

# FROM ABOVE TO BELOW

IT SEEMED AN UNSOLVABLE CHALLENGE: HOW TO ADD HYDROGRAPHIC SURVEY CAPABILITIES TO A HELICOPTER WITHOUT MAKING IT IMPOSSIBLE TO FLY. **MARTIN PFENNIGBAUER** AND **KOHEI WAKAMATSU** EXPLAIN HOW TWO COMPANIES WORKED TO MAKE THE IMPOSSIBLE POSSIBLE

Nakanihon Air Service Co Ltd is one of the largest general aviation companies in Japan. It operates approximately 70 aircrafts, offering transport, emergency medical services, and aircraft maintenance, repair and modification services, as well as airborne research and survey.

In 2007, the company started airborne LiDAR works using a helicopter and a RIEGL LMS-Q560 with JIRCO's high density medium-format digital camera part of a system called Sakura ('cherry blossoms') – approximately 70% of land in Japan is mountainous, so a helicopter platform is preferable.

The system gained wide acceptance in the market for its

capture of high-density 3D point clouds, especially in dense vegetation.

Since then, the company has steadily upgraded the Sakura, with the Sakura-IV offering a pulse repetition rate of 400 kHz thanks to adoption of the RIEGL LMS-Q680i and a multiple field of view, medium-format camera-configuration that offers up to five different camera angles at the same time. It can now achieve more than 30 points per square metre of topographic point clouds simultaneously with multiple digital images, including approximately 5cm ground sample distance (GSD) nadir images, on a daily basis.

In 2016, in order to cater to growing demands for riverine and shoreline surveys,

Nakanihon decided to give the fifth generation of Sakura hydrographic capability. Climate is changing drastically and serious flooding is becoming more common every year. At the time of writing, at least 376 people have been killed in flooding and landslides due to heavy rain in Japan since 2010. The flood of July this year alone killed more than 160 people. Nakanihon is eager to contribute the river improvement measures and managements with its vast experience and technologies in airborne research and survey.

In the middle of 2016, Nakanihon started planning helicopter integration of the RIEGL VQ-880-G. This state-of-the-art topo hydrographic scanner system has two LiDAR channels: 532nm (green) and 1064nm (IR). Given the fact that modern airborne bathymetric LiDAR systems operation altitude typically is 500 to 600m, fixed wing operation is often challenging or even impossible when flying upstream over rivers in Japan.

With no suitable UAV-based systems available, Nakanihon again chose a helicopter as a platform for its airborne hydrographic survey system.





All monitors and controls are put together in a compact console. The operator shares flight guidance with the pilot via two monitors mounted in the cockpit

However, it was faced with a big challenge at the very first phase of the project. From the preliminary calculations, the aircraft's centre of gravity with the VQ-880-G mounted exceeded the rearward limitation of the AS350 helicopter. Additionally, the company wanted to operate a 100Mpx RGB and a 100Mpx NIR digital camera and other sensors.

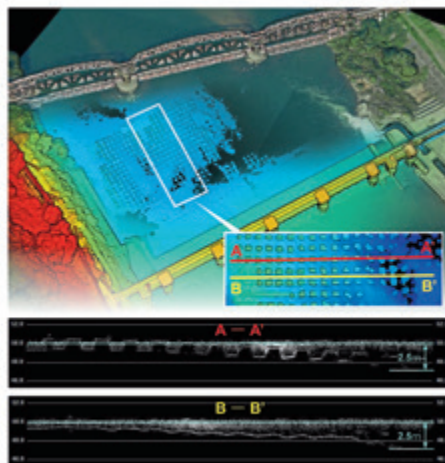
### The right platform

Some say there is the right platform for the job, not the platform that is convenient. That is true. Nakanihon might have been able to choose a more powerful helicopter, such as an AS350B3, as a platform for VQ-880-G. However, it wanted to use its standard survey helicopter, the AS350B, to save operational costs and pass those savings to the potential customers. So how did it overcome these challenges?

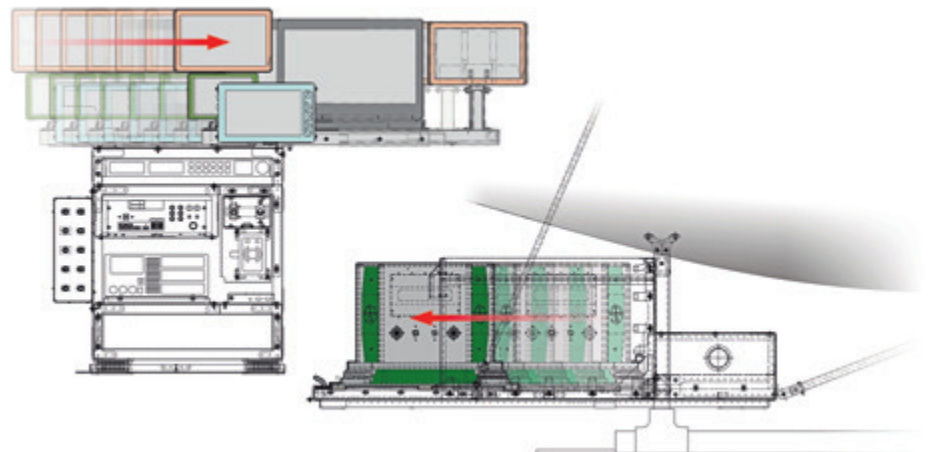
In 2017, RIEGL provided Nakanihon with the VQ-880-GH, which has been especially designed with a reduced height optimised for helicopter integration. This dramatically changed the sensor location, bringing it closer to the front of the helicopter. This brought the aircraft's centre of gravity back within the operational range.

The result is a 550kHz topo-hydrographic helicopter-based system with Phase One 100Mpx RGB and NIR cameras now integrated with the laser scanning system. What's more, Nakanihon has added a 4k resolution video camera system manufactured by Blackmagic Design. All of these are in a sensor pod, installed at the helicopter's belly.

Nakanihon's production team also had to make some changes. With the VQ-880-GH installed as close to the front of the helicopter as possible, there is not enough space above the sensor head when taking it out of the



Anti-erosion concrete blocks are captured really well. Also, detailed river bed structure shows VQ-880-GH's capability for acquiring high density underwater point clouds



In order to fully use very limited space, Sakura uses sliding mechanisms

helicopter. The production team therefore had to use the storage space of the sliding shutter door that protects the optical parts of instruments as a guide rail – they can slide the VQ-880-GH to the back side of the helicopter so that they can move it out from the platform safely once the helicopter has landed.

In the aircraft cabin, there is an operator console consisting of a laptop, three external monitors, a video camera controller, a shutter door controller, and data recorders for each device. To provide better monitoring and controls for the operator, Nakanihon made the top part of the console, which mounts the display monitors and the laptop, so it can be slid to just in front of the operator.

### The results

The preliminary acquisition data, which was obtained from Kinokawa River in October 2017, was then used to generate point clouds using RIEGL data processing software packages such as RiPROCESS and RiHYDRO. They were then visualised using Nakanihon's in-house software Mierre.

The results show the VQ-880-GH's capability for capturing high-density underwater structure. The system achieved more than 40 points per square metre of averaged underwater point clouds, with a GSD of 4cm of RGB and NIR digital images in a depth range of 2m to 3m (result from 50% overlapped multiple scanlines).

Nakanihon is confident that the RIEGL VQ-880-GH has made its latest helicopter-based high-density topo-hydrographic LiDAR system. It is going to use the helicopter system mainly in the field of river management, as the company expects more demand for riverine surveys than coastline surveys, although it would also like to contribute its technology to disaster countermeasures and management.

**Martin Pfennigbauer is product manager for hydrographic airborne laser scanning at RIEGL Laser Measurement Systems ([www.riegl.com](http://www.riegl.com)). Kohei Wakamatsu is a member of Nakanihon Air Service Co Ltd's research-survey division ([www.nnk.co.jp](http://www.nnk.co.jp))**