School of Surveying Te Kura Kairūri academic instrumental in supporting Nepalese surveyors to measure Mount Everest for the first time

Dr Chris Pearson and Guy Frederick, Sciences Communications Adviser, University of Otago

Geodesist Dr Chris Pearson has taken a lead role in New Zealand's MFAT Head of Mission Fund project by providing Nepal's Department of Survey with training and expertise to undertake the work themselves.

David Pine, New Zealand ambassador-designate to Nepal, says supporting this partnership between the Government of Nepal and the University of Otago honours the legacy of Sir Ed Hillary and Tenzing Norgay Sherpa, as well as fostering New Zealand-Nepal relations.

Dr Pearson, an Honorary Senior Fellow of School of Surveying, says his involvement supporting Nepalese surveyors reach the goal of measuring Mt Everest, and also contributing to the development of the country, has been immensely gratifying.

Mt Everest's new height of 8,848.86 metres was announced in a joint statement by Nepal and China, marking a small increase from the commonly referenced height of 8,848m, established by the Survey of India in 1954, the year after Sir Ed reached the summit of the world's highest peak.

"Owing to tectonic activity such as the significant 2015 Gorkha Earthquake, the height of Everest is constantly changing and using the latest technologies allowed the new accurate measurements to be made," Dr Pearson says.

He has led New Zealand's involvement in surveying mapping projects in Nepal since the 2015 earthquakes which caused massive ground displacement across the landlocked country and resulted in significant inaccuracies in coordinates and geodetic databases.

"As New Zealand is so seismically active, we have developed specialist surveying knowledge and technological expertise such as developing semi-dynamic datum models that allow for the fact everything is constantly moving," Dr Pearson says.

New Zealand's role also involved Land Information New Zealand (LINZ), and New Zealand company Trimble

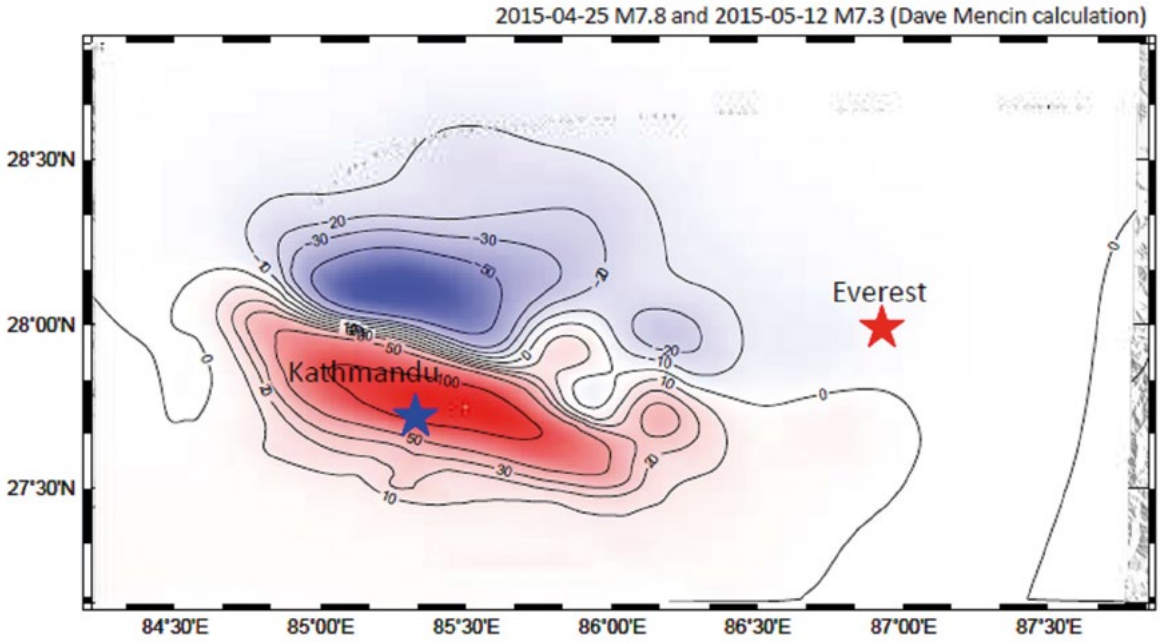

Figure 1: Uplift (red) and subsidence (blue). Values are in cm.

which donated equipment including GPS receivers, and other advanced surveying technology and software. One of the GPS receivers was installed at the summit of Everest to determine its final height.

"The School of Surveying has a long association with Trimble and together our surveying expertise and specialist technologies have really been harnessed for benefit of the Everest project," Dr Pearson says.

This year Trimble generously donated five robotic total stations and other equipment to the School of Surveying Te Kura Kairūri, providing students with the latest technologies before starting professional careers.

Graduates at the school have had internships at Trimble, and about 50 graduates have worked in Trimble's research and development area over the years, both in Christchurch and overseas.

Dr Pearson was invited to assist with the Mt Everest project through his involvement in a mapping project after the 2015 earthquakes, which included spending about six months in Nepal and providing technical assistance from New Zealand. His work involved developing a New Zealand-style 'semi-dynamic' datum for Nepal based on ITRF2014 with a reference epoch of 2016.0 (a long enough time after the earthquake to ensure that the coordinates were not affected by ongoing post-seismic relaxation).

He developed tools to allow the Survey Department to calculate accurate coordinates for the new datum and a New Zealand-style 'deformation model' to correct for tectonic motion including the earthquakes and a special version of LINZ's Survey Net adjustment program (SNAP) to allow the deformation

Figure 2: Survey officer Khim Gautam on the summit of Everest. Note GNSS antenna from Trimble NZ on the right-hand side.

model to be applied in least square adjustments.

To implement the new datum, it was necessary to develop a Nepal national network of continuous GNSS (cGNSS) stations. Dr Pearson realised a network of suitable stations already existed but before they could be used, they needed coordinates in the new datum. Chris collaborated with Paul Denys (also from the School of Surveying) to develop coordinates for these stations in the new datum.

As a capacity-building exercise, Dr Pearson conducted the first readjustment of Nepal's triangulation network by working with survey officers to identify geodetic-quality GNSS observations from the Nepal first order network. "We then tied these into the CORS network and processed the GNSS data to provide reliable coordinates in the new datum," he says.

However, the Gorka Earthquake caused vertical changes with 1m uplift in the Kathmandu Valley and nearly 1m subsidence by the China border 50km to the north (see Figure 1). This caused concern that the height of Everest might have been affected, but it also is a serious problem to all surveyors in central and eastern

Nepal and an impediment to national development projects.

So, when the height of Everest project began, Dr Pearson was keen to support the Survey Department because it was an opportunity to develop expertise in Nepal to produce an improved vertical datum.

He attended an international workshop on the measurement of the height of Mt Everest (Sagarmatha) in December 2017 as the New Zealand representative and was invited to spend a month in Kathmandu to assist the Survey Department in planning the Everest programme. As part of this visit, he coordinated with Trimble Navigation (New Zealand) for the donation of survey equipment and provided a course of lectures on geodetic surveying to Survey Department staff, along with training in the Trimble software TBC.

He explains that measuring peaks in the Himalayas comes with additional challenges, such as gravity, which need to be accounted for when conducting survey work.

"Nepal has an extreme geoid undulation that is unique on the planet, and is the result of something really heavy under India on one side of Nepal and the extraordinary light Tibetan Plateau on the other," Dr Pearson says. As a result, the Survey Department incorporated a programme of gravity measurements to develop an improved geoid in eastern Nepal so GNSS technology could be used as one of the height measurement techniques.

"We don't know exactly why this is, but the levelling network and models have to be adjusted to take this big variation across the country into account."

The new measurement is by far the most accurate sea-level height for Mount Everest due to the technology used, and the new models will also make it easier to measure the exact heights throughout Nepal using modern GPS techniques, Dr Pearson says.

Mr Pine says, "Sir Edmund maintained strong links to Nepal for the rest of his life and went on to serve as New Zealand's ambassador to Nepal. Our support for this project honours his and Tenzing Norgay Sherpa's legacy, as well as underlining the warmth of contemporary New Zealand-Nepal relations."

Chris says of his six-year involvement with the Survey Department of Nepal; "When I arrived in Kathmandu in September 2015, I asked to see their geodetic database and I was conducted into basement vault where I saw shelves of dusty notebooks, and the GPS equipment was at least 20 years old.

"When I compare this to the confident, technologically savvy department that just carried out one of the most challenging geodetic surveying projects in the world just six years later, I am amazed at the transition that has occurred in such a short time. I played no role in redetermining the height of Everest. That is as it should be. It is a Nepali project after all.

"However, I think that all New Zealanders can take pride in the fact that we provided critical training and equipment that enabled the Survey Department of Nepal to carry out the measurements."

Figure 2 shows a GNSS antenna provided by Trimble NZ on the summit of Everest. This figure shows the importance of New Zealand's contribution and the technical challenges that the Survey Department had to overcome to complete the measurements. The photo has a black background because it is taken in the middle of the night, the only time that the summit is not crowded by climbers." ●