Blog also has some related posts:

http://blogs.lincoln.ac.nz/gis/2016/08/05/keeping-our-heads-above-water/

http://blogs.lincoln.ac.nz/gis/2016/08/28/and-standing-up-straight/

Both pieces are full of useful information with links to further interesting related material, including a recent Radio NZ article and podcast about NZVD2016 (featuring LINZ's Graeme Blick and Rachelle Winefield):

http://www.radionz.co.nz/national/programmes/ourchangingworld/audio/201807946/exactly-where-is-sea-level-gravity-can-tell-us.

PositioNZ-RT & RTCM3.2

In the last few years LINZ has upgraded the GNSS hardware at its PositioNZ permanent GNSS reference station sites from GPS+GLONASS hardware to new multi-GNSS hardware. The new multi-GNSS units are capable of tracking satellites from GPS, GLONASS, Galileo, Beidou & QZSS constellations. However in order to utilise full multi-GNSS functionality for real-time applications it is necessary to also implement firmware upgrades which have only become available more recently. The necessary firmware upgrades have been implemented and are already operational at

Warkworth (WARK), Mt John Observatory (MTJO), Taupo Airport (TAUP), Whangarei (WHNG), Waiarapa (WRPA) & Puysegur Point (PYGR).
Real-time corrections for multi-GNSS are not supported in the RTCM3.0 format in which corrections from all PositioNZ-RT sites were streamed until just recently. In order to utilise the PositioNZ-RT service for multi-GNSS positioning, corrections must be streamed in the RTCM3.2 format. Users must also configure their GNSS receivers to receive corrections in the RTCM3.2 format.
As the RTCM format has evolved it has been refined to contain correction messages in more compact data packets. This has resulted in more efficient and accurate positioning by end users whilst also freeing up valuable bandwidth for the expanded amount of message information required to support a growing number of GNSS signals. The RTCM3.2 format incorporates Multi Signal Messages (MSM) into the RTCM format, and is an open and standardised format designed to support real-time GNSS correction messages streamed from reference stations observing any or all of the GNSS constellations already or soon to be available.
Most modern survey-grade GNSS receivers with up to date firmware should be able to be configured to receive corrections in the RTCM3.2 format, but the users of legacy GNSS equipment might find that their equipment does not support it.

Only some PositioNZ-RT sites are readily capable of supporting dual RTCM3.0 & RTCM3.2 streams, and LINZ has signalled its intention to eventually migrate corrections at all PositioNZ-RT sites to the RTCM3.2 format, and possibly cease support of the RTCM3.0 format. In order to gauge when or if this should occur, LINZ currently has a trial in progress whereby both RTCM formats are being provided for streaming corrections from stations WARK, MTJO, TAUP & WRPA. LINZ also has yet to finalise a programme for upgrading all sites to RTCM3.2. To assist in its decision making, LINZ is now requesting that users of the PostioNZ-RT service experiment with their GNSS receivers to determine if they can be configured to operate receiving the RTCM3.2 format. Users are encouraged to provide feedback to LINZ in the form of an on-line survey (https://goo.gl/forms/0wVvm7o4mzt4T0Oh2). For additional information refer to LINZ's recent RTCM notice: http://www.linz.govt.nz/news/2016-08/preparing-positionz-rt-for-multi-gnss-%E2%80%93-can-you-connect.

Subscribers of commercial real-time correction services (comprised of reference station networks which include the PositioNZ-RT sites and other private reference stations) should contact their correction service providers to inquire which RTCM formats are supported by those services.
For some background about RTCM, refer to XYHT magazine's November 2015 article *RTCM – Real Time Correction Messages: Why this is important and where it is going* (http://www.xyht.com/gnsslocation-tech/rtcm/). [Note that the acronym RTCM does not stand for real time correction messages, but for the Radio Technical Commission for Maritime Services which is an international communications standards organisation. More detail at: http://www.rtcm.org/].

NZVD2016 & NZGeoid2016
In our September column we previewed the new NZ vertical datum and geoid model, including links to some useful resources. The Lincoln University based GIS Blog also has some related posts:
http://blogs.lincoln.ac.nz/gis/2016/08/05/keeping-our-heads-above-water/
http://blogs.lincoln.ac.nz/gis/2016/08/28/and-standing-up-straight/
Both pieces are full of useful information with links to further interesting related material, including a recent Radio NZ article and podcast about NZVD2016 (featuring LINZ's Graeme Blick and Rachelle Winefield):

http://www.radionz.co.nz/national/programmes/ourchangingworld/audio/201807946/exactly-where-is-sea-level-gravity-can-tell-us.

August 2016

Focus on InSAR

"*InSAR. How can you monitor broad-area land deformation with high precision? Why, from space, of course!*" This statement, the title from the feature article of the July issue of XYHT magazine (http://www.xyht.com/aerialuas/insar/) may come as a surprise, but at optimum performance it is possible to monitor ground deformation in the order of millimetres of change by InSAR methods.

InSAR (Interferometric Synthetic Aperture Radar) is a satellite-based ranging technology which is perhaps outside the experience of most New Zealand surveyors, but the technology has been in use for deformation monitoring for many years. Synthetic Aperture Radar (SAR) was first used in the 1978 NASA SEASAT remote sensing mission. InSAR results for deformation measurement were first published in "Nature" in July 1993 for the June 1992 Landers (California) earthquake. Although the technology has evolved somewhat since then, it remains a tool utilised primarily by the geo-sciences research community. InSAR has become a widely used tool internationally for measuring deformation of the Earth's surface, but expensive data costs, limited numbers of radar acquisitions, challenging surface conditions and a lack of local training has limited its usage across New Zealand. In fact currently there would appear to be only a single InSAR scientist actively utilising InSAR for deformation monitoring in New Zealand – GNS Science's InSAR Scientist Ian Hamling.

LINZ has a web-link to a set of presentation slides prepared by Ian Hamling and GNS colleagues, which describes the fundamentals of how InSAR works, how it can be used for deformation monitoring, and recent examples of its use in New Zealand. More at: http://www.linz.govt.nz/system/files_force/media/file-attachments/Hamling_InSAR_Obs_NZ_Deformation.pdf.

Further general information about InSAR and its utilisation for deformation monitoring can be found at the following US Geological Survey's resources: https://volcanoes.usgs.gov/vhp/insar.html; http://pubs.usgs.gov/fs/2005/3025/2005-3025.pdf.

Ian reports that: "Successful interferograms were produced following the 2009 Dusky Sound and 2010-2011 Christchurch earthquakes using the Japanese Space Agencies ALOS satellite, but analysis of smaller scale deformation is still in its infancy. In the last few years, work at GNS Science has started to utilise the existing archive of data acquired by the European (ESA) and Japanese (JAXA) Space Agencies, to search for evidence of surface motion across New Zealand at unprecedented spatial scales. With the launch of Sentinel 1a and 1b by ESA (in 2014 and 2016 respectively), ALOS-2 by JAXA, and the addition of the Taupo Volcanic Zone as a global supersite, radar acquisitions over New Zealand are now being made approximately every 10 days. "Supersites" are an initiative of the geo-hazard community to provide access to space-borne and in-situ geophysical data of selected sites prone to earthquake, volcano or other hazards (http://supersites.earthobservations.org/). With the Taupo Volcanic Zone added as a supersite, we now have access to data provided from all major satellite agencies free of charge for monitoring of volcanic hazards. Although not without challenges, this level of data coverage will start to provide new opportunities for measuring deformation of the Earth's surface (whether from anthropogenic activities, tectonics, or volcanism) at millimetric precision."

For more detailed information, full scientific papers on the research described above on the Dusky Sound and Christchurch earthquake events, and the Taupo Volcanic Zone can be freely accessed on-line:

Off-axis magmatism along a subaerial back-arc rift: Observations from the Taupo Volcanic Zone, New Zealand (Hamling et al, 2016) http://advances.sciencemag.org/content/2/6/e1600288.full;

The Mw 6.2 Christchurch earthquake of February 2011: preliminary report (Kaiser et al, 2012) http://www.tandfonline.com/doi/full/10.1080/00288306.2011.641182;

Ground deformation in the Taupo Volcanic Zone, New Zealand, observed by ALOS PALSAR interferometry (Samsonov et al, 2011) http://gji.oxfordjournals.org/content/187/1/147.full;

Oblique slip on the Puysegur subduction interface in the 2009 July MW 7.8 Dusky Sound earthquake from GPS and InSAR observations: implications for the tectonics of southwestern New Zealand (Beavan et al, 2008) http://onlinelibrary.wiley.com/enhanced/doi/10.1111/j.1365-246X.2010.04798.x.

Ian has also contributed the InSAR processing which eventually ends up in the NZGD2000 deformation model. LINZ's Technical Manager Geodesy, Nic Donnelly, describes the importance of InSAR data to LINZ: "LINZ doesn't process InSAR data itself at the moment, although we are working to build this capability. But the interferograms produced by GNS are a critical data source for the earthquake sub-models within the NZGD2000 deformation model. The deformation model directly impacts geodetic coordinates and therefore all geospatial data that is connected to geodetic control marks."

A huge advantage of deformation monitoring by InSAR methods over monitoring by surveying methods is that InSAR enables very efficient analysis of deformation over large geographic areas. In comparison large-area monitoring by surveying methods would require considerable resources, time and expense. However deformation monitoring by InSAR and surveying methods can be considered complementary rather than competing technologies, with each method having its own unique set of advantages and limitations, but which when combined provide a more comprehensive data set than is feasible by either method in isolation.

This month's image has been provided by Ian Hamling. It shows a recent interferogram over the North Island made by ALOS-2. This interferogram uses the ScanSAR mode on ALOS-2 which enables the formation of interferograms approximately 400 km x 400 km in size.

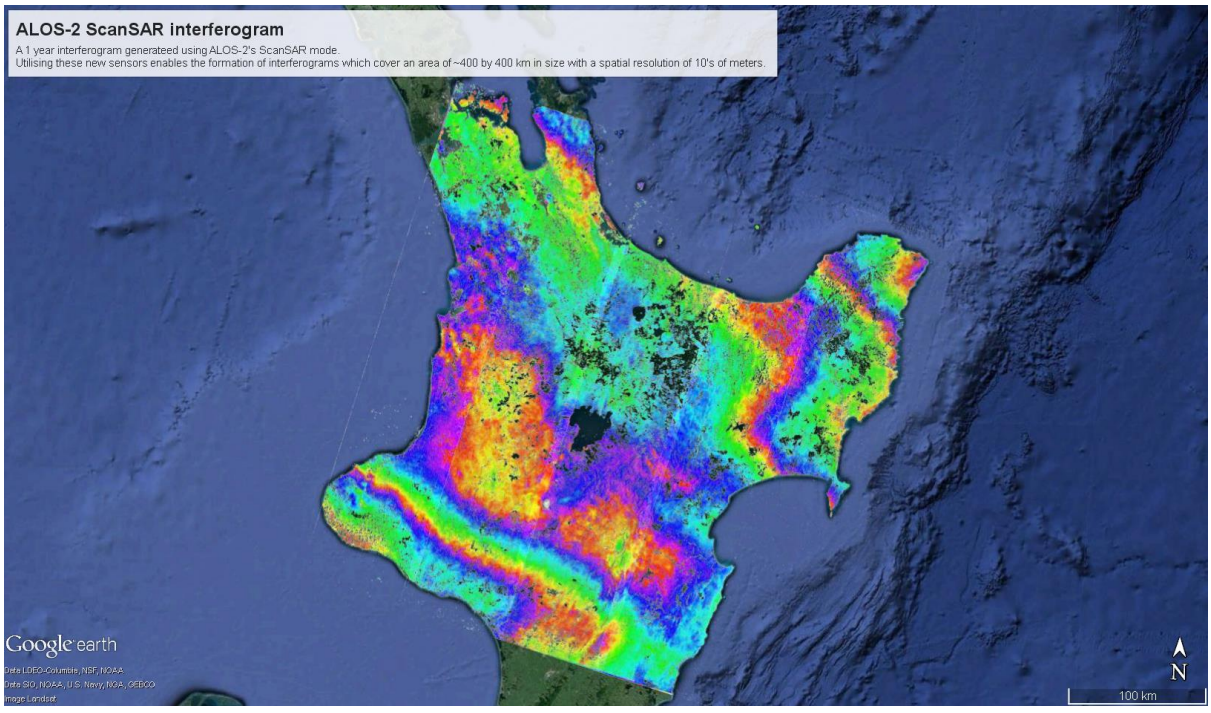


Image credit: Ian Hamling.

To submit material for inclusion in future Positioning & Measurement stream Newslink columns please contact us via the stream LinkedIn group (http://tinyurl.com/njbpejn), or post material directly there.

July 2016

There is an increasing number of media stories about how automation has the potential to make the roles of many of today's workforce redundant or obsolete within a generation. A recurring theme of these stories is that the impact of automation will not be limited to unskilled or manual labour type roles, and many professional roles (including those within the geospatial sector) are also likely to be significantly impacted or threatened in the traditional sense of those roles. Indeed all around us are examples of how technology is transforming just about every aspect of our lives, and the possibilities are almost as limitless as imagination. The shift towards automation in surveying applications is evidenced by the advancement in just the last decade of terrestrial laser scanners, UAV's, 3D guidance/control of earthmoving machinery, automated monitoring, mobile mapping systems etc.

Some sectors of the workforce will rightly feel threatened by the rise of automation, but the geospatial sector has a long and fine history of embracing opportunities presented by advancements in technology, and the advent of increasing automation can be viewed as just another step on this technological evolutionary journey. Instead of feeling threatened, we should consider ourselves fortunate to be alive in a technological golden age - with all the opportunities which that presents. While many of a surveyor's traditional roles are either already or soon might be under threat by automation, the flipside of that threat is the opportunity to harness that very same technology for commercial gain.

There will therefore continue to be an expanding range of opportunities for those geospatial professionals willing to seize the initiative and diversify their existing set of skills, knowledge and experience. Early adopters stand to gain an advantage over their competitors by upskilling and re-skilling themselves (and their staff). It will be important to not only invest in the new technological tools themselves, but also to invest in the education required to master those tools. Those brave enough to embrace these changes stand to become masters of the new technologies in a whole range of new applications, as the traditional boundaries of our professional sphere of influence are blurred by a proliferation of emerging technologies.

NZIS's June 2016 Surveying + Spatial features a piece on this fascinating subject with *Technology, Urbanisation, and Choking on It*, by well-known NZ economist Shamubeel Eaqub, which was also the topic of his well-received presentation at the 2015 NZIS conference. The way technology is already radically transforming the way surveyors go about their daily business, right here in NZ, right now today, is the theme of a number of other articles in this issue: *Preserving History – 3D Scan of the Triumphal Arch of the Bridge of Remembrance*, by Rowan Hallam (Woods); *Understanding 3D Laser Scanning and Revit Technology*, by Malcolm Archbold (asBUILT); *Delivering Project Efficiency through Digital Collaboration*, by Keri Niven (Aurecon). In a similar vein the March 2016 Surveying + Spatial also featured exposes on the utilisation of modern spatial measurement technology with: *Mackays to Peka Peka – Using Trimble Connected Community*, by Will Newall (Mackays to Peka Peka Alliance); and *Mobile 3D Mapping – A hydrographic first in NZ*, by Declan Stubbing & Kevin Smith (Discovery Marine Ltd).

The June 2016 Surveying + Spatial also features an article in the regular space allocated to the Positioning and Measurement stream, with *A History of the NZGD2000 Datum*, by Chris Crook, Dionne Hansen & Paula Gentle (all LINZ).

For those who do not have a subscription to receive hard copies of the Surveying + Spatial magazines, they can be freely viewed on-line (or downloaded as a PDF) at http://www.surveyors.org.nz/Category?Action=View&Category_id=108.

This month's image is yet another example of the drive towards automation. Pegasus: Multiscope, the offspring of collaboration between Leica and Milrem which can perhaps best be described as an autonomous tank fitted with a mobile mapping system. Read more or watch a video of it in action at http://www.spatialsource.com.au/introducing-pegasusmultiscope-a-new-unmanned-ground-vehicle/. Image credit: www.spatialsource.com.au.

June 2016

The FIG Working Week conference in Christchurch in May featured many excellent presentations in the FIG Commission 5 (Positioning & Measurement) and Commission 6 (Engineering) sessions, and covered a broad range of topics relevant to our stream. There was a respectable number of presenters (and contributors to presentations/papers) who are either members of the stream, or affiliated with the stream via our LinkedIn group.

A summary follows of all Commission 5 & 6 presentations with either a NZ author or focus. Most of these have web-links to downloadable papers.

- Christopher Pearson (New Zealand), Niraj Manandhar (Nepal) and Paul Denys (New Zealand): Towards a Modernized Geodetic Datum for Nepal: Options for Developing an Accurate Terrestrial Reference Frame Following the April 25, 2015 Mw7.8 Gorkha Earthquake (7970) http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts01b/TS01B_pearson_manandhar_et_al_7970.pdf.
- Nic Donnelly (New Zealand), Chris Rizos and Craig Roberts (Australia): Using a Deformation Model to Calculate Coordinates in a Local Reference Frame (8297).
- Chris Crook, Dionne Hansen and Paula Gentle (New Zealand): Aligning the New Zealand National Datum with the International Terrestrial Reference Frame in the Face of Tectonic Deformation (8138)

http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts01b/TS01B_crook_hansen_et_al_8138.pdf.

- Toms Brent and Doherty Callum (New Zealand):
  Automated Remote Monitoring for Earthquake Recovery Work (8167)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts01b/TS01B_brent_callum_8167.pdf.
- Sjoerd van Ballegooy, James Russell, Virginie Lacrosse, Simpson Joeseph (New Zealand) and Ellen Rathje (USA):
  Residential Building Fragility due to Liquefaction Induced Ground Surface Movement (7966).
- Yong Chien Zheng, Paul Denys and Christopher Pearson (New Zealand):
  Consequence of 2012 Mw 8.6 Northern Sumatra Earthquakes Towards Sundaland Plate (8128)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts03b/TS03B_chien_zheng_denys_et_al_8128.pdf.
- Marc Jaspers, Guillaume Clin and Richard Harrison (New Zealand):
  Data Capture for Underground BIM (8136)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts03d/TS03D_jaspers_clin_et_al_8136.pdf.
- Paul Denys and Christopher Pearson (New Zealand):
  Positioning in Active Deformation Zones - Implications for NetworkRTK and GNSS Processing Engines (8012)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts04b/TS04B_denys_pearson_8012.pdf.
- Guillaume Clin and Richard Harrison (New Zealand):
  Virtual Reconstruction - the Resurrection of the Lyttelton Timeball Station in a Digital Space. (8140)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts04d/TS04D_clin_harrison_8140.pdf.
- Adrian Cowie (New Zealand):
  The Canterbury Earthquake Sequence - Recovery from Disaster. How Professionals Have Helped to Prevent Recovery in Canterbury and Have Caused a Separate Disaster for Property Owners. (8211)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts04d/TS04D_cowie_8211.pdf.
- Graeme Blick (New Zealand):
  The Evolution of Crustal Deformation Monitoring in New Zealand for Datum Definition (8100).
- Paula Gentle, Chris Crook (New Zealand) and Ryan Ruddick (Australia):
  How Accurately Can the Relationship Between a VLBI and a GNSS Antenna Be Determined? (8171).
- Phil Dewar (New Zealand):
  Building Floor Levels and Verticality Surveys – data capture and presentation using a Canterbury example (8227)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts06b/TS06B_dewar_8227.pdf.

- Michael Olsen, Dan Gillins (USA), Michael Eddy, Sjoerd Ballegooy and Bruce Deam (New Zealand):
  Terrestrial Laser Scanning Deformation Analyses of Blast-Induced Liquefaction Settlements (8271).

- Andrew Sinclair (New Zealand):
  Innovation from Disaster – Applying 3D Laser Scanning Technology to Earthquake Recovery Projects (8127)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts06d/TS06D_sinclair_8127.pdf.

- Vanda Kadlecikova and Rowan Hallam (New Zealand):
  High Definition Scanning – What's the Buzz? (8162).

- Ken Harima, Suelynn Choy and Chris Rizos (Australia):
  Performance of Real-time Precise Point Positioning in New Zealand (8010)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts07b/TS07B_harima_choy_et_al_8010.pdf.

- Mark Nichols (New Zealand):
  Recent Advances in High Accuracy Positioning (8150)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts08b/TS08B_nichols_8150.pdf.

- Matt Amos (New Zealand):
  Improving New Zealand's Geoid-Based Vertical Datum with Airborne Gravimetry (8103).

- Rachelle Winefield and Matt Amos (New Zealand):
  Enabling the Uptake of New Zealand's Improved National Vertical Datum (8081).

There were many other excellent stream related presentations from international attendees, some notable highlights being:

- Christina Kempe, Lotti Jivall, Martin Lidberg and Mikael Lilje (Sweden):
  On the Management of Reference Frames in Sweden (8179)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts02b/TS02B_kempe_jivall_et_al_8179.pdf.

- Jerom Vanderstappen, Craig Roberts and Thomas Grinter (Australia):
  Does Beidou Enhance Positioning Performance Within CORSnet-NSW? (8135)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts02b/TS02B_vanderstappen_roberts_et_al_8135.pdf.

- Lee Hellen (Australia):
  4D Survey and Geotechnical Monitoring Achieving Enhanced Project Outcomes for Construction. (8175)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts05d/TS05D_hellen_8175.pdf.

- Mark Bell (Australia):
  Advances in the use of Ground Based Radar for Disaster Recovery Risk Management (8393)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts05d/TS05D_bell_8393.pdf.

- Neil Ashcroft (Singapore), Youssef Tawk, Anthony Cole, Colosimo Gabriele and Frank Pache (Switzerland):
  Leica VADASE - First Autonomous GNSS Monitoring Solution for Fast Movements Onboard a Stand-Alone GNSS Receiver (7952)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts07b/TS07B_ashcroft_tawk_et_al_7952.pdf.
- Anders Nesse and Ulf Hagnefelt (Norway):
  3D Data Fusion for 3D Modeling Applications for the Energy Sector (8357)
  http://www.fig.net/resources/proceedings/fig_proceedings/fig2016/papers/ts07d/TS07D_nesse_hagnefelt_8357.pdf.

As indicated by the titles of presentations by Matt Amos and Rachelle Winefield (noted above), LINZ is developing a new NZ Geoid model and vertical datum that are due to be finalised and available later this year. The objective is to be able to derive heights to 3cm accuracy in all developed areas of NZ, which is a significant improvement over the existing NZGeoid2009 & NZVD2009.

For all those contemplating rushing out to purchase a UAV to add to their surveying toolkit, Australian aerial mapping experts AeroMetrex have a blog “From High Above” with a cautionary opinion piece about UAV’s well worth reading first: “20 things they don’t tell you about UAVs”, http://aerometrex.com.au/blog/?p=1098.

For more encouraging views about the present and future of UAV mapping technology, the May 2016 issue of XYHT magazine is devoted almost exclusively to UAV’s. A companion publication is the 2016 XYHT Heights supplement, which looks at a wider range of airborne mapping technology (not just UAV’s). The many articles in these two magazines describe how airborne sensors are being utilised to capture data for a wide range of mapping applications. More at: http://www.xyht.com/.

This month's image

Credit: www.bbc.com "Queen Elizabeth II, 63 years in 63 pictures".

Caption: 1998: Queen Elizabeth II, Colonel-in-Chief of the Corps of the Royal Engineers, looking though a Theodolite during her visit to the 42 Engineer Regiment at Denison Barracks in Hermitage, Berkshire.