AMUSE ONESELF

TDOT™ 3

DRONE LASER SYSTEM

TDOT™ 3

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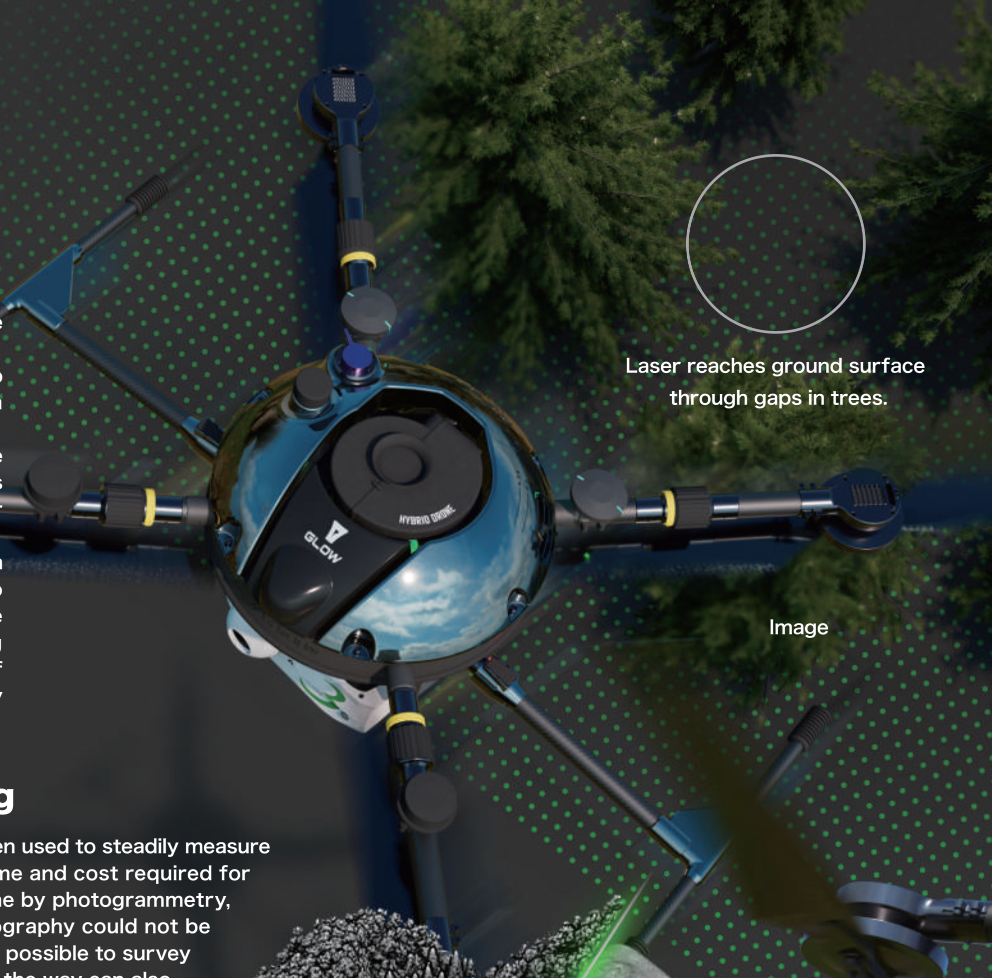
The era of drone laser surveying solutions has arrived.

With TDOT 3, which irradiates a green laser that is not easily absorbed by water, you can seamlessly visualize 3D terrain below the water's surface from the ground.
TDOT 3 provides a one-stop service from the execution of surveying by flight to the creation of 3D data deliverables.
It is a surveying solution tool that can be used to grasp not only the topography of mountainous areas, but also riverbeds, coastal areas, or the condition of devastated areas immediately after a heavy rainfall.

FEATURE Features of TDOT 3

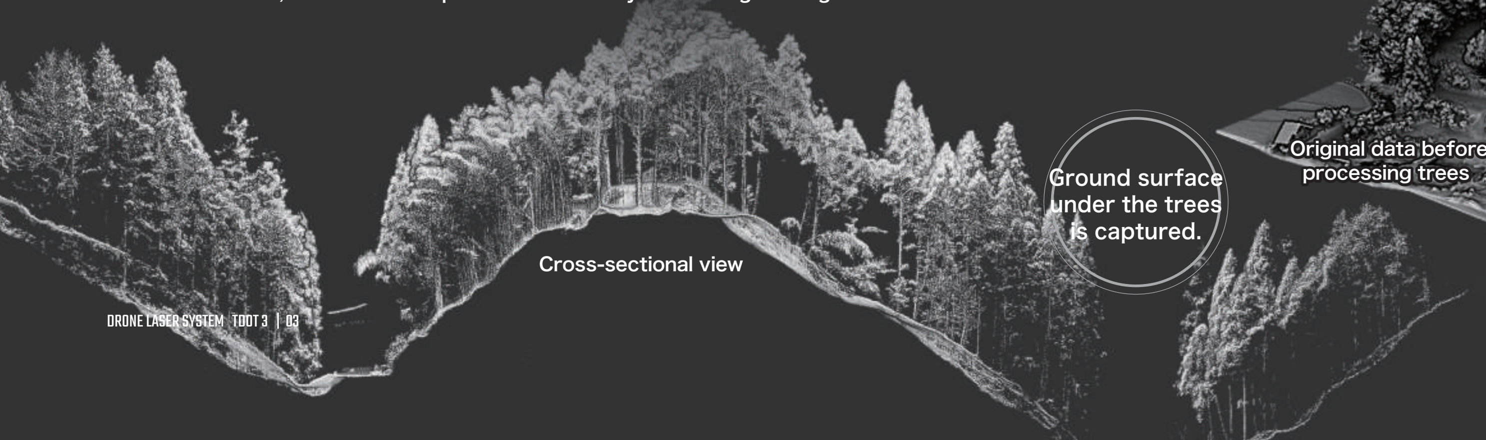
Principles of drone laser surveying

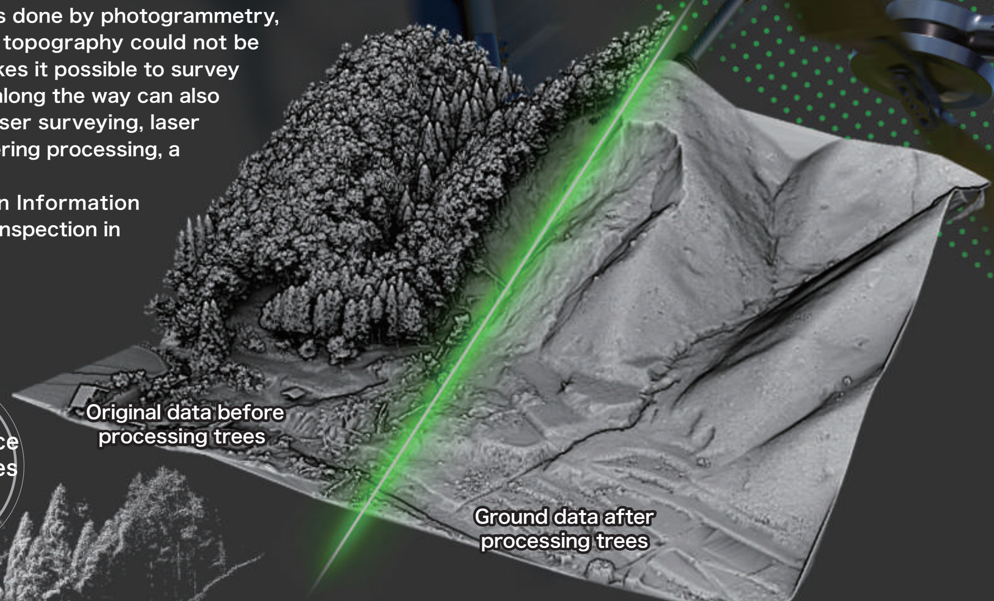
By irradiating the laser from a bird's-eye view over the site from the sky, the 3D coordinates of the ground surface can be surveyed through gaps in the trees, even if the site is covered with trees.
Furthermore, the trees themselves that were irradiated before the laser beam reached the ground surface are also visualized as a 3D point cloud. The time it takes for the laser beam to return is measured and converted to a distance to obtain the value of the distance to the object.
Furthermore, by knowing the angle at which the laser was irradiated, the 3D coordinate values of the object can be calculated. Therefore, it is impossible to obtain accurate coordinate values unless the position at which the laser is irradiated is known. However, since the drone irradiates the laser while moving in the sky, the position of the laser constantly changes from time to time.
In order to determine the drone's position, a GNSS receiver is installed, but it can only provide metric accuracy, so a "kinematic surveying" method is introduced to determine the position of objects moving at high speed, similar to laser surveying using airplanes. At the same time, the IMU (Inertial Measurement Unit) is used to determine the position with an accuracy of several centimeters by performing an optimum trajectory analysis combining acceleration and angular acceleration data, and the IMU measures the attitude to properly correct the direction of laser beam irradiation. The analysis using the three pieces of information from the laser, GNSS, and IMU accurately expresses the coordinate values of the point where the laser beam reached on the world coordinate system.



Difference between photogrammetry and laser surveying

Until now, topographic maps have been created using total stations and GNSS surveying equipment, which have been used to steadily measure local topography and landforms while setting up poles to create topographic map data. By using drones, the time and cost required for measurement and data collection can now be greatly reduced. However, because most of the surveying was done by photogrammetry, only the surface data (DSM: Digital Surface Model) of the imaged surface could be obtained, and detailed topography could not be surveyed in an environment where trees were growing. Drone laser surveying, like aerial laser surveying, makes it possible to survey the ground surface under trees from the sky. Furthermore, the 3D coordinates of the laser beam reflected along the way can also be acquired, enabling accurate representation of the shapes of the trees. In addition, compared to aerial laser surveying, laser point cloud data with higher density can be obtained, and if only the ground surface data is extracted by filtering processing, a drawing (DEM: Digital Elevation Model) that represents detailed topographic features can be obtained.
Drone laser surveying, which easily acquires 3D data, can be used to acquire data for CIM (Construction Information Modeling) in the field of civil engineering and construction, including damage assessment and infrastructure inspection in devastated areas, and can also improve the efficiency of civil engineering structure construction.



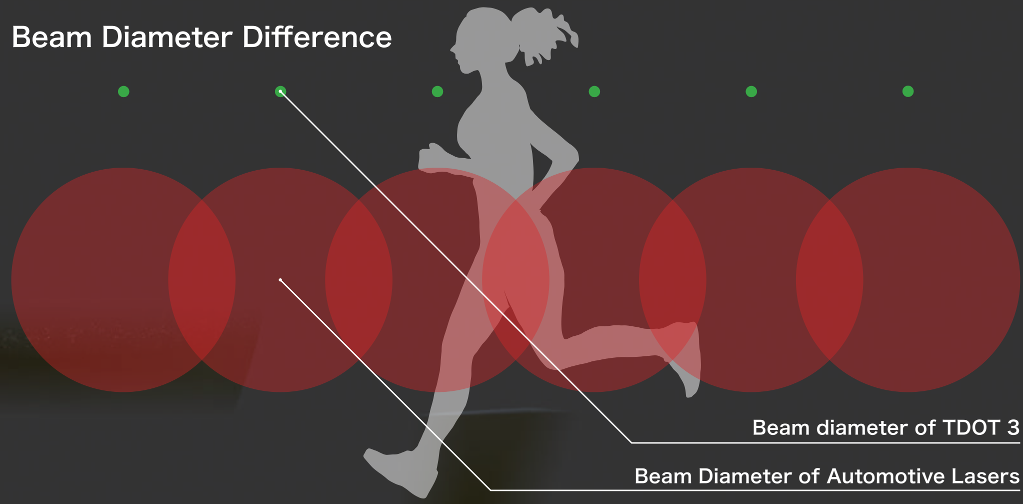


TDOT3 -GREEN- TDOT3 -NIR-

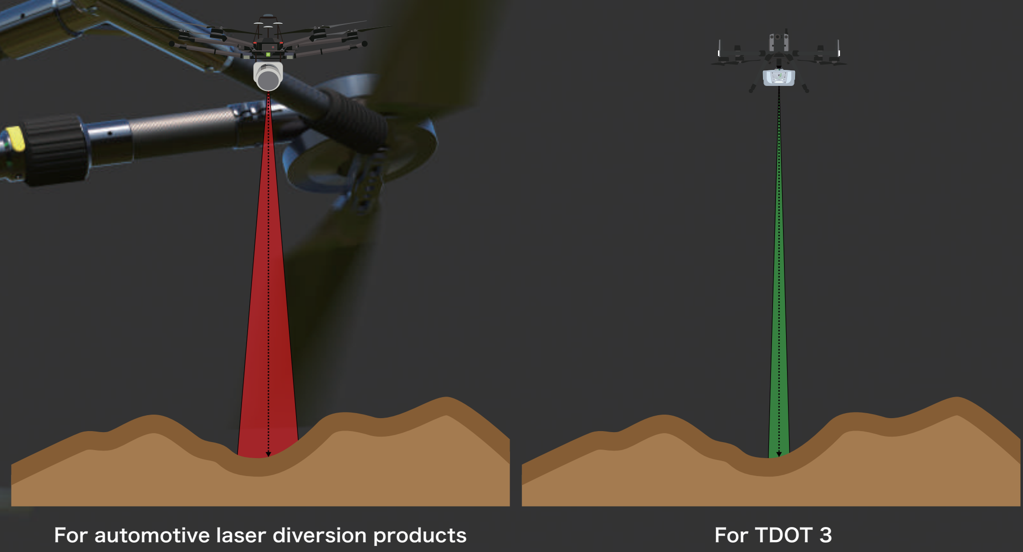
Suitable beam diameter for laser surveying

Most lasers for drones are adapted from car-mounted laser scanner modules known as Lidar, which are attracting attention for automated driving. As these laser modules are designed to locate nearby obstacles and people, the laser beam diameter is very wide, and the distance data is not designed for accuracy. The wide beam diameter also obscures the location of the laser beam, which compromises the accuracy of the data. The TDOT 3 laser scanner is a module developed specifically for drone surveying. A module for surveying purposes should not be designed to detect surrounding objects, but to measure objects as far away as possible with high accuracy. TDOT 3's laser beam has a range accuracy of a few millimeters rather than the centimeters required for automotive use, and its ability to extend only 15 cm in diameter (1.5mrad) at 100 m makes it suitable for capturing detailed terrain from 150 m above the ground.

Beam Diameter Difference



Error due to spreading angle



TDOT 3 GREEN — 1.5mrad TDOT 3 NIR — 0.5x1.7mrad

FOV Field Of View

TDOT3 -GREEN- TDOT3 -NIR-

90° viewing angle suitable for drone laser surveying

The FOV (field of view) was the most important consideration in the design of TDOT 3. This viewing angle was chosen to be 90° for the following reasons.

Accuracy

Elevation accuracy is a requirement for drone laser surveying. While horizontal position accuracy is important, elevation accuracy is very important for the purpose of the data. TDOT 3 scans a restricted area directly under the drone's body, as shown in Figure 1. The surveying accuracy of the elevation value is the accuracy of the GNSS added to the ranging accuracy of the laser. The further the scan angle is from the vertical, the greater the surveying accuracy of the attitude at the time of laser irradiation will affect the accuracy of the elevation. Therefore, the scanning range of the laser beam, called FOV (Field Of View), is limited to the green line as shown in the figure, and we emphasize obtaining elevation values that are less affected by the surveying accuracy of the attitude.

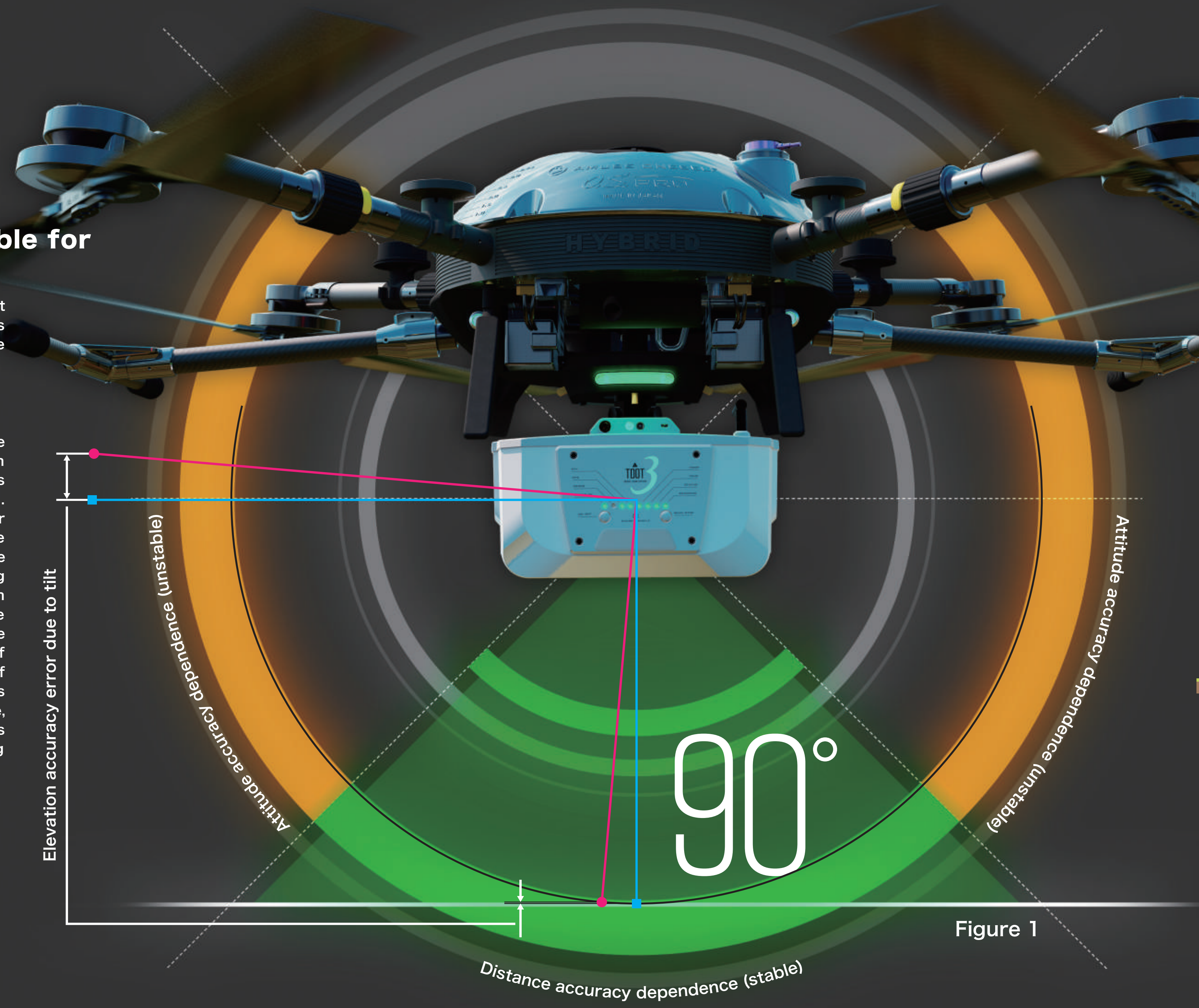
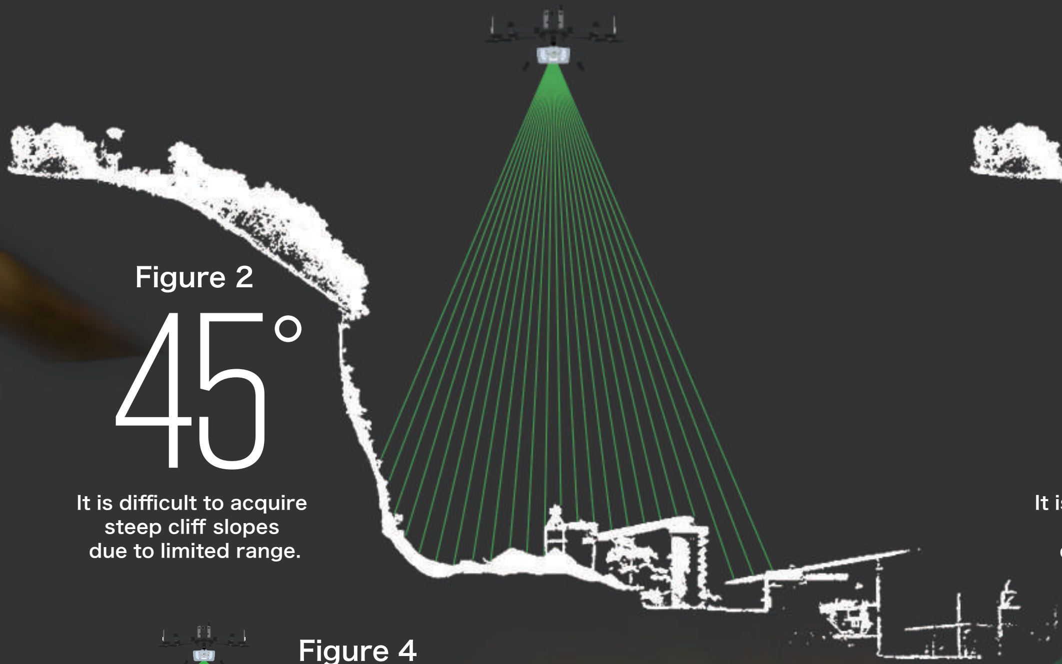


Figure 1

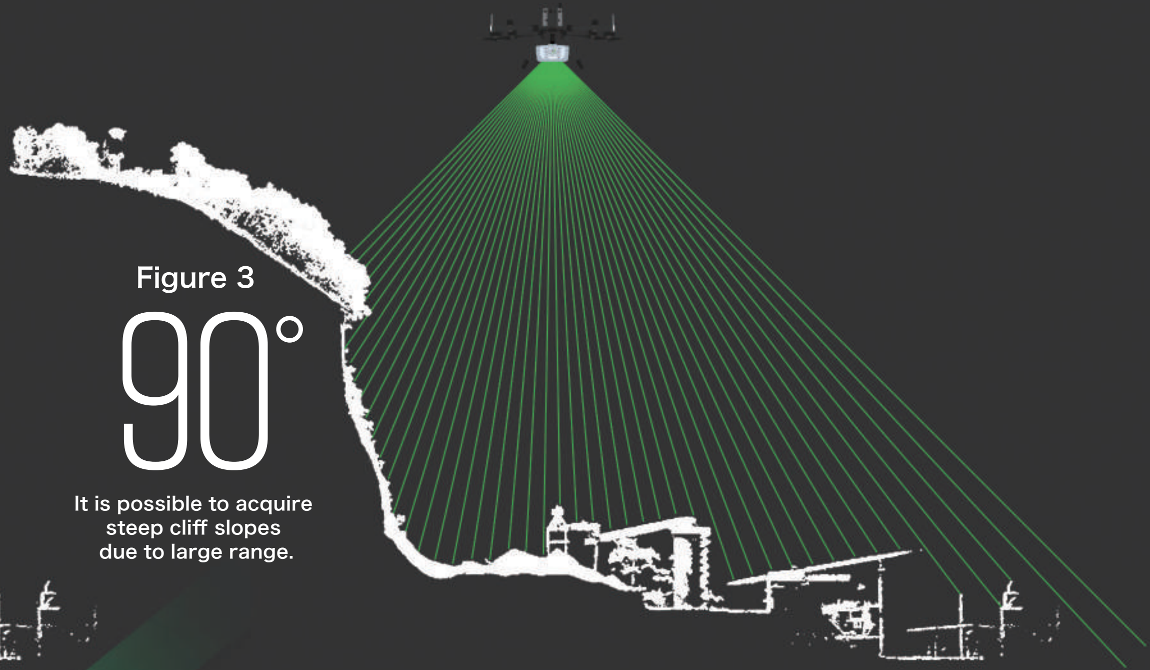
Figure 2



45°

It is difficult to acquire steep cliff slopes due to limited range.

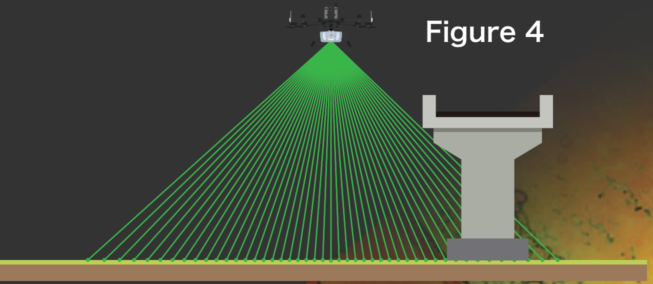
Figure 3



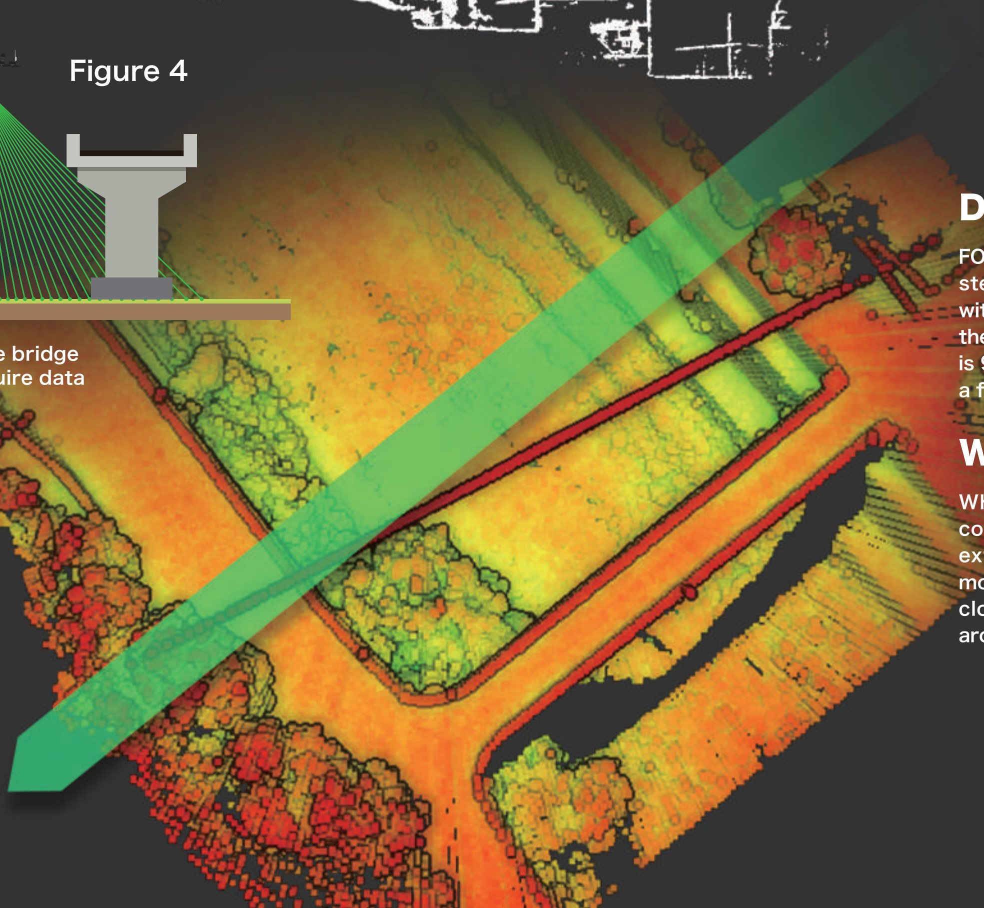
90°

It is possible to acquire steep cliff slopes due to large range.

Figure 4



Data flown along the bridge
It is possible to acquire data under the bridge.



Data acquisition range

FOV affects the data acquisition range. Figure 2 shows an example of surveying a steep slope with an FOV of 45°, and Figure 3 shows the data acquisition range with an FOV of 90°. The narrower the FOV, the more difficult it becomes to survey the sides of steep cliffs. Figure 4 shows an example of river surveying. If the FOV is 90°, it is possible to fly next to a bridge to acquire data under the bridge. Thus, a feature of TDOT 3 is that it is designed with practical aspects in mind.

Weight saving

When surveying is conducted with data accuracy and acquisition range in consideration, it is possible to use one that scans 360° around the drone and extract only the area directly below the drone afterward. However, this laser module has a complicated mechanism that increases the weight. The laser point cloud density directly under the drone is the same as one that scans 360° around it, and the module weighs less if it scans as limited an area as possible.

WEIGHT SAVING

TDOT3 -GREEN- TDOT3 -NIR-

Lightweight directly related to flight time, safety, and convenience

Drones fly with multiple propellers powered by batteries. Without a payload, a flight of several tens of minutes is possible, but the heavier the payload, the larger the drone becomes and the shorter the flight time. Drones that can only be flown for short periods of time consume batteries quickly, which is dangerous because it increases the risk of crashes due to dead batteries. In addition, the convenience of the drone cannot be fully utilized if the battery must be changed frequently on site.

A lightweight, compact laser scanner can be mounted on a small drone, allowing for longer flight times. The dangers associated with flying are greatly reduced, as there is no need to worry about running out of battery power when surveying large areas, and you can choose more convenient locations for takeoffs and landings.

Aiming for "drone surveying that anyone can use," we developed and launched the "TDOT" drone laser system in 2013 to enable aerial laser surveying, which could only be done with manned airplanes, to be conducted with drones. It uses a near-infrared laser and has achieved a lightweight scanner weighing 1.8 kg. By introducing this know-how, we developed a green laser scanner system, TDOT GREEN, in 2017, which was considered difficult to reduce the weight of the system, and we started selling it in 2019. Incorporating innovations such as fiber-optic modulation technology, it weighs only 2.7 kg. The lightweight technology, which is highly functional and minimized to the utmost limit, improves footwork in business operations.

TDOT3 GREEN	TDOT3 NIR
2.7KG	1.8KG

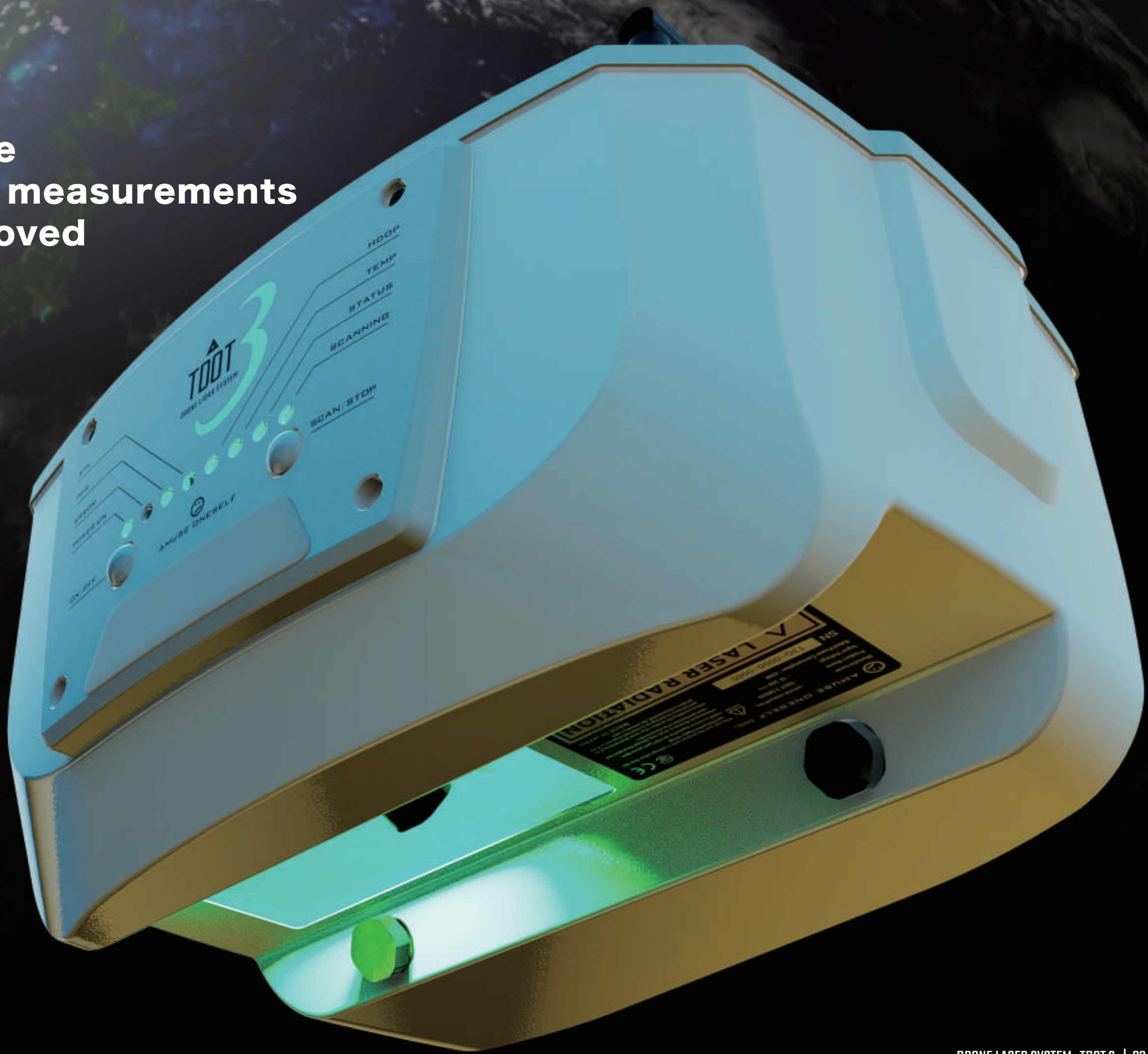
INS

Inertial Navigation System

TDOT3 -GREEN- TDOT3 -NIR-

Achieving Higher Surveying Performance Accuracy of drone position and attitude measurements Built-in high-performance INS with improved data output rate

In laser surveying, the laser beam must be calculated tens of thousands of times per second to determine how long it takes for the laser beam to return. In this process, the position of the laser beam is measured by GNSS, but GNSS can only make several dozen measurements per second, which alone can cause a large error in the position of the object. It also causes a positional slippage equivalent to the error in the measurement of the laser beam irradiation angle multiplied by the distance to the object. In other words, the further away the object is, the less accurate the coordinates of the object can be determined due to small errors in the laser beam irradiation angle. Therefore, an accelerometer is used to capture the drone's movement, and a gyro sensor is used to detect the drone's attitude, which changes from time to time. The combination of IMU (Inertial Measurement Unit) and GNSS is called INS (Inertial Navigation System), and by utilizing the advantages of each other, a highly accurate surveying system can be completed. TODT 3's INS has the specifications to achieve laser surveying of several tens of thousands of laser beams per second while providing a laser survey of several tens of millimeters.



New IMU specification

Positional accuracy	>	5mm
Heading	>	0.03°
Pitch/Roll	>	0.006°
Speed	>	0.01m/sec

GREEN LASER

TDOT3 -GREEN-　TDOT3 -NIR-

Irreplaceable light, green laser

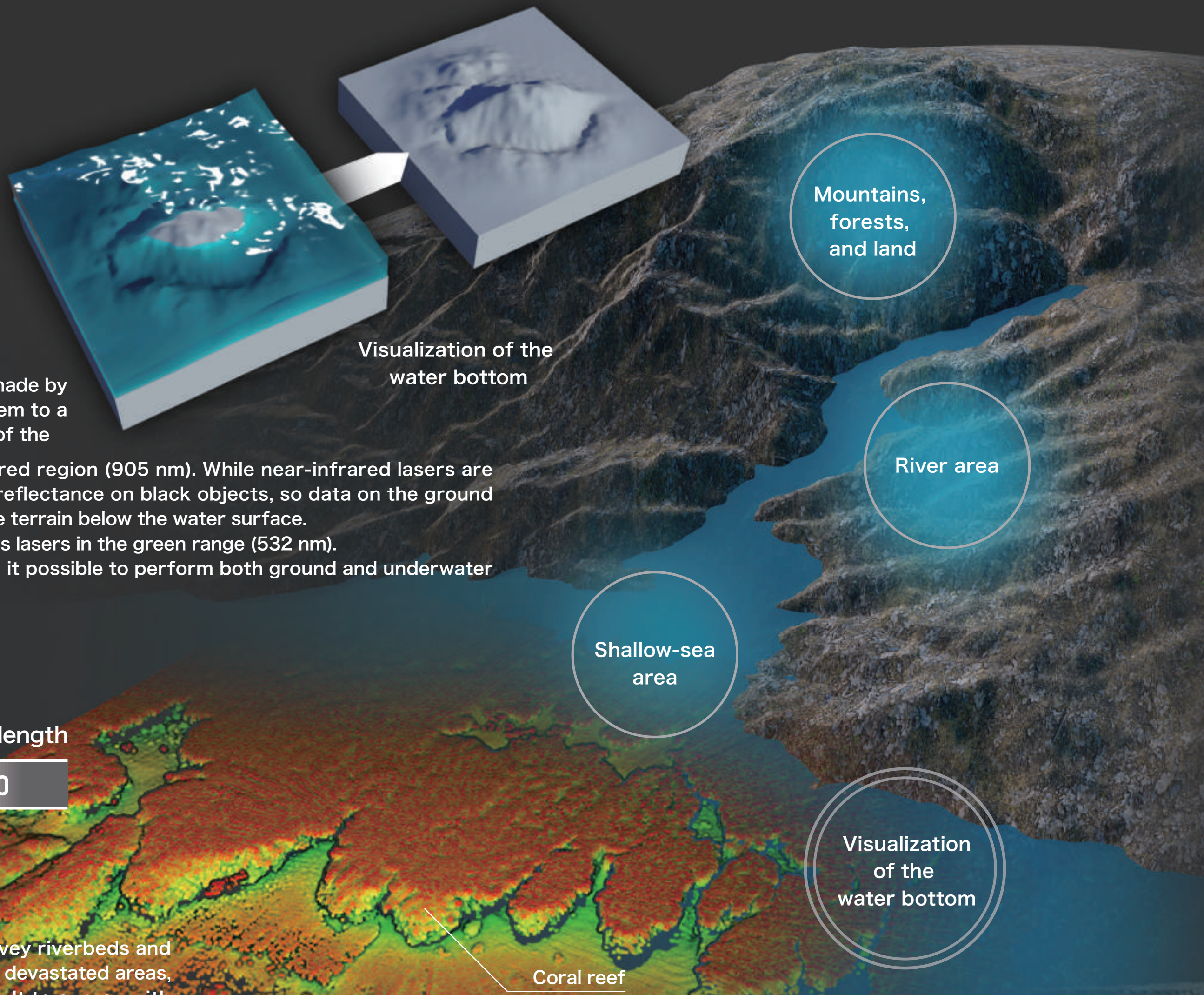
Sunlight and fluorescent light are a mixture of various wavelengths, but lasers are made by extracting only certain wavelengths from these (monochromatic) and focusing them to a single point (directional). The characteristics of the laser depend on the wavelength of the light to be extracted. Typical drone laser surveying uses lasers in the near-infrared region (905 nm). While near-infrared lasers are inexpensive and easy to handle, they are easily absorbed by water and have low reflectance on black objects, so data on the ground surface may not be obtained depending on the condition of the ground as well as the terrain below the water surface.
TDOT 3 GREEN overcomes this weakness of near-infrared lasers because it irradiates lasers in the green range (532 nm).
Of course, it can also perform the same surveying as a near-infrared laser, making it possible to perform both ground and underwater topographic surveying with a TDOT 3 GREEN.

* Underwater measurements depend on the clarity of the water.
* It is difficult to measure the bottom of the water when it is muddy with algae, mud, etc.

Visible light　Laser wavelength

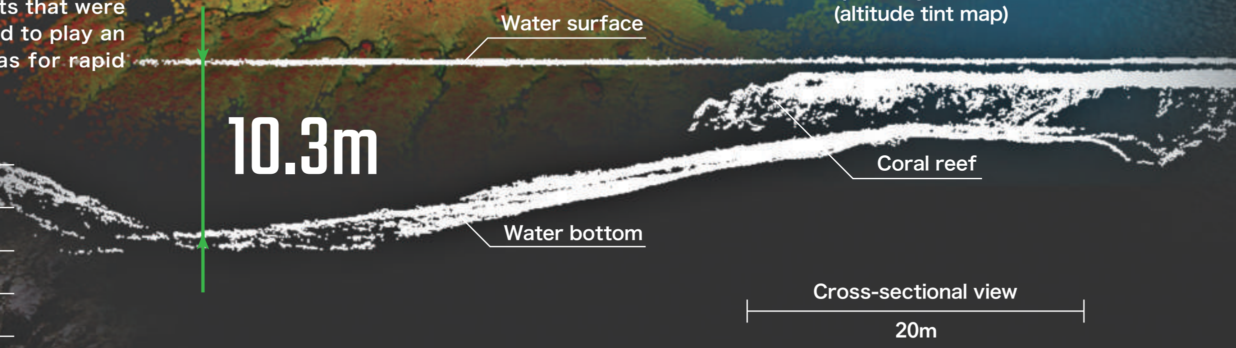
400nm	500	600	700	800	900

TDOT 3 GREEN (532)　Near-infrared laser



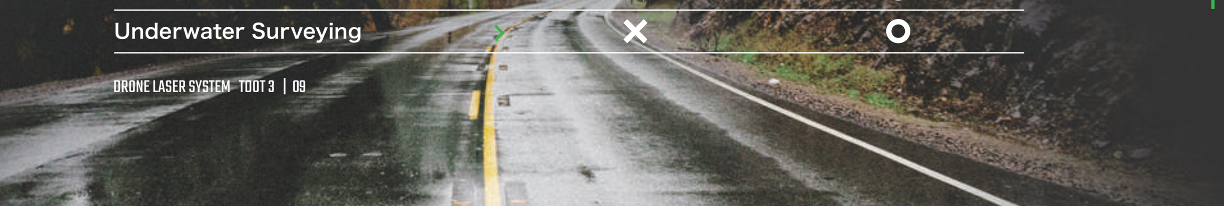
Data acquired by TDOT 3 GREEN (altitude tint map)

Green laser drone surveying with the TDOT 3 GREEN can be used not only to survey riverbeds and seafloors (theoretical depth of 13.5 m), but also to survey wet ground and slopes in devastated areas, or objects with black surfaces such as landfill or asphalt, which have been difficult to survey with conventional near-infrared lasers. The green laser is also effective in surveying objects that were difficult to survey with conventional near-infrared lasers. The green laser is expected to play an especially important role in the urgent survey and assessment of devastated areas for rapid restoration.



Cross-sectional view

Comparison of acquisition range	Near-infrared laser	Green laser
Land survey	○	○
Surveying from high altitude	△	○
Puddles and black road surfaces	×	○
Underwater Surveying	×	○



EYE-SAFE

TDOT3 -GREEN-　TDOT3 -NIR-

Eye safety for protect eyes

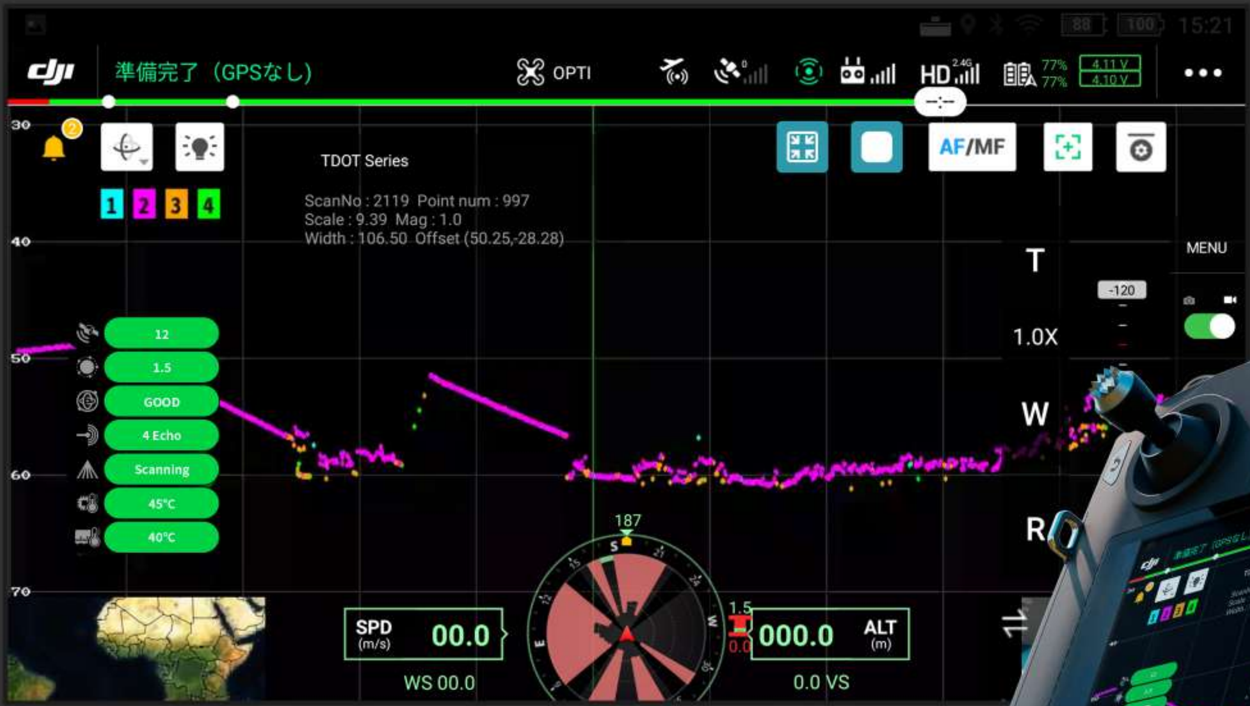
In the case of drone laser surveying, the operator and people in the vicinity are required to keep a close eye on the drone. Also, because the laser beams over a wide area, it can have an impact on people in the vicinity, and care must be taken to ensure safety for their eyes. Therefore, it is necessary to pay close attention to eye safety. International safety standards have been established for laser products to prevent eye injury.
The green laser in TDOT 3 is classified as "Class 3R". To avoid the risk of instantaneous exposure to the naked eye, TDOT 3 is equipped with an eye-safe function. Specifically, within 40 m of ground altitude, the laser is automatically controlled to be "Class 1M," a level at which it is safe to look at the laser with the naked eye. Then, when the altitude exceeds 40 m above ground level, the laser output is switched to "Class 3R" to ensure safety.

JIS C 6802 レーザ製品安全基準（「JIS C 6802」は国際基準を日本工業規格が翻訳したものです。）

Class 1	Essentially safe
Class 1M	It is safe for prolonged direct in-beam observation with the naked eye. Observation with optical instruments may be dangerous.
Class 2	Visible light, low power (400-700 nm wavelength). It is safe for instantaneous exposure, but dangerous when intentionally staring into the beam.
Class 2M	Visible light, low power (400-700 nm wavelength). Safe laser for brief exposure only to the naked eye. Observation with optical instruments may cause eye damage due to exposure.
Class 3R	A laser that may cause eye damage when observed in-beam with the naked eye, but the risk of such damage is relatively small. Risk of eye damage increases with exposure time. Intentional exposure to the eye is dangerous.
Class 3B	When in-beam exposure to the eye occurs, even brief exposures are dangerous.
Class 4	Observation and exposure to skin is dangerous. Observation of diffuse reflection is also potentially dangerous laser. Fire hazard.

* Class 3R laser equipment can be operated by installing an auto power reduction mechanism that saves power in dangerous areas.
* Class 3B and Class 4 laser equipment must have a jurisdictional area that is not accessible to people.

REAL TIME DATA DISPLAY



TDOT3 -GREEN-　TDOT3 -NIR-

Scan data is displayed in real time

You can see the data during surveying in real time. For example, by displaying a cross-section of the object, it is possible to check in real time during flight the acquisition status of ground surface data under vegetation in areas where trees are flourishing, and the status of reaching the water bottom in water areas. This allows the operator to check on the spot whether the surveying is being carried out as planned, and thus allows for efficient surveying operations without rework.

*To browse cross-sectional data during surveying, the drone must be equipped with an image transmission device that can be connected to HDMI. In the case of the DJI Matrice 300RTK, it is possible to browse the data through the DJI SkyPort.

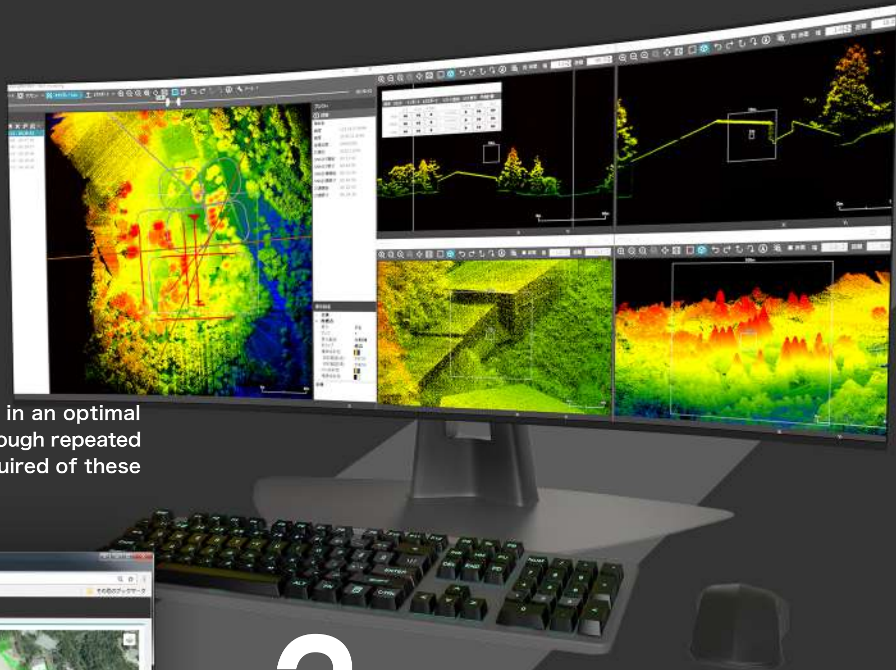
PLATFORM Drone surveying platform

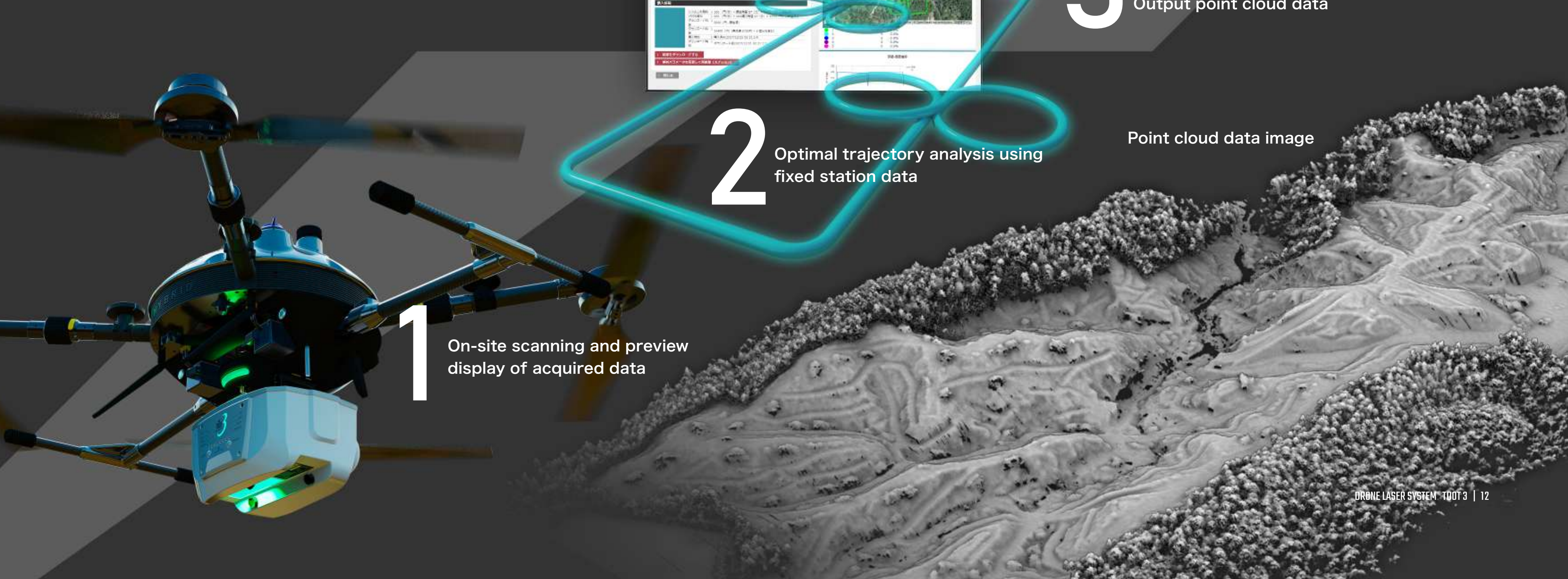
TDOT3 -GREEN- TDOT3 -NIR-

Integrated platform that realizes the concept of easy surveying for everyone

A laser scanner system is composed of many precise devices, and it is not easy to set each one of them in an optimal condition. In addition, without specialized knowledge, it takes a lot of effort to master the work procedures through repeated trial and error to achieve highly accurate output. It is no exaggeration to say that the complexity of use required of these operators is a barrier to the widespread adoption of drone laser surveying.

TDOT 3 provides a platform that allows anyone to maximize its performance. This platform includes, for example, the ability to perform pre- and post-survey calibration flights simultaneously with flight route input, or to automatically perform optimal trajectory analysis in combination with INS data immediately after a simple drag-and-drop operation. By using our platform, which incorporates our surveying service know-how, anyone can easily perform laser surveying with accurate 3D coordinates.





MOUNTABLE DRONES

PROMOTION

AMUSE ONESELF™

MADE IN JAPAN

GLOW.H
HYBRID DRONE

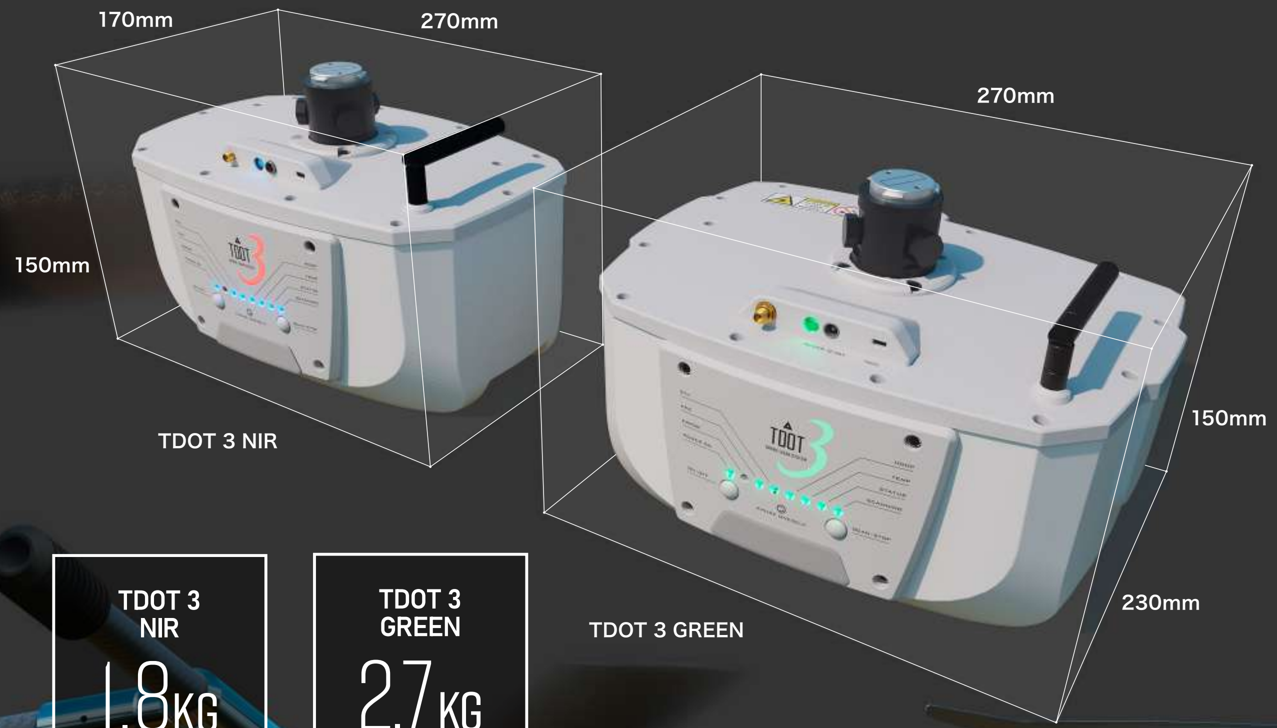
FLIGHT TIME	
NON-INSTALLED	EQUIPPED WITH TDOT 3 GREEN
4 hours+	2 hours+

Image of equipped with Grow. H

Japanese-made hybrid drone equipped with TDOT 3 GREEN for long flight time of more than 2 hours

The flight time of a typical drone is several tens of minutes. As the weight of the onboard equipment increases, the flight time is further shortened. The GLOW.H is equipped with a small range extender that allows it to fly while constantly recharging its built-in battery. There is no need to recharge and replace batteries, which has prevented surveying operations from becoming more efficient so far.
When equipped with TDOT 3 GREEN, the GLOW. H can fly for 2.5 hours, equivalent to a manned helicopter, simply by refueling with mixed gasoline.

PROMOTION Commercial release of GLOW.H is scheduled in 2023.
Product specifications and appearance are subject to substantial change.



TDOT 3 NIR
1.8KG

TDOT 3 GREEN
2.7KG

TDOT3 -GREEN- TDOT3 -NIR-

One-touch mounting on any drone

TDOT 3 can be installed on our domestic drone "GLOW" and DJI's industrial drone "Matrice300RTK" with a single touch without any modification. In addition, TDOT 3 can be used with any drone that can carry a weight of 3 kg or more.
*In this case, the user must install and modify the TDOT 3 mounting attachment and the dedicated GNSS antenna.

MADE IN CHINA

DJI MATRICE 300 RTK

TDOT 3 can be installed on DJI's Matrice 300 RTK industrial drone with a single touch without any modifications.

Image of equipped with Matrice 300 RTK

SPECIFICATION

Product name	TDOT 3 GREEN
Size (approx.)	W270 × D230 × H150mm
Weight (approx.)	2.7kg (Main unit only/excluding antenna)

Laser Scanner Specifications

Maximum measurement distance	≧10% 158m ≧60% 300m over
Accuracy of measurement distance	≧10% ±15mm ≧60% ±5mm
Pulse rate	60,000Hz
Field of view	90°(±45°)
Echo switching	1st&Last / 4echo
Scanning speed	30scans / sec.
Laser wavelength	532±1nm
Beam spreading angle	1.5mrad
Working temperature range	0 ～ 40℃ (No condensation)
Longevity	10,000 hours

INS specification*1

Positional accuracy	5mm
Heading	0.03°
Pitch/Roll	0.006°
Speed	0.01m / sec.

Eye safe function

TDOT 3 GREEN has an eye-safe function that limits laser output at ground altitude. Complies with Laser Class 1M.

- Ground altitude < 40m : Class 1M
- Ground altitude > 40m : Class3R(NOHD*2 : < 40m)

Depth measurement capability

At a distance of 50 m from the water surface

- R=1.0,absorption coefficient=0.25(1/m) > 1.4 secchi*3
- R=0.5,absorption coefficient=0.25(1/m) > 1.25 secchi
- R=0.2,absorption coefficient=0.25(1/m) > 1 secchi

Accessory

- TDOT 3 GREEN main unit
- GNSS antenna
- TDOT GATEWAY
- Exclusive hard case
- Preview application the “TDOT PrePROCESSING”
- User's manual

Option

- TDOT Installation Kit (for DJI Matrice300RTK / other drones)
- Underwater correction system “UNDERWATER CORRECT”
- Processing application the “TDOT PROCESSING” or “TDOT PROCESSING PRO”

*1 This is the accuracy after post-processing with the “POST-PROCESSING CLOUD” cloud service. A separate contract is required to use the service.
*2 NOHD (Nominal Ocular Hazard Distance) is the distance from the laser source at which the beam irradiance or radiant exposure equals the maximum permissible exposure to the eye. Even a laser beam has a spreading angle, so the further away the beam is, the more it spreads, resulting in less energy per unit area. Even if the level is dangerous at the point of emission, the further away it goes, the lower the so-called safe level below the MPE.
*3 A white disc (transparency plate or secchi plate) of 30 cm in diameter is submerged in water and the depth at which it becomes invisible is 1 secchi.

TDOT™ 3 GREEN
DRONE LASER SYSTEM

Pulse rate
(240,000 pulses in 360° conversion)
60, 000Hz

lean field of view for surveying
90°

Scanning speed
30scans/sec.

Accuracy of measurement distance
≧10% : ±15mm / ≧60% : ±5mm

Main unit weight
(lightweight design suitable for drones)
2.7kg

Green wavelength 532nm that can measure underwater (green laser)
532nm (green laser)

Product name	TDOT 3 NIR
Size (approx.)	W270 × D170 × H150mm
Weight (approx.)	1.8kg (Main unit only/excluding antenna)

Laser Scanner Specifications

Distance	≧30%~200m over
Accuracy of measurement distance	±4mm@50m ±20mm@150m
Pulse rate	60,000Hz
Field of view	90° (±45°)
Echo switching	1st&Last / 4echo
Scanning speed	30scans / sec.
Laser wavelength	905±1nm
Beam spreading angle	0.5×1.7mrad
Laser class	Class 1M
Working temperature range	0 ~ 50℃ (No condensation)
Longevity	10,000hours

INS specification[*1]

Positional accuracy	5mm
Heading	0.03°
Pitch/Roll	0.006°
Speed	0.01m / sec.

Accessory

- TDOT 3 NIR main unit
- Exclusive hard case
- GNSS antenna
- Preview application the "TDOT PrePROCESSING"
- TDOT GATEWAY
- User's manual

Option

- TDOT Installation Kit (for DJI Matrice300RTK / other drones)
- Processing application the "TDOT PROCESSING" or "TDOT PROCESSING PRO"

*1 This is the accuracy after post-processing with the "POST-PROCESSING CLOUD" cloud service. A separate contract is required to use the service.

TDOT™ NIR 3
DRONE LASER SYSTEM

Pulse rate
(240,000 pulses in 360° conversion)
60, 000Hz

lean field of view for surveying
90°

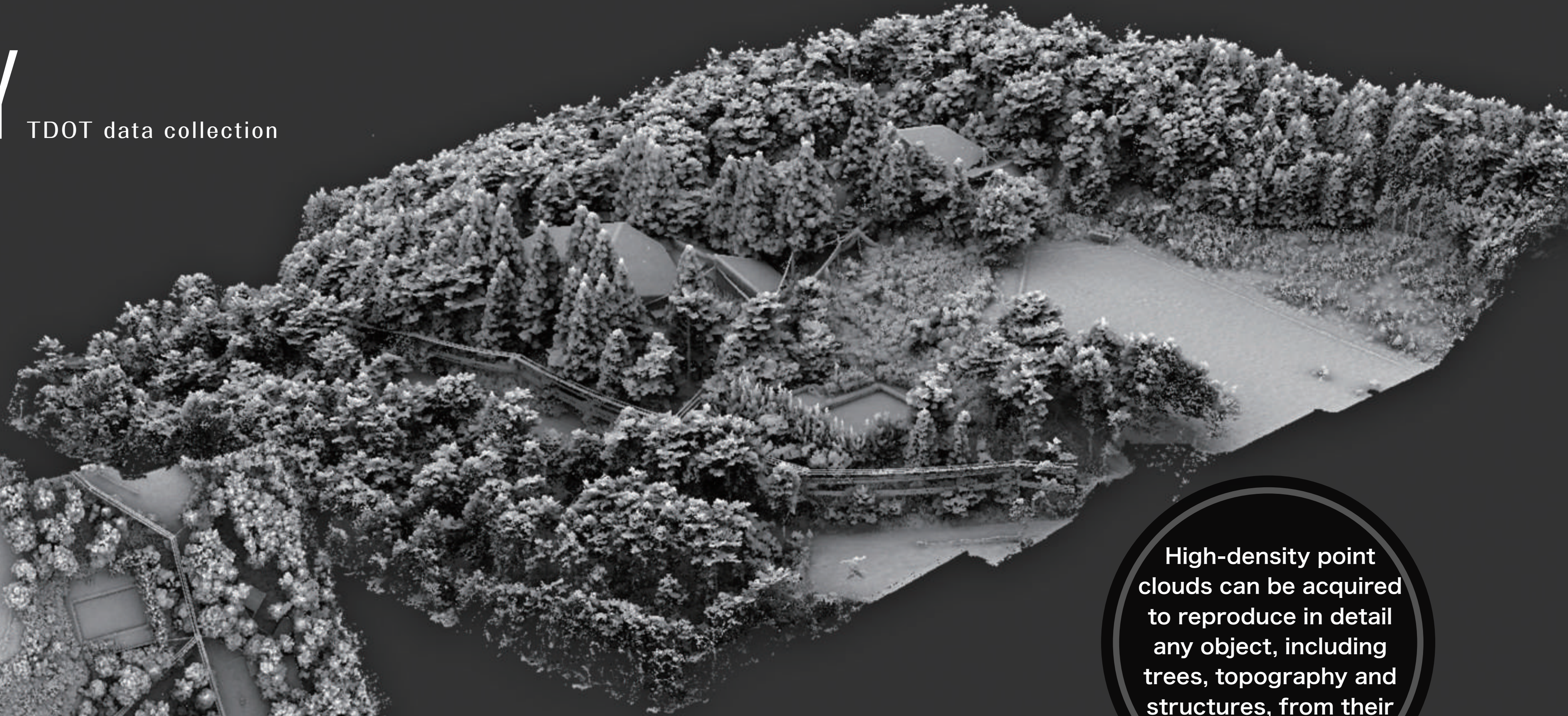
Scanning speed
30scans/sec.

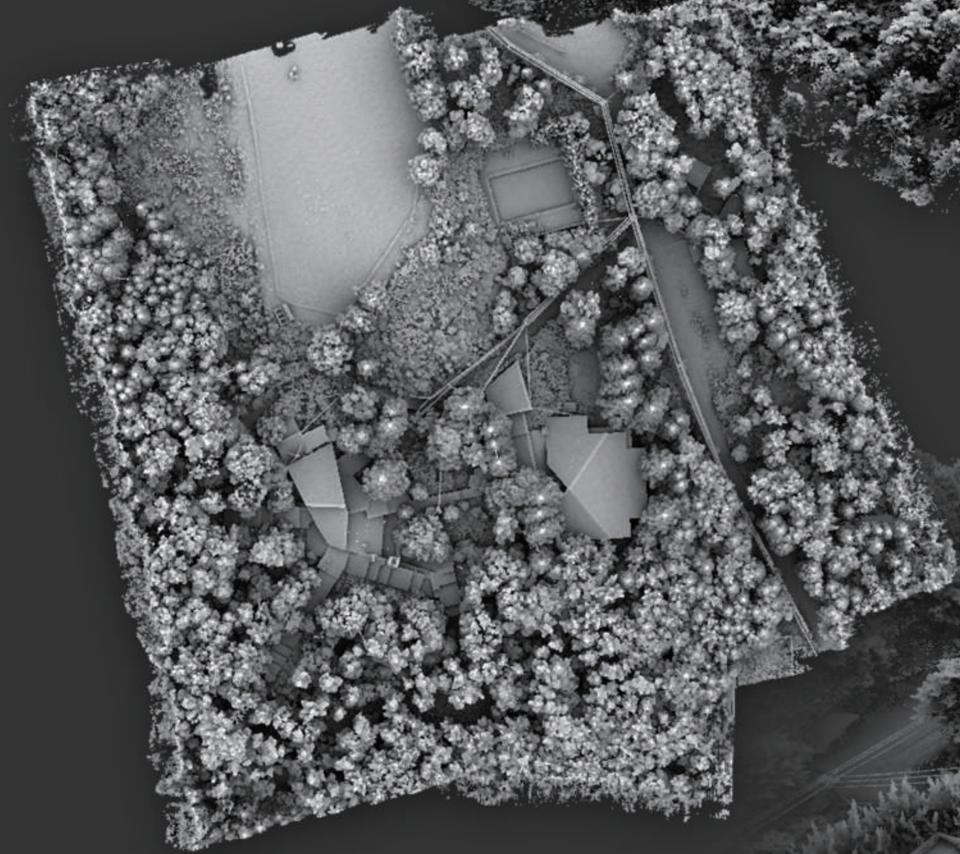
Accuracy of measurement distance
150m : ±20mm / 50m : ±4mm

Main unit weight
(lightweight design suitable for drones)
1.8kg

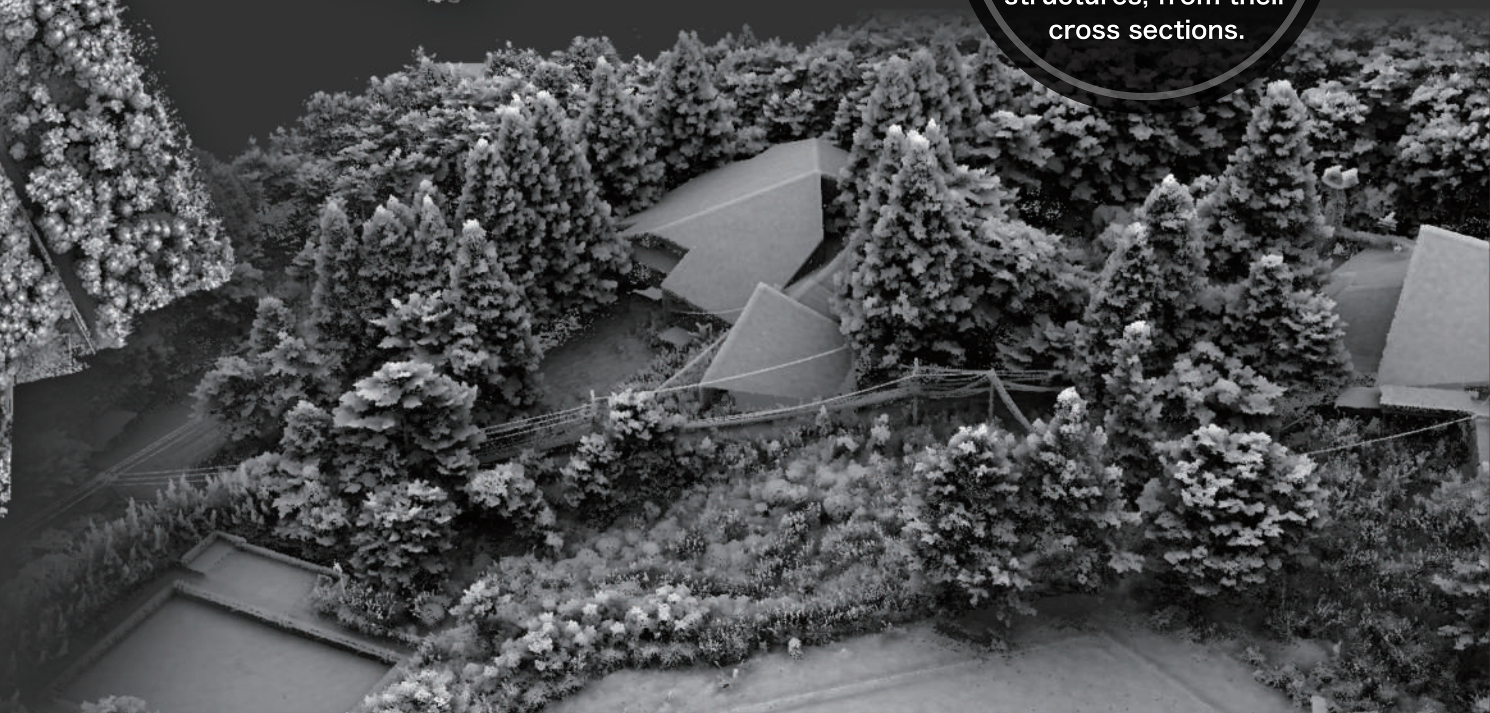
Safe general-purpose laser wavelength
905nm (near-infrared laser)

GALLERY TDOT data collection





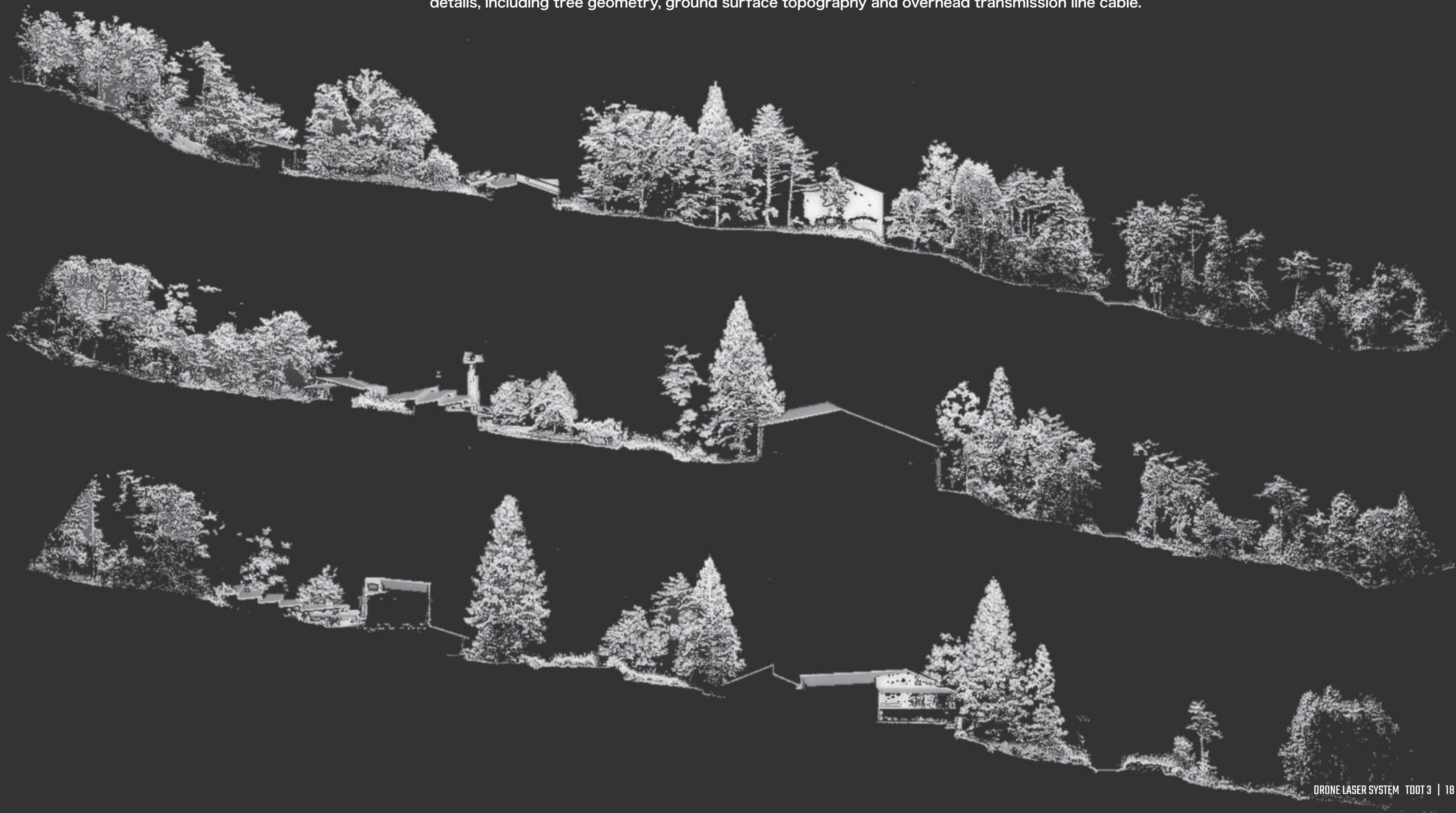
High-density point clouds can be acquired to reproduce in detail any object, including trees, topography and structures, from their cross sections.



TDOT3 -GREEN- TDOT3 -NIR-

SURVEYING Use in creation of National Land Infrastructure Platform

Digital twin" technology, which copies and reproduces geospatial information in the real world onto digital space, is attracting attention.
The 3D data of about 60 cities has already been released (PLATEAU), and in these 3D virtual spaces, smart city concepts are being studied based on various ground information and infrastructure development situations, and disaster prevention and mitigation plans are being formulated based on the results of various simulations.
TDOT 3 enables anyone to participate in the growing digital twin market by continuously visualizing cross sections and recreating structural details, including tree geometry, ground surface topography and overhead transmission line cable.

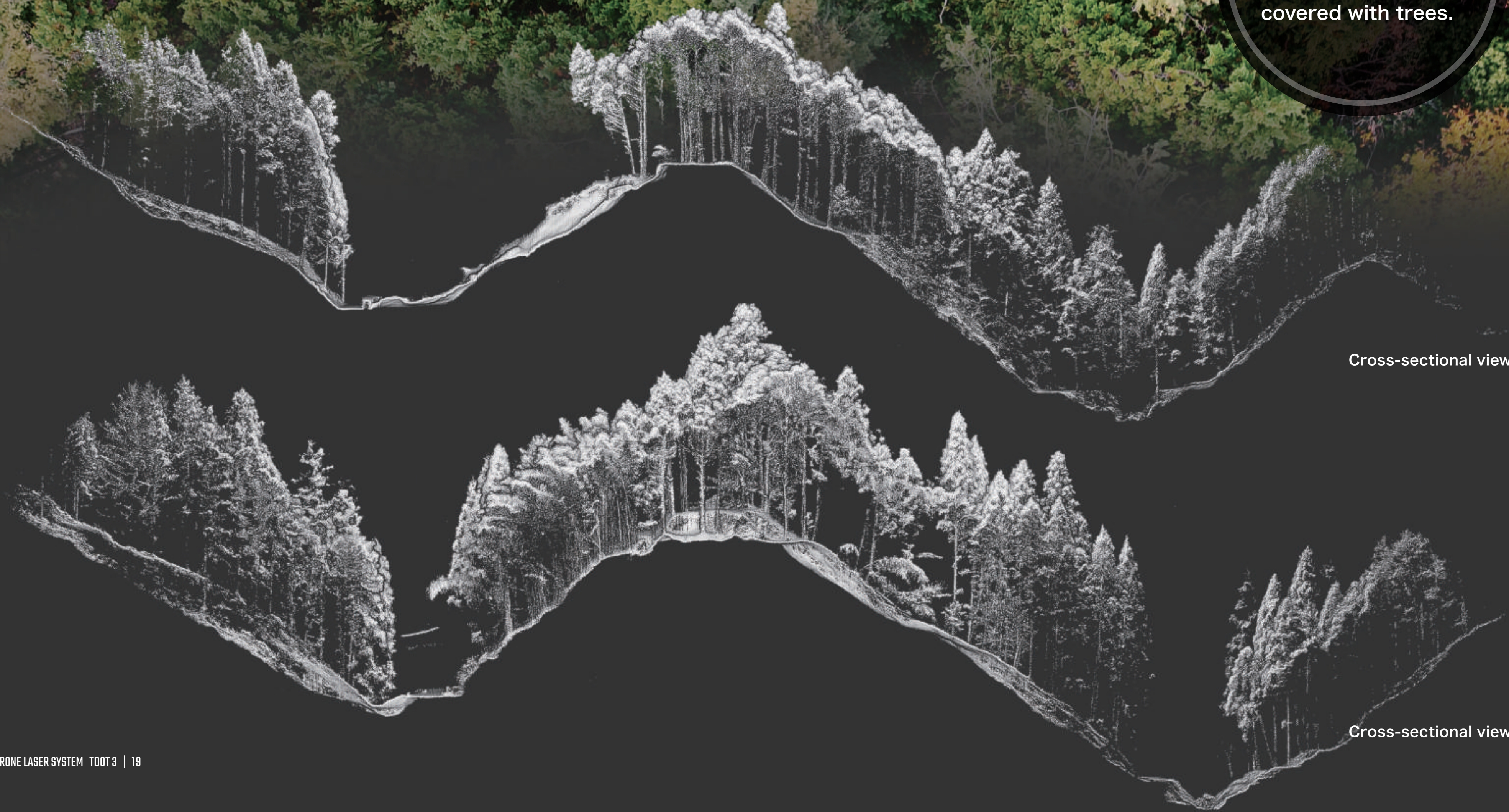


TDOT3 -GREEN-　TDOT3 -NIR-

SURVEYING　Use in slope disaster prevention consulting

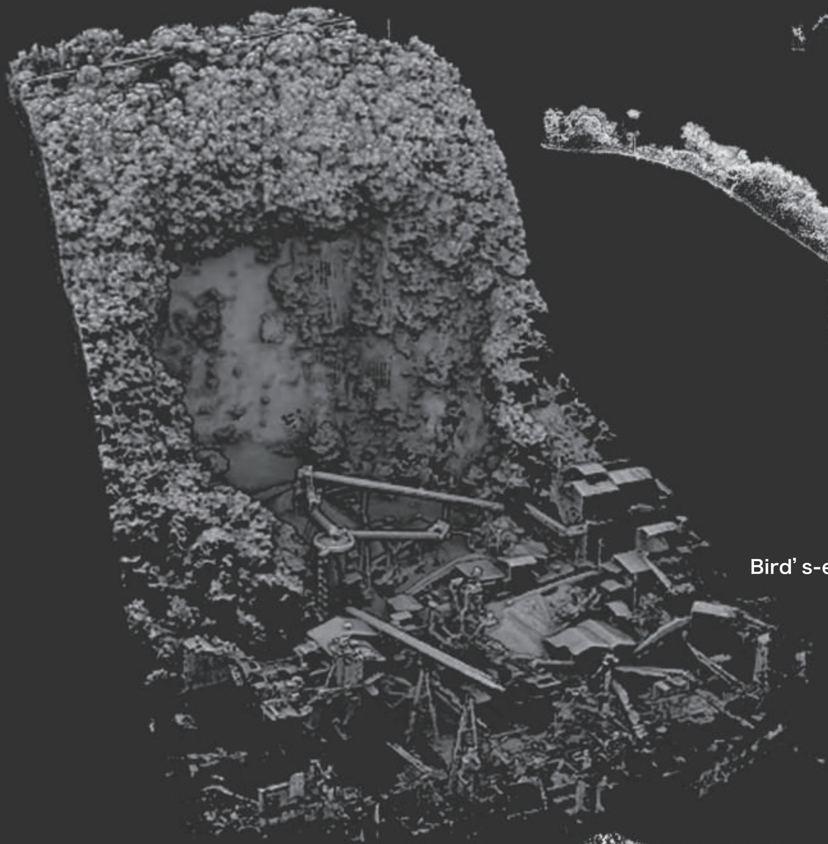
On-site work in slope surveying requires a great deal of effort.
By introducing a preliminary desktop survey using 3D data obtained with TDOT 3, the locations to be confirmed can be identified, which greatly improves work efficiency.
Currently, various municipalities are actively utilizing 3D data of mountainous areas as DX for road disaster prevention.

Lasers can acquire ground data even in mountainous terrain covered with trees.



Cross-sectional view

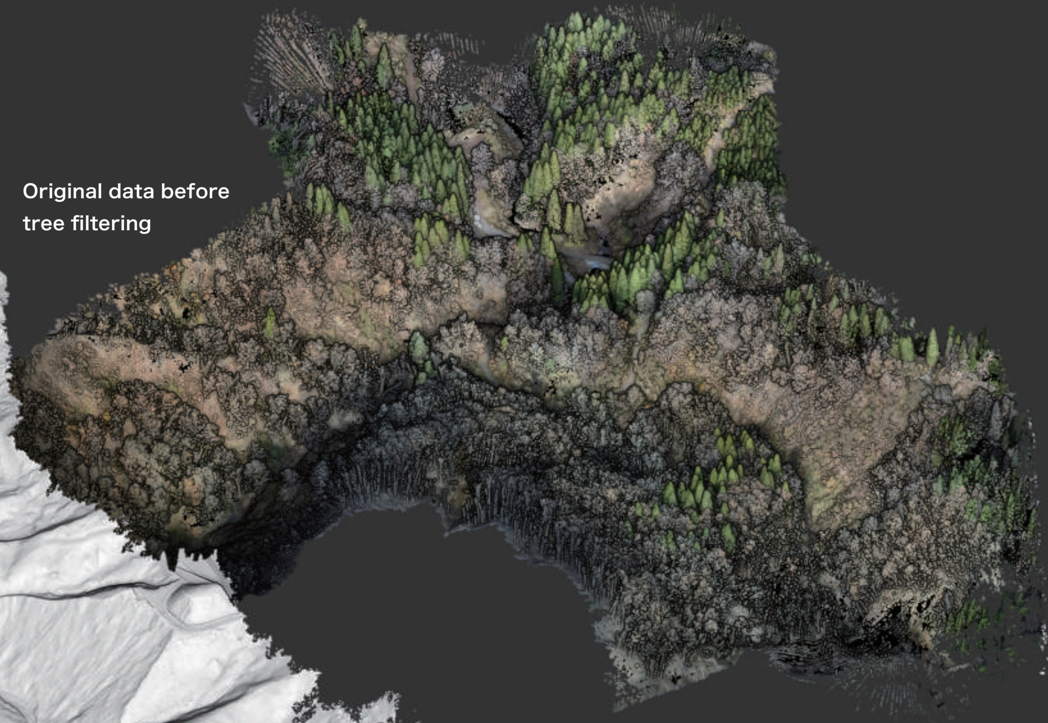
Cross-sectional view



Bird' s-eye view

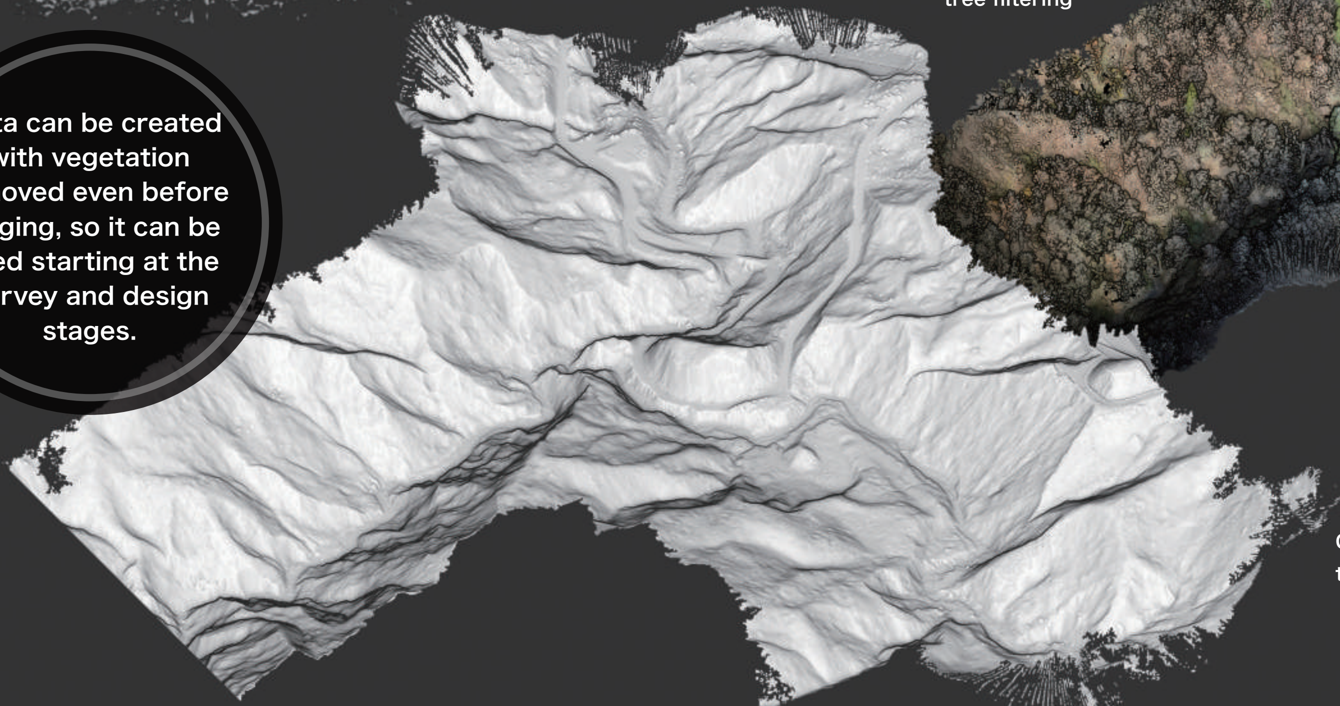
Cross-sectional view

Data can be efficiently acquired even on steep slopes.



Original data before tree filtering

Data can be created with vegetation removed even before logging, so it can be used starting at the survey and design stages.



Ground data after tree filtering

TDOT3 -GREEN-　TDOT3 -NIR-

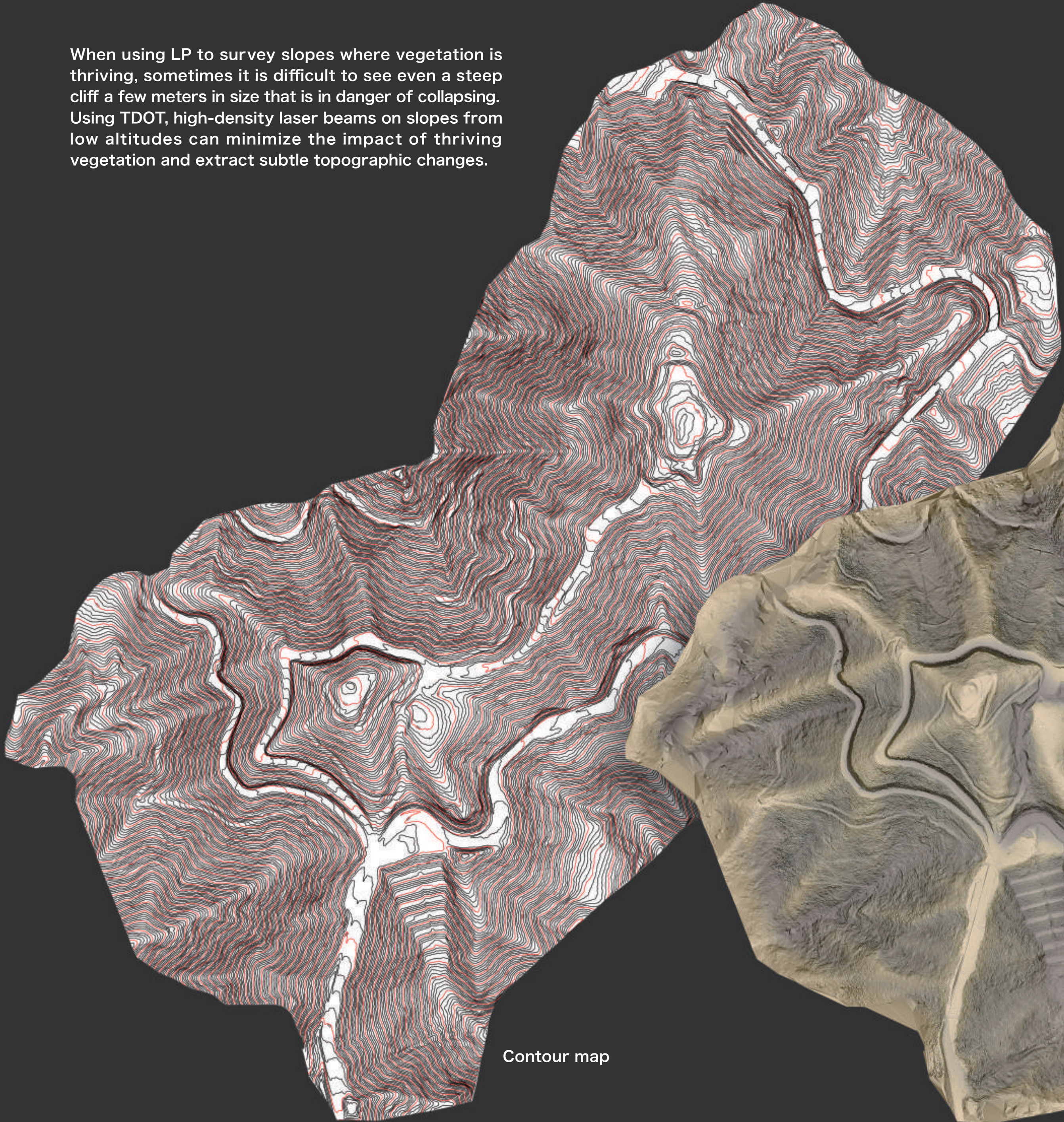
SURVEYING

Use in slope disaster prevention consulting

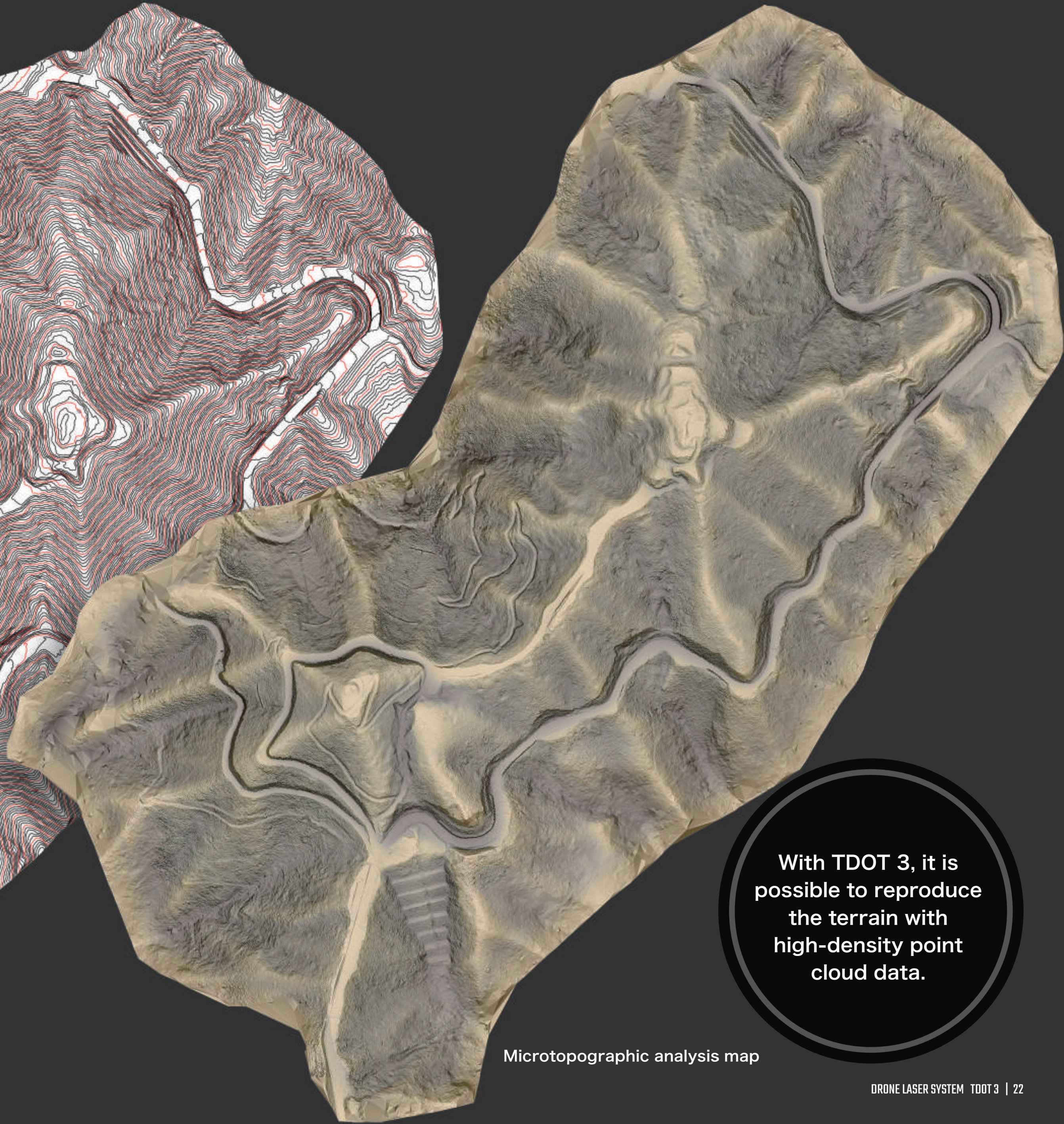
When laser surveying is used on slopes, the density of the laser point cloud changes the topography that is reproduced, and consequently the size of the hazardous areas that can be found. TDOT 3 not only provides an alternative to costly aerial laser profilers (LPs), but also eliminates the problem of missing hazardous areas with LPs because of the high laser density from low altitude.
With TDOT 3, it is possible to conduct reliable slope surveys.

With TDOT 3, it is possible to reproduce the terrain with high-density point cloud data.

When using LP to survey slopes where vegetation is thriving, sometimes it is difficult to see even a steep cliff a few meters in size that is in danger of collapsing. Using TDOT, high-density laser beams on slopes from low altitudes can minimize the impact of thriving vegetation and extract subtle topographic changes.



Contour map



Microtopographic analysis map

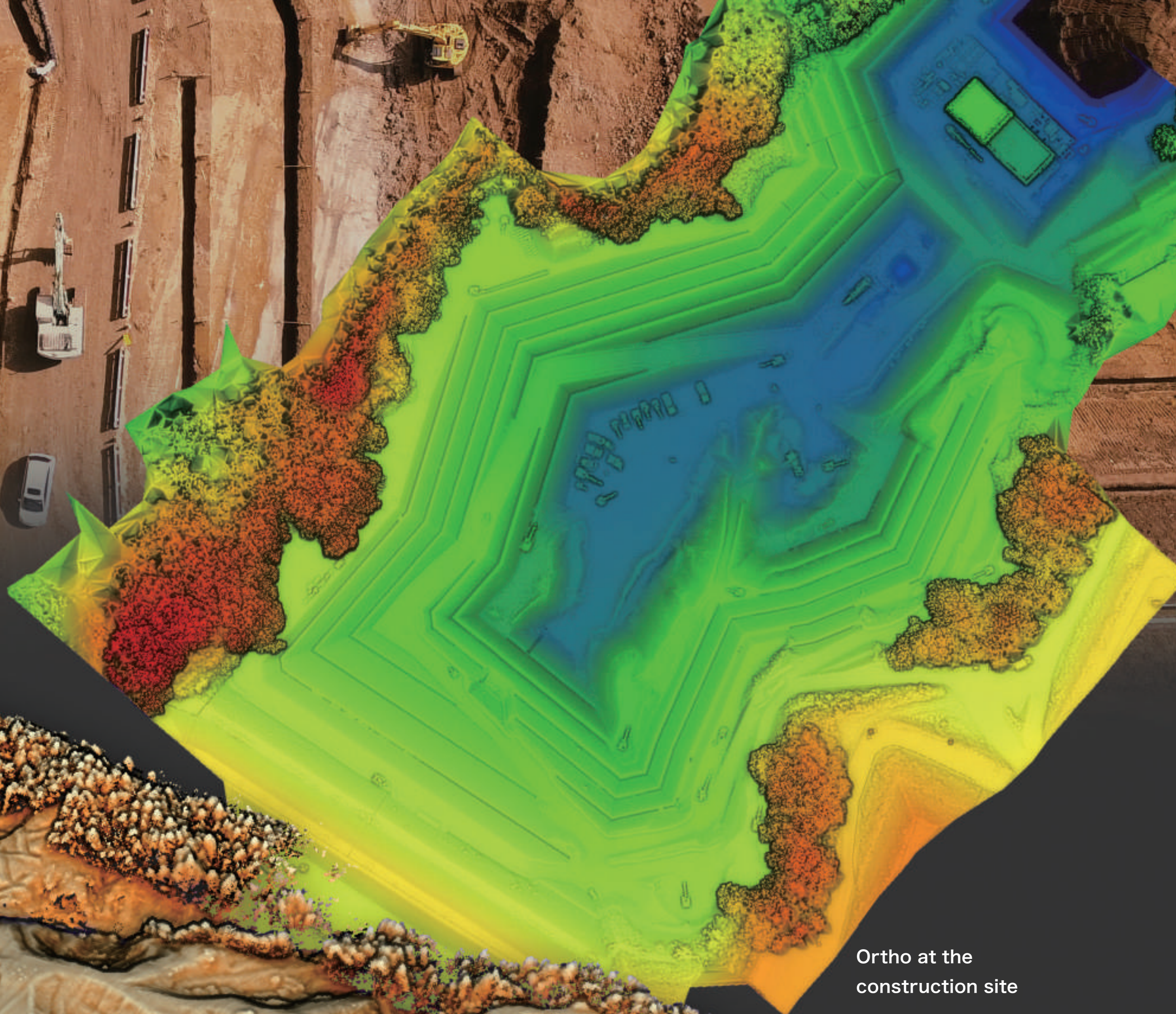
With TDOT 3, it is possible to reproduce the terrain with high-density point cloud data.

TDOT3 -GREEN-　TDOT3 -NIR-

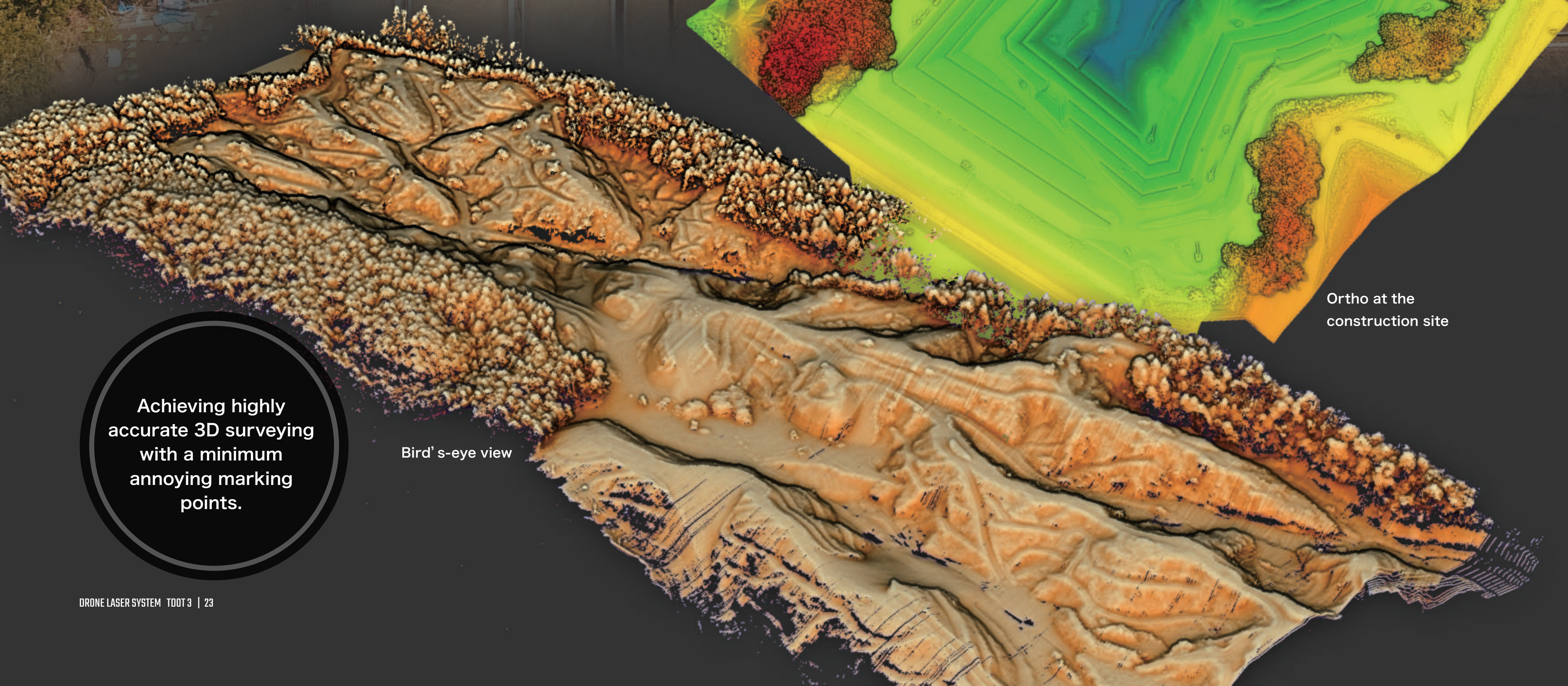
SURVEYING

Use in construction DX

The success or failure of ICT construction depends on how quickly and accurately on-site conditions can be grasped. With TDOT 3, which anyone can use, it is possible to operate the drone and survey by yourself and the automated analysis process allows you to immediately grasp the work progress control of each day, making construction DX independent on outsourcing.



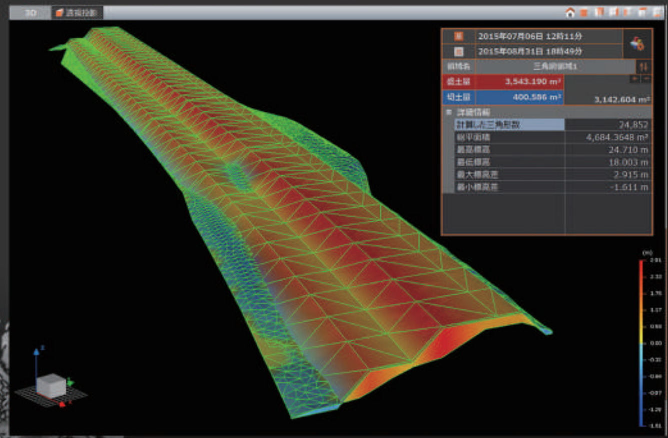
Ortho at the construction site



Bird' s-eye view

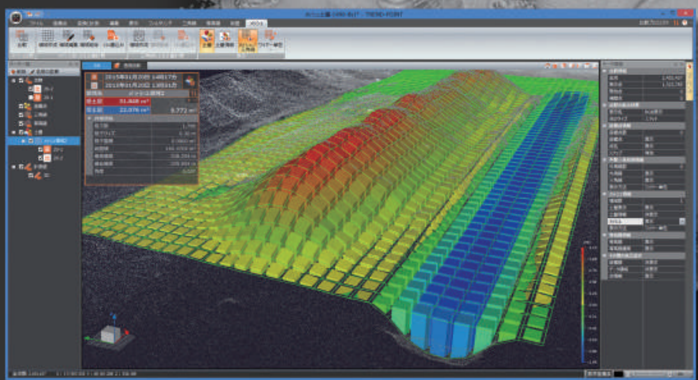
Achieving highly accurate 3D surveying with a minimum annoying marking points.

Since TDOT 3 has a small beam diameter with high point density, it can grasp the shapes of electric wires and signs, thereby enhancing maintenance and management work on infrastructure structures.



Easy calculation of accurate soil volume and heat maps for work progress control.

*A separate application is required.

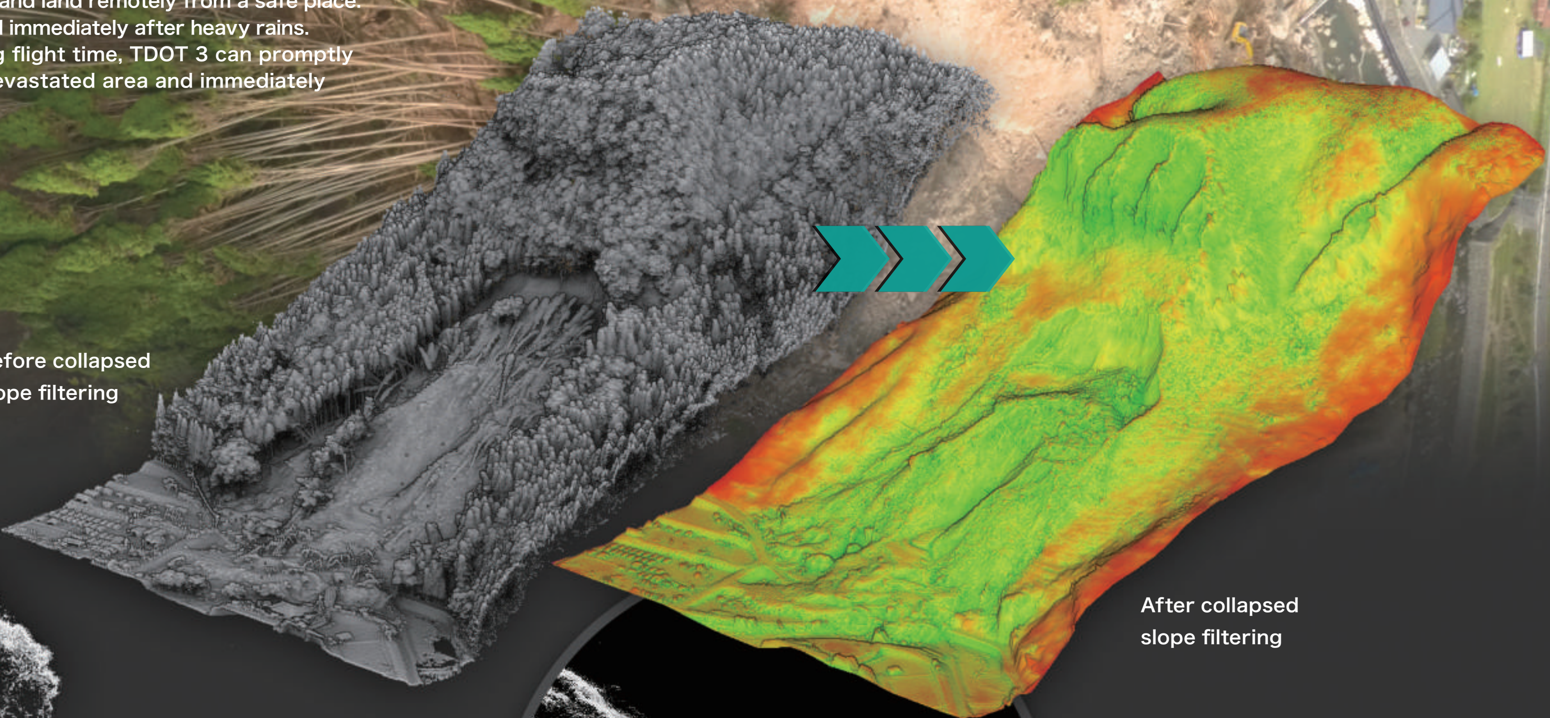


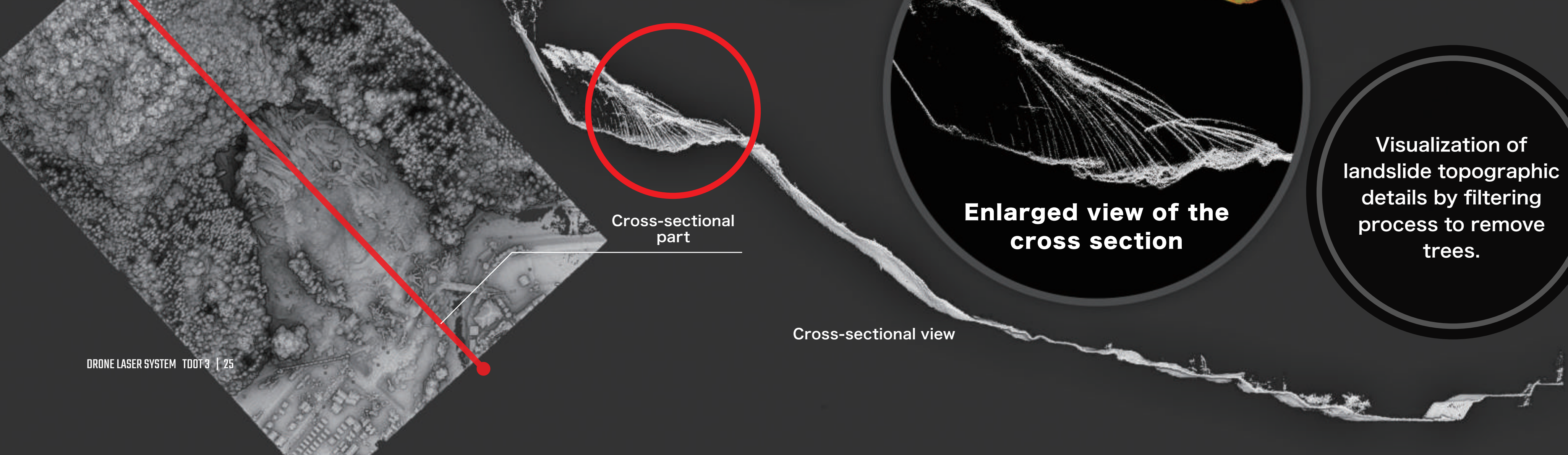
Bird’ s-eye view

TDOT3 -GREEN-　TDOT3 -NIR-

DISASTER RESPONSE　Use in devastated area for the current situation and disaster assessment

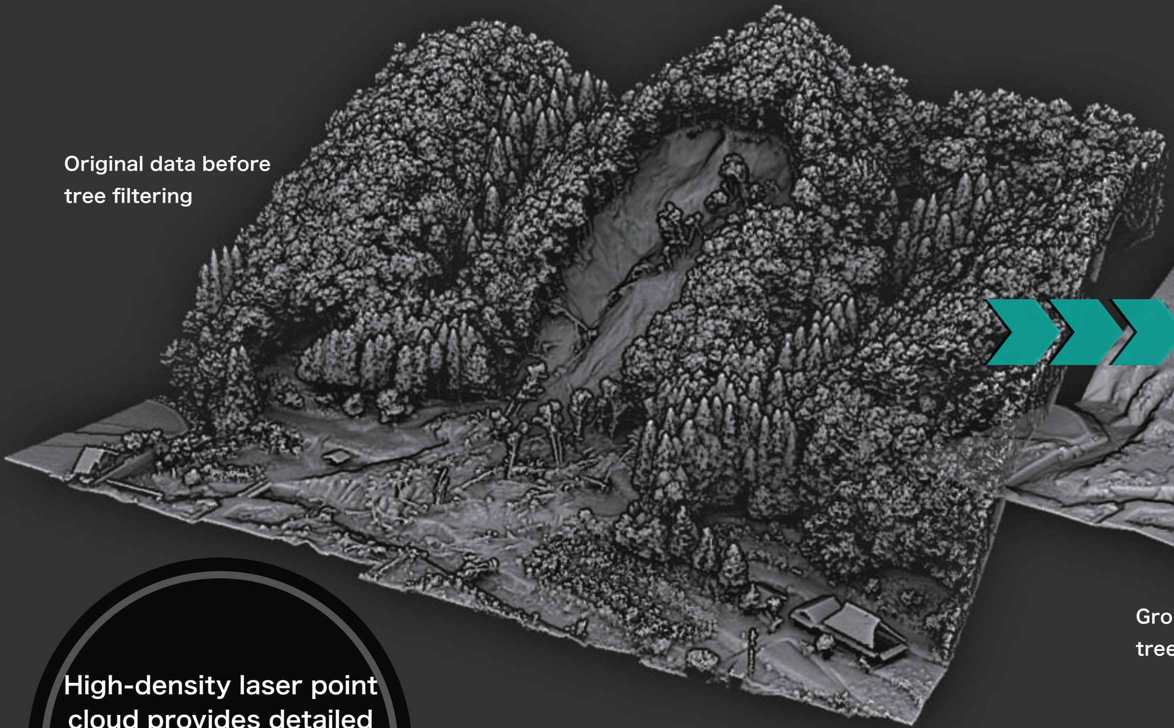
TDOT 3 can also be an effective tool in responding to disaster areas where rapid response is required. It can be transported to the site and take off and land remotely from a safe place. With TDOT 3, data can be acquired even on wet ground immediately after heavy rains. Taking advantage of the lightweight system and long flight time, TDOT 3 can promptly acquire data to determine the current status of a devastated area and immediately output the data necessary for damage assessment.

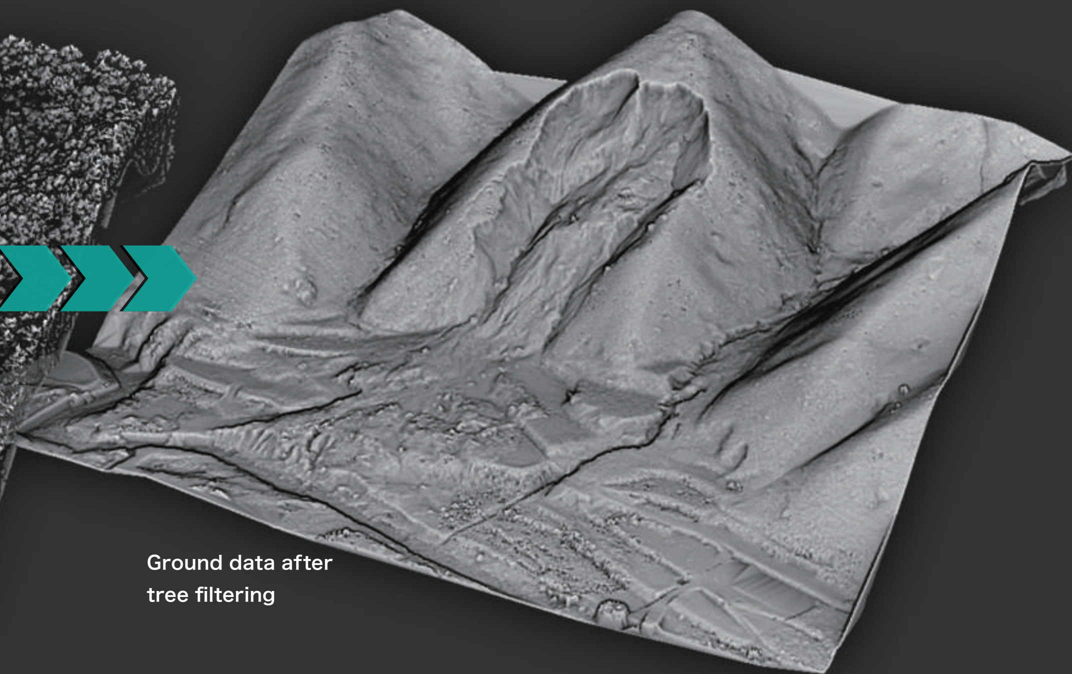




Visualization of landslide topographic details by filtering process to remove trees.

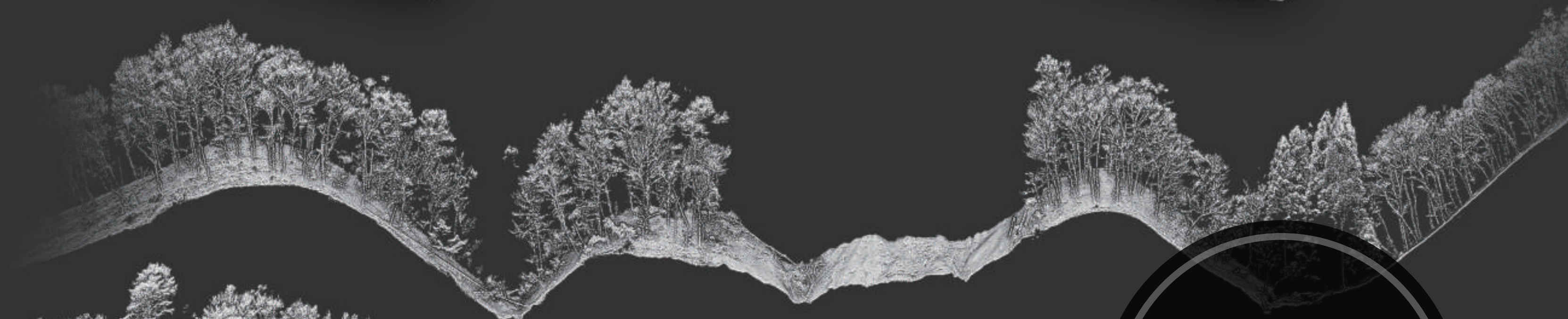
Original data before
tree filtering



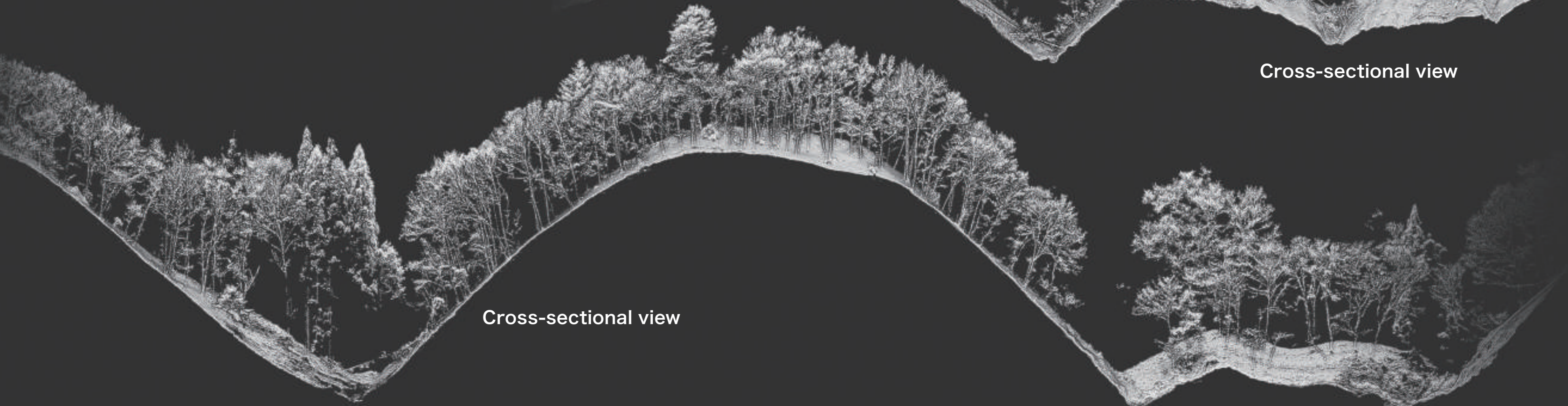


Ground data after
tree filtering

High-density laser point cloud provides detailed topographic information even in forested areas.



Cross-sectional view



Cross-sectional view

Quick visualization of conditions under vegetation

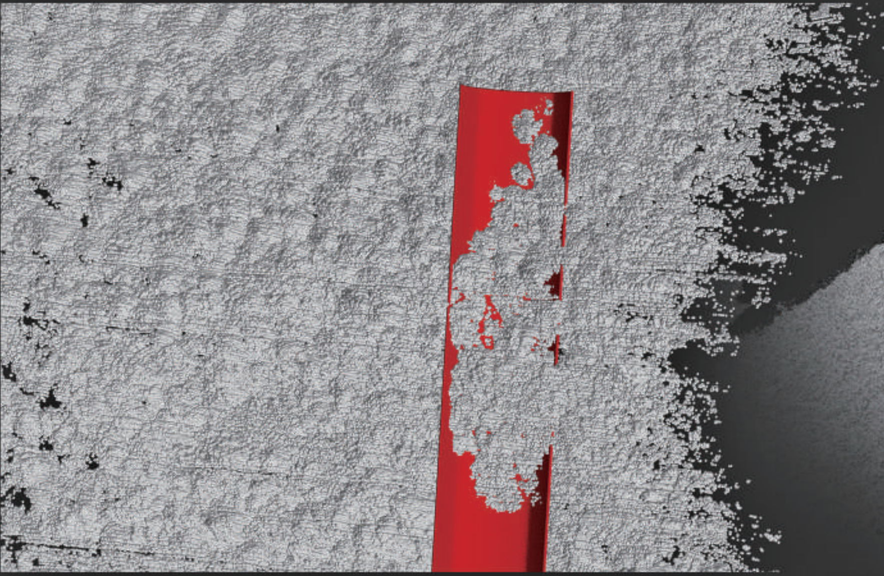
TDOT3 -GREEN-　TDOT3 -NIR-

INFRASTRUCTURE SURVEY Use in infrastructure research in mountainous area

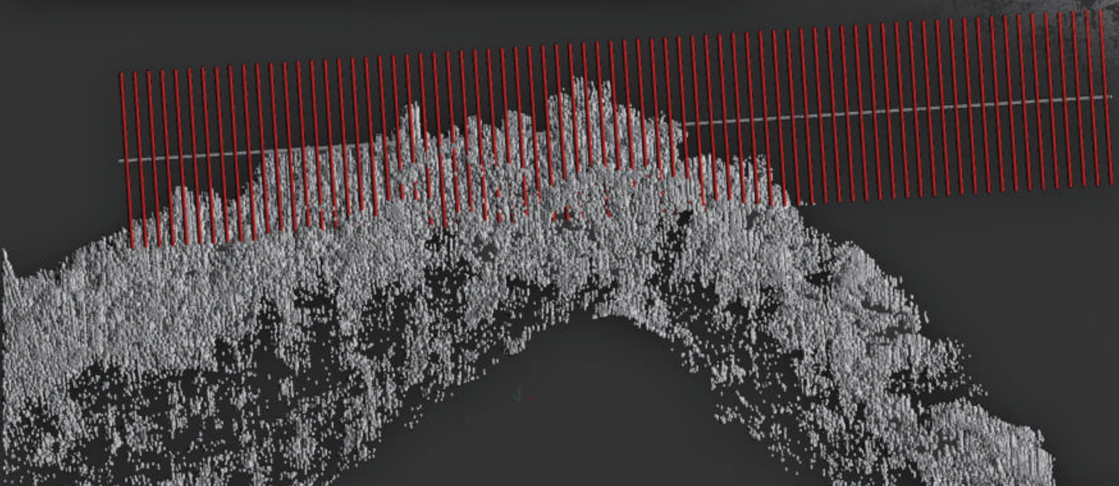
When conducting drone surveying in mountainous areas, the distance from the takeoff/landing point to the destination is much greater, making the demands on flight time much more demanding.
TDOT 3 can significantly improve surveying time due to its unprecedented light weight.
TDOT 3 allows you to simultaneously survey mountainous terrain and thin electric wires.
Also, electric wires can be safely inspected remotely without worrying about interrupting the surveying process to change batteries.

With TDOT 3, which enables long-distance flights, long-distance wires in mountainous areas can be also inspected efficiently.

TDOT 3 visualizes tree growth in detail. This not only improves the efficiency of tree cutting plans (deforestation operations) near electric wires, but also identifies trees between radio towers and radio reflectors that may be blocking radio waves. Until now, it has been difficult to obtain detailed 3D data on radio towers, radio reflectors or trees in mountainous areas, making it difficult to develop effective, environmentally friendly deforestation plans.



Simulations were conducted to identify trees between the radio tower and the radio reflector that would cause radio interference, and the results showed that trees within the red circles are subject to radio interference.

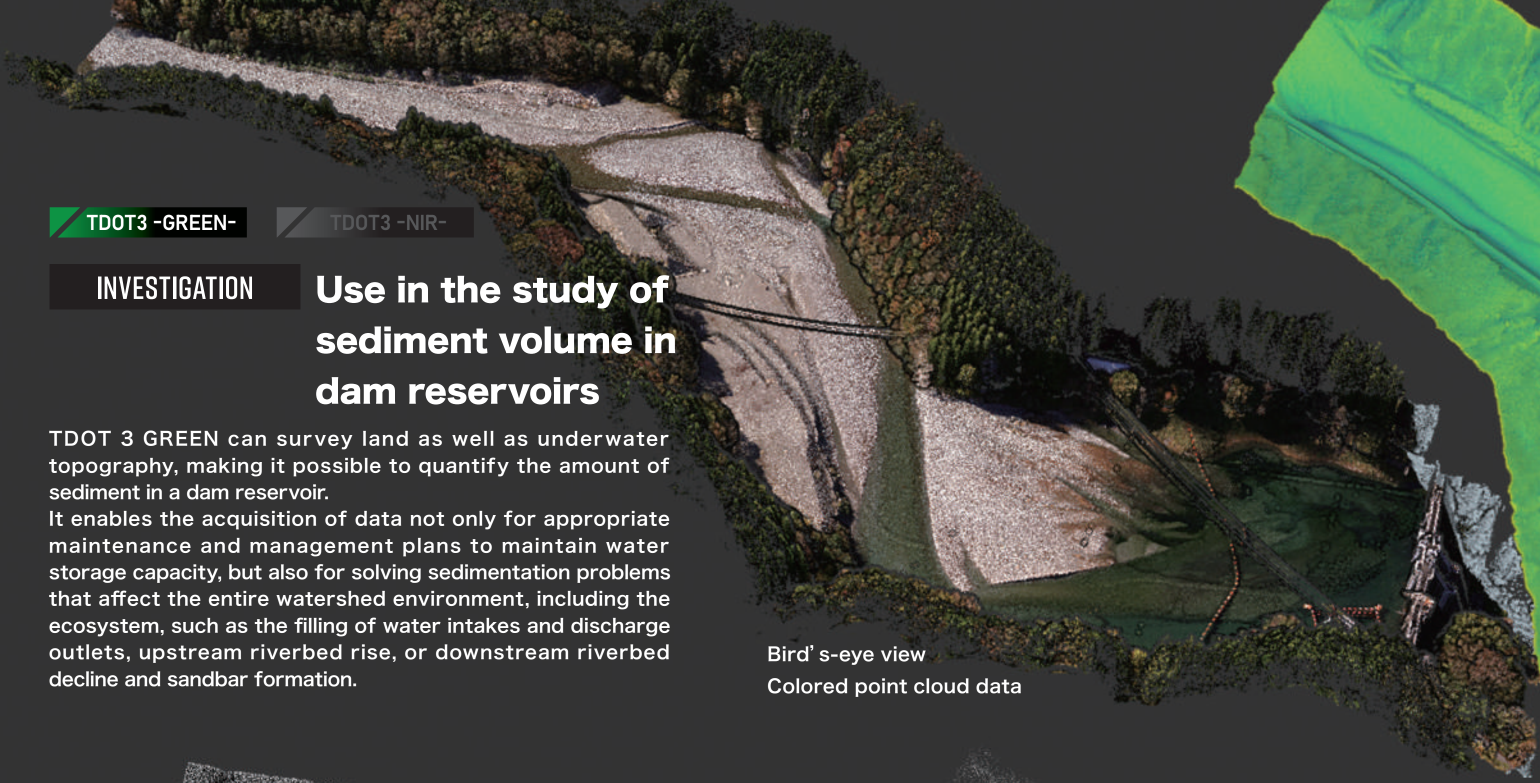


TDOT3 -GREEN-　TDOT3 -NIR-

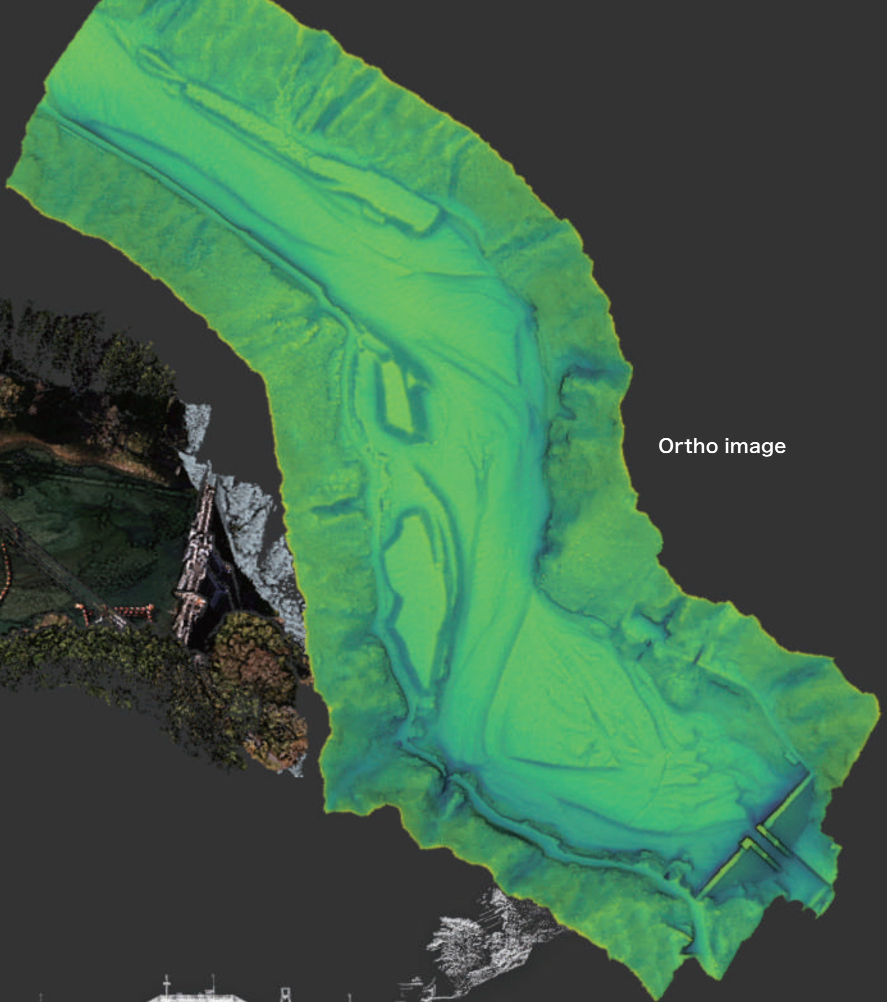
INVESTIGATION

Use in the study of sediment volume in dam reservoirs

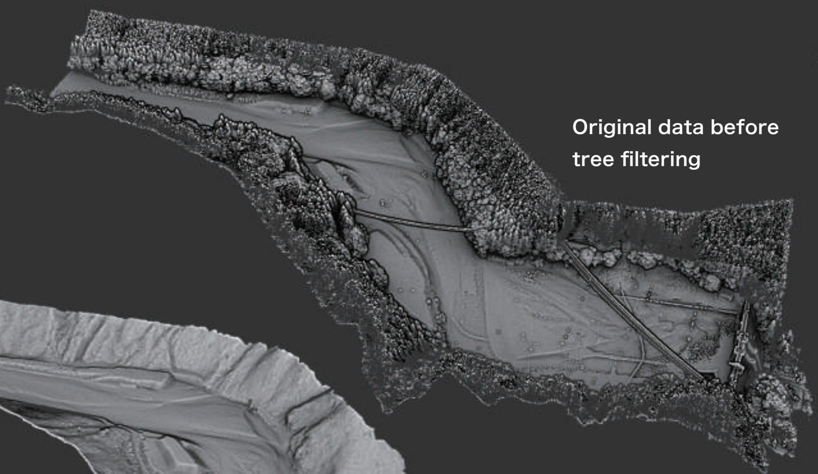
TDOT 3 GREEN can survey land as well as underwater topography, making it possible to quantify the amount of sediment in a dam reservoir.
It enables the acquisition of data not only for appropriate maintenance and management plans to maintain water storage capacity, but also for solving sedimentation problems that affect the entire watershed environment, including the ecosystem, such as the filling of water intakes and discharge outlets, upstream riverbed rise, or downstream riverbed decline and sandbar formation.



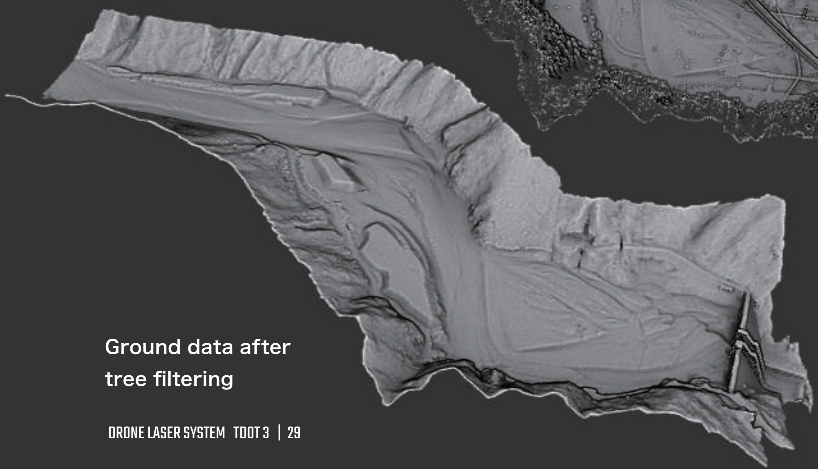
Bird' s-eye view
Colored point cloud data



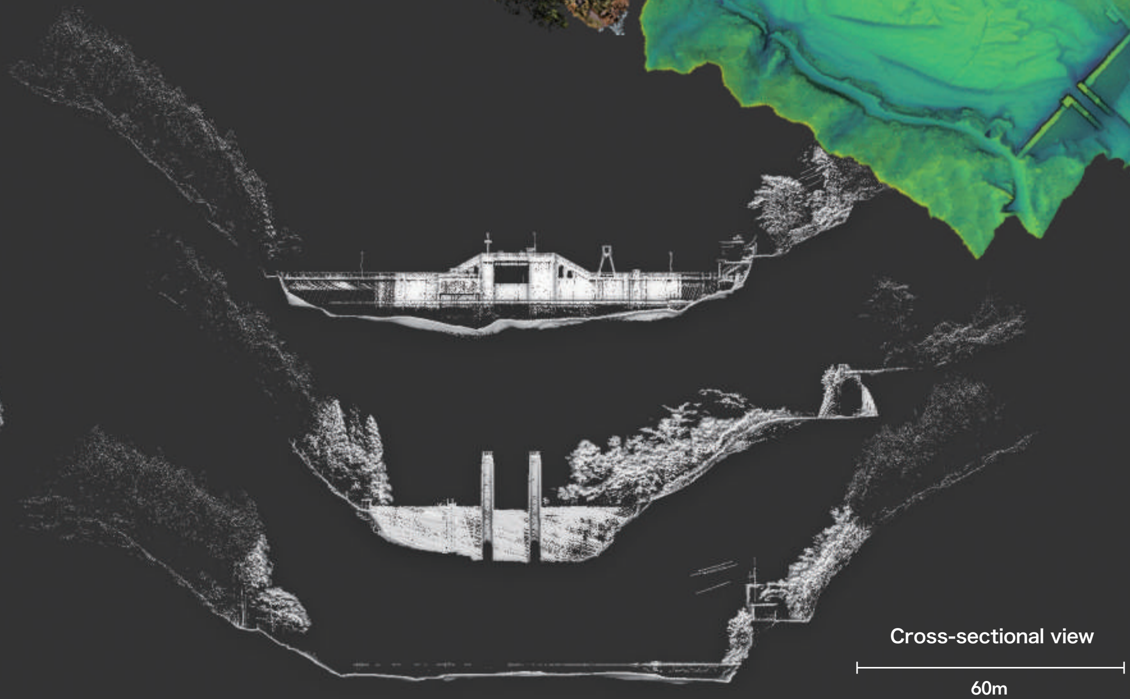
Ortho image



Original data before tree filtering



Ground data after tree filtering



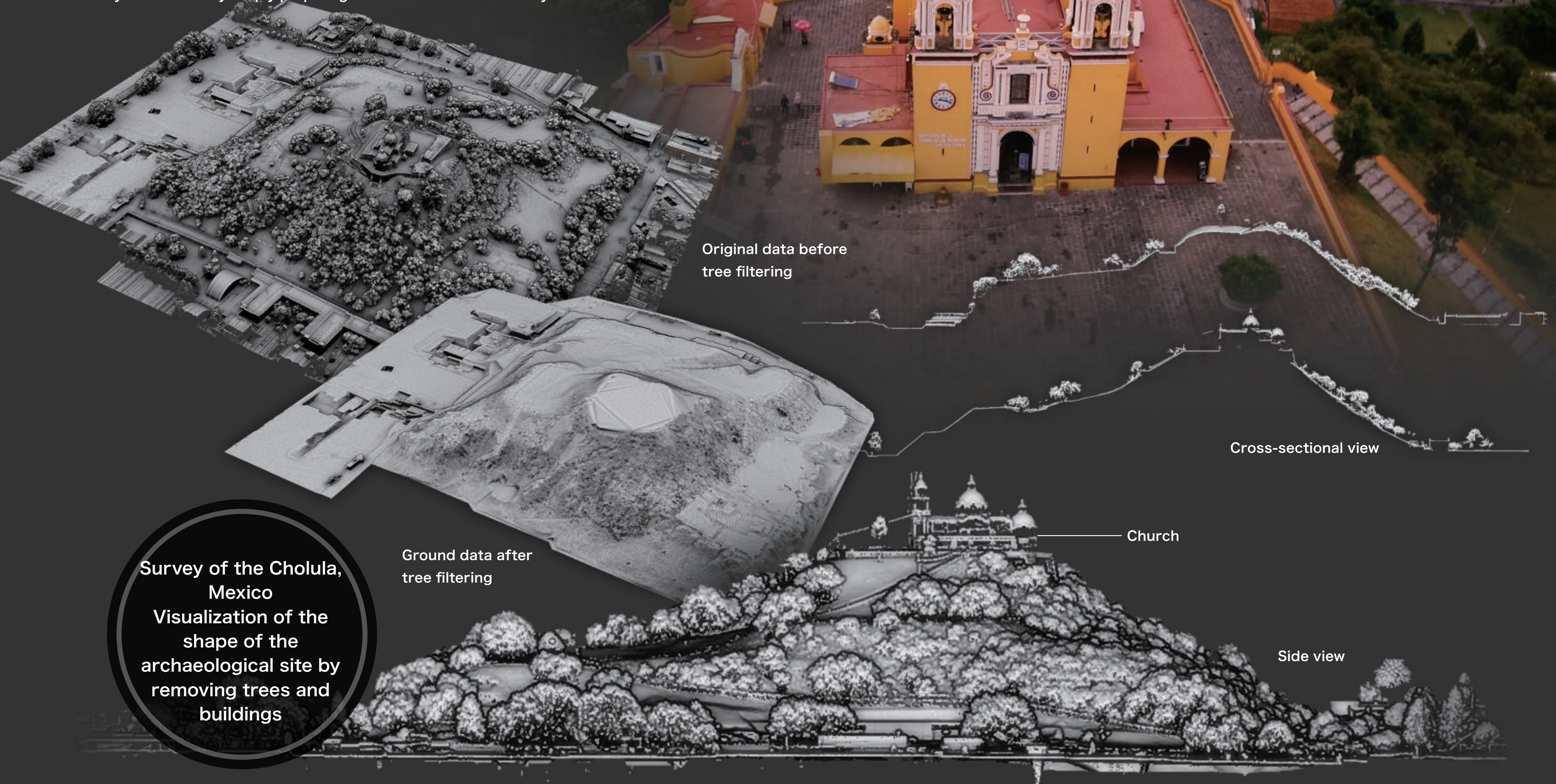
Cross-sectional view

TDOT3 -GREEN- TDOT3 -NIR-

INVESTIGATION

Use in archaeological sites

TDOT 3 releases you from flight time constraints, allowing you to efficiently survey wide areas including distant points from the takeoff/landing point. Since TDOT 3 can be mounted on DJI drones, which are distributed worldwide, researchers can find structures behind trees by themselves by simply preparing TDOT 3 for overseas surveys.

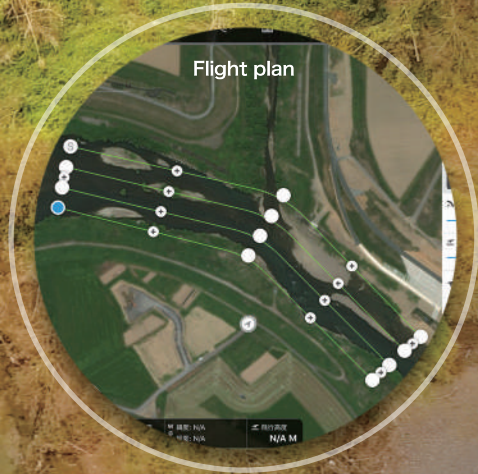


Survey of the Cholula, Mexico
Visualization of the shape of the archaeological site by removing trees and buildings

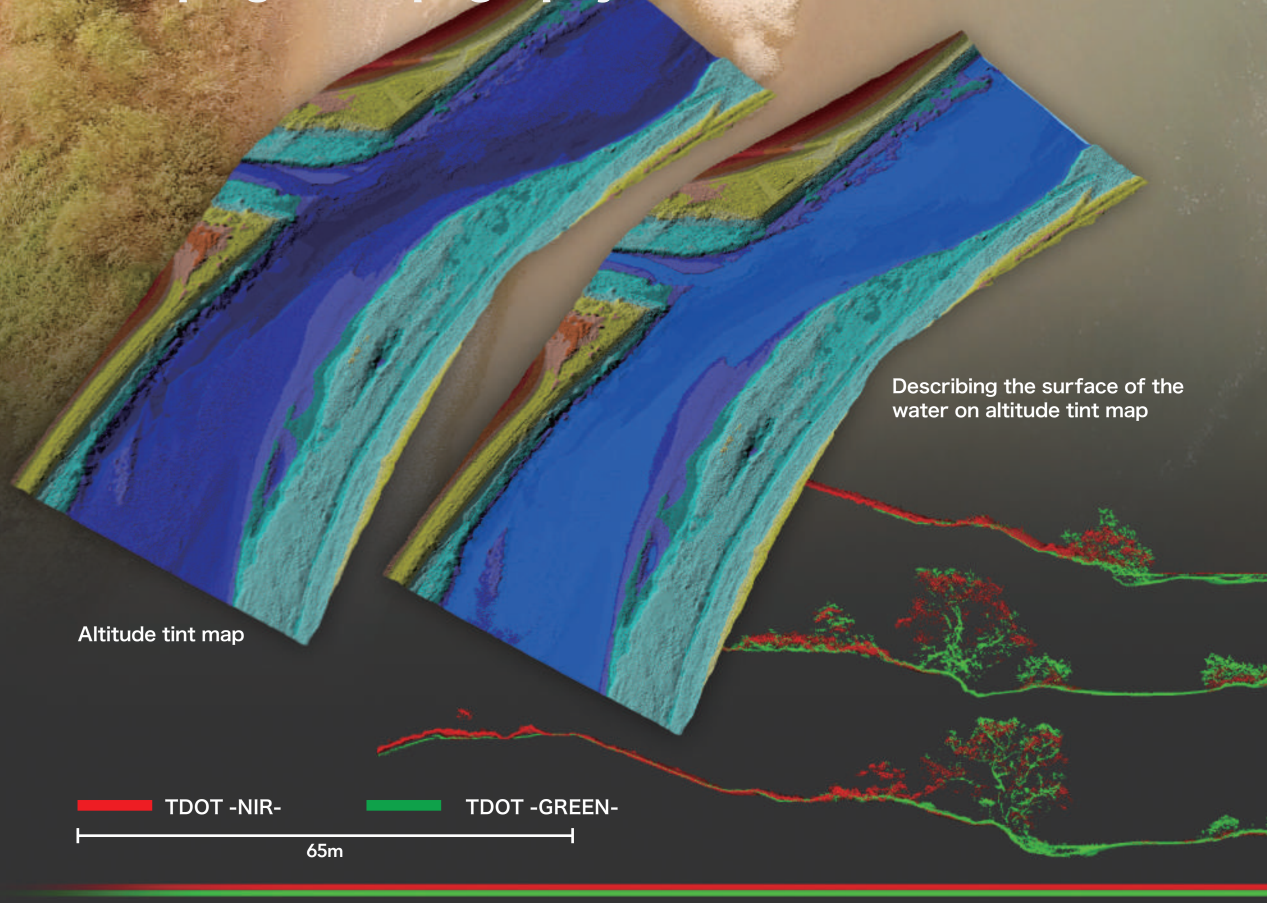
TDOT3 -GREEN- TDOT3 -NIR-

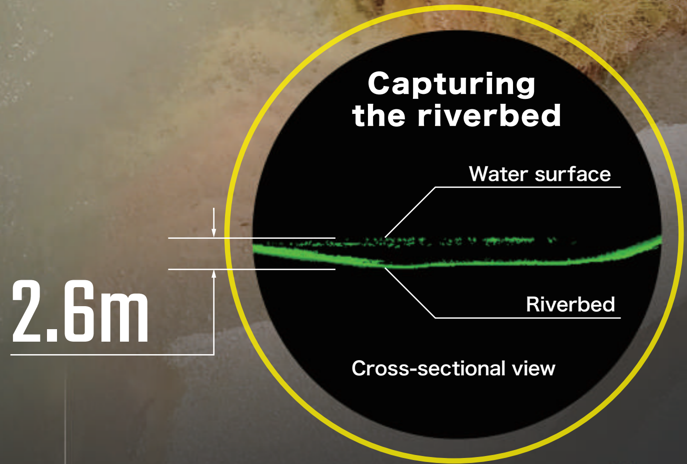
INVESTIGATION Use in river survey

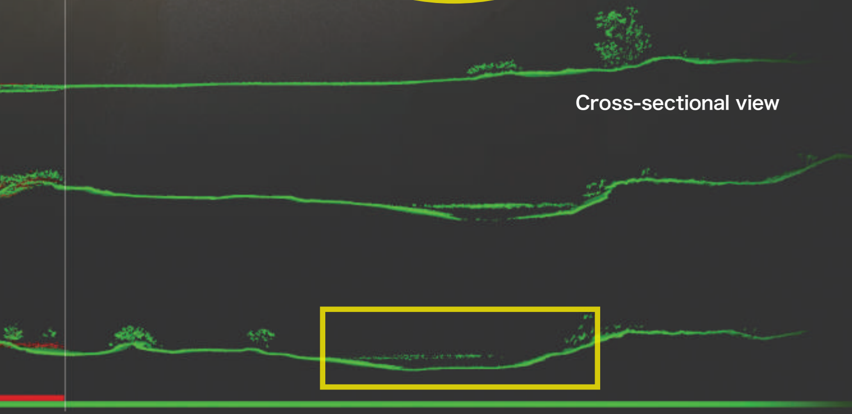
TDOT 3 GREEN enables the surveying of the riverbed as well as overland and under vegetation, thus realizing river channel management with 3-dimensional areal data that cannot be obtained with conventional periodic longitudinal and cross-sectional surveying. Also, it is possible to improve the accuracy of models for runoff analysis and water level calculations by assessing tree distribution and canopy shape in the river channel, for example, facilitating the prediction of sudden changes in channel cross-sectional profile and the occurrence of dead water areas formed by riparian forests.
This allows TDOT 3 GREEN to improve flood control capacity as well as enable community-based river management that takes into account the preservation and maintenance of the river environment for future generations.

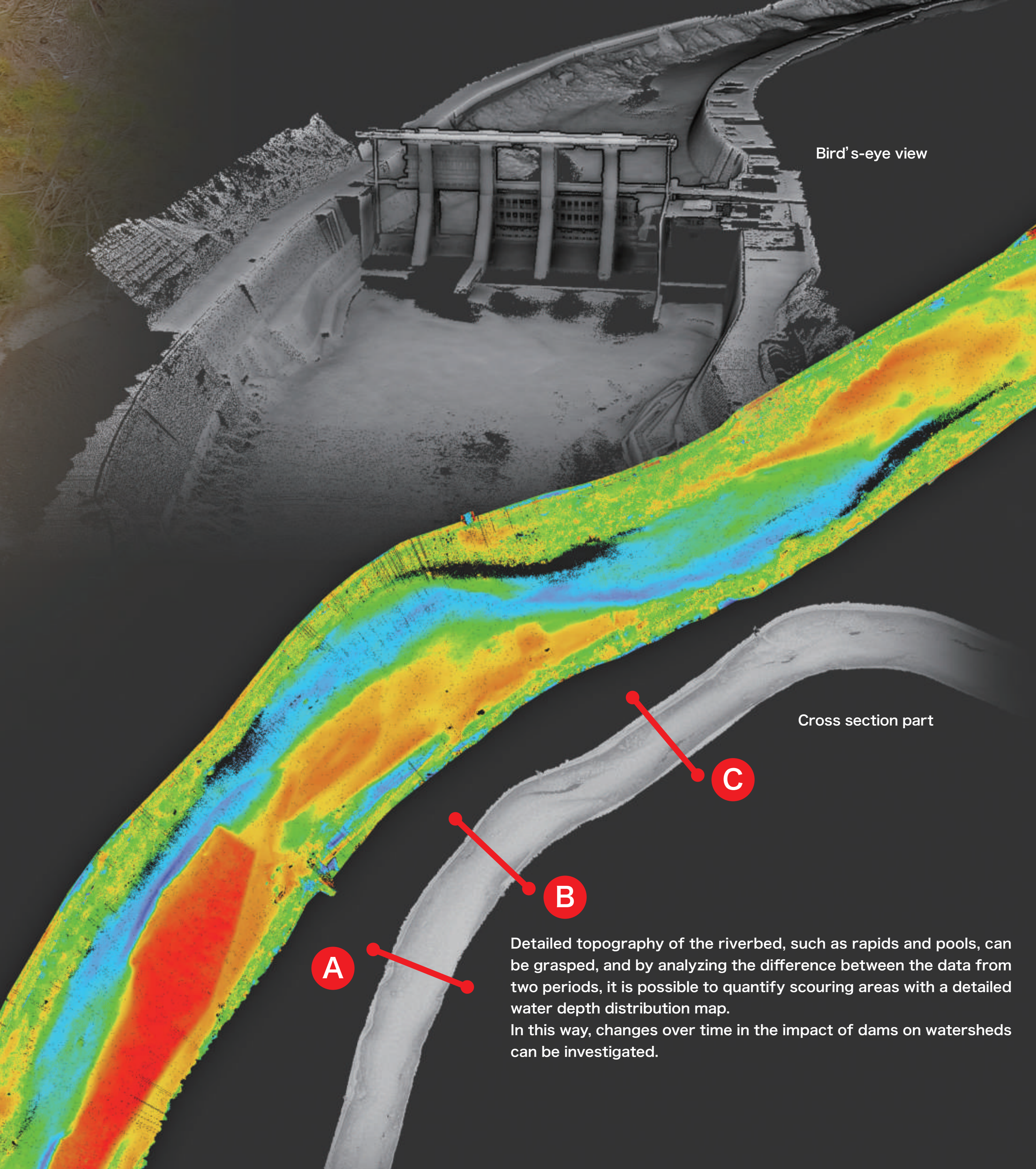


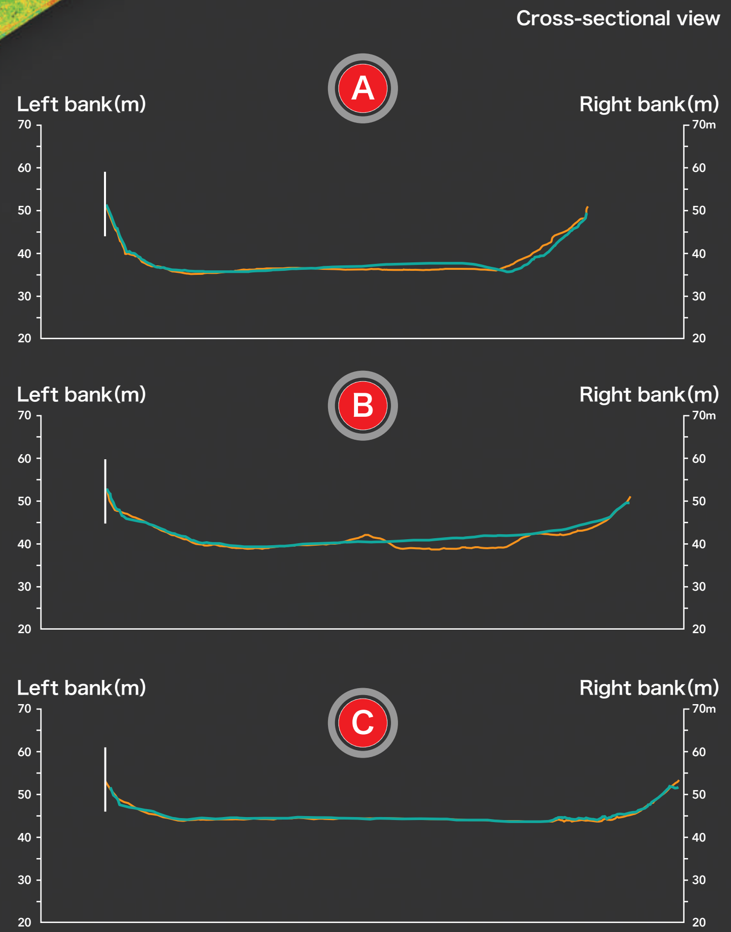
Grasping the topography of the river channel











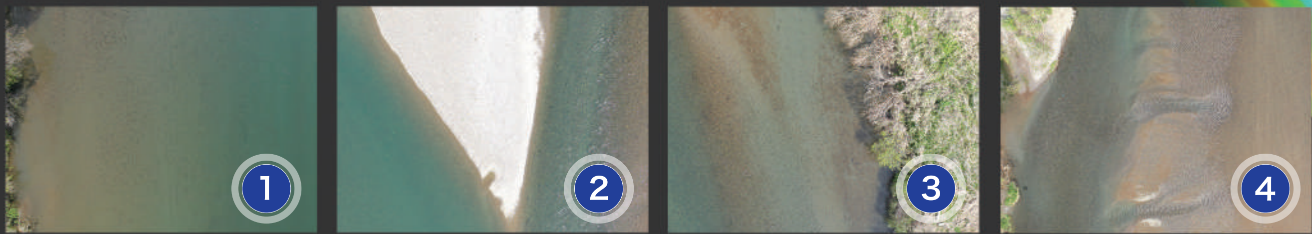
Detailed topography of the riverbed, such as rapids and pools, can be grasped, and by analyzing the difference between the data from two periods, it is possible to quantify scouring areas with a detailed water depth distribution map.
In this way, changes over time in the impact of dams on watersheds can be investigated.

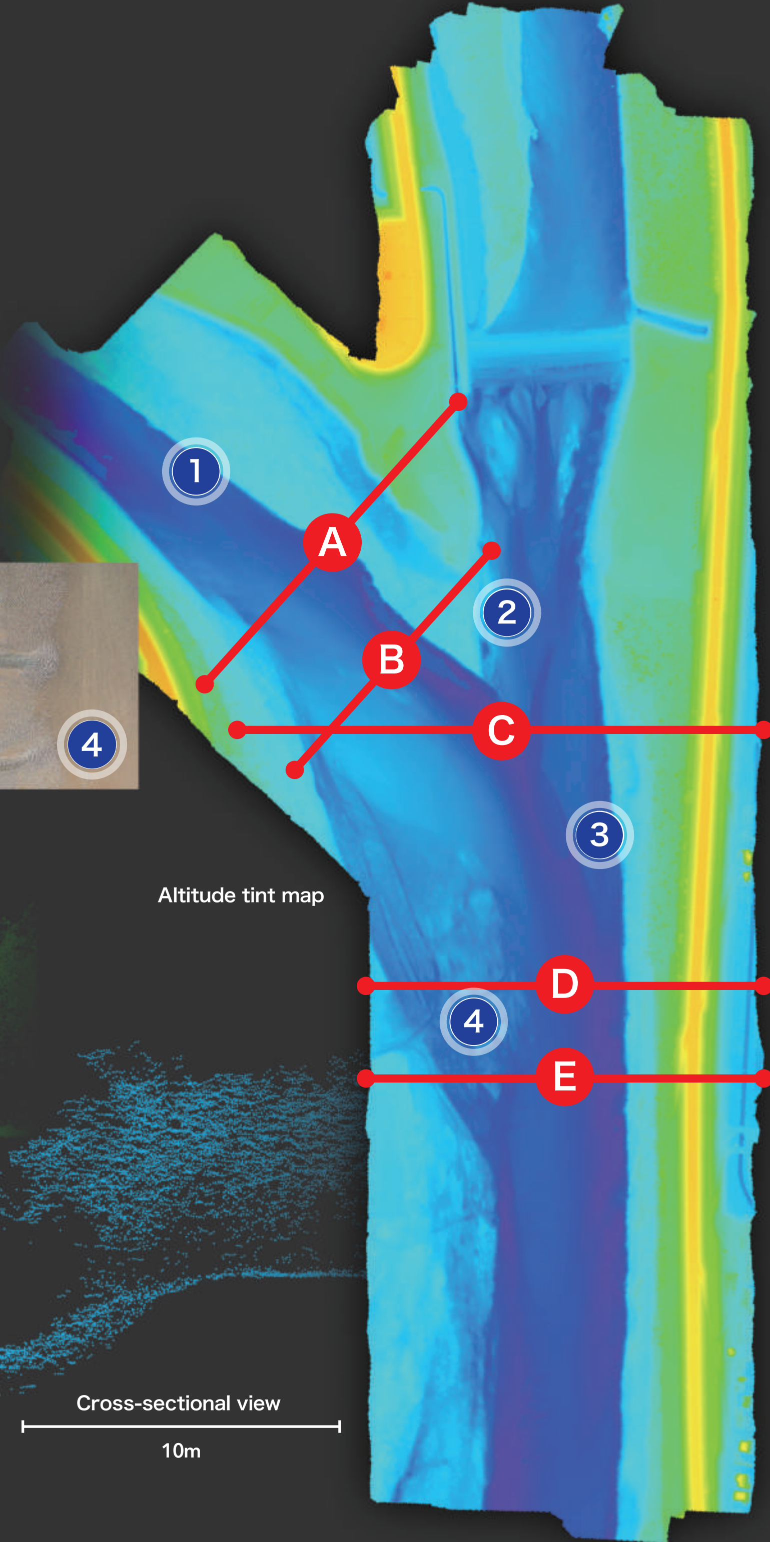
INVESTIGATION

Use in ALB alternative method

Airborne Laser Bathymetry (ALB) is a manned aircraft technique that uses a green laser to survey the topography under water. However, ALB is difficult to implement quickly and inexpensively, and because it measures from a ground elevation of 400m or more, it can only provide a low-density laser point cloud of about 8 points/m^2 over land and about 1 point/m^2 underwater.
The accuracy of the elevation values is also limited.
On the other hand, TDOT 3 GREEN enables surveying from lower altitudes of 150m or less, so that the geometry of onshore river banks and the topography of the riverbed and the shape of trees in the river channel can be accurately reproduced with a high-density point cloud of more than 100 points/m^2.

Photographs of conditions at time of survey

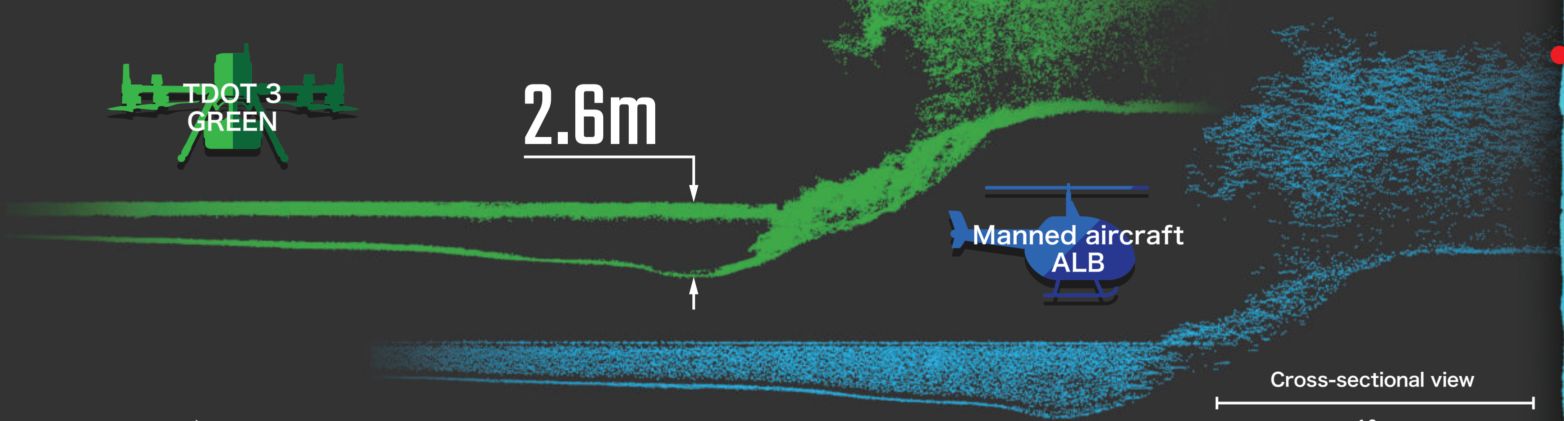




Altitude tint map

Enlarged view of cross section

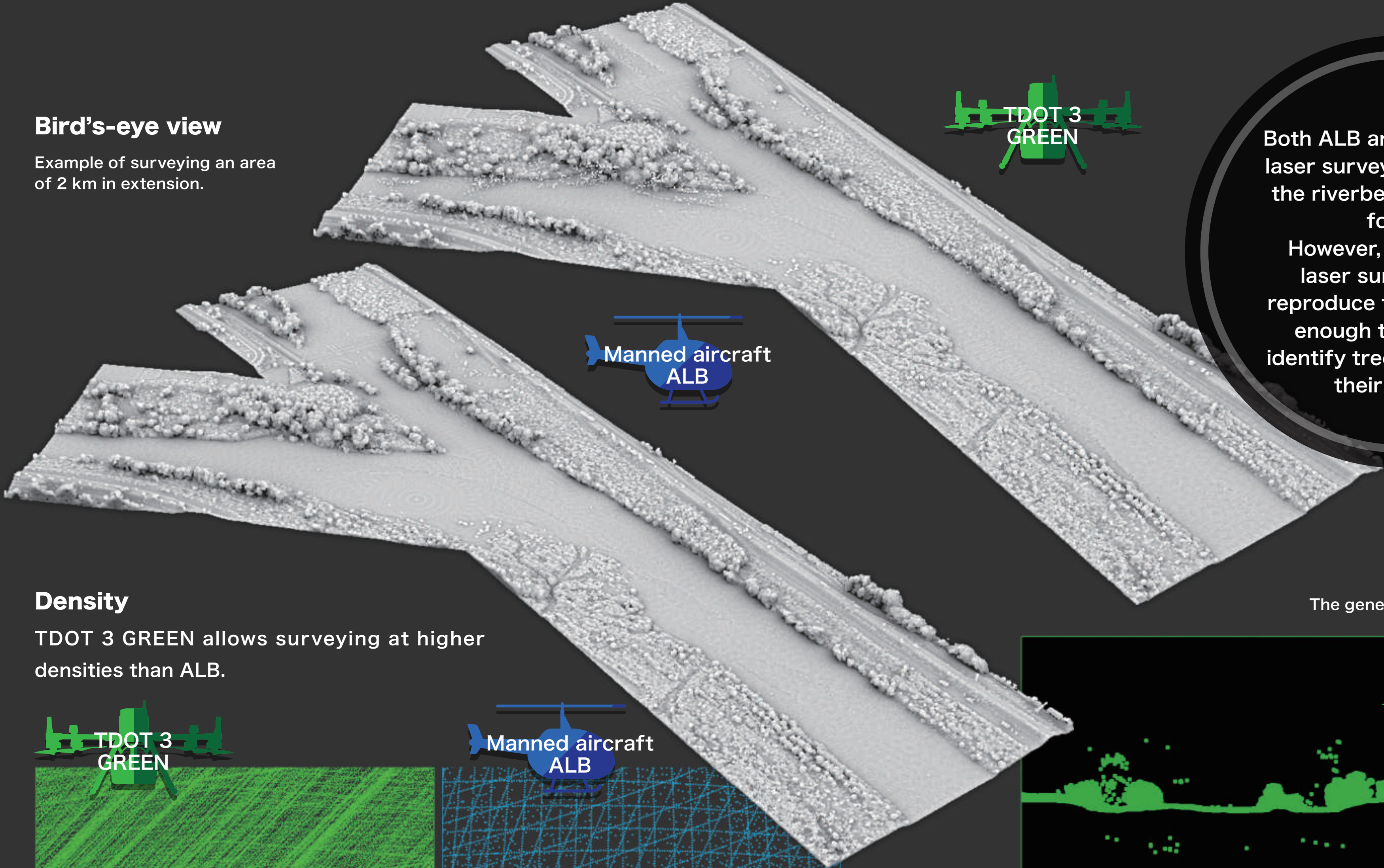
With TDOT 3 GREEN, the surface and bottom of the water tend to be clearly defined.



Cross-sectional view

Bird's-eye view

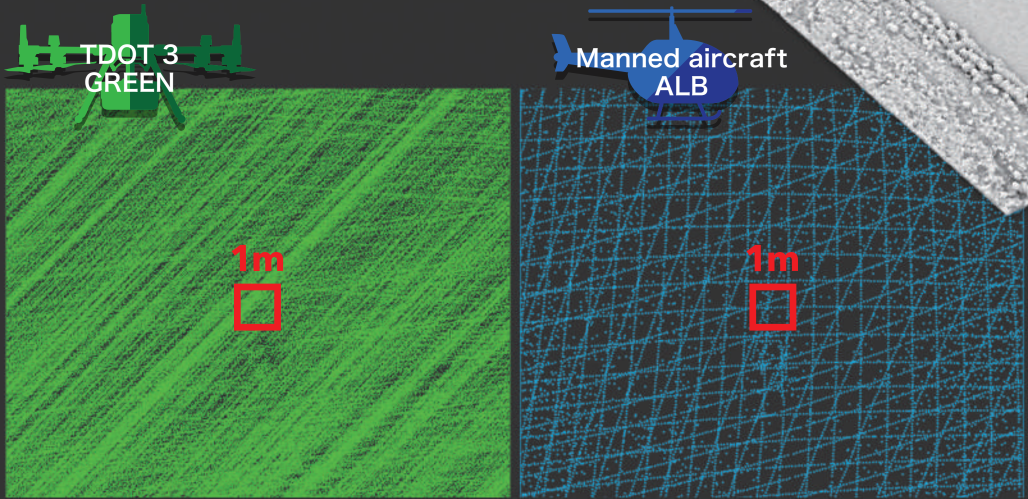
Example of surveying an area of 2 km in extension.



Both ALB and drone green laser survey data visualize the riverbed and riparian forest.
However, drone green laser surveying can reproduce trees precisely enough to be able to identify tree species from their shapes.

Density

TDOT 3 GREEN allows surveying at higher densities than ALB.



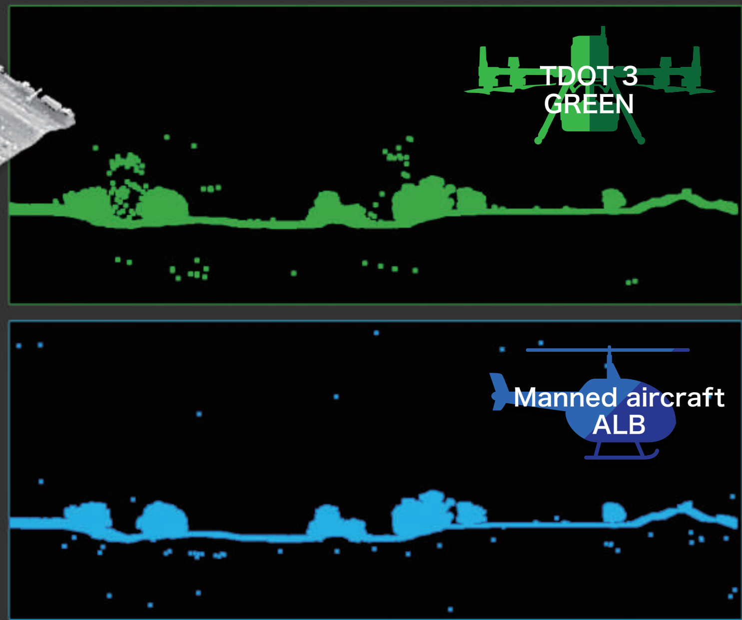
1,903points/m² (475,647points/250m²)

55points/m² (13,863points/250m²)

*The time taken for surveying is different.

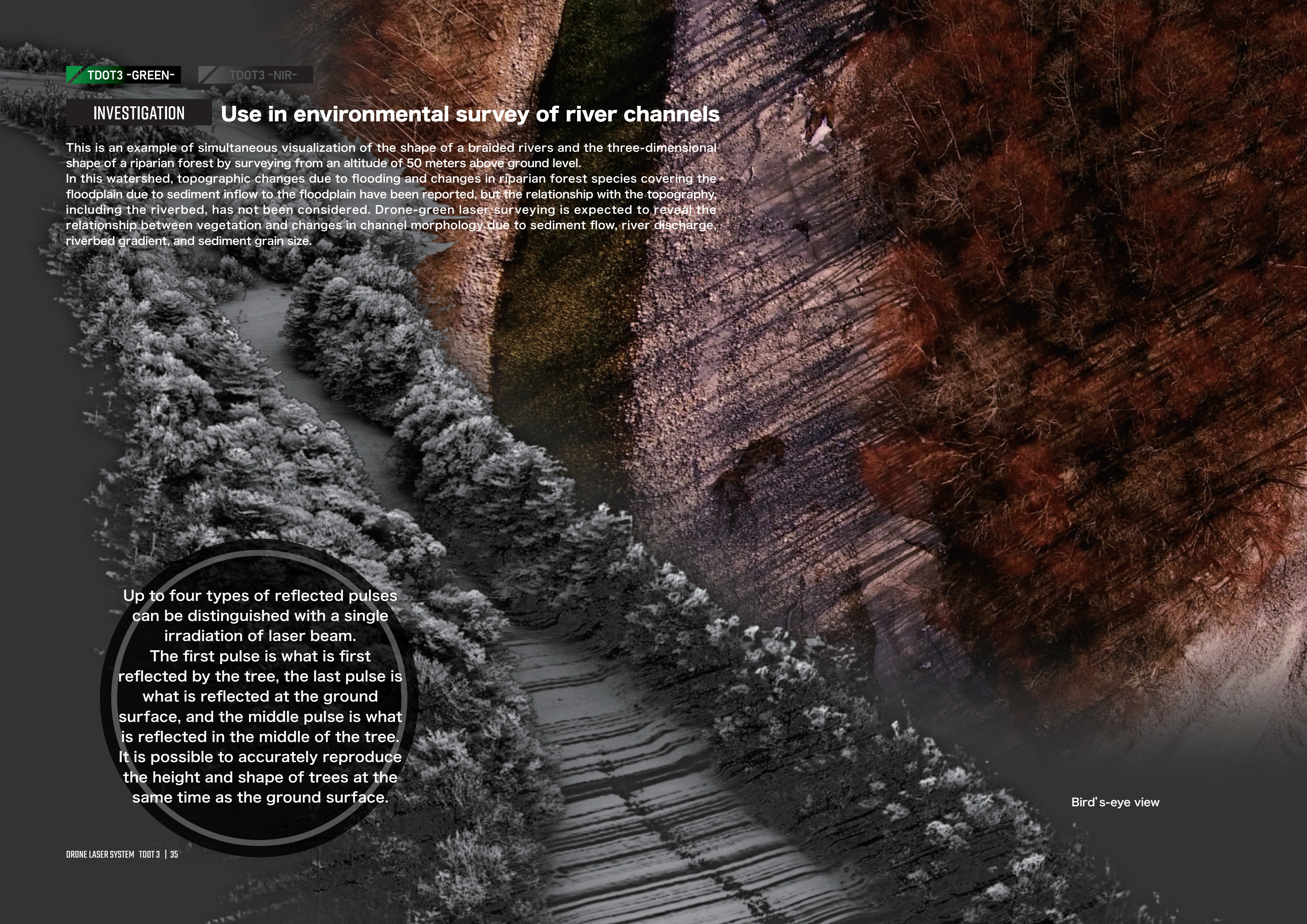
Noise

The generated noise data are equal.



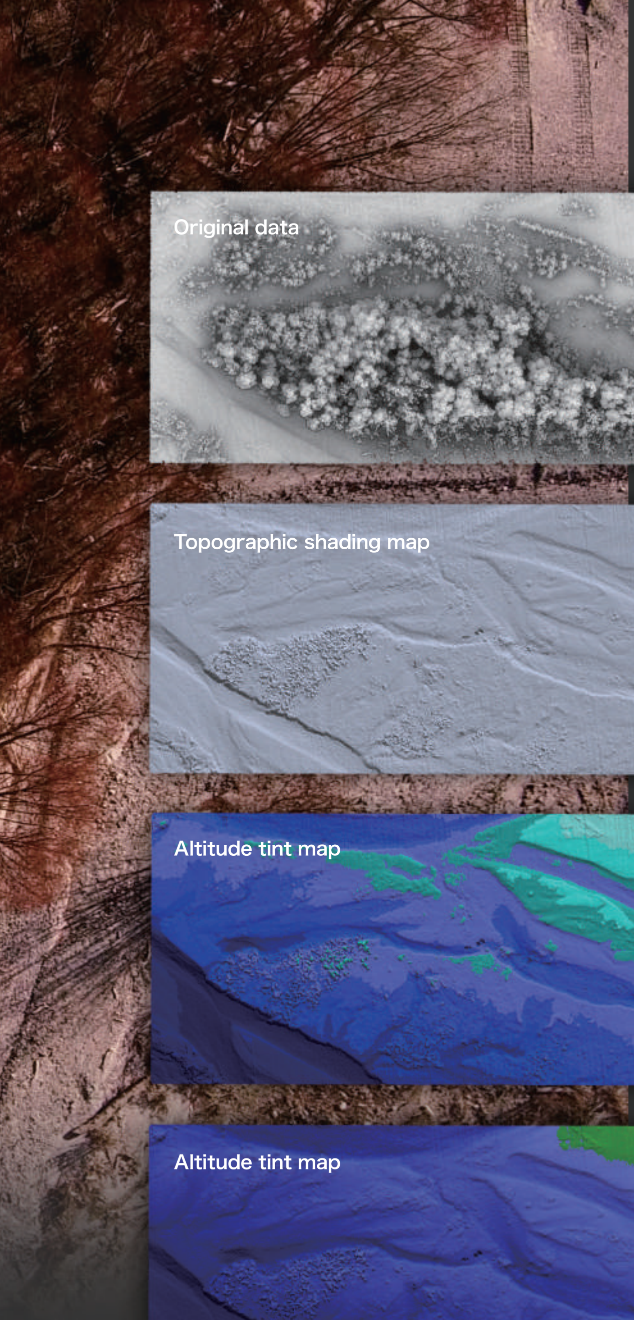
INVESTIGATION Use in environmental survey of river channels

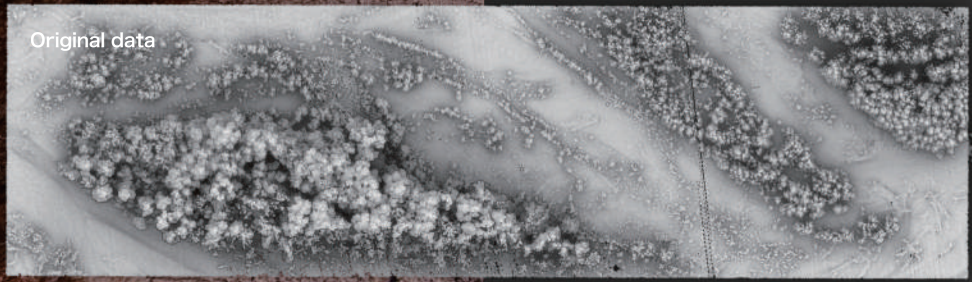
This is an example of simultaneous visualization of the shape of a braided rivers and the three-dimensional shape of a riparian forest by surveying from an altitude of 50 meters above ground level.
In this watershed, topographic changes due to flooding and changes in riparian forest species covering the floodplain due to sediment inflow to the floodplain have been reported, but the relationship with the topography, including the riverbed, has not been considered. Drone-green laser surveying is expected to reveal the relationship between vegetation and changes in channel morphology due to sediment flow, river discharge, riverbed gradient, and sediment grain size.

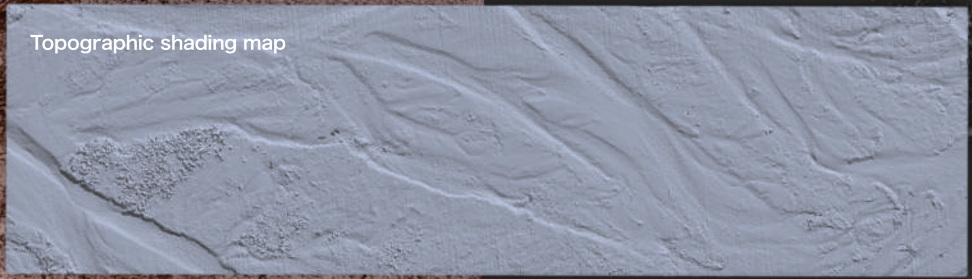


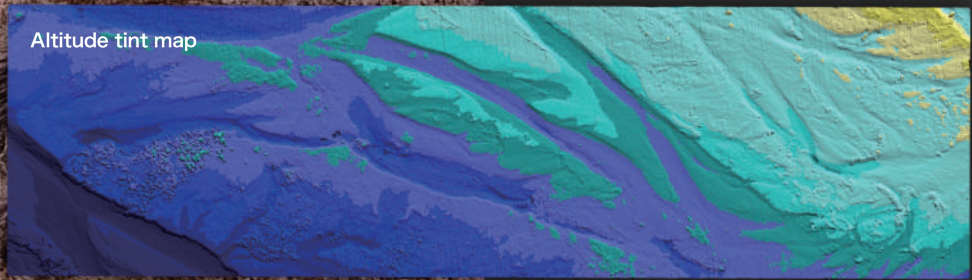
Up to four types of reflected pulses can be distinguished with a single irradiation of laser beam.
The first pulse is what is first reflected by the tree, the last pulse is what is reflected at the ground surface, and the middle pulse is what is reflected in the middle of the tree.
It is possible to accurately reproduce the height and shape of trees at the same time as the ground surface.

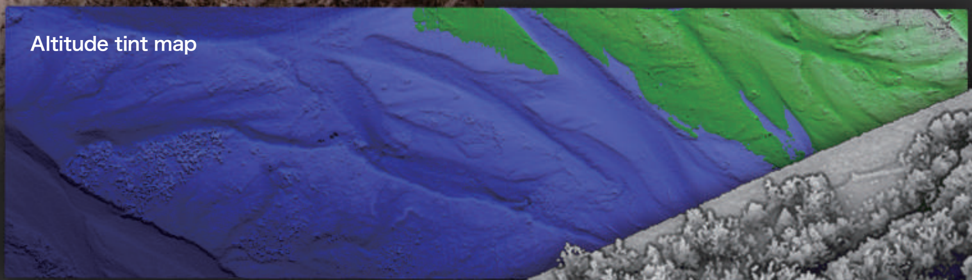
Bird's-eye view

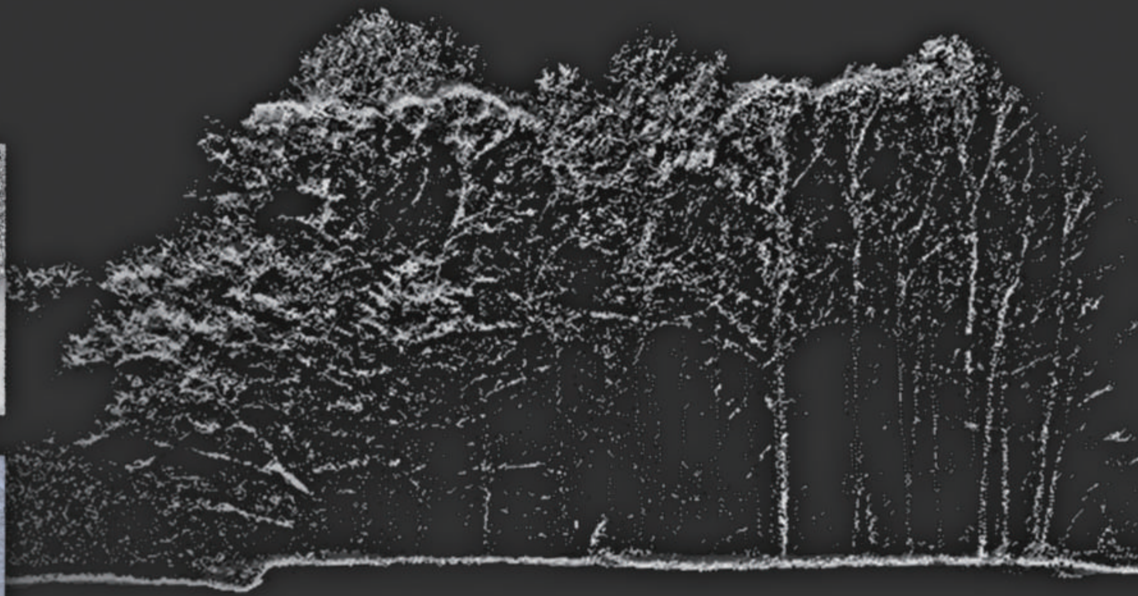








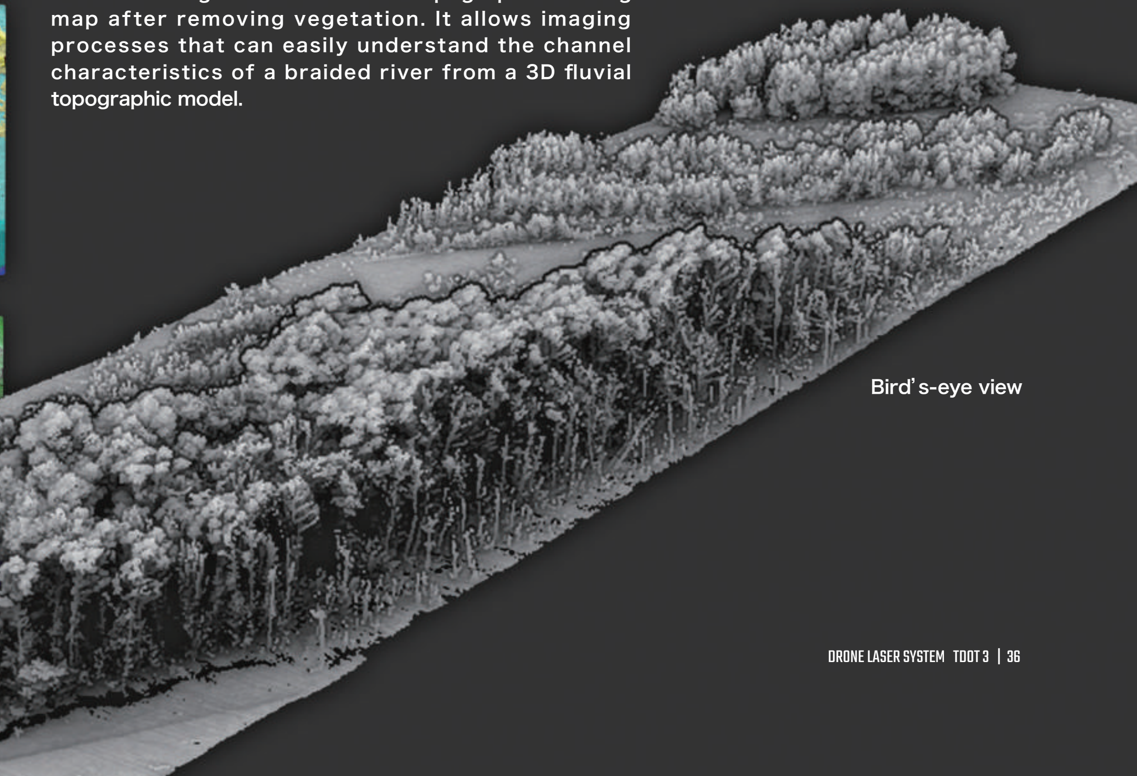




Cross-sectional view

10m

Developing altitude tint map created from 3D laser point cloud including river channel and topographic shading map after removing vegetation. It allows imaging processes that can easily understand the channel characteristics of a braided river from a 3D fluvial topographic model.



Bird's-eye view

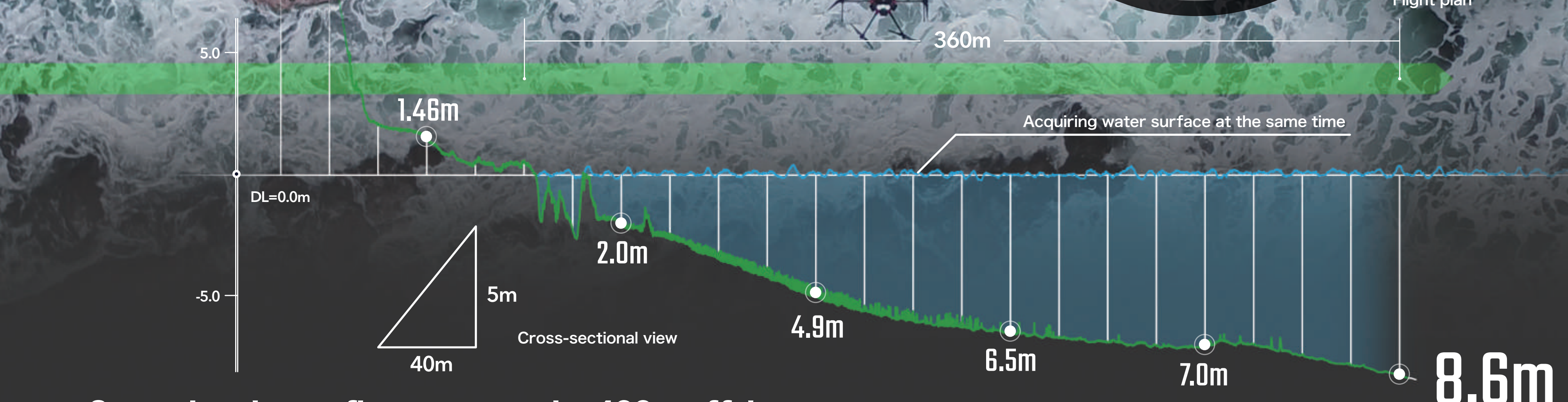
TDOT3 -GREEN- TDOT3 -NIR-

INVESTIGATION Use in surveying breaking waves in coastal areas

Although sonic bathymetry such as the multibeam method is used in the ocean, it is difficult for survey vessels to enter shallow areas where the water depth is only a few meters, so the use of drone-green laser surveying is desired to quickly assess the micro-topography in the coastal area. Although coastal areas are subject to the effects of breaking waves, TDOT 3 GREEN's high-density laser can be used to acquire data on the seafloor topography between waves.

Drone green laser surveying is expected to provide effective data for region-specific environmental protection measures in coastal areas because it captures changes in the sea floor topography of coastal areas, which are constantly changing due to changes in sea level, coastal currents, and wind waves.

Flight plan

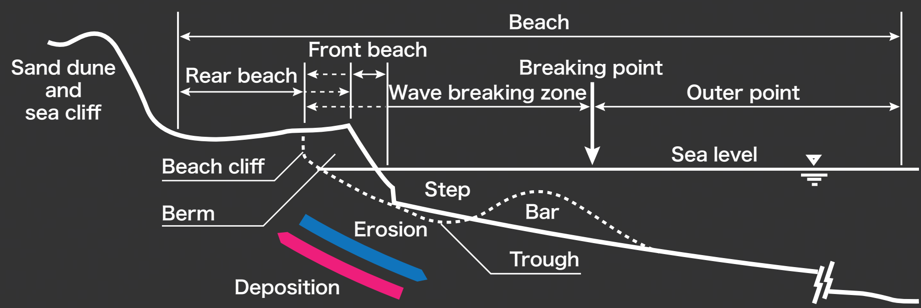


Cross-sectional view

Surveying the seafloor topography 400m offshore

- Obtaining data both surface and bottom of the water
- Between 400m offshore, approx. 9m deep at the deepest point

In Japan, an island nation, coastal areas play an extremely important role in the growth of marine life. On the other hand, it is also an area greatly affected by topographic changes due to changes in sea level or sea temperature caused by recent climate change. TDOT 3 GREEN is expected to be utilized in the field of coastal conservation projects because it can quickly and efficiently grasp the microtopography of coastal areas.



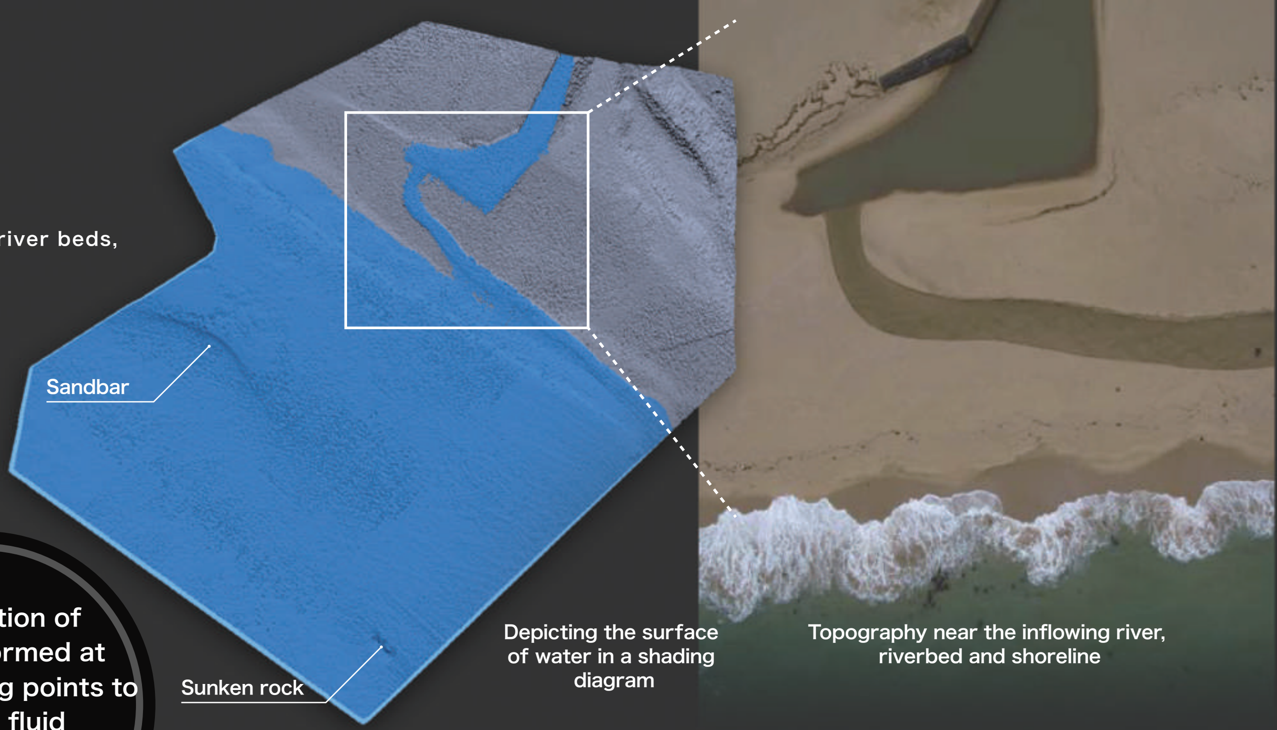
General seaside profiles, the classification and typical topography (Prof. Sunamura in 1999)

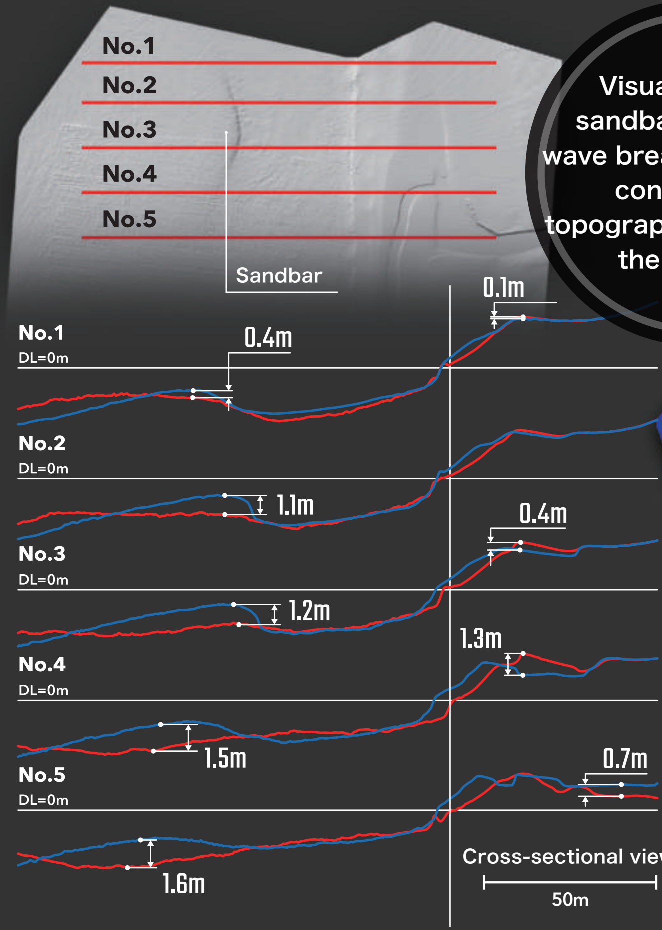
Areal scanning of shallow water areas

Sea Visualization of reef and sandbar geometry within a depth of approximately 6m

Land Visualization of blocked and meandering river mouths, river beds, shorelines and step topography near shorelines

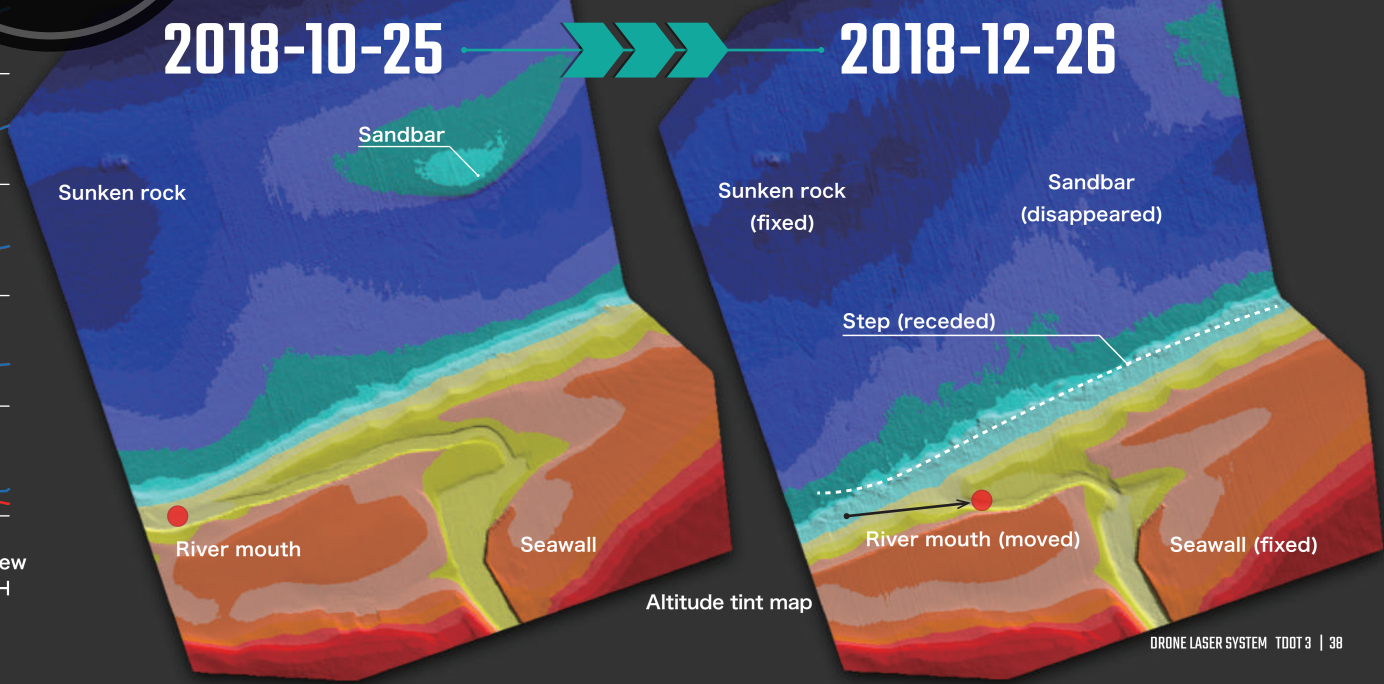
The bar initially seen below the sea surface has disappeared and the seafloor has flattened over a large area. The river mouth location has moved significantly to the east, and the step location has receded landward. On the landward side of the step, a beach cusp is observed, which is a rhythmic series of arched shoreline features. This beach cusp is an important feature to consider wave effects on the beach. Surveying with TDOT 3 GREEN provides a clear picture of this topography.





Visualization of sandbar formed at wave breaking points to confirm fluid topographic changes in the sea area

Comparative verification of seashore topography



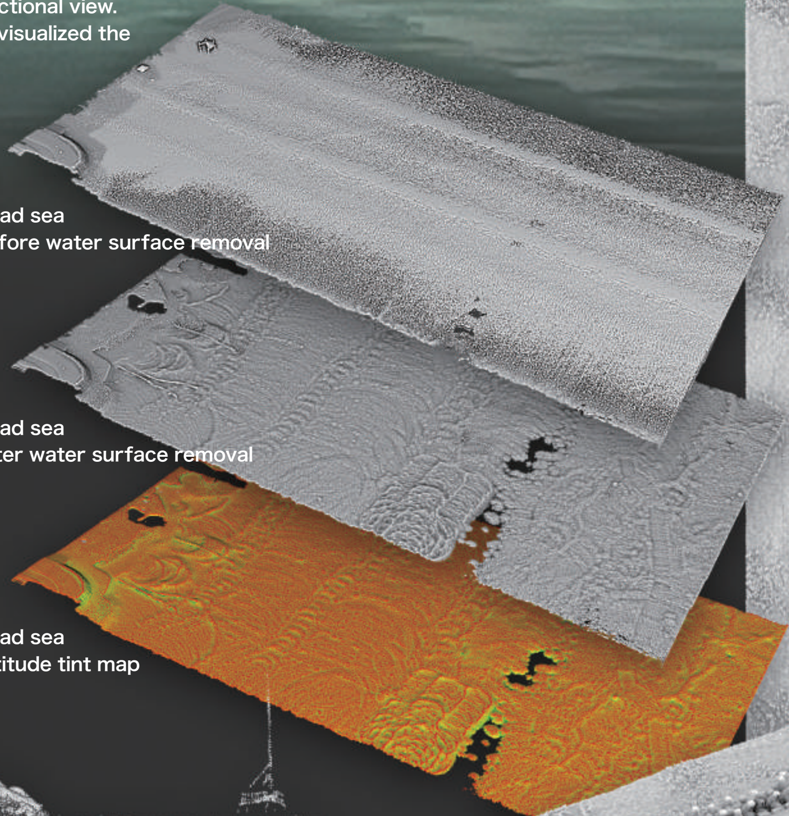
Altitude tint map

TDOT3 -GREEN-　TDOT3 -NIR-

INVESTIGATION

Use in surveying seafloor topography under special conditions
Surveying the seafloor topography of high-salinity seas accurately

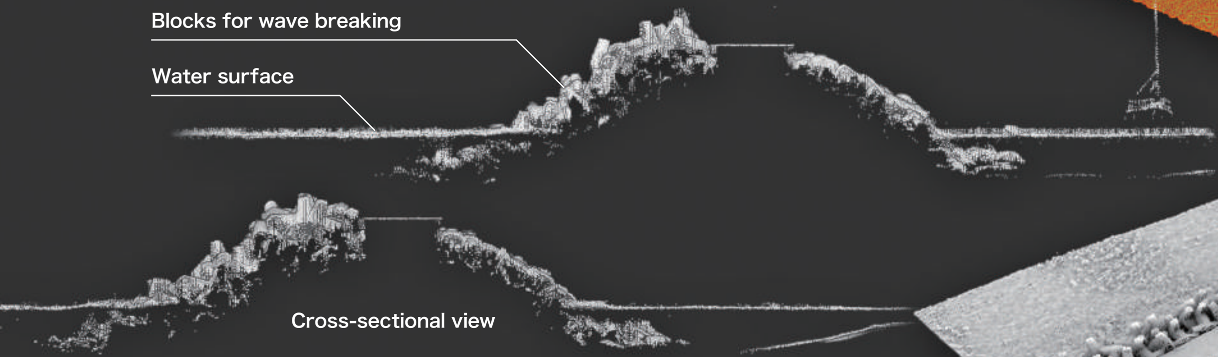
Laser beams travel slower in water than in air, so they are refracted at the water's surface.
Surveying under water requires specifying the water surface location, calculating the effect of laser beam refraction and calculating the correction of coordinates for the point cloud under water.
Using TDOT 3 GREEN's dedicated UNDERWATER CORRECT, these refractive index effects can be compensated automatically by simply specifying the water surface location from a cross-sectional view.
The Dead Sea in Israel, shown here with a salinity of 30%, was also accurately visualized the subsea topography using UNDERWATER CORRECT.



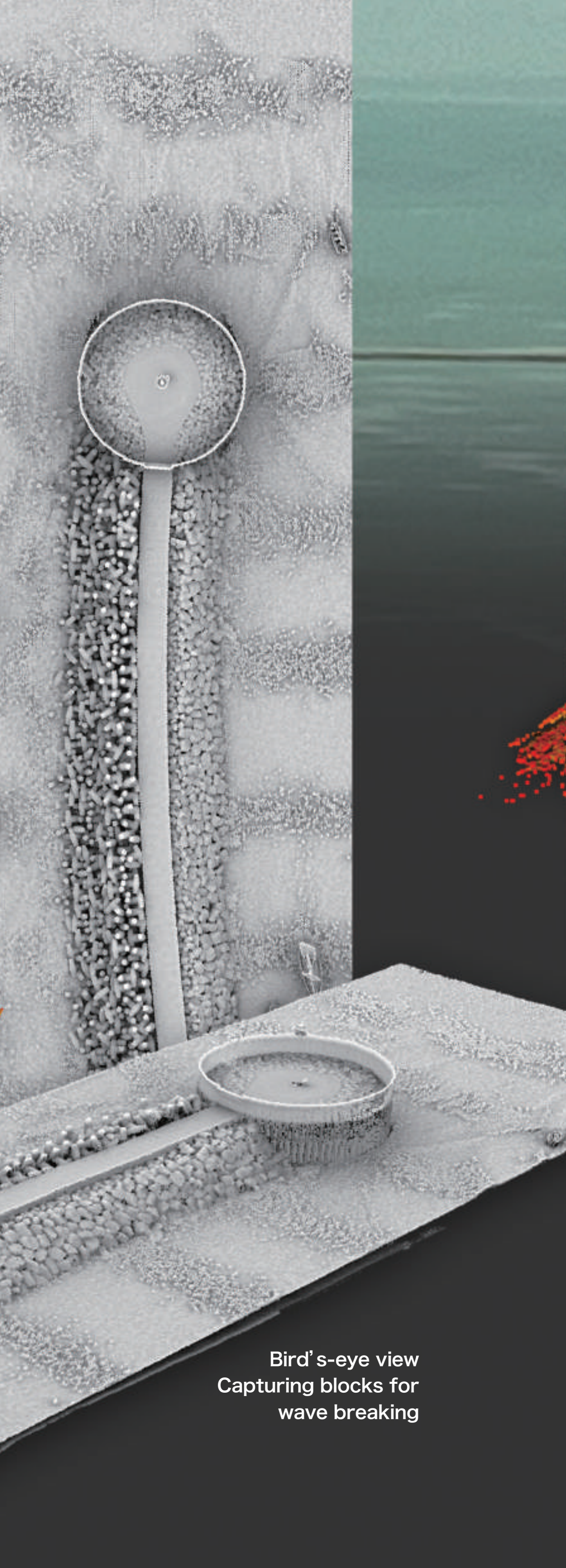
Dead sea
before water surface removal

Dead sea
after water surface removal

Dead sea
Altitude tint map



Cross-sectional view

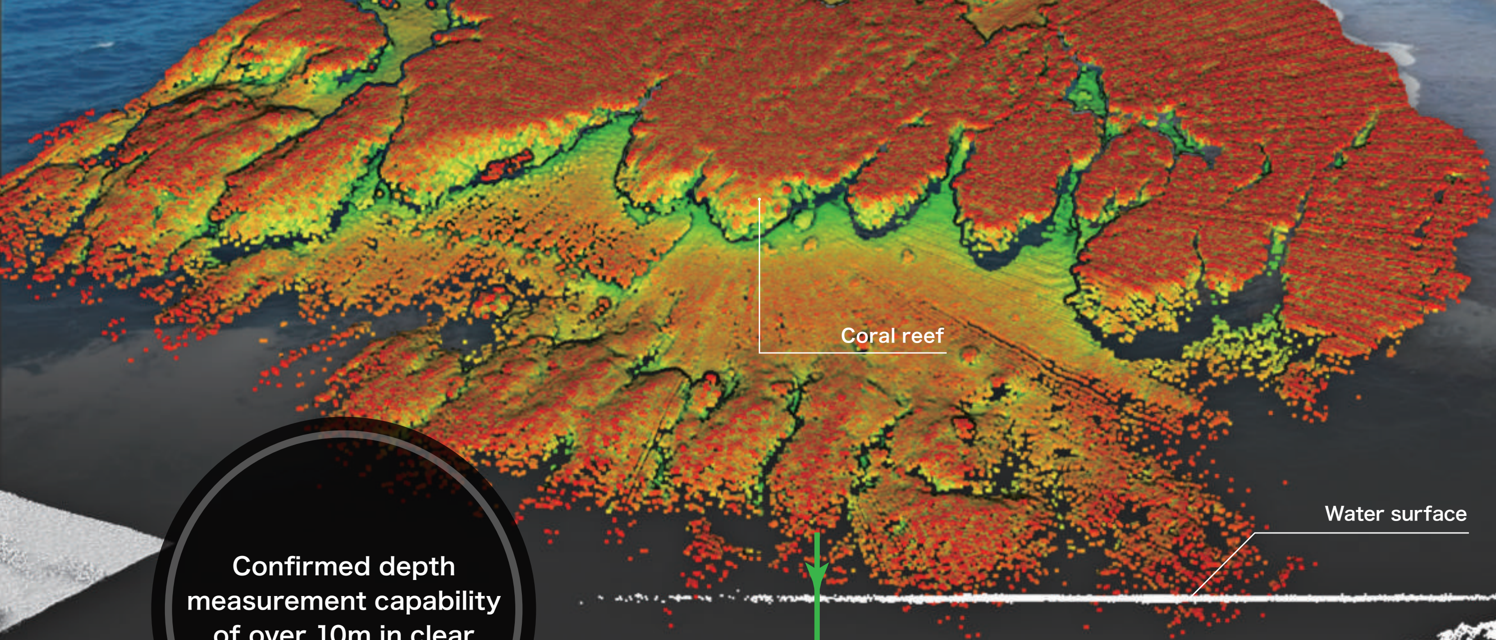


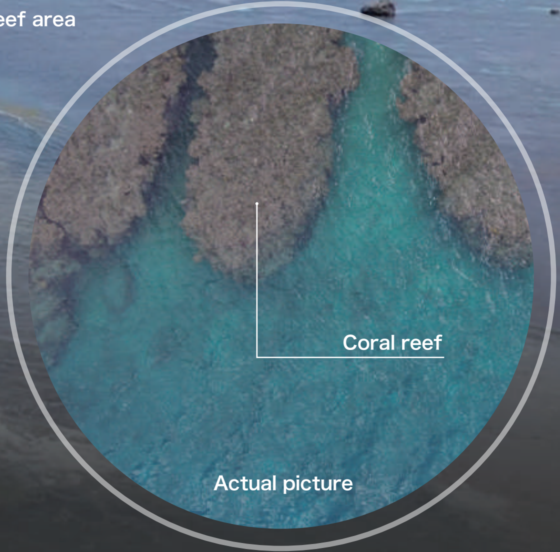
Bird's-eye view
Capturing blocks for wave breaking

INVESTIGATION Surveying relatively deep bathymetry in clear water

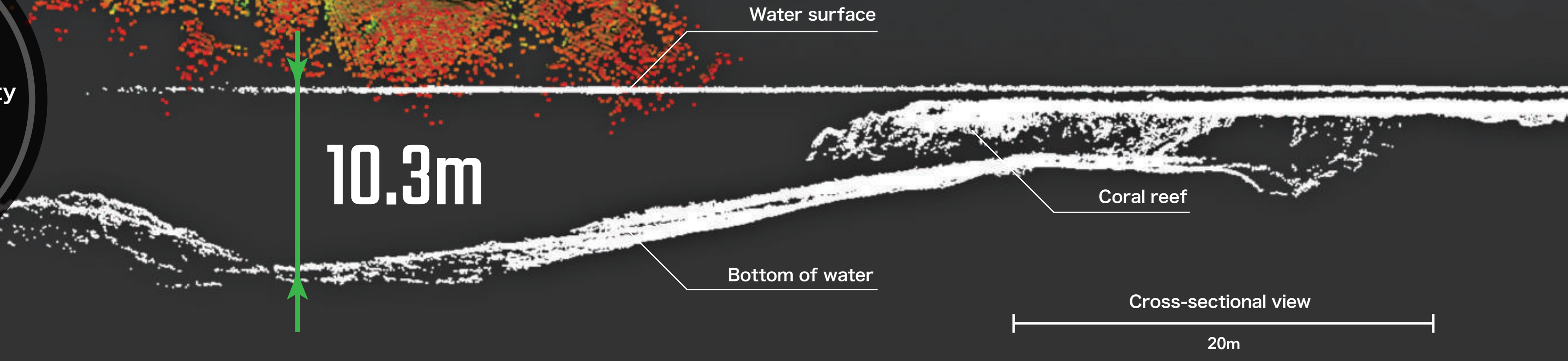
● Succeeded in visualization of the deepest, approx. 10-meter underwater data

Rising sea levels due to global warming are causing various damages in coastal areas, and there are concerns that rising sea levels and erosion of coral reefs will reduce the wave suppression effect of coral reefs and increase the waves that come into coastal areas.
The TDOT 3 GREEN survey can grasp the details of the marginal grooves eroded by waves and seawater flow and the marginal feet formed by the growth and accumulation of reef-building corals, and is expected to be used for environmental conservation measures in coral reef areas.





Confirmed depth measurement capability of over 10m in clear water



TDOT3 -GREEN- TDOT3 -NIR-

INVESTIGATION

Surveying in shallow sea area

Succeeded in surveying long-duration seafloor topography using a green laser scanner mounted on a hybrid drone
Enables efficient surveying of high-resolution topography

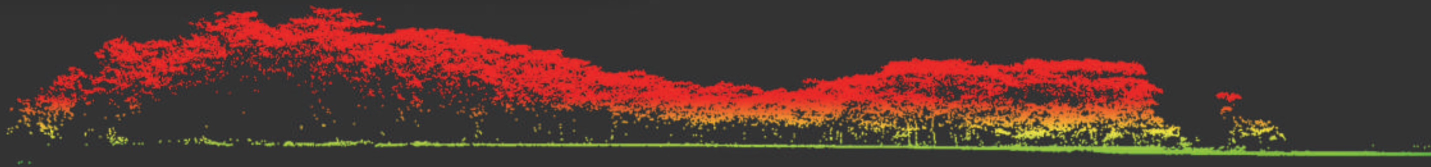
The world first

In collaboration with the Port and Airport Research Institute of the National Maritime, Port and Aerospace Research Institute (NMRI), we have demonstrated that the TDOT 3 GREEN drone-mounted green laser scanner on the newly developed GLOW.H hybrid drone can efficiently survey high-definition seafloor topography. The demonstration test was conducted on Iriomote Island, Taketomi Town, Okinawa Prefecture, and covered an area of approximately 2.6km in length and 1km in width from land to a depth of approximately 17m. The survey took approximately 4 hours to acquire the continuous topography of the shallow water area and the complex topography of the coral reefs from land.

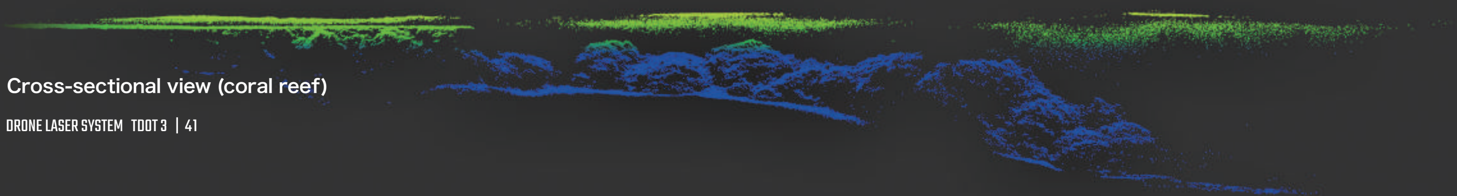
Surveying area
Take-off and landing point
Spurs and grooves

Aerial photo of the site (coral reef in the northwest area)

The survey data (including both water surface and seafloor) resulted in a high density with an average spacing of approximately 12cm and a high accuracy with an average error of ±20mm in height.
TDOT 3 GREEN has revealed topographic features below wave breaking zones[*1] that were previously difficult to approach by boat and could not be surveyed, as well as spurs and grooves[*2], which is a characteristic feature of coral reefs. As a result, scientific developments related to coastal landforms are expected to be greatly enhanced, which will also lead to improving the accuracy of predicting wave and landform changes in coastal areas.

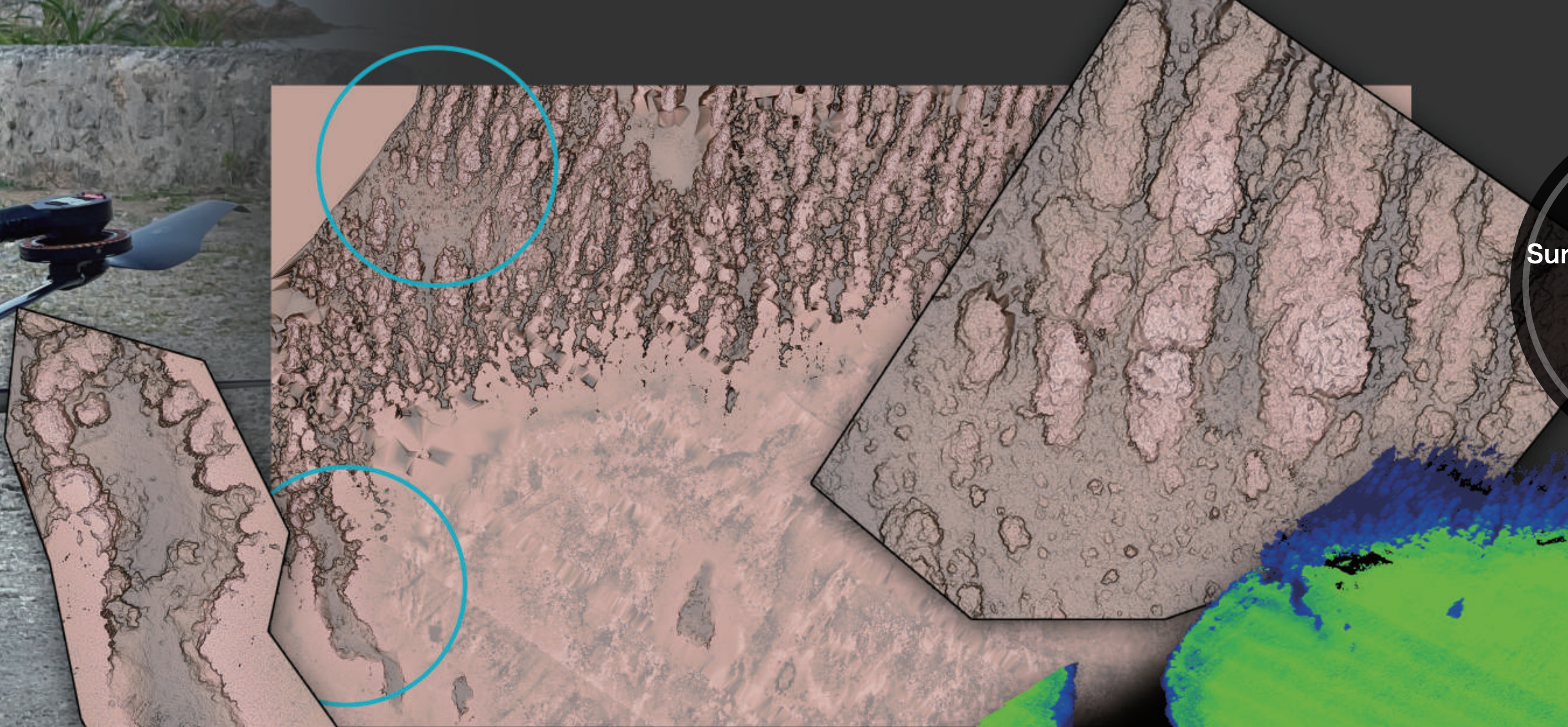


Cross-sectional view (mangrove forest to coast)

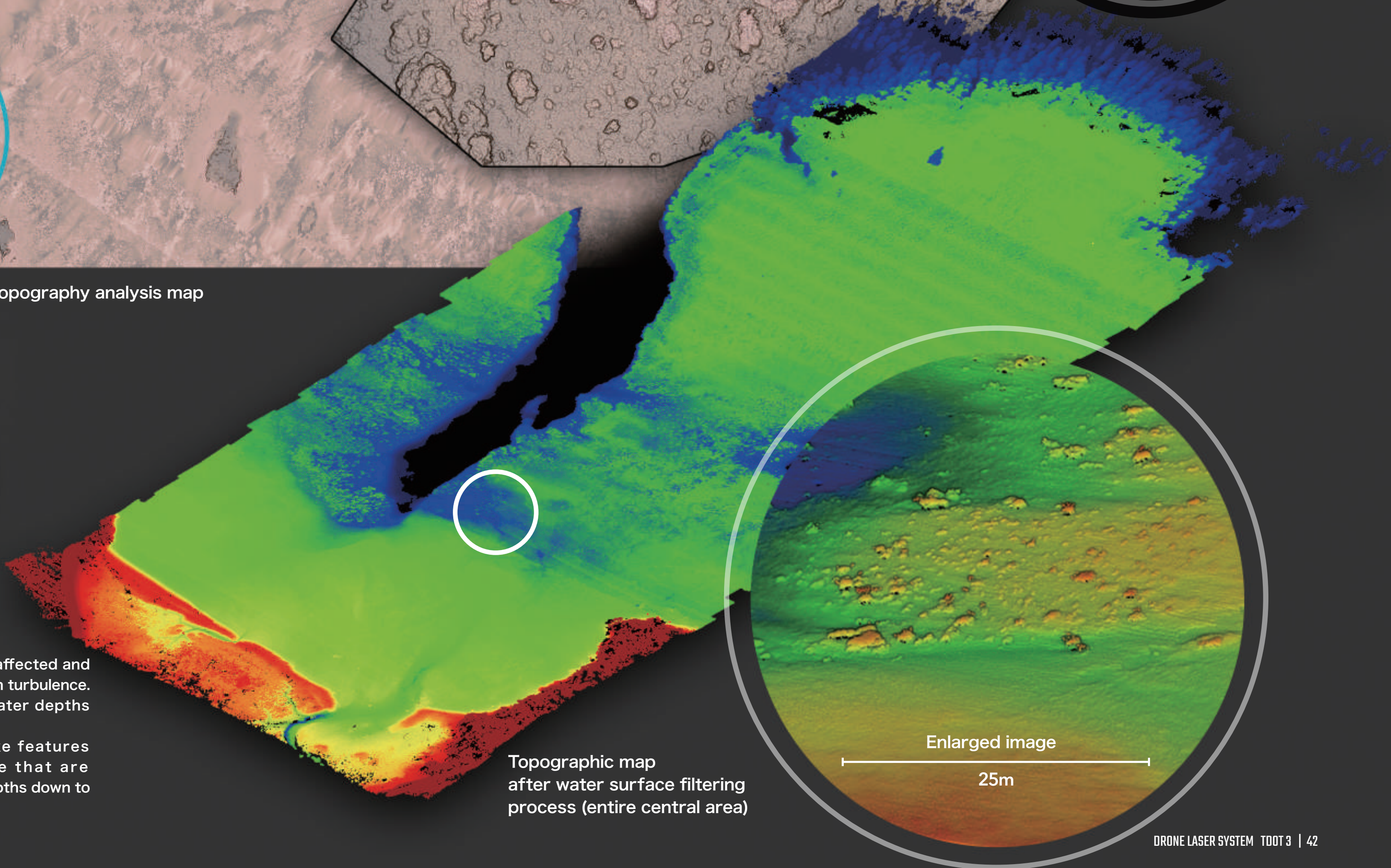


Cross-sectional view (coral reef)

Surveying of an area of approx.2.6 x 1km completed in only 4 hours.



Microtopography analysis map



Topographic map after water surface filtering process (entire central area)

*1 Wave breaking zone: an area where waves are affected and deformed by the seabed, causing it to collapse with turbulence. Wave breaking is more likely to occur where water depths become shallower.

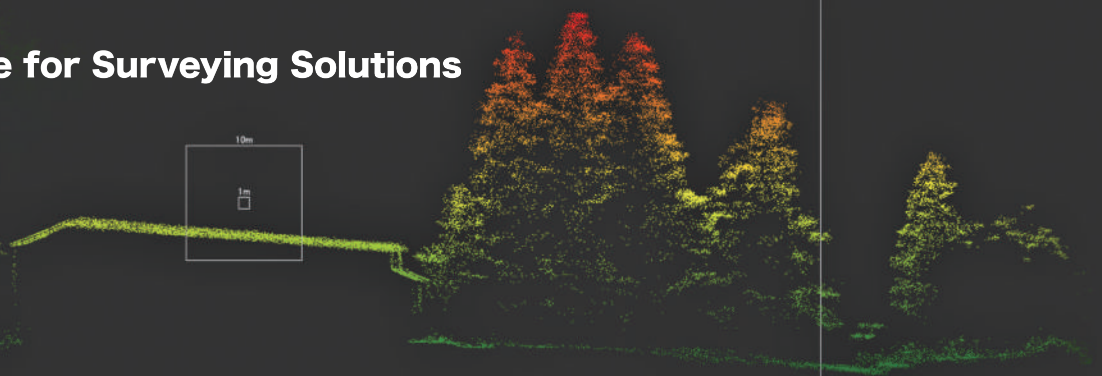
*2 Spurs and grooves: grooves and ridge-like features extending perpendicular to the shoreline that are characteristic of coral reefs. They are found at depths down to around 20 m and influence wave deformation.

APPLICATION SOFTWARE

TDOT PROCESSING PRO

TDOT's All in One Software for Surveying Solutions

	Viewer mode (without license key)	Professional mode (with license key)
Browse survey data	●	●
Check flight route	●	●
Timeline		●
Calibration		●
Analysis process		●
Export		●



Viewer Mode

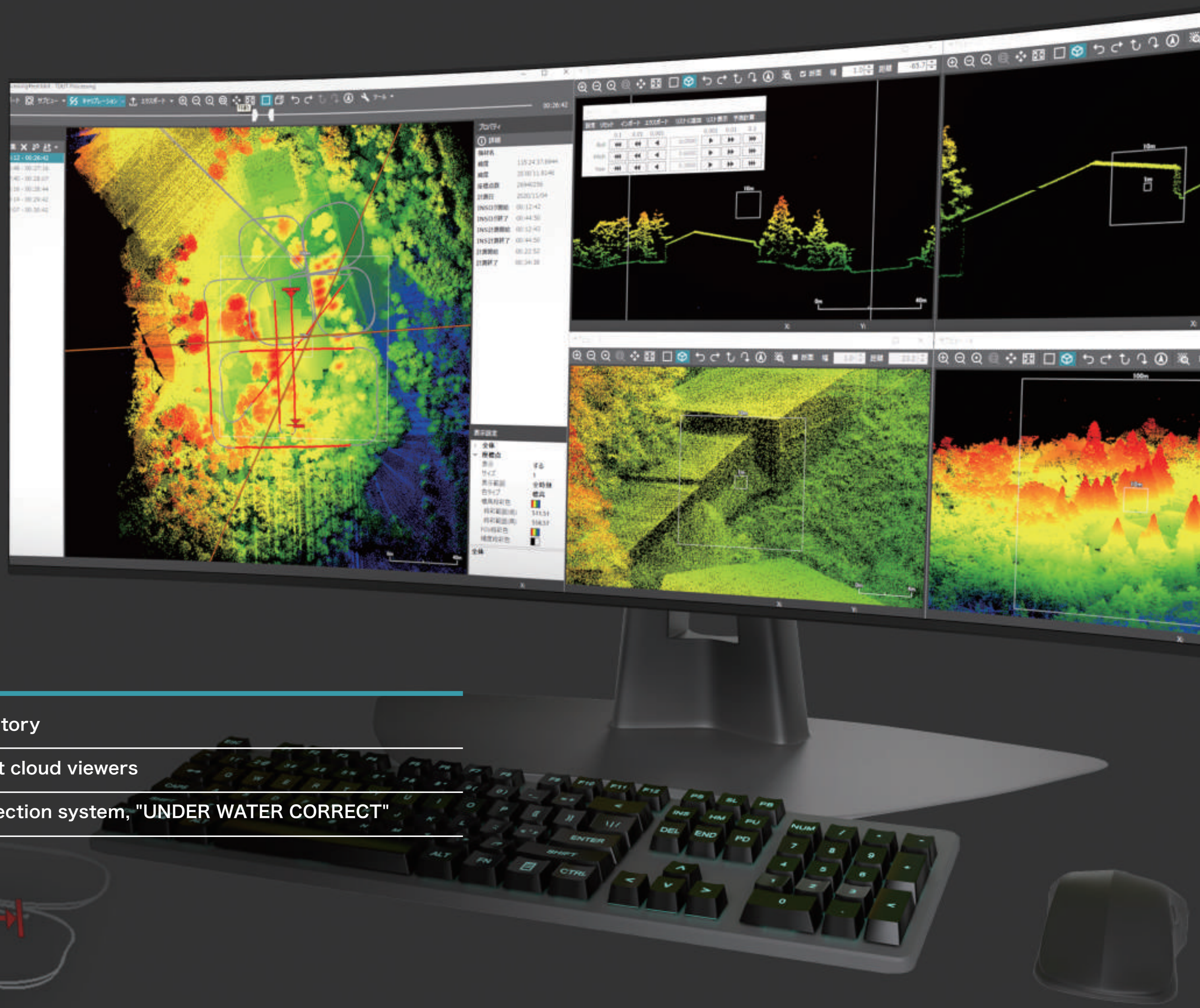
Preview of the survey data and flight route

When the application software is started without the USB type license activation key connected, the viewer mode is activated to browse the acquired data along with the drone trajectory.
It is possible to check onsite whether the survey has been completed as planned, allowing you to work efficiently and without rework. No network environment is required.

Professional Mode

Equiped with long-awaited functions for the ultimate UX (user experience)

Graphical User Interface such as timeline and point cloud display method has been renewed.
This application automates calibration for accuracy control and creates point cloud data with easy and stress-free operation.

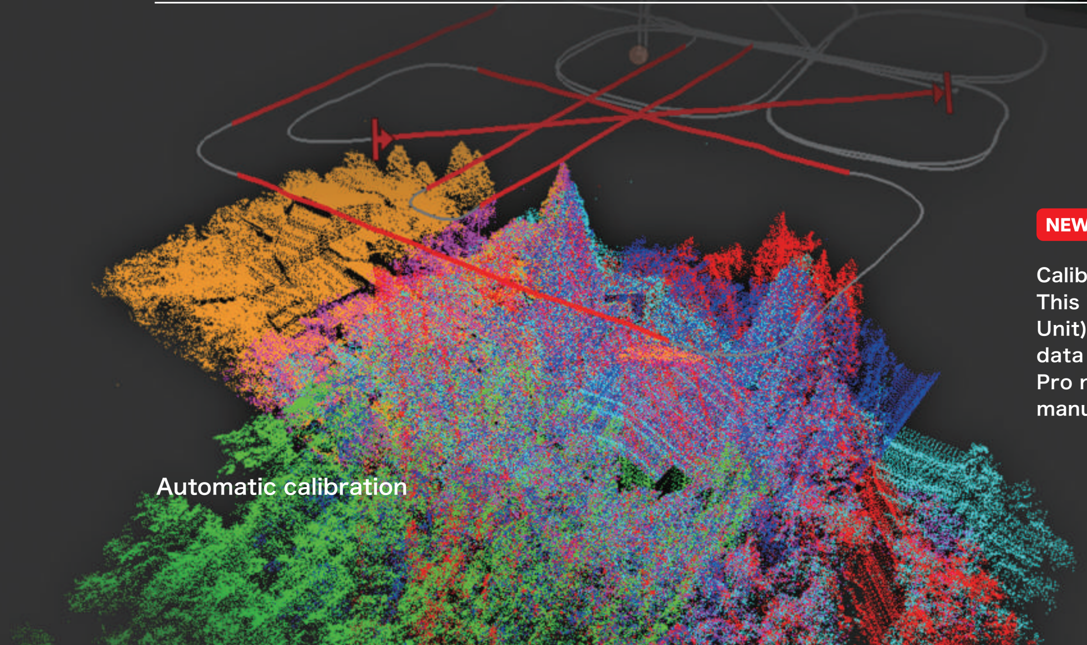


Analysis processing and export

Point cloud data in various formats are exported at high speed after highly accurate point cloud processing without any technical knowledge required.

Export data format

KML (.kml)	›	Google file format Output flight path and laser trajectory
LAS (.las)	›	Data formats that can be displayed by common point cloud viewers
eLAS (.elas)	›	Extended LAS format for receiving underwater correction system, "UNDER WATER CORRECT"



Automatic calibration

NEW Automatic calibration

Calibration work is necessary to achieve high accuracy quality of laser survey data.
This is the process of setting the adjustment value (misalignment value) of the IMU (Inertial Measurement Unit), which is important information that determines the positional accuracy when creating point cloud data with 3D coordinates, and greatly affects the accuracy of the laser point cloud. TDOT PROCESSING Pro now has the ability to automatically process calibration operations that were previously performed manually.

TDOT APPLICATION

TDOT-supported applications specifically designed for drone laser surveying operations We provide solution services produced from the pursuit of user experience.

The process of drone surveying and outputting highly accurate data requires a great deal of expertise and experience, including "optimal trajectory analysis," which adjusts for errors by repeatedly calculating trajectories using data from data INS (GNSS /IMU) devices, and the calculation of 3D coordinates for laser point clouds by integrating the survey data with the results obtained from the optimal trajectory analysis. This process requires specialized knowledge and a great deal of experience.
TDOT, aiming for "drone surveying that anyone can use," provides a variety of application software that relieves users of the labor involved. For example, a high-speed viewer that checks survey data on site, a cloud service that automatically completes optimum trajectory analysis simply by uploading the necessary data, and software that downloads optimum trajectory analysis data and outputs highly accurate point cloud data, all of which can be completed seamlessly and with minimal effort.

1 **PREVIEW** Check on site

2 **KINEMATIC** Kinematic Analysis

3 **EXPORT** Output point cloud

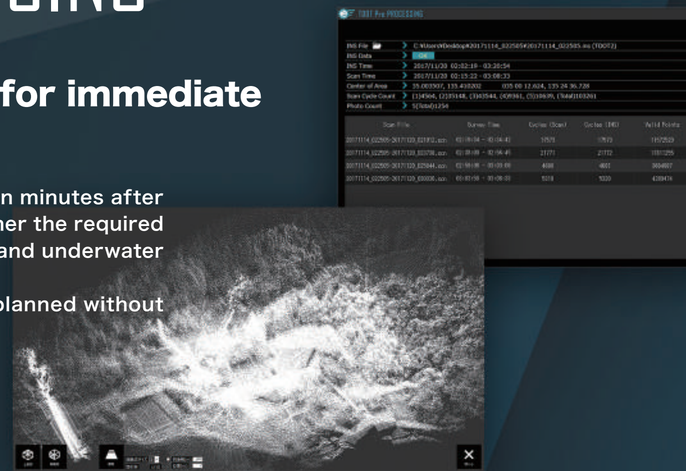
PREVIEW

1

TDOT Pre PROCESSING

Viewer software specialized for immediate data checks on site

The software allows you to check in the field, within minutes after the flight, whether the saved data is correct, whether the required area has been surveyed, and to what extent trees and underwater surfaces have been surveyed.
By doing so, the surveying can be carried out as planned without rework, preventing problems.



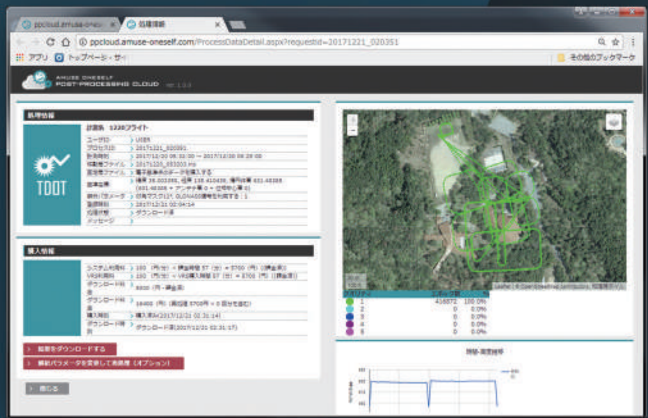
KINEMSTIC

2

POST-PROCESSING CLOUD

Cloud service that automatically completes optimal trajectory analysis by simply uploading

Until now, optimal trajectory analysis required expensive applications and specialized knowledge. With TDOT's cloud service, all you need to do is upload INS data and fixed station data (observation information from a GNSS receiver installed at a known reference point). The optimal trajectory analysis is automatically completed by simply uploading the INS data and fixed station data.
POST-PROCESSING CLOUD is a pay-as-you-go service.



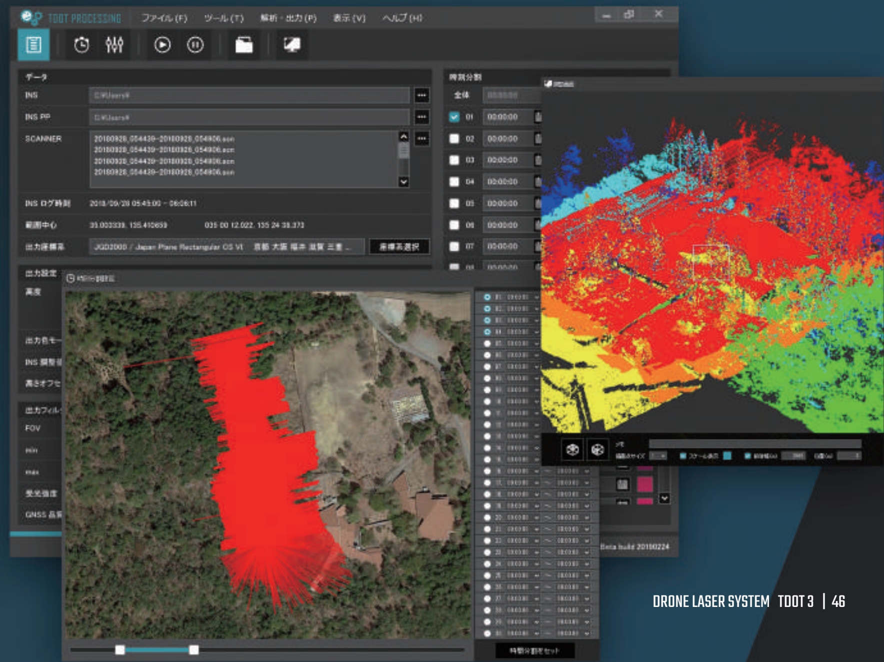
EXPORT

3

TDOT PROCESSING

Software for outputting 3D point cloud data with high-precision coordinate values

By integrating and processing the laser surveyed data and the data from the optimum trajectory analysis, a laser point cloud with high-precision 3D coordinate values can be obtained. This process, which is critical to the quality of the point cloud data, is performed automatically to create and output the final high-precision data. The drone can also be calibrated manually to fine-tune the drone's attitude during laser irradiation.

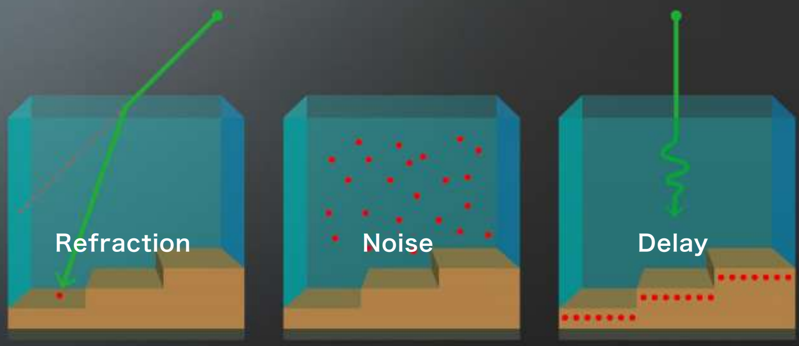


Correct refraction

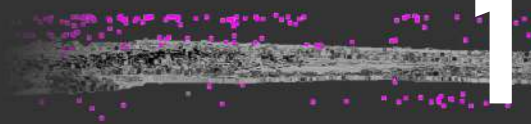
UNDERWATER CORRECT

Application for correction of point cloud data under water

A green laser beam can be used to visualize the topography under water. However, the laser beam must be corrected for the effect of the refractive index of water to accurately reproduce the topography. Laser light is characterized by its strong linearity, but since its speed is slower in water than in air, the laser light is refracted by the water surface and its direction of motion is changed. Have you ever experienced that the bottom of a river appears shallower than it actually is? Without taking into account this effect of water refraction, it is impossible to obtain accurate coordinates of the topography under water. Unfortunately, it is not possible to know the value of the refractive index of the water at the point of survey, and users usually do not have the knowledge of how to compensate for this. UNDERWATER CORRECT solves this problem. Simply specify the water surface location from the cross-section displayed on the screen, and UNDERWATER CORRECT automatically produces data that corrects for the effects of refractive index. This is a feature of TDOT 3 GREEN, produced by the concept of "drone surveying that anyone can use.

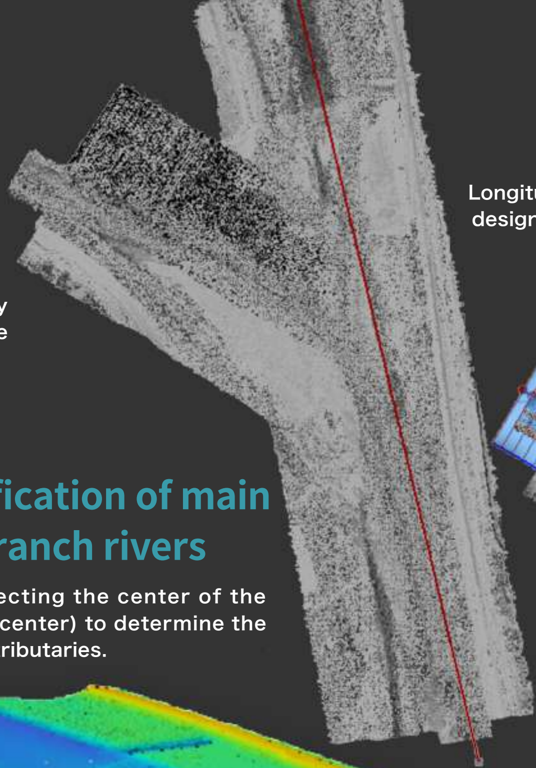


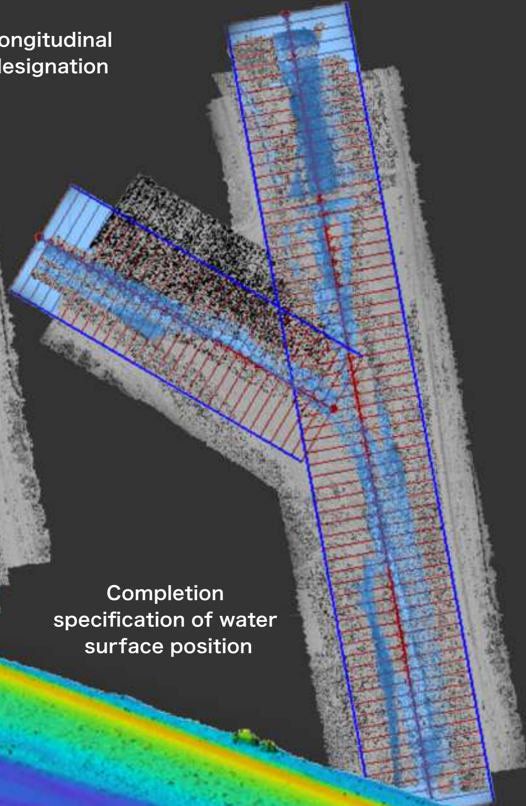
Work procedure in the case of riverbed survey



1 Noise removal

Laser point cloud data including the topography under water is displayed on the screen, and noise data is removed.





Specification of water surface position

2 Specification of main and branch rivers

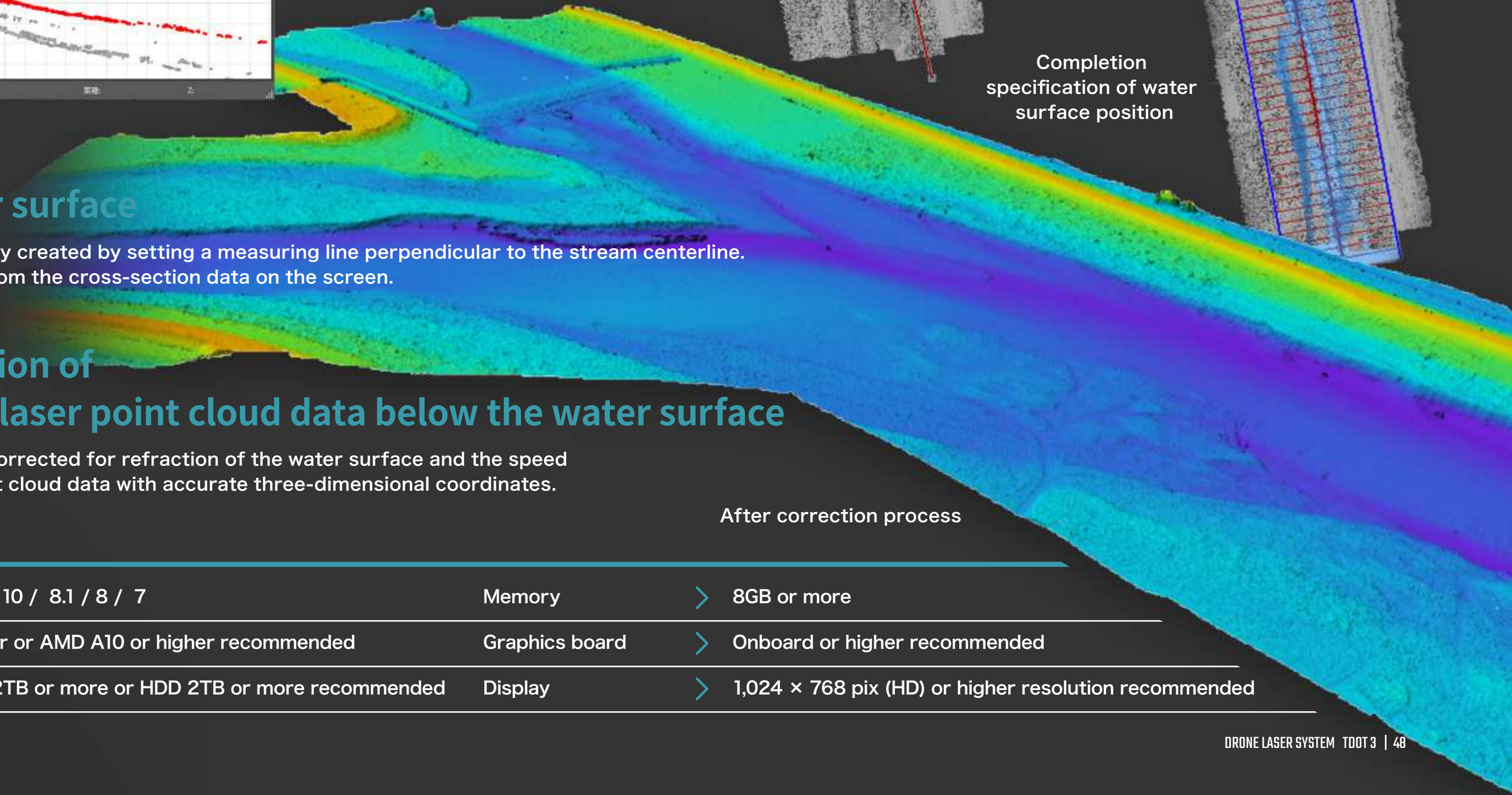
Draw a line connecting the center of the river's flow (river center) to determine the main river and its tributaries.

3 Specification of water surface

The cross-section data is automatically created by setting a measuring line perpendicular to the stream centerline. The water surface is then specified from the cross-section data on the screen.

4 Calculation of correction of coordinate values for laser point cloud data below the water surface

The laser point cloud under water is corrected for refraction of the water surface and the speed of light, and converted into laser point cloud data with accurate three-dimensional coordinates.



After correction process

Operating environment

OS	Microsoft® Windows 10 / 8.1 / 8 / 7	Memory	8GB or more
CPU	Intel Core i5 or higher or AMD A10 or higher recommended	Graphics board	Onboard or higher recommended
Storage media	Internal SSD + HDD 2TB or more or HDD 2TB or more recommended	Display	1,024 × 768 pix (HD) or higher resolution recommended


GLOW
HYBRID DRONE
TOOT SERIES
GLOW
GLOW
PROMOTION

The latest model to respond to user-first marketing is now available. Japanese-made drone that realizes "what future users really want“

Here we have created a Japanese-made drone that brings together our experience and know-how in response to user demands, such as suitability for the field from the user's point of view, long flight time achieved by considering all possibilities, and weight balance to realize stable and unwavering flight to any extent.
Until now, flight controllers, which are the brains of drones, have been built on the assumption that they use sensors and other components from specific manufacturers, making it difficult to develop drones with new functions. Therefore, we adopted PIXHAWK, a flight controller compatible with open-source flight codes whose source code is publicly available.
As a result, we have completed a drone that frees pilots from stress by giving TDOT the best performance while allowing them to feel the handling performance that is comfortable in their hands.
We invite you to experience a drone that pursues the peace of mind and user satisfaction unique to Japanese manufacture.

PROMOTION The official release is scheduled for the end of 2022. Product specifications and appearance are subject to substantial change.


AMUSE ONESELF™
O.S. PROFESSIONAL
MADE IN JAPAN
PROMOTION
GLOW.H
HYBRID DRONE
Open source
flight controller
PIXHAWK series
Support for safe landing
Landing position target
recognition sensor
Realize out-of-sight and
wide-area flight
LTE Communications /
Satellite Telemetry (OPTION)
AI processing of image data
and various sensors
Equipped with NVIDIA JETSON
One-touch installation
(cameras, sensors, power supply, etc.)
Payload Attachment
Display various
device information
Excellent interface

Japan-made hybrid drone equipped with an extender that generates power with the engine and charges the battery

GLOW.H is a hybrid drone equipped with an extender that is being developed to extend the driving range of electric vehicles. It can fly for extended periods of time by constantly recharging its internal battery. Without payload, it can fly for more than 6 hours. When equipped with TDOT 3 GREEN, GLOW.H can fly for 2.5 hours, which is equivalent to a manned helicopter. This means that a large area can be surveyed at once without worrying about running out of battery power. In addition, the drone only needs to be refueled with gasoline mixture in order to fly, eliminating the need to recharge and replace batteries, which has hindered surveying efficiency in the past, and greatly improving the labor efficiency of field work. For the extender, a Japanese-made compact extender that combines durability and quietness, developed by O.S. PROFESSIONAL (Ogawa Seiki Co., Ltd.), is used. All services, from the supply of consumables to maintenance, can be provided in Japan.

FLIGHT TIME

4 hours+ NON-INSTALLED

2 hours+ EQUIPPED WITH TDOT 3 GREEN

Excellent portability and greatly improved mobility
Foldable for easy portability

Simply fold, store, and carry it, unfold and lock the foldable arm on site, and the preparation work is complete. No tools are required for its construction, and it is ready for flight immediately upon arrival on site.
Fuel is a mixture of gasoline. GLOW.H is a next-generation drone that enables wide-area surveying while thoroughly pursuing improved work efficiency.

Storage

W650 x D650 x H250 mm

Flight

W900 x D900 x H530 mm

Using open source PIXHAWK series flight controllers

The most standard open source PIXHAWK series flight controllers are used.
PIXHAWK series flight controllers have high-performance attitude control capability to realize stable flight. Necessary functions such as autopilot function, payload management, and battery management are covered. Since it is an open-source system, the source code is publicly available, making it easy to implement your own customizations and guaranteeing reliable user support and maintenance over the long term.

Equipped with NVIDIA's JETSON

It is equipped with NVIDIA JETSON, which enables the construction of a neutral network that is the foundation of an AI system. The system can be uniquely customized to incorporate AI processing using image sensors and various other sensors.

* A neutral network is a combination of mathematical models that mimic the network structure of nerve cells (neurons) in the brain.

Customized with an open system that responds to the user's requests.

Adoption of GREMSY payload attachment

GREMSY attachments are adopted.
Various devices can be connected to it, and it works with the flight controller while simultaneously supplying power and transmitting images.
It is possible to connect not only TDOT 3 GREEN, but also cameras and various sensors, and all kinds of other devices. Original devices can also be freely mounted.

Equipped with LTE communication / Satellite telemetry (optional) Realization of out-of-sight flight and wide-area surveying by remote control

GLOW.H is equipped with LTE (Long Term Evolution), a next-generation high-speed mobile communication standard widely used in cellular phones. This LTE connection enables the operator to monitor the status of the aircraft and control it remotely.
H, which can fly for longer periods of time, can be optionally equipped with satellite telemetry in case the LTE line is interrupted. This allows for continued out-of-sight and wide-area surveys regardless of radio signal conditions.

Equipped with LiDAR and landing position target recognition sensor Supporting for safe landing

Landing operations are the scene where the accident rate is highest due to human error.
GLOW.H is equipped with a LiDAR sensor and a landing position target recognition sensor to precisely determine the distance to the ground and landing position, and control the drone to support safe landing.

SPECIFICATIONS

PROMOTION The official release is scheduled for the end of 2022. Product specifications and appearance are subject to substantial change.

Model name	GLOW. H
Power method	Hybrid (battery powered by extender)
Size (approx.)	Storage: 650 x 650 x 250mm (height)
	Flight: Rotor to rotor distance 900 x 900mm x 530mm (height)
Flight time	No equipment: more than 6 hours
	Equipped with TDOT 3 GREEN: more than 2 hours
Flight Controller	PIXHAWK series
Engine type	GT33REU Range Extender (O.S.PROFESSIONAL)
Engine Start	Starter motor
Fuel used	Regular unleaded gasoline, 2-cycle oil (mixed)
Main battery	Lithium polymer batteries (6S 1800mAh 22.2V 75C) x 2 sets 3kg
Main battery for power	3kg
Communication frequency	2.4GHz / LTE / Satellite telemetry (optional)
GNSS	GPS / GLONASS / Galileo / QZSS (Michibiki) / BeiDou
Standard equipment	NVIDIA JETSON / FPV camera / High-brightness LED (lighting, blinking) / LTE
Flight controller (transmitter)	Herelink HD Transmission (2.4GHz)
Attachment	GREMSY attachments
Country of origin	Japan

AMUSE ONESELF INC.™

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