AMUSE ONESELF™

2024 NEW PRODUCT

TDOT™ GREEN 7

DRONE LASER SYSTEM

GLOW.L
+
TDOT 7 GREEN

Image of the TDOT 7 GREEN
Mounted on a Intelligence
Battery-Powered Drone with
Portability and Maneuverability

GLOW.H
+
TDOT 7 GREEN

Image of the TDOT 7 GREEN
Japanese Hybrid drone
with Extended Flight Time

"Always Ready",
The Essential Starting Point
Land and Shallow Water Laser System

In recent years, LiDAR surveying using drone has become more common. Today, there are varieties from affordable system with Vehicle-mounted-laser to high end systems specially designed for survey purpose.
In 2013, we were pioneers in developing and implementing a drone-mounted laser system optimized for surveying purposes. Four years later, we led the world by developing a drone-mounted laser system with green light.
However, what we introduced to the market was not a green laser system solely for bathymetric surveying. Born from the needs of the Ministry of Land, Infrastructure, Transport and Tourism, we created an "All-terrain and Underwater Drone Laser System" that is always ready for use. Many of the green laser systems currently on the market are expensive and heavy. While there are many affordable options for land-only surveying. Heavier systems reduce flight time and decrease operational efficiency.
"TDOT 7 GREEN" is an optimized system built on our extensive development history and surveying experience using drones. It is an "always ready" system capable of surveying from land to shallow water.

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LiDAR system for surveying land and in shallow water
In fact, there is no other.

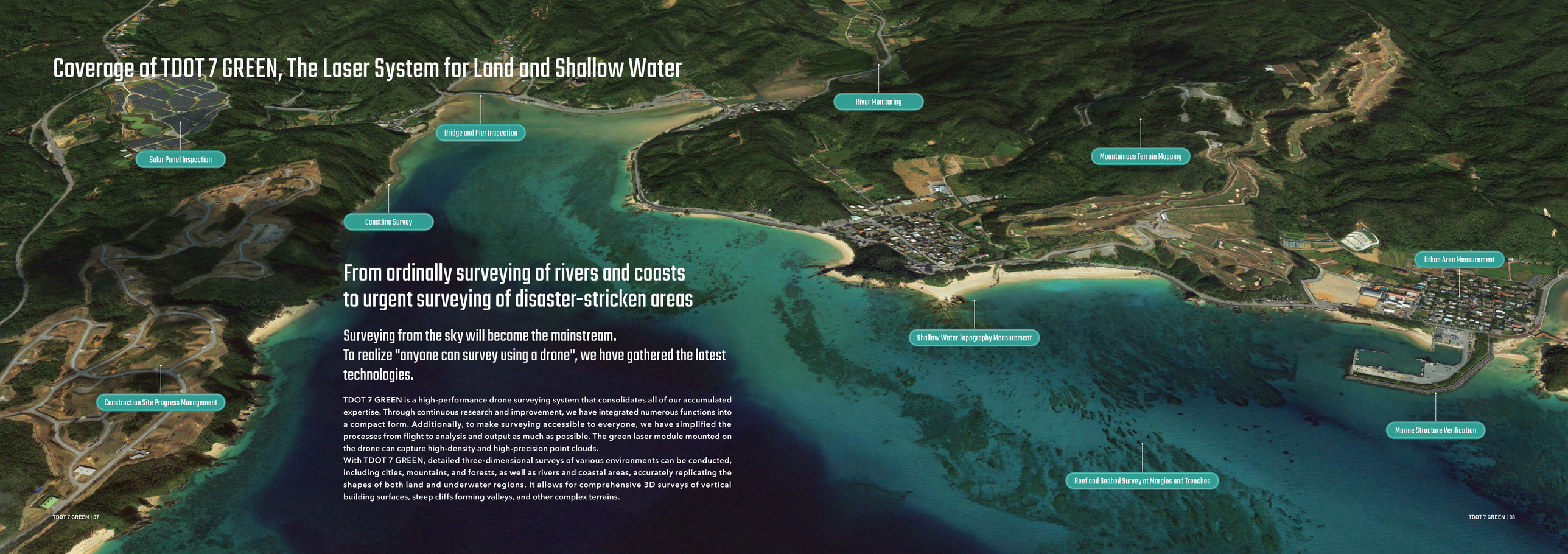
Green laser light
For drone laser surveying
It is an irreplaceable and important light.

TDOT™ GREEN 7

DRONE LASER SYSTEM

Coverage of TDOT 7 GREEN

Coverage of TDOT 7 GREEN, The Laser System for Land and Shallow Water



From ordinally surveying of rivers and coasts to urgent surveying of disaster-stricken areas

Surveying from the sky will become the mainstream. To realize "anyone can survey using a drone", we have gathered the latest technologies.

TDOT 7 GREEN is a high-performance drone surveying system that consolidates all of our accumulated expertise. Through continuous research and improvement, we have integrated numerous functions into a compact form. Additionally, to make surveying accessible to everyone, we have simplified the processes from flight to analysis and output as much as possible. The green laser module mounted on the drone can capture high-density and high-precision point clouds.
With TDOT 7 GREEN, detailed three-dimensional surveys of various environments can be conducted, including cities, mountains, and forests, as well as rivers and coastal areas, accurately replicating the shapes of both land and underwater regions. It allows for comprehensive 3D surveys of vertical building surfaces, steep cliffs forming valleys, and other complex terrains.


Surveying

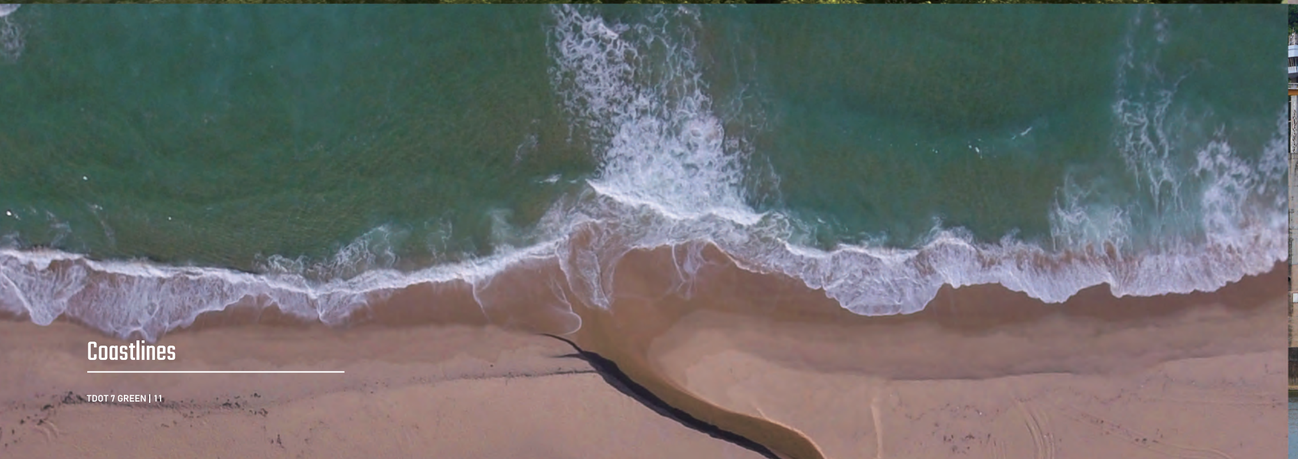

Disaster Response


Construction Sites


Inspection

Rivers

Ports



Coastlines

Dams

TDOT™ GREEN 7

DRONE LASER SYSTEM

Features of TDOT 7 GREEN

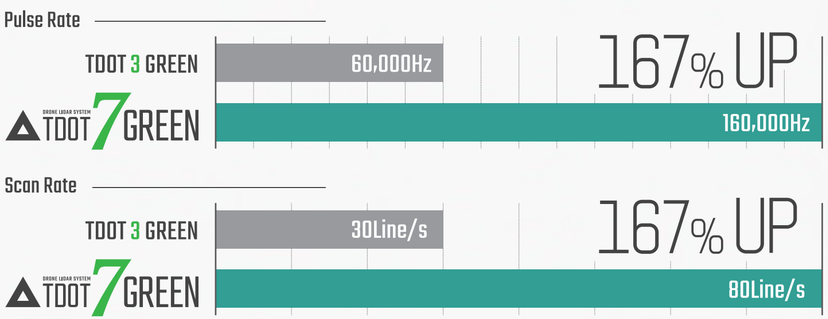
Performance Improvement
Faster and More Efficient

Laser Power: 2x, Concentration: 1.9x, Light Sensitivity: 2x

We have upgraded the performance by doubling the laser power, increasing the concentration by 1.9 times, and doubling the light sensitivity from previous models.

Measurement Speed Improved by 167%

The measurement speed has been improved by 167%, with a pulse rate of 160,000 pulses per second and a scan rate of 80 lines per second. This significant speed increase dramatically enhances operational efficiency.



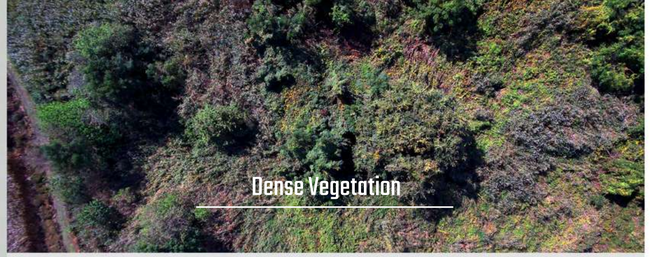
Performance Improvement
More Detailed and, Deeper Insights

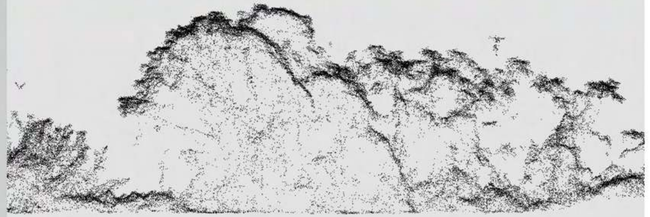
TDOT GREEN 3
DRONE LASER SYSTEM

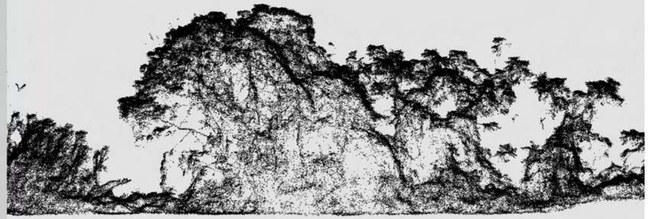
Pulse Rate	: 60,000 Hz
Scan Rate	: 30 lines/second
FOV	: 90°
Number of Returns	: 4
Laser Wavelength	: Green (532 nm)
Compatible Drone	: MATRICE 350 RTK

TDOT GREEN 7
DRONE LASER SYSTEM

Pulse Rate	: 160,000 Hz
Scan Rate	: 80 lines/second
FOV	: 120°
Number of Returns	: 6
Laser Wavelength	: Green (532 nm)
Compatible Drone	: GLOW.H

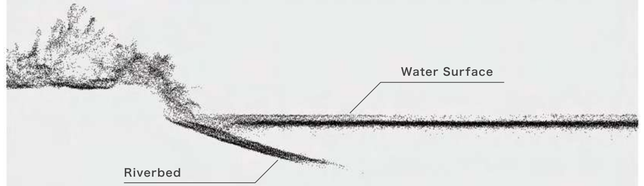


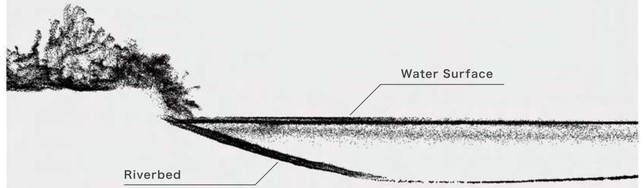




More point clouds on ground surface and detailed tree reproduction.

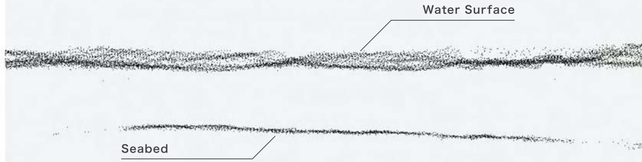
Cross-sectional Diagram
10m





Deeper riverbed data is obtained.

Cross-sectional Diagram
7m



Comprehensive seabed data acquisition.

Cross-sectional Diagram
5m

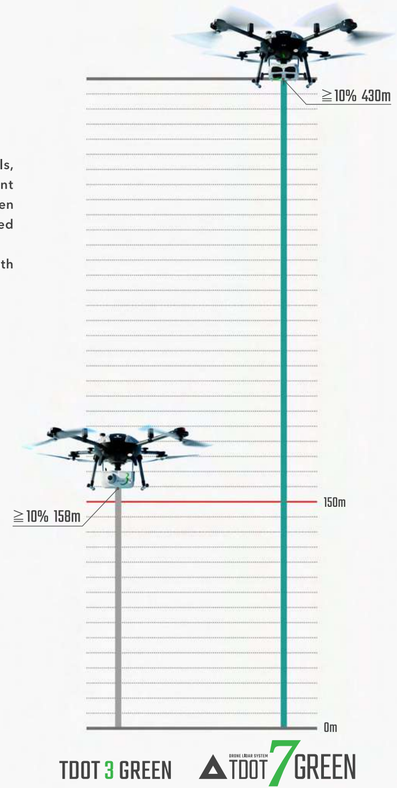
Range Performance
Accurately Capturing Targets

The measurement distance has improved by 172% from previous models, achieving ≥10% at 430 meters. With excellent distance measurement performance that allows measurement from an altitude of 430 meters even for objects with only 10% light intensity, targets can be reliably captured within the normal operating altitude of 150 meters or less.
In land area, it is advantageous for capturing the ground surface beneath trees, and in water areas, it allows for deeper measurements.

Maximum Range

TDOT 3 GREEN ≧10% 158m

TDOT 7 GREEN ≧10% 430m

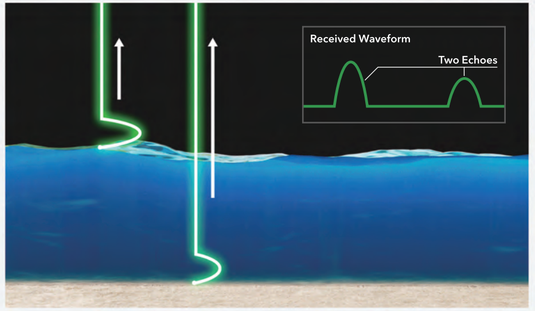


Depth Measurement Performance
Capturing deeper waterbeds

The depth measurement capabilities have improved compared to previous models.
The depth measurement capability is 13.5 meters from an altitude of 50 meters and 16.8 meters from an altitude of 15 meters, both exceeding 10 meters depth.
The extended laser reach underwater allows for more in-depth measurements of aquatic areas.

Depth Measurement Ability		TDOT 3 GREEN	TDOT 7 GREEN
Clear Water	R=0.40 @ Altitude 50m	1.13 Secchi	1.43 Secchi
Turbid Water	R=0.40 @ Altitude 50m	0.47 Secchi	0.60 Secchi
Clear Water	C=0.22 @ Altitude 50m	10.7m	13.5m
Clear Water	C=0.22 @ Altitude 15m	14.2m	16.8m

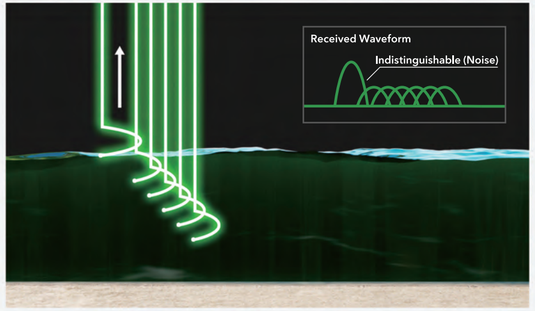
R=Reflectivity C=Beam attenuation coefficient



Clear Water

Detecting the Waterbed

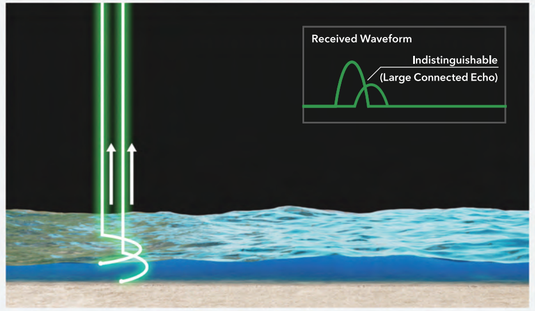
A single laser reflects off both the water surface and the waterbed. The reflected waves received are distinguished based on their reflection intensity, allowing high-precision topography measurements even underwater.



Turbid Water

In Turbid Water

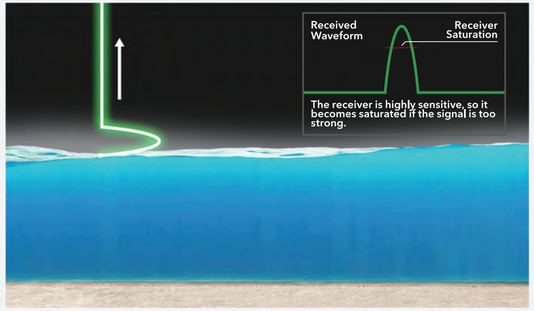
Impurities can cause multiple reflections (noise), making it difficult to identify the clear reflection surface of the target, which may reduce depth measurement performance. The feasibility of measurements can be predicted in advance based on information about the transparency of the target area.



Too Shallow Water

Where the Water is Too Shallow

The two waveforms reflected from the water surface and the waterbed overlap, making it impossible to distinguish between them from the reflected waves, potentially causing measurement errors. However, it may still be possible to measure with laser incidence at an angle.



Close Range and Strong Reflections from Frontal Surface/ Directly Below

Where Reflections are Too Strong

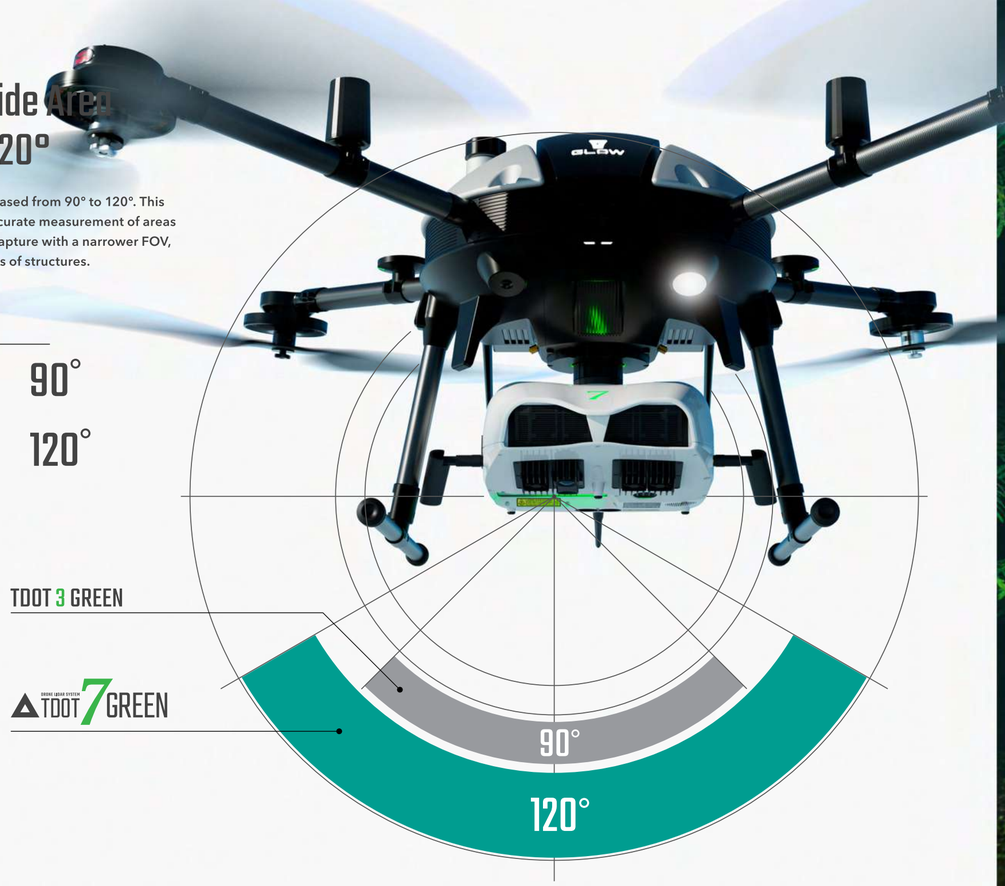
It may exceed the sensor's sensitivity limit, preventing accurate readings. Attention is required for measurements from low altitudes and at points where the laser enters the water surface perpendicularly, due to the strong reflection from the water surface.

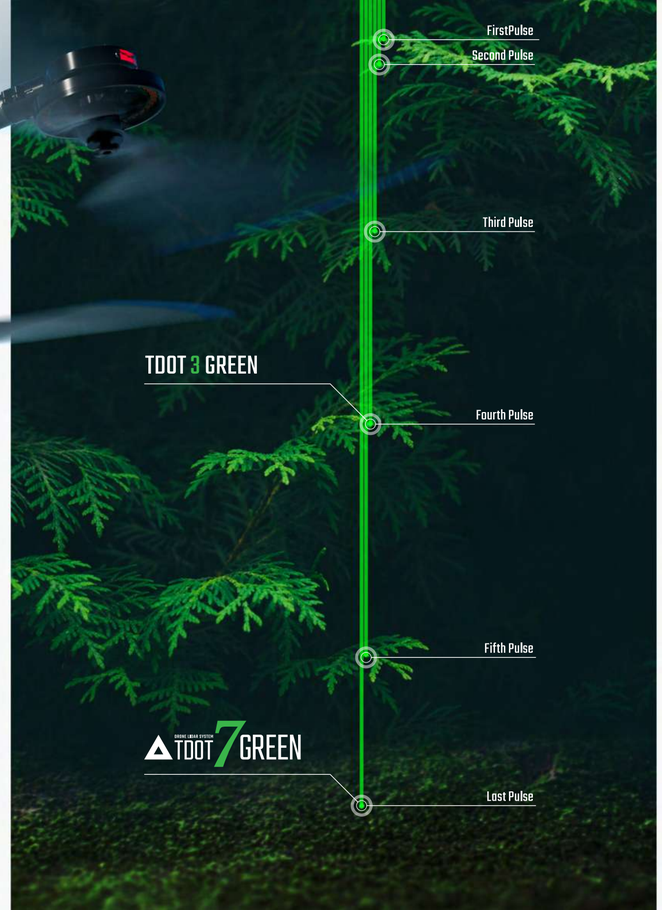
Capturing a Wide Area Field of View 120°

The Field of View (FOV) has increased from 90° to 120°. This wider FOV allows for safe and accurate measurement of areas that were previously difficult to capture with a narrower FOV, such as steep slopes and the sides of structures.

Field of View (FOV)

TDOT 3 GREEN	90°
TDOT 7 GREEN	120°





Improved Number of Returns

The number of returns refers to the number of echoes received from objects that the emitted laser beam encounters on its way to the farthest target. Therefore, it is also called the number of echoes. The first object hit by the laser is called the first pulse, and the last object is called the last pulse. In areas with dense vegetation, the first pulse typically captures the tree canopy, while the last pulse captures the ground surface, depending on the conditions. The more returns there are, the greater the number of middle pulses between the first and last pulses, resulting in a clearer representation of the tree structure.

Number of Returns

TDOT 3 GREEN	4 echo
TDOT 7 GREEN	6 echo

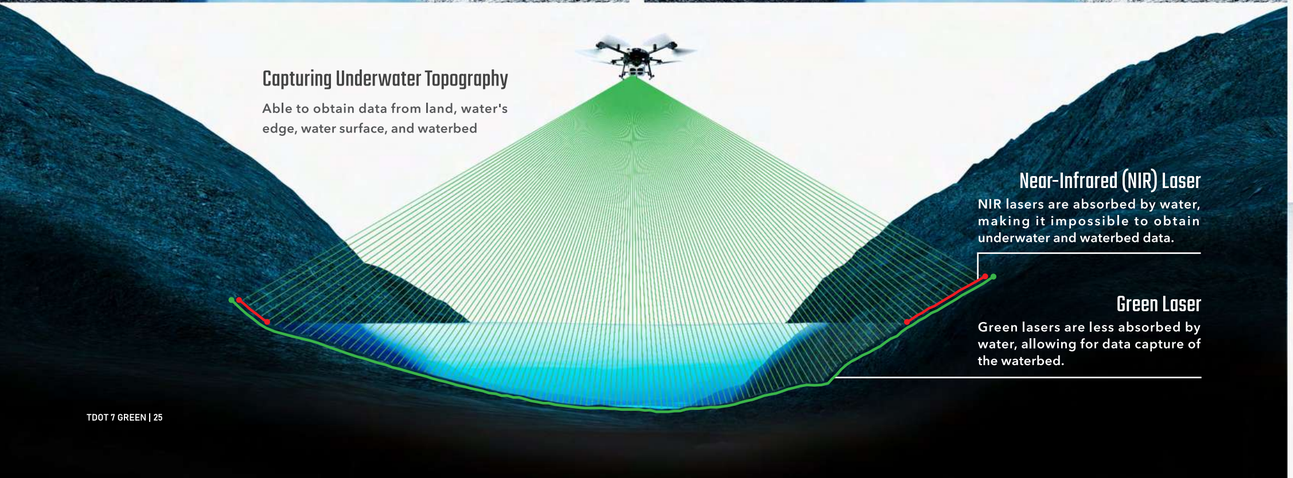
As a Land and Shallow Water Laser System

Green laser
for depth measurement
made by other company

approx. 40°

Ability to Capture Wider Area Data

Wide Field of View for Efficient
Land Surveying



Capturing Underwater Topography

Able to obtain data from land, water's edge, water surface, and waterbed

Near-Infrared (NIR) Laser

NIR lasers are absorbed by water, making it impossible to obtain underwater and waterbed data.

Green Laser

Green lasers are less absorbed by water, allowing for data capture of the waterbed.

Long Flight Time Due to Reduced Weight

Longer flight times directly correlate with higher work efficiency. The laser system is relatively lightweight (3.6 kg), making it suitable for surveying large land areas and water bodies in wide area.

Ability to Measure Wet Objects

Conventional NIR laser is absorbed by water, making surveying difficult immediately after rain. Green light, which is less absorbed by water, is effective not only for surveying the waterbed but also for measuring wet surfaces.

Eye Safe

Eye safety for eye-protection

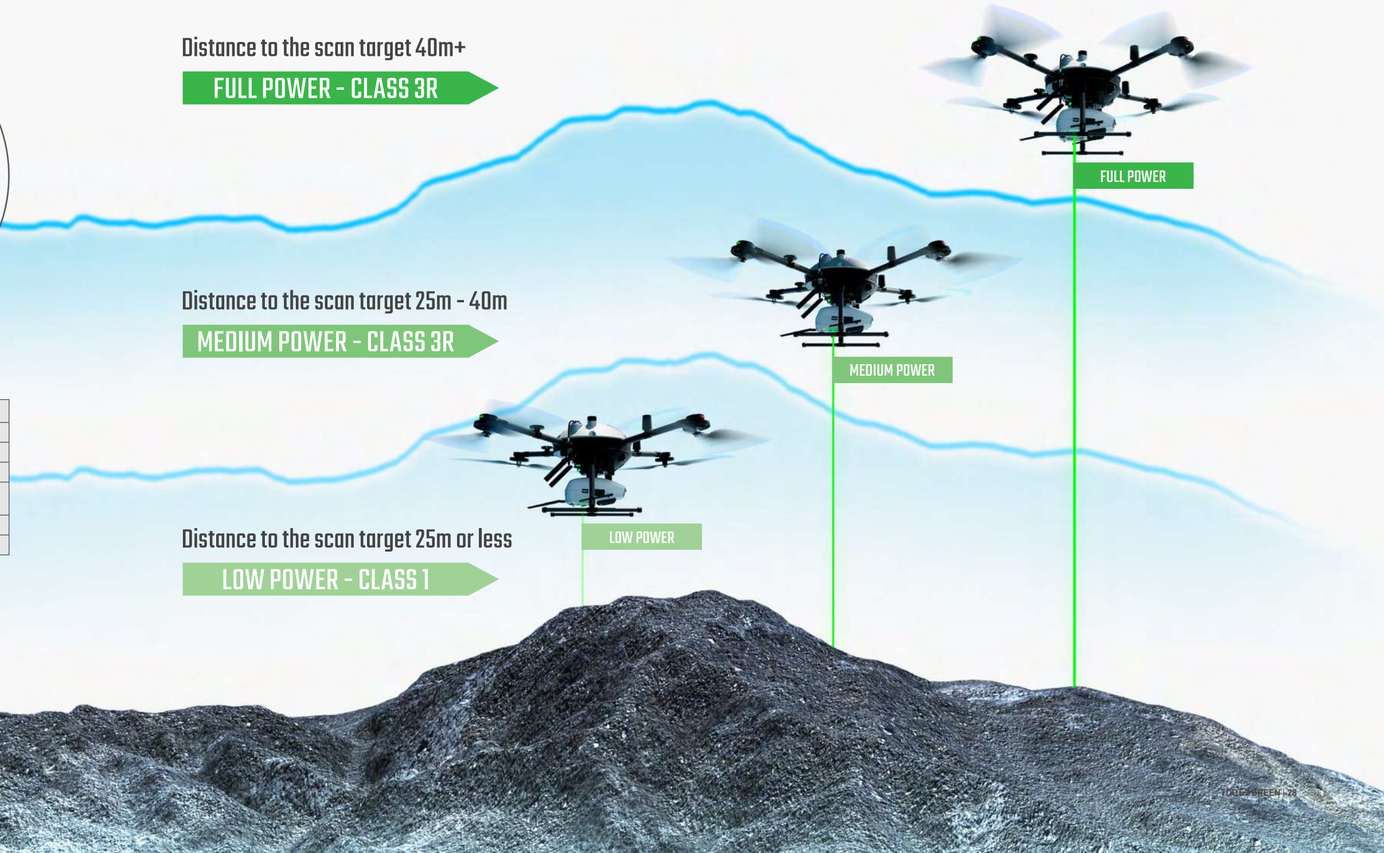
In the case of drone laser surveying, the operator and people in the vicinity are required to keep eyes on the drone.
Also, because the laser beams over a wide area, it can have an impact on people in the vicinity, and it is necessary to ensure safety for their eyes. Therefore, it is necessary to pay close attention to eye safety. International safety standards have been established for laser products to prevent eye injury.

The green laser in TDOT 7 GREEN is classified as “Class 3R”. To avoid the risk of instantaneous exposure to the naked eye, TDOT 7 GREEN is equipped with an eye-safe function.

Accurately monitors the distance to the scan target.
operation is ensured by strictly adhering to the Nominal Ocular Hazard Distance (NOHD).

JIS C 6802

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.



INS

GNSS/IMU Combined Inertial Navigation System

Precision of Position and Attitude Measurement of the Laser System
Equipped with a high-performance INS that improves data output rate

In laser surveying, it is necessary to calculate how long it takes for the laser light to return from the target object hundreds of thousands of times per second. While the position where the laser light is emitted is measured by GNSS, it can only measure a few dozen times per second, causing significant errors in the position of the target object. Additionally, the measurement error in the laser light's emission angle results in a positional deviation proportional to the distance to the target object. Therefore, the further the target object is, even a small error in the laser light's emission angle can prevent obtaining accurate coordinates of the target object.

To address this, accelerometers capture the drone's movements, and gyroscopes detect the drone's continuously changing attitude. Combining these IMUs (Inertial Measurement Units) with GNSS forms what is known as an INS combined navigation (inertial navigation) system. By leveraging the strengths of both systems, a high-precision surveying system is achieved.

The INS in TDOT 7 GREEN is designed to provide high-precision surveying with an accuracy of several tens of millimeters, even while emitting laser light tens of thousands of times per second.

TDOT Series IMU Specifications

Position Accuracy	5mm
Heading	0.03°
Pitch/Roll	0.006°
Velocity	0.01m/sec

Real-time processing

Emergency Surveying

Real-Time Processing and Remote Transmission

In recent years, the frequency of earthquakes and heavy rain disasters has been increasing. To prepare for such urgent surveying needs, the TDOT 7 GREEN is equipped with real-time processing of survey results and real-time remote transmission capabilities.

The TDOT 7 GREEN features an LTE module, allowing it to obtain data from GNSS reference stations during survey flights and maintain an RTK (Real Time Kinematic) state. By performing real-time calculations with its built-in computer, the collected data can be transferred to remote servers or PCs as point cloud data. This functionality is highly effective for initial survey tasks that require immediate response.

*To use this feature, a separate SIM card capable of aerial mobile communication is required.

Uploaded point cloud data can be viewed from anywhere

Visible CAMERA / Thermal CAMERA

Equipped with Visible Camera / Thermal camera (Optional)

Images captured by the visible light camera can provide color information to the point cloud. Additionally, since the images contain coordinate information, it is possible to create orthophotos with coordinates. By equipping the optional thermal camera, temperature information can be added to the point cloud, allowing for the visualization and understanding of conditions such as groundwater seepage from slopes. Various data embedded in the point cloud can enhance the visualization of relationships, characteristics, and trends of different phenomena.

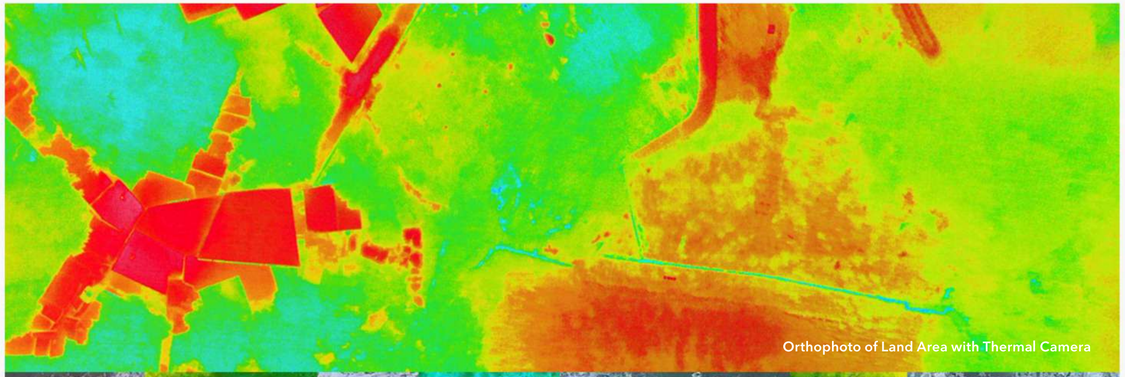
*Separate SfM (Structure from Motion) software is required to create orthophotos.

Visible Light Camera **Standard Equipment**

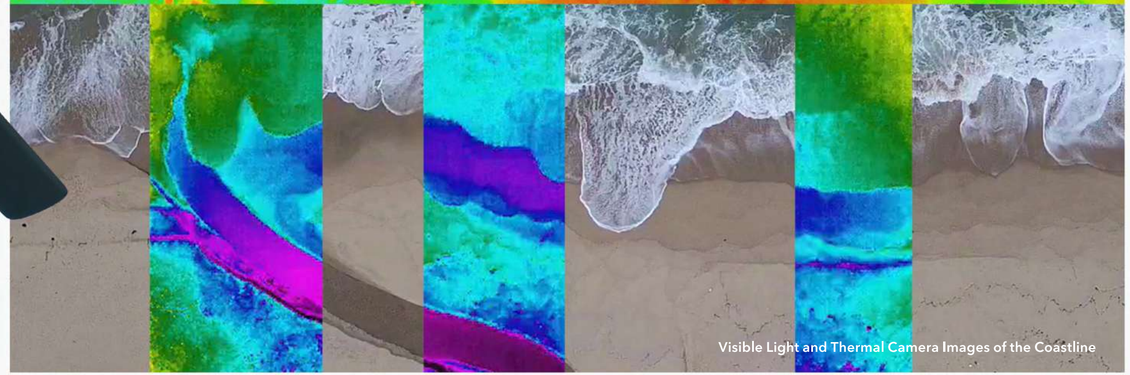
Resolution	3,840 × 3,046 (12.4 Megapixels)
Sensor	1/1.7-inche (7.533(H) x 5.635(V) mm)
Focal Length	Approximately 20mm (35mm equivalent)
F-number	F2.7
FOV	Approximately 94°

Thermal Camera **Optional**

Resolution	640 x 512 pixels
FOV	95°
Radiometry	Capable



Orthophoto of Land Area with Thermal Camera



Visible Light and Thermal Camera Images of the Coastline

TDOT 7 Setting Tool

Updated TDOT 7 Dedicated Application

You can access TDOT 7 GREEN by using WiFi communication on devices that support browsers, such as tablets and smartphones. The application allows you to check status information, set laser emission speed and scan rate, display real-time cross-sections, configure various settings for the visible light camera and thermal camera, and manage RTK usage. This enables more detailed settings and viewing capabilities.

Real Time Data

Real-Time Display of Survey Data

You can check the measurement data in real-time during the survey. For example, by displaying cross-sections of the target objects, you can confirm the acquisition status of ground surface data beneath vegetation in areas with dense tree cover, or the reach of the laser light to the waterbed in aquatic areas, all in real-time during the flight. This allows you to verify on-site whether the survey is proceeding as planned, enabling efficient surveying operations without the need for rework.

*To view cross-sectional data during the flight, the drone must be equipped with an image transmission device that can connect to HDMI.

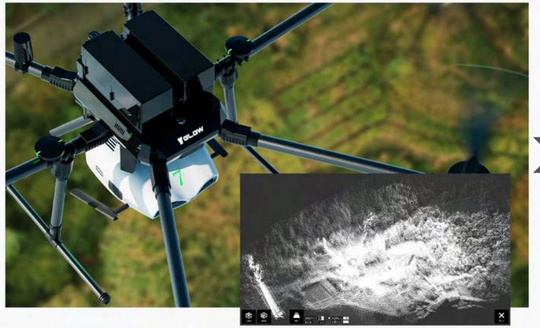
Work flow

Workflow from Flight to Data Processing

An Integrated Platform to Realize the Concept of Easy Surveying for Everyone

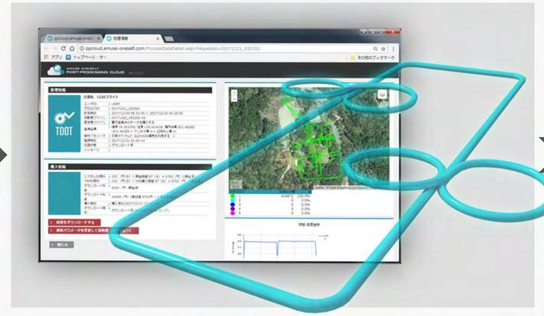
The laser scanner system is composed of number of precision devices, and setting each of them to optimal conditions is not an easy task. For those without specialized knowledge, it takes significant effort to master the procedures, often through many trials and errors, to achieve high-precision outputs. These complex operations required of the operators have been an obstacle to the widespread adoption of drone laser surveying.

TDOT 7 GREEN offers a platform that enables anyone to maximize its performance. It includes features such as performing alignment flights before and after the survey while entering the flight route, and downloading corresponding GNSS Reference station data with simple drag-and-drop operations to immediately combine with INS data for automatic optimal trajectory analysis. By using our platform, which incorporates our surveying service expertise, anyone can easily conduct accurate laser surveys.



Scanning and Preview Display

Verify scan data on-site through preview.
Supports efficient surveying without rework.

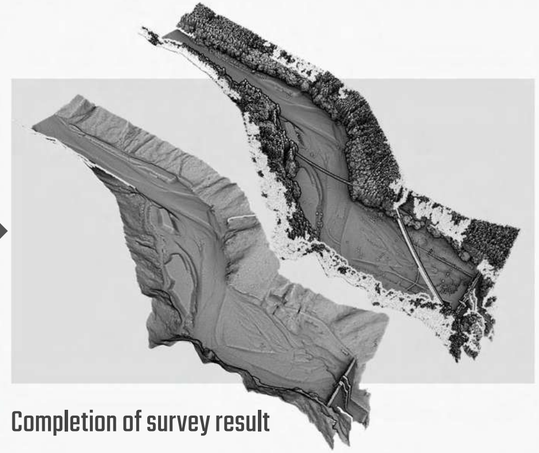


Optimal Trajectory Analysis with Cloud Services

Simply upload the necessary data to the cloud service for automatic trajectory analysis (optimal trajectory analysis) using INS data.

Linking Analysis Results and Data Output by PC

Integrate optimal trajectory analysis with scan data to output high-precision point cloud data.



Completion of survey result

SPECIFICATION

TDOT 7 GREEN Specifications

Model name	TDOT 7 GREEN		
Size (approx.)	W250 x D310 x H135mm		
Weight (approx.)	3.6kg		
Communication frequency band	920MHz, 2.4GHz, LTE		
GNSS	GPS, GLONASS, Galileo, QZSS, Bei Dou		
Input voltage	24V / PD (USB Type-C) 20V 100W		
Rated power consumption	100W		
Standard equipment	NVIDIA JETSON, LTE module, visible camera		
Built-in SSD	2TB		
Operating temperature	10 - 40°C (non-condensing)		
Storage temperature	0 - 40°C (non-condensing)		

Laser Scanner Specifications

Maximum measurement distance	≧10% 430m		
	≧100% 1400m		
Minimum measurement distance	2.5m		
Resolution	1mm		
Measuring accuracy (1σ)	Strong echo : 4mm		
	Weak echo : 15mm		
Accuracy	5mm		
Beam spread angle	1.5mrad		
Laser wavelength	532nm		
Pulse rate	160,000 Hz (measurement rate: 106,560 Hz)		
Scanning Mirror	4-sided polygon mirror		
	Scanning angle (FOV)	120°	
	Scanning speed	40Hz	80Hz
	Step accuracy	0.045°	0.09°
	Number of measuring points (120°)	2,666	1,332
Number of echoes	6		
Laser Class	40m+ (FULL) : Class 3R		
Distance to the scan target	25m - 40m (MEDIUM) : Class 3R		
	25m or less (LOW) : Class 1		
Bathymetric performance (seawater)	Clear Water R=0.40 @ Altitude 50m : 1.43 Secchi*1		
R=Reflectivity	Turbid Water R=0.40 @ Altitude 50m : 0.60 Secchi		
C=Beam attenuation coefficient	Clear Water C=0.22 @ Altitude 50m : 13.5m		
	Clear Water C=0.22 @ Altitude 15m : 16.8m		

Built-in INS Specifications*2

Positioning accuracy	5mm
Heading	0.03°
Pitch/roll	0.006° (0.006°)
Velocity	0.01m/sec

Visible Camera Specifications

Number of pixels	3,840 x 3,046 12.4Mpixel
Sensor size	1/1.7-inch 7.533(H) x 5.635(V) mm
Focal length(35mm equivalent)	Approx. 20mm
F value	F2.7
FOV	Approx. 94 degrees

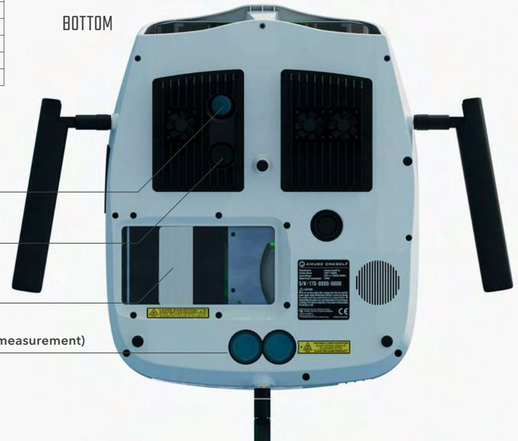
Thermal Camera Specifications (Option)

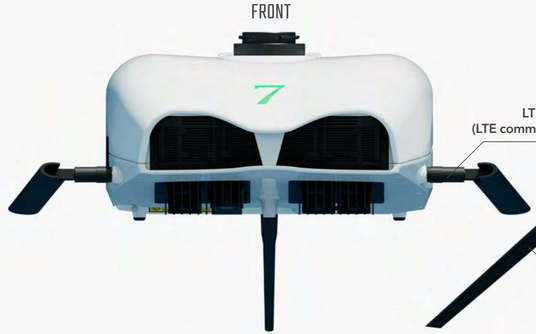
Number of pixels	640x512pixel
FOV	95° Radiation measurement possible
Radiation measurement	possible

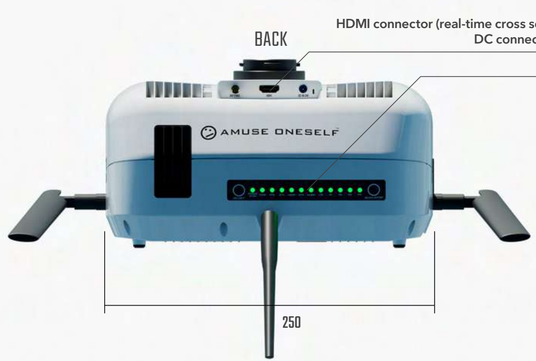
Accessories

TDOT 7 GREEN main unit
REMOTE GATEWAY (TDOT accessory)
GNSS antenna cable
USB memory stick (64GB)
Dedicated hard case
Instruction Manual

*1 One secchi is the depth at which a 30cm-diameter white disc (transparency plate or secchi plate) is submerged underwater and becomes invisible.
*2 Accuracy after post-processing with the POST-PROCESSING CLOUD cloud service. A separate contract is required to use the service.







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		●
Processing		●
Export		●

Viewer Mode

Preview of Survey Data and Flight Route

When the software is launched without inserting the USB license key, it starts in viewer mode, allowing you to view the data collected along with the drone's trajectory. This enables you to verify on-site whether the survey was completed as planned, facilitating efficient operations without rework. An internet connection is not required.

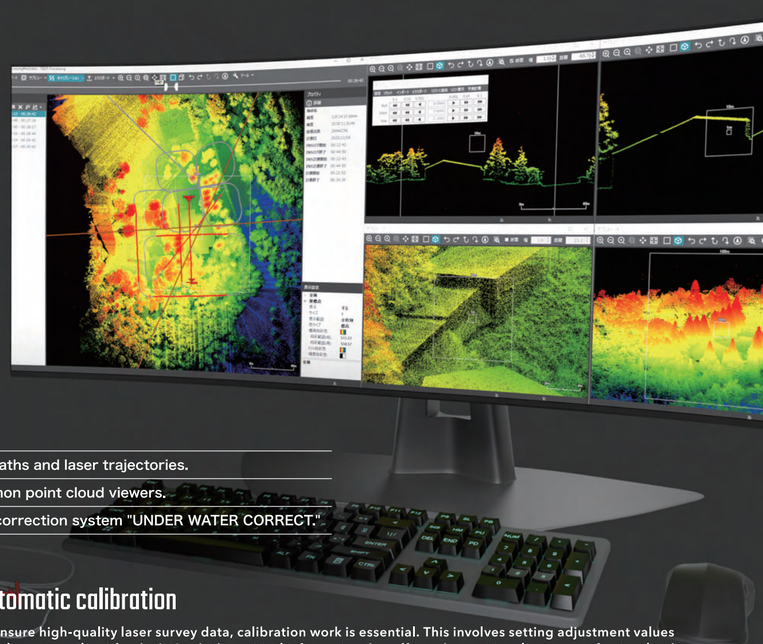
Professional Mode

The Ultimate User Experience

We have revamped the GUI (Graphical User Interface) for methods like time division and point cloud display. Calibration for accuracy management and the creation and output of reports in compliance with public surveying manuals have been automated, allowing for the creation of point cloud data with simple and stress-free operations.

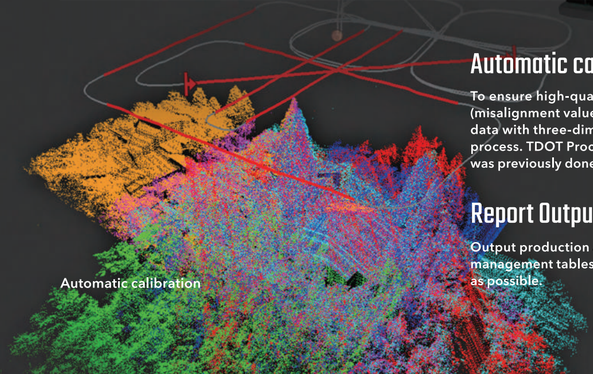
Analysis Processing and Export

After high-precision point cloud processing that requires no specialized knowledge, data can be exported quickly in various formats.



Export Data Formats

KML (.kml)	"Google Earth" file format. Outputs flight paths and laser trajectories.
LAS (.las)	Data format that can be displayed in common point cloud viewers.
eLAS (.elas)	Extended LAS format for the underwater correction system "UNDER WATER CORRECT."



Automatic calibration

Automatic calibration

To ensure high-quality laser survey data, calibration work is essential. This involves setting adjustment values (misalignment values) for the INS, which is critical information that affects the positional accuracy of point cloud data with three-dimensional coordinates. The accuracy of the laser point cloud is significantly impacted by this process. TDOT Processing Pro is equipped with a feature that automatically handles the calibration work, which was previously done manually.

Report Output

Output production and quality reports for drone laser surveying operations. From flight trajectories to accuracy management tables, we have automated the creation of reports required to drone laser surveying flights as much as possible.

TDOT APPLICATION

TDOT 7 GREEN supported applications specifically designed for drone laser surveying operations

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 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 7 GREEN, 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 data, and software that downloads optimum trajectory analysis result 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

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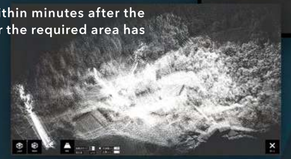
Viewer software specialized for immediate data checks on site

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.



KINEMATIC 2

POST-PROCESSING CLOUD

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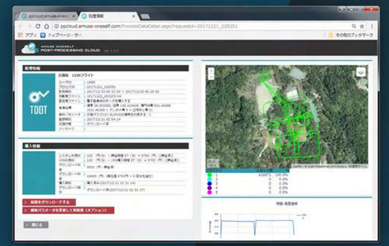
Cloud service that automatically completes optimal trajectory analysis by simply uploading

Optimal trajectory analysis usually 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

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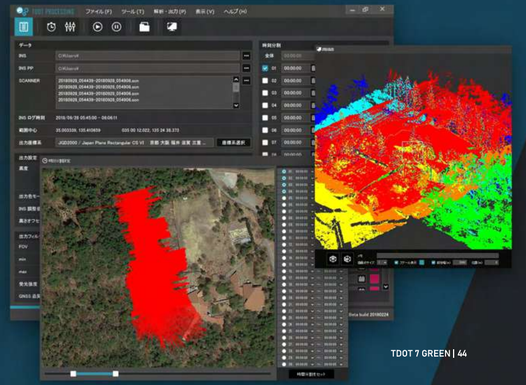
Software for outputting 3D point cloud data with high-precision coordinate values

By integrating and processing the laser surveyed data and the optimum trajectory analysis result, high-precision 3D point cloud data obtained. This process, which is critical to the quality of output, is performed automatically and output high-precision data. This calibration process can be done also by manually.

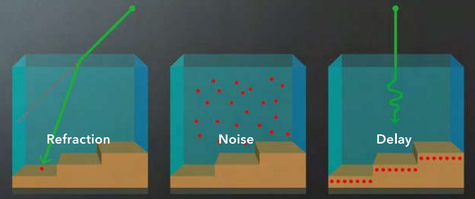


Correct refraction

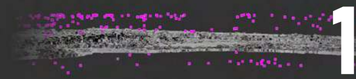
UNDERWATER CORRECT

Application for correction of point cloud data under water

A green laser beam can be used to visualize the topography under water. However, 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. The laser beam must be corrected for the effect of the refractive index of water to accurately reproduce the topography. 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

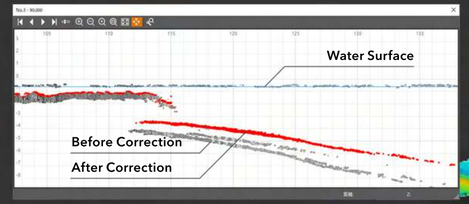


Work procedure in the case of riverbed survey



1 Noise removal

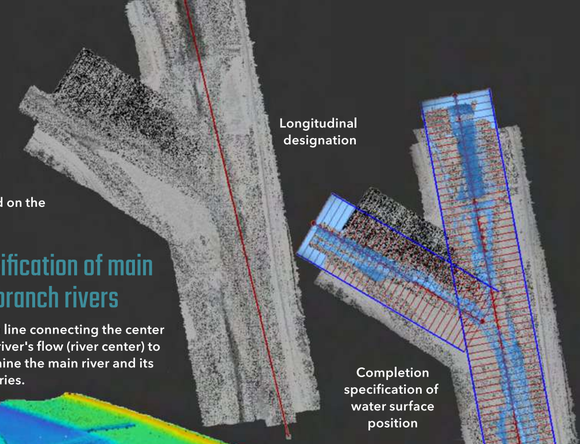
Laser point cloud data including the topography under water is displayed on the screen, and noise data is removed.



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.

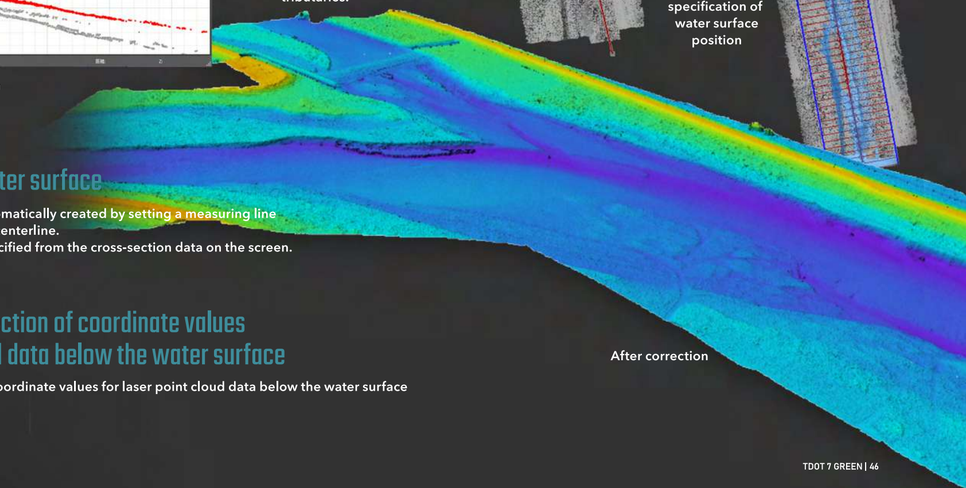


3 Specification of water surface

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

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



TDOT™

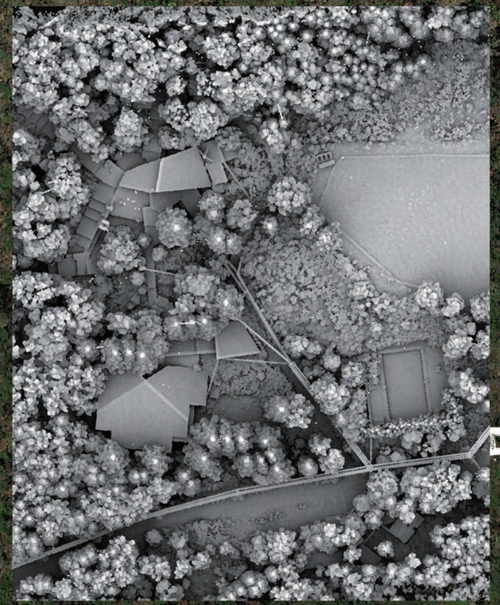
DRONE LASER SYSTEM

TDOT Series Case Studies

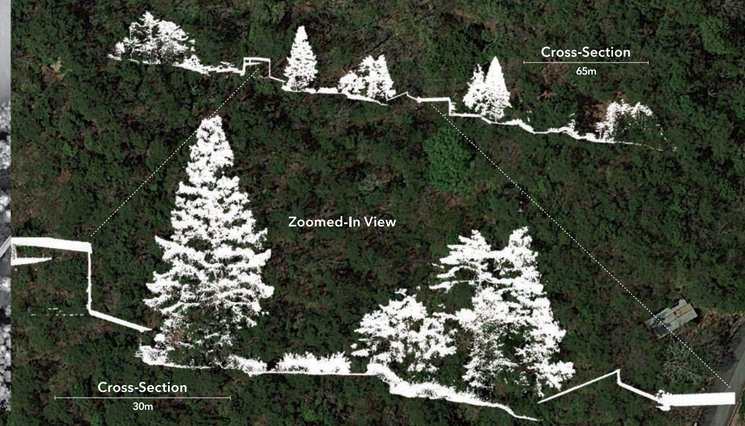
CASE STUDIES

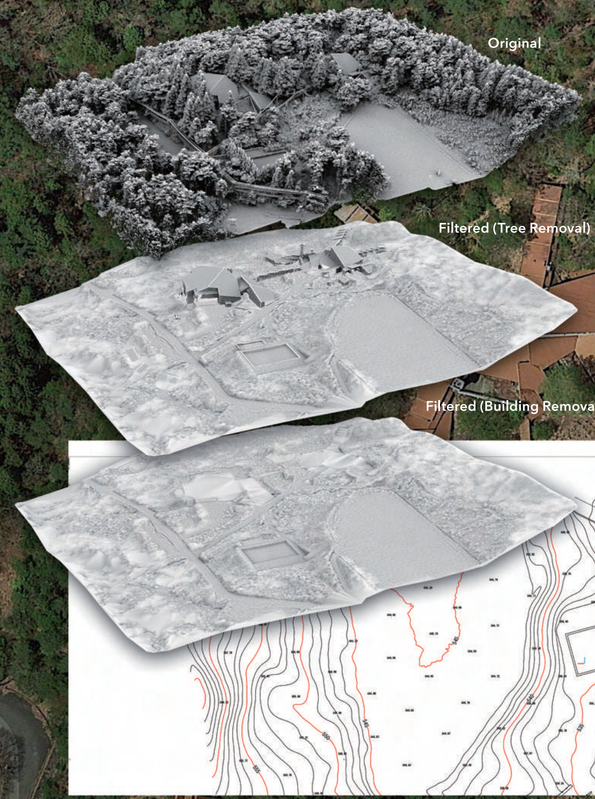
Surveying | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

Top View



Bird's Eye View



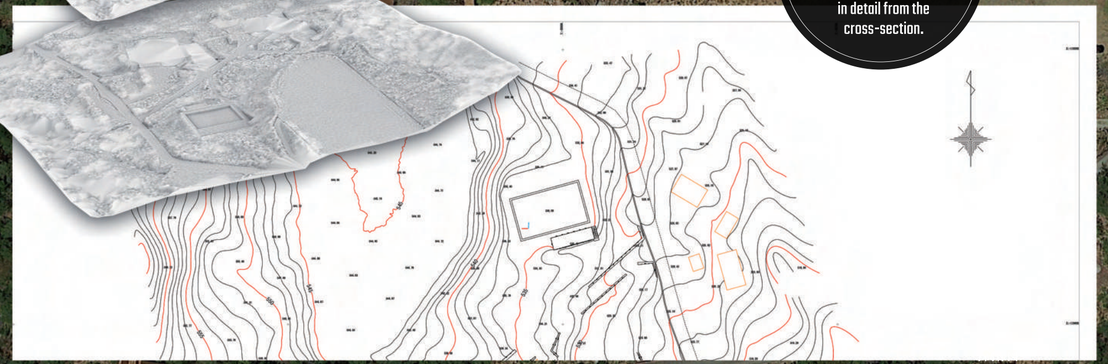


Use in creation of National Land Infrastructure Platform

Digital twin" technology, which reproduces geospatial information in the real world onto digital space, is attracting attention.
The 3D data of about 100 cities has already been released, 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 Series 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.

With the ability to obtain high-density point clouds, everything from trees, terrain, and structures can be accurately reproduced in detail from the cross-section.

Contour Map



CASE STUDIES

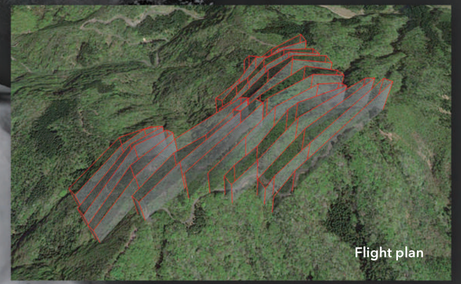
Surveying | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

Use in aerial laser profiler (LP) alternative work

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 Series not only provides an alternative to costly aerial laser profilers (LP), but also eliminates the problem of missing hazardous areas with LPs because of the high laser density from low altitude.
With using TDOT Series, it is possible to conduct reliable slope surveys.

Original data before tree filtering

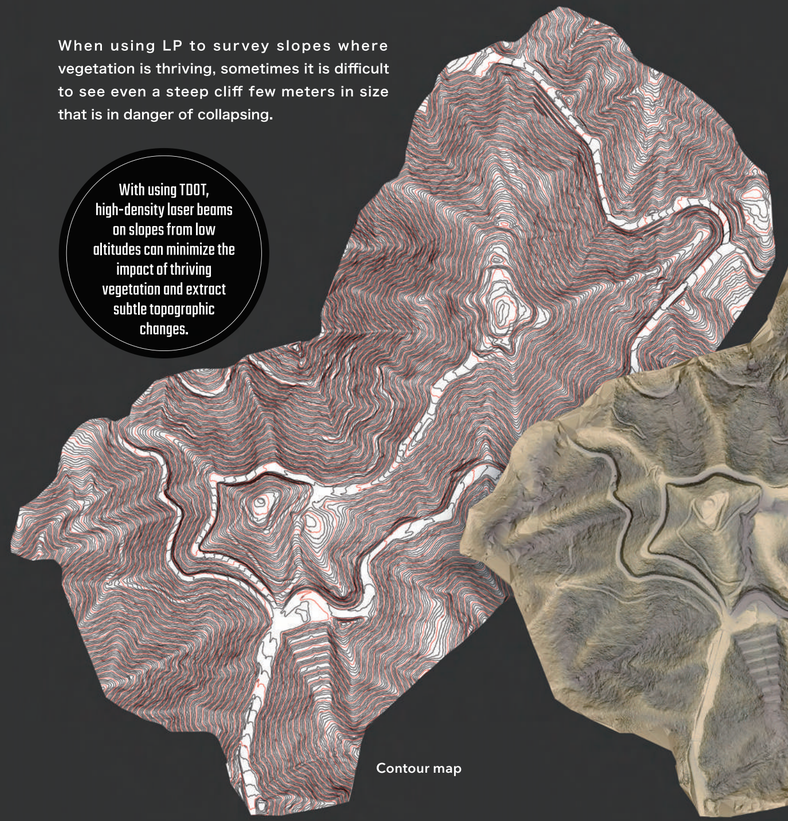
Ground data after tree filtering



Flight plan

When using LP to survey slopes where vegetation is thriving, sometimes it is difficult to see even a steep cliff few meters in size that is in danger of collapsing.

With 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

TDOT Series's contour and slope maps capture subtle topographic changes. This enables reliable desktop surveys that allow for a complete on-site inspection during disaster prevention inspections.

CASE STUDIES

Construction Sites | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

Use in construction DX

The success or failure of ICT construction depends on how quickly and accurately on-site conditions can be acquired. With TDOT, 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.

Color Shaded Map of Construction Site

Bird's Eye View

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

CASE STUDIES

Infrastructure survey | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

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 Series can significantly improve surveying time due to its unprecedented light weight.

Bird's-eye view

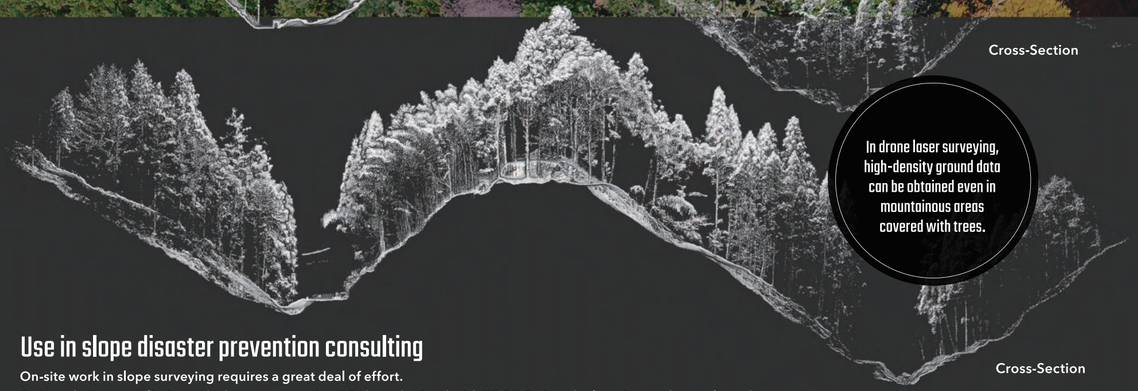
Cross-sectional view
The electric wires are recognizable.

Electric wires

Bird's-eye view

CASE STUDIES

Surveying | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR



Cross-Section

In drone laser surveying, high-density ground data can be obtained even in mountainous areas covered with trees.

Cross-Section

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 Series, 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.

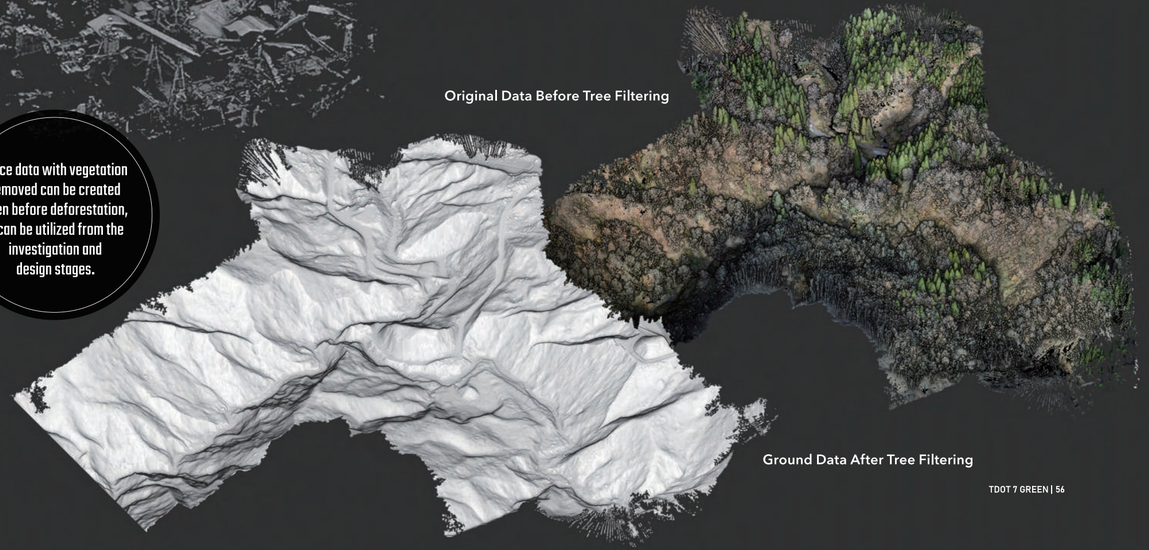
Bird's Eye View

Cross-Section

Data can be efficiently obtained even on steep slopes.

Original Data Before Tree Filtering

Since data with vegetation removed can be created even before deforestation, it can be utilized from the investigation and design stages.



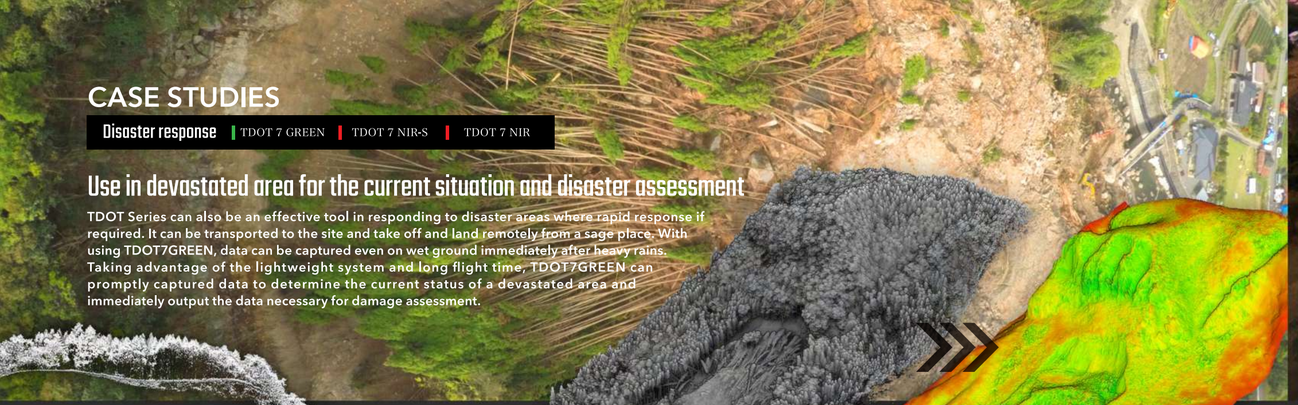
Ground Data After Tree Filtering

CASE STUDIES

Disaster response | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

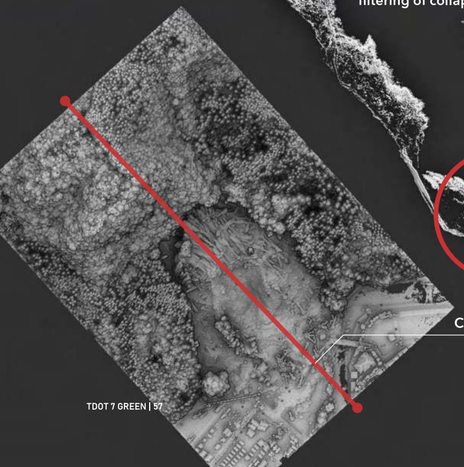
Use in devastated area for the current situation and disaster assessment

TDOT Series can also be an effective tool in responding to disaster areas where rapid response if required. It can be transported to the site and take off and land remotely from a sage place. With using TDOT7GREEN, data can be captured even on wet ground immediately after heavy rains. Taking advantage of the lightweight system and long flight time, TDOT7GREEN can promptly captured data to determine the current status of a devastated area and immediately output the data necessary for damage assessment.



Before point cloud filtering of collapsed

after point cloud filtering of collapsed



Cross-section part

Cross-section view

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

Enlarged view of the cross-section

CASE STUDIES

Investigation | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

Use in archaeological sites

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

Original data before tree filtering

Ground data after tree filtering

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

Cross-sectional view

Church

Side view

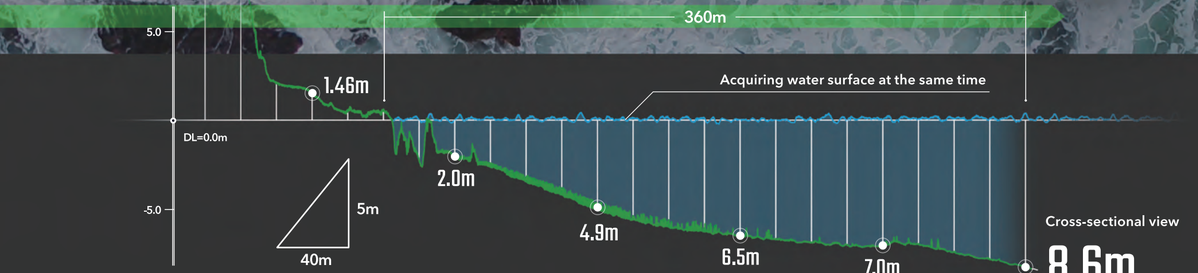
CASE STUDIES

Surveying in shallow sea area | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

Supporting Surveys of Coastal Areas with Breaking Waves

In marine areas, depth measurement using sonar methods such as multibeam systems is common. However, survey vessels find it challenging to access shallow areas with depths of only a few meters. Therefore, the use of drone-based green laser surveying, which can quickly capture detailed topography of coastal areas, is highly anticipated.
While breaking waves impact coastal regions, the high-density laser of TDOT 7 GREEN can obtain seabed topography data from between the waves.

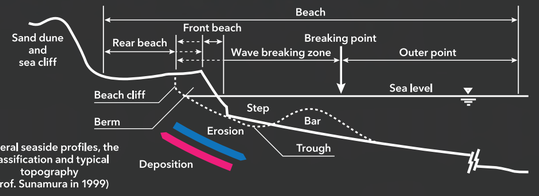
Drone green laser surveying is expected to provide effective data for region-specific environmental protection measures in coastal areas because it captures changes in the seabed topography of coastal areas, which are constantly changing due to changes in sea level, coastal currents, and wind waves.



Surveying the seabed topography 400m offshore

- Acquires data of both the water surface and the seabed
- Covers an offshore distance of 400m, with a maximum depth of approximately 9m

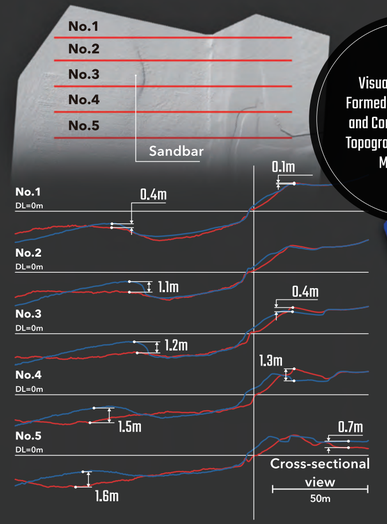
In our island nation, coastal areas play a crucial role in the growth of marine life. At the same time, these regions are significantly affected by changes in sea level and sea temperature due to recent climate change. TDOT 7 GREEN, with its ability to capture detailed coastal topography quickly and efficiently, is expected to be utilized in the field of coastal conservation projects.



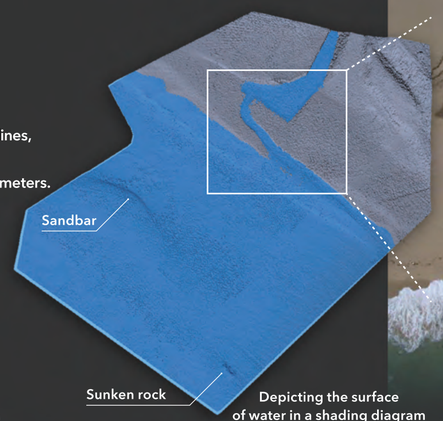
Areal scanning of shallow water areas

- Visualizing Estuarine Blockage and Meandering Rivers, Riverbeds, Shorelines, and Step Topography near Shorelines
- Visualize the shapes of reefs and sandbars at depths of approximately 6 meters.

Below the sea surface, the initially observed bars have disappeared, and the seabed has flattened over a wide area. The estuary has shifted significantly to the east, and the step position has retreated landward. Additionally, landward of the step, beach cusps with arched shoreline shapes are observed in a rhythmic pattern. These beach cusps are important topographical features for considering the impact of waves on sandy beaches.
With the TDOT 7 GREEN survey, such topography can be clearly identified.



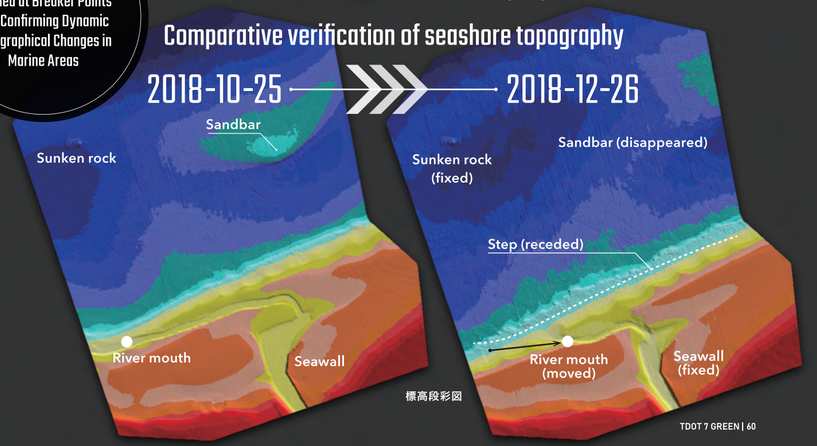
Visualizing Sandbars Formed at Breaker Points and Confirming Dynamic Topographical Changes in Marine Areas



Depicting the surface of water in a shading diagram

Topography near the inflowing river, riverbed and shoreline

Comparative verification of seashore topography



標高段彩図

CASE STUDIES

Surveying in shallow sea area | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

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

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 2.6 km in length and 1 km in width from land to a depth of approximately 17 m. 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.

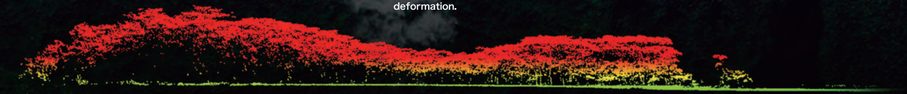
The survey data (including both water surface and seafloor) resulted in a high density with an average spacing of approximately 12 cm and a high accuracy with an average error of ±20 mm in height.

TDOT 7 GREEN has revealed topographic features below wave breaking zones that were previously difficult to approach by boat and could not be surveyed, as well as spurs and grooves, 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.

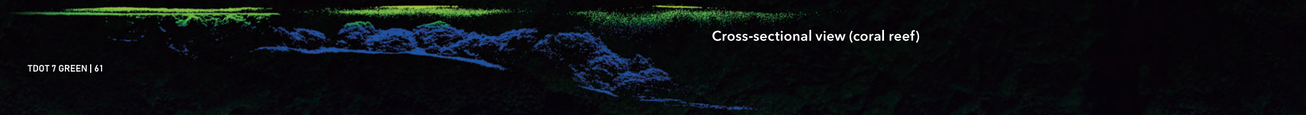
*1 Wave breaking zone: an area where waves are affected and deformed by the seabed, causing it to collapse with turbulence. Wave breaking is more likely to occur where water depths become shallower.
*2 Spurs and grooves: grooves and ridge-like features extending perpendicular to the shoreline that are characteristic of coral reefs. They are found at depths down to around 20 m and influence wave deformation.

Surveying area
Take-off and landing point
Spurs and grooves

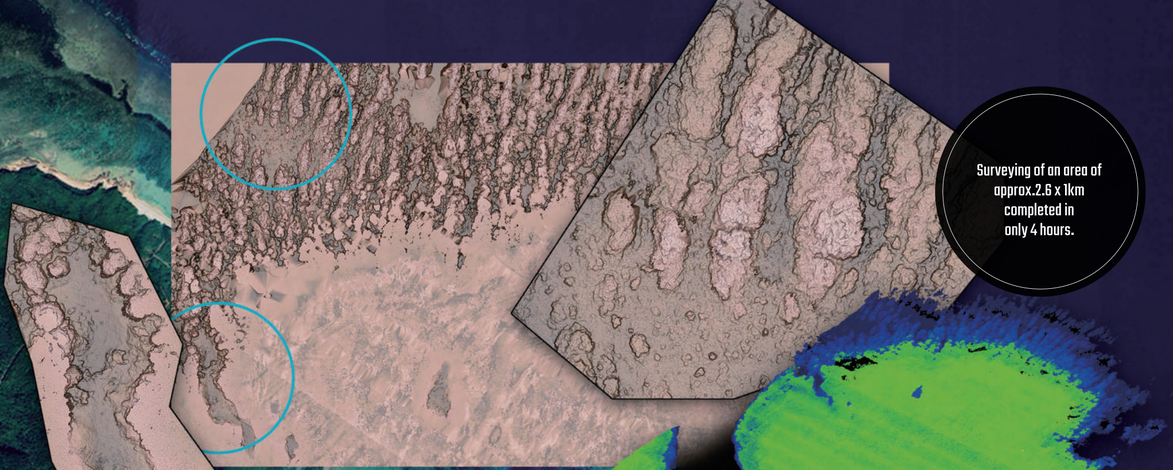
Aerial photo of the site (coral reef in the northwest area)



Cross-sectional view (mangrove forest to coast)

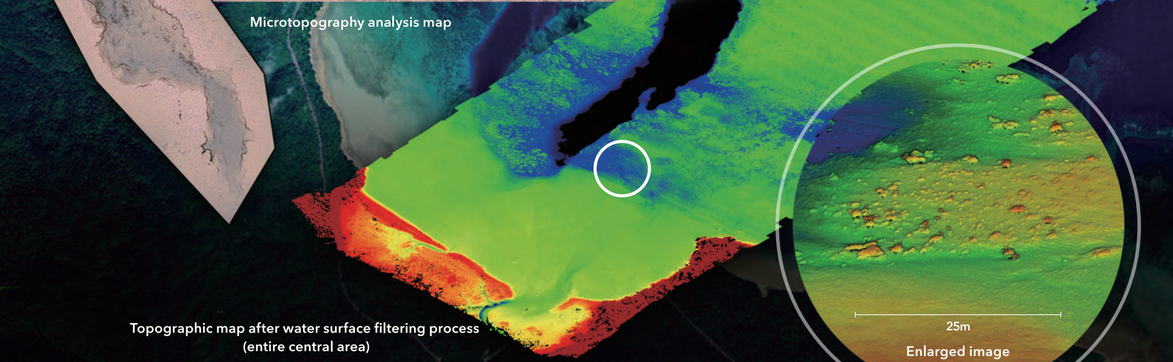


Cross-sectional view (coral reef)



Microtopography analysis map

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



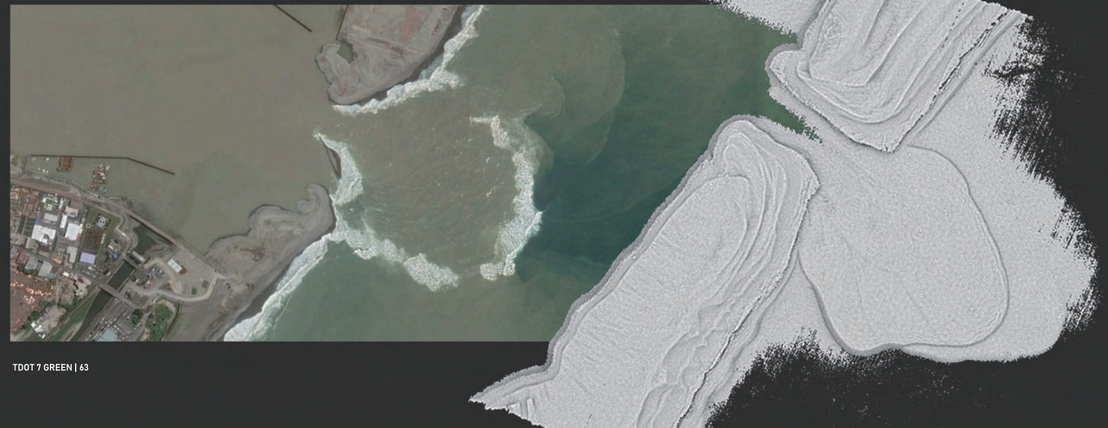
Topographic map after water surface filtering process (entire central area)

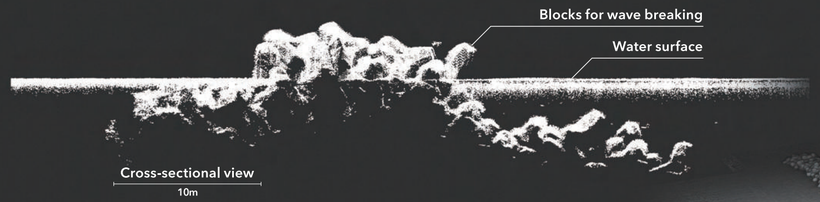
Enlarged image

CASE STUDIES

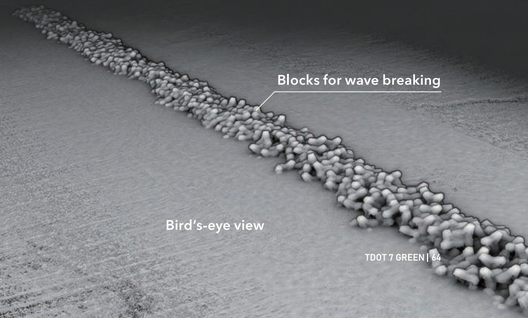
Shallow water survey | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

Near estuaries, sediment is constantly supplied from upstream and can accumulate. Additionally, heavy rain can transport sediment, potentially blocking river channels, necessitating dynamic monitoring after rainfall. With TDOT 7 GREEN, these observations become much easier.





With TDOT 7 GREEN, the condition of offshore wave-dissipating blocks can be confirmed up to a certain depth, contributing to the maintenance of port facilities not only during normal times but also during emergencies such as typhoons and storm surges.



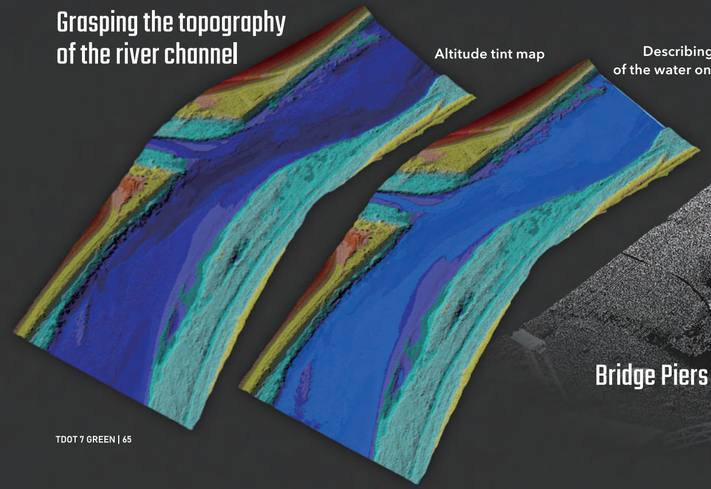
CASE STUDIES

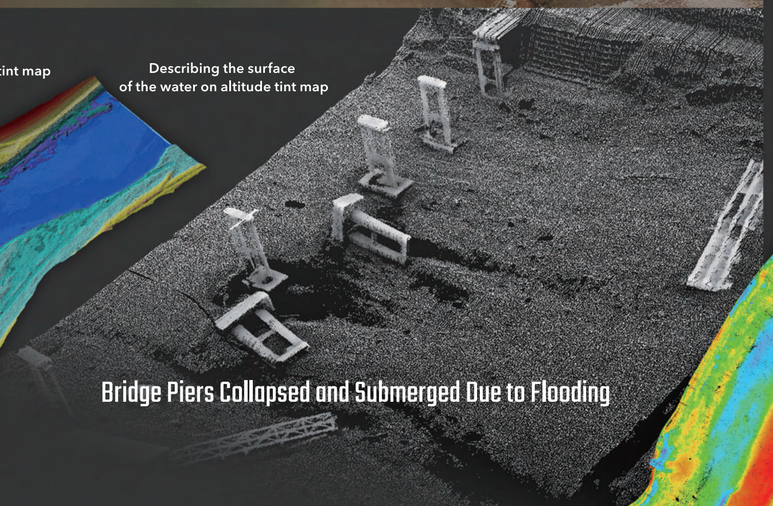
River Survey | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR

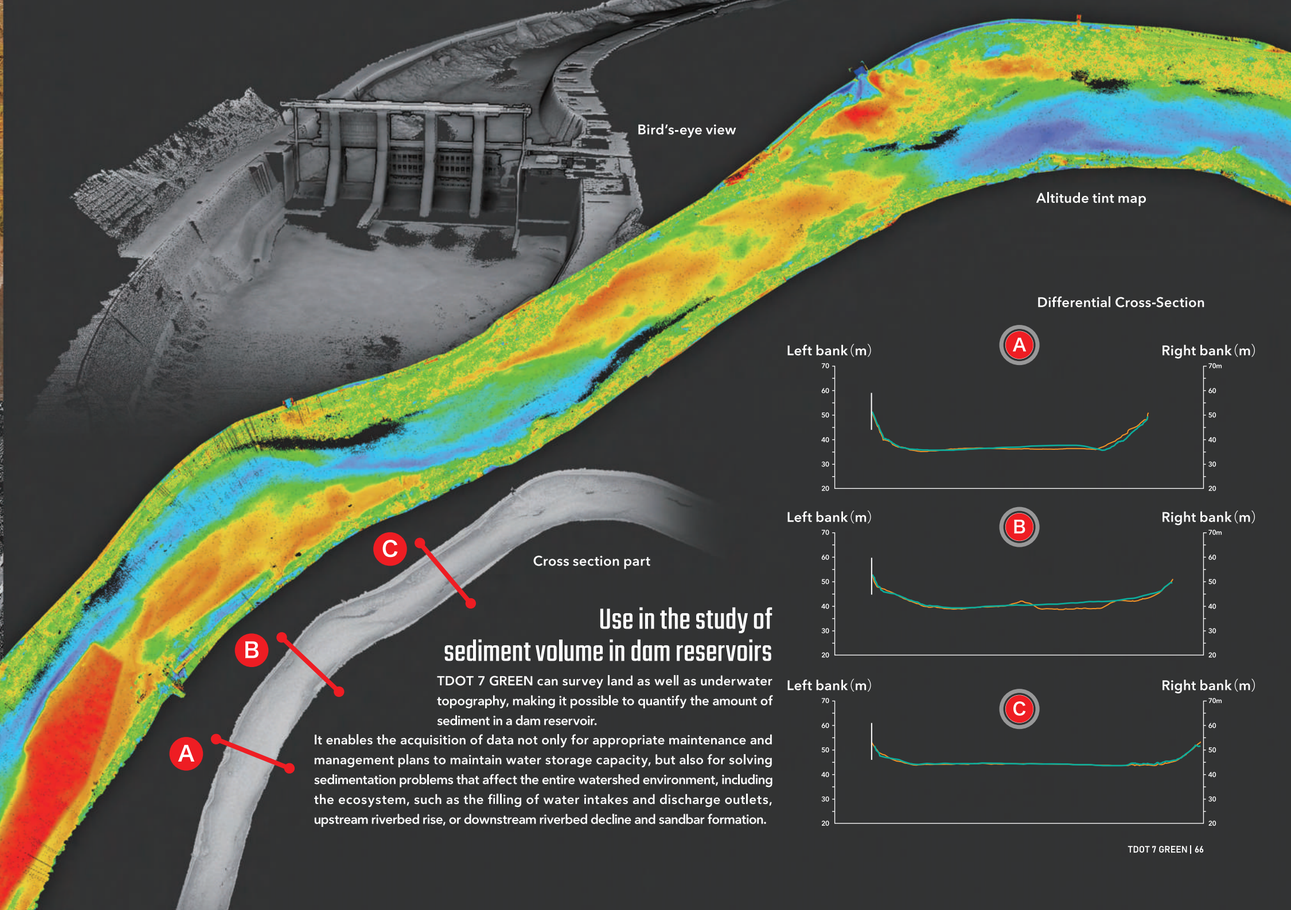
Use in river survey

Using TDOT 7 GREEN allows for surveying riverbeds as well as land and areas beneath vegetation. This enables river channel management using three-dimensional data that cannot be obtained with traditional periodic cross-sectional surveys. By evaluating the distribution of trees and the shapes of tree canopies within the river channel, it becomes easier to predict the occurrence of stagnant water zones formed by riparian forests, and to detect sudden changes in river cross-sections. This improves the accuracy of runoff analysis and water level calculations. Consequently, it enhances flood control capabilities while enabling regionally-focused river management that considers the conservation and maintenance of river environments for future generations.

Grasping the topography of the river channel







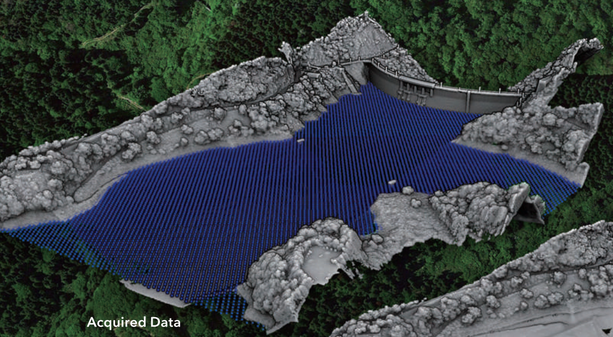
Use in the study of sediment volume in dam reservoirs

TDOT 7 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.

Supporting Dam Surveys

To ensure the functionality of a dam, it is essential to regularly monitor the sedimentation conditions within the reservoir. For instance, if the maximum depth is 80 meters and the water is turbid, a multibeam echosounder is required for depth measurement. However, since multibeam cannot capture shallow areas and the water's edge, using TDOT 7 GREEN allows for comprehensive monitoring from deep areas to the water's edge.



Acquired Data

Data after removing the water surface

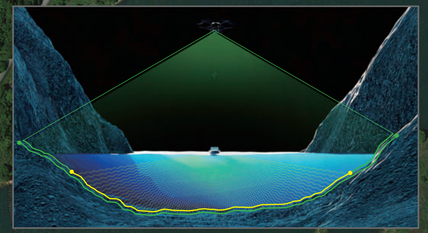
Data after removing the water surface and trees

Acquired Data

Data after removing the water surface

Data after removing the water surface and trees

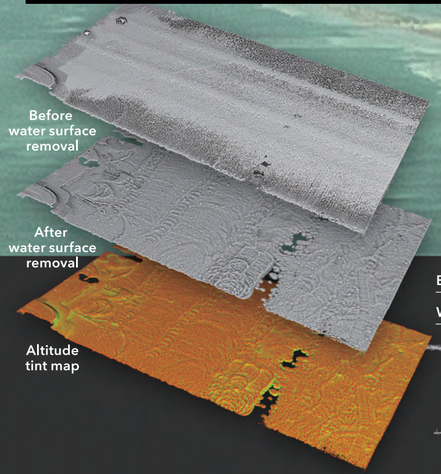
Multibeam-equipped boats and RC boats cannot enter shallow areas.

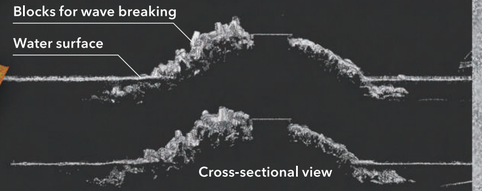


Since multibeam systems are mounted on boats, they cannot be used in areas without sufficient depth. In contrast, TDOT 7 GREEN can capture topography from slightly shallow areas to the land. By combining traditional bathymetric surveys with TDOT 7 GREEN, detailed topography from deep areas to ridges can be visualized.

CASE STUDIES

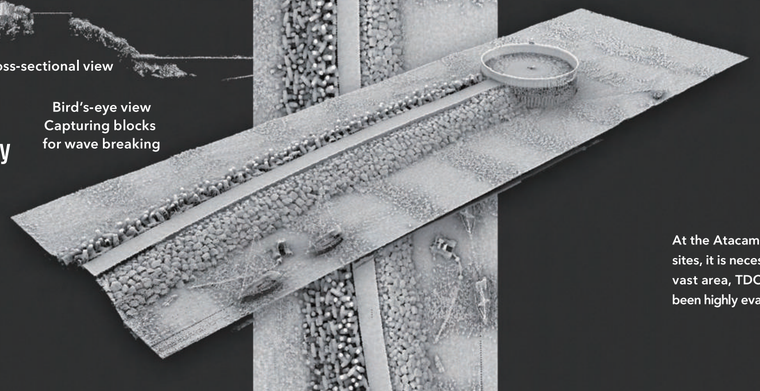
Investigation | TDOT 7 GREEN | TDOT 7 NIR-S | TDOT 7 NIR



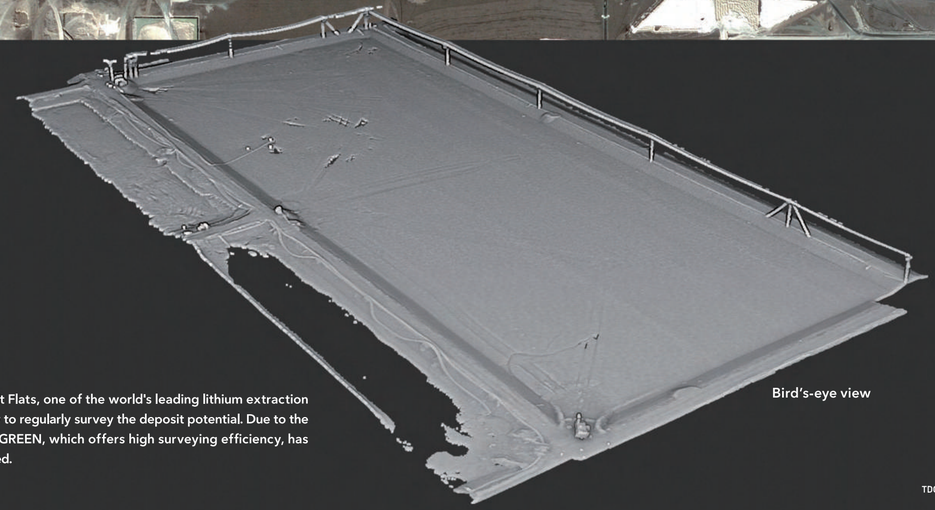


Use in surveying seafloor topography under special conditions
Surveying the seafloor topography of high-salinity seas accurately

Laser light travels more slowly in water than in air, causing refraction at the water surface. When conducting surveys underwater, it is necessary to specify the water surface position, calculate the effects of laser light refraction, and correct the coordinate values for the point cloud underwater. By using the "UNDERWATER CORRECT" application for underwater refraction correction, these calculations to correct for the effects of the refractive index can be automatically performed with simple operations, such as specifying the water surface position from cross-sectional diagrams. The Dead Sea in Israel, a unique salt lake with a salinity concentration of over 30%, has had its precise underwater topography visualized accurately.



Bird's-eye view
Capturing blocks for wave breaking



Bird's-eye view

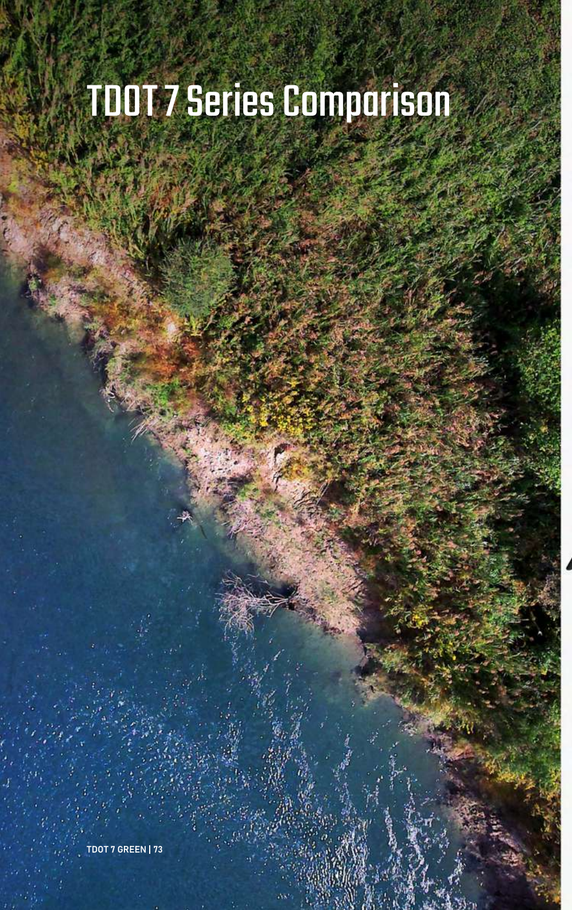
At the Atacama Salt Flats, one of the world's leading lithium extraction sites, it is necessary to regularly survey the deposit potential. Due to the vast area, TDOT 7 GREEN, which offers high surveying efficiency, has been highly evaluated.

TDOT™ 7 SERIES

DRONE LASER SYSTEM

TDOT 7 Series Comparison

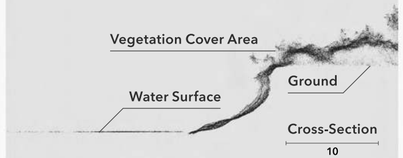
TDOT 7 Series Comparison



TDOT NIR 7
DRONE LASER SYSTEM

Laser Module
RIEGL miniVUX-3UAV

Pulse Rate	: 300,000 Hz
Scan Rate	: 100 lines/second
FOV	: 360°
Number of Returns	: 5
Laser Wavelength	: Near-Infrared

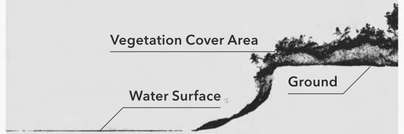


The system is a general-purpose drone-mounted near-infrared laser system that, with its multi-echo capability of 300,000 pulses per second, can sufficiently acquire ground surface data even in areas with vegetation.

TDOT NIR-S 7
DRONE LASER SYSTEM

Laser Module
RIEGL VUX120[23]

Pulse Rate	: 2,400,000 Hz
Scan Rate	: 400 lines/second
FOV	: 100°
Number of Returns	: 32
Laser Wavelength	: Near-Infrared

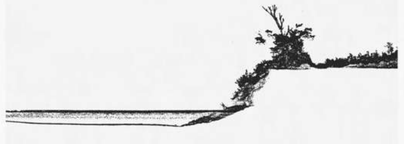


Compared to the TDOT 7 NIR, it can acquire high-density data that clearly captures not only a lot of ground surface data but also the shape of trees.

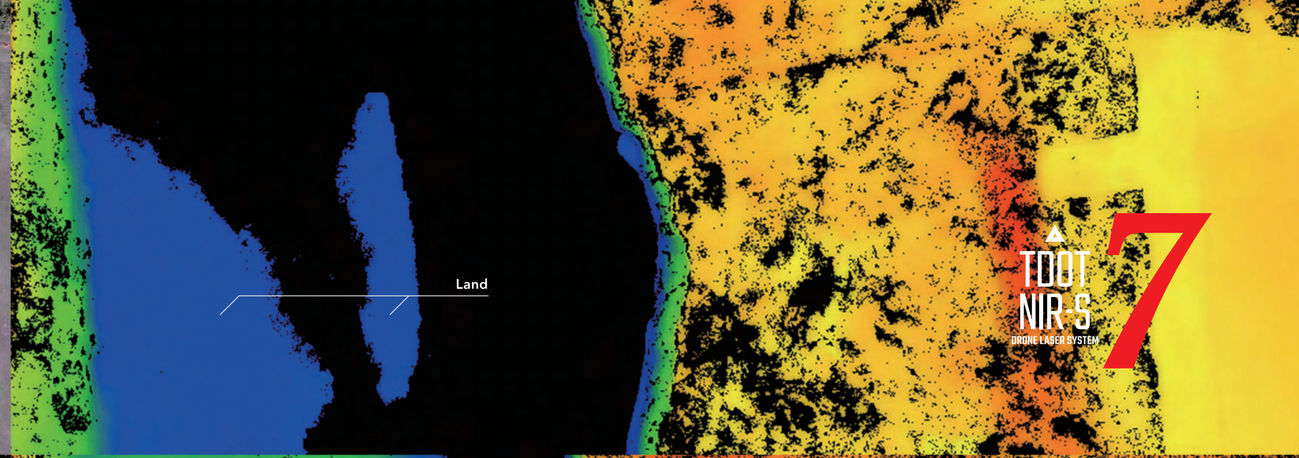
TDOT GREEN 7
DRONE LASER SYSTEM

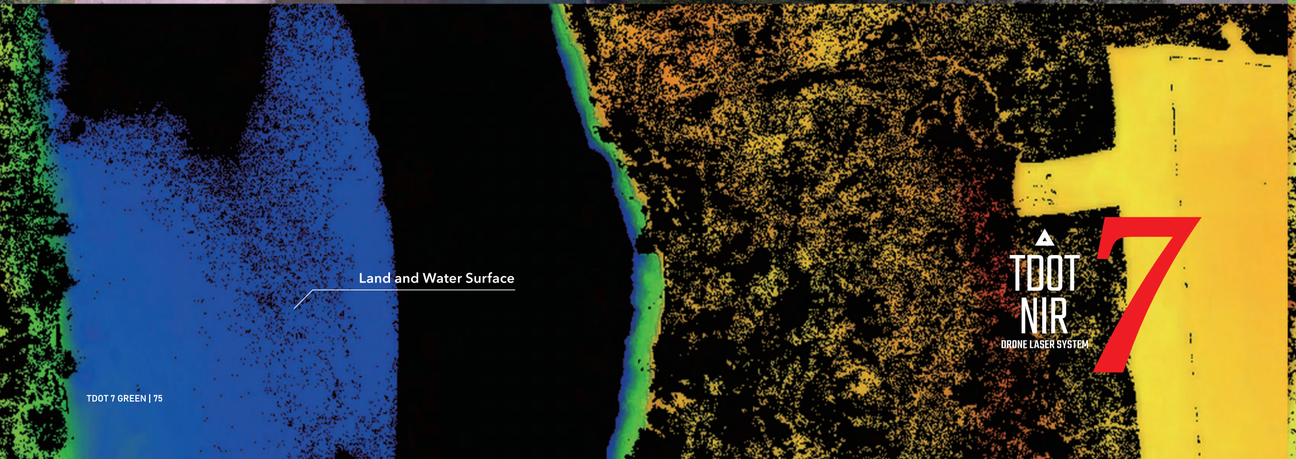
Laser Module
amuse oneself

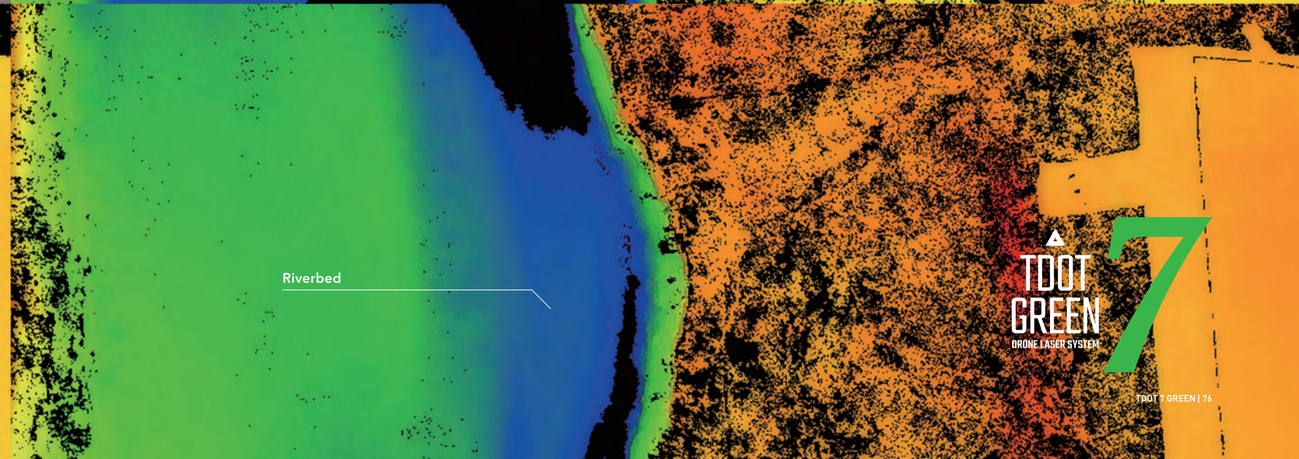
Pulse Rate	: 160,000 Hz
Scan Rate	: 80 lines/second
FOV	: 120°
Number of Returns	: 6
Laser Wavelength	: 532nm Green



In addition to fully capturing ground surface and tree shape data, it can also clearly confirm water surface and riverbed data.


Land
TDOT
NIR-S
DRONE LASER SYSTEM
7


Land and Water Surface
TDOT
NIR
DRONE LASER SYSTEM
7


Riverbed
TDOT
GREEN
DRONE LASER SYSTEM
7

TDOT™ NIR-S 7

DRONE LASER SYSTEM

Ultra-High-Speed Laser System Capable of 3D Surveying at 2.4 Million Points Per Second

Integrates our proud laser scanning system "TDOT" with RIEGL's "VUX120" which has amazing performance of up 2,400,000 pulses per second and 400 lines.

Laser Module

RIEGL VUX120[23]

Laser wavelength	Pulse rate	Scan Speed	Number of Echoes	FOV
Near infrared	2,400,000Hz (maximum)	400Line/sec. (maximum)	32 (maximum)	100°

Laser Scanner Specifications[*1]

Model Name	RIEGL VUX120-23	
Pulse Repetition Rate[*2]	150kHz (minimum)	2,400kHz (maximum)
Maximum Measurement Range (m)[*3,4] Natural Target : ρ≧20/60/80%	760/1,260/1,430 (minimum)	200/350/400 (maximum)
Maximum Flight Altitude (m)[*3,5] ρ≧20/60%	440/720 (minimum)	110/200 (maximum)
Maximum Number of Echoes[*6]	32 (maximum)	5 (minimum)
Minimum Range (m)	5	
Accuracy (mm)[*7,9]	10mm	
Precision (mm)[*8,9]	5mm	
Maximum Scan Speed	50 - 400 lines/second	
Laser Class / Wavelength	Class 1 / Near-Infrared	
Beam Divergence[*10]	0.4 mrad	

TDOT 7 NIR-S Specifications

Product Name	TDOT 7 NIR-S
Product Size	W220 x H180 x D115 mm (excluding camera unit)
Product Weight	2.7 kg
Communication Frequency Band	2.4 GHz
GNSS	GPS, GLONASS, Galileo, QZSS (Quasi-Zenith Satellite System), BeiDou

INS Specifications[*11]

Position Accuracy	5mm
Heading	0.03°
Pitch/Roll	0.006°
Velocity	0.01 m/s

*1 Specifications as of May 2024. For detailed specifications, please refer to the RIEGL website.
*2 Approximate value.
*3 Representative values under average environmental and lighting conditions. Maximum range is shorter in bright sunlight compared to under cloudy skies.
*4 Assumptions: target size larger than laser beam spot size, perpendicular incidence angle, visibility 23 km. Maximum range is shorter in bright sunlight compared to under cloudy skies.
*5 Considering a maximum effective FOV of 100° and an additional roll angle of ±5°.
*6 When a part of the laser beam hits multiple targets, the pulse power is divided, resulting in a shorter range.
*7 Accuracy is the degree of conformity of the measured quantity to its true value.
*8 Precision, also known as reproducibility, is the degree to which further measurements show the same results.
*9 Under RIEGL test conditions, 1σ @ 150m distance.
*10 Measured at 1/e². 0.4 mrad corresponds to a beam diameter expansion of 40 mm per 100 m.
*11 Accuracy after post-processing with the cloud service "POST-PROCESSING CLOUD". A separate subscription is required to use this service.

TDOT™ NIR 7

DRONE LASER SYSTEM

General-Purpose Laser System Capable of Real-Time 3D Surveying

Integrating our proud laser scanning logging system "TDOT Logger" with RIEGL's "miniVUX-3UAV," which achieves up to 300,000 points per second and 100 lines.

Laser Module

RIEGL miniVUX-3UAV

Laser wavelength	Pulse rate	Scan Speed	Number of Echoes	FOV
Near infrared	300,000Hz (maximum)	100Line/sec. (maximum)	5	360°

Laser Scanner Specifications[*1]

Model Name	RIEGL miniVUX-3UAV
Pulse Repetition Rate[*2]	150kHz (minimum)
Maximum Measurement Range (m)[*3] Natural Target : ρ≧20/60/80%	170/290/330
Maximum Flight Altitude (m)[*2,4] ρ≧20/60%	100/160
Maximum Number of Echoes[*5]	5
Minimum Range (m)	2m
Accuracy (mm)[*6,8]	15mm
Precision (mm)[*7,8]	10mm
Maximum Scan Speed	10 - 100 lines/second
Laser Class / Wavelength	Class 1 / Near-Infrared
Beam Divergence[*9]	1.6 x 0.5 mrad

TDOT 7 NIR-S Specifications

Product Name	TDOT 7 NIR-S
Product Size	W315 x H140 x D110 mm
Product Weight	2.4 kg
Communication Frequency Band	2.4 GHz
GNSS	GPS, GLONASS, Galileo, QZSS (Quasi-Zenith Satellite System), BeiDou

INS Specifications[*10]

Position Accuracy	5mm
Heading	0.03°
Pitch/Roll	0.006°
Velocity	0.01 m/s

*1 Specifications as of May 2024. For detailed specifications, please refer to the RIEGL website.
*2 Approximate value.
*3 Assumptions: target size larger than laser beam spot size, perpendicular incidence angle, visibility 23 km. Maximum range is shorter in bright sunlight compared to under cloudy skies.
*4 Assuming flat terrain, FOV ±45°.
*5 When a part of the laser beam hits multiple targets, the pulse power is divided, resulting in a shorter range.
*6 Accuracy is the degree of conformity of the measured quantity to its true value.
*7 Precision, also known as reproducibility, is the degree to which further measurements show the same results.
*8 Under RIEGL test conditions, 1σ @ 150m distance.
*9 Measured at 50% peak intensity. 1.6mrad corresponds to a beam diameter expansion of 160mm per 100m.
*10 Accuracy after post-processing with the cloud service "POST-PROCESSING CLOUD". A separate subscription is required to use this service.

TDOT 3 GREEN R

Scheduled to Launch in 2024

TDOT GREEN R 3

DRONE LASER SYSTEM

Scheduled to Launch in 2024

Compatible with DJI MATRICE 350 RTK Lightweight Green Laser Scanner System

The TDOT 3 GREEN R is a surveying solution tool that can capture not only the terrain of mountainous areas but also riverbeds, coastal areas, and the state of disaster-stricken areas immediately after heavy rain. It is a lightweight model compatible with the DJI MATRICE 350 RTK.

Laser wavelength	Pulse rate	Scan Speed	Number of Echoes	FOV
532nm (GREEN LASER)	60,000Hz	30Line/sec.	4	90°

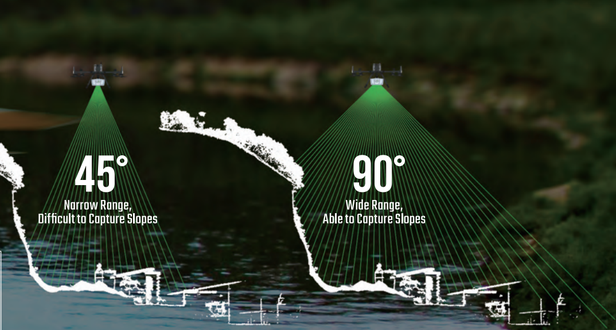
Laser Scanner Specifications

Product Name	TDOT 3 GREEN R (Certified Refurbished Product)
Product Size (approx.)	W270 × D230 × H150mm
Product Weight (approx.)	2.7kg (main unit only, excluding antenna)
Maximum Measurement Distance	≧10% at 158m
Distance Measurement Accuracy	≧10% at ±15mm
Pulse Rate	60,000Hz
Field of View	90° (±45°)
Echo Switching	1st & Last / 4 echoes
Scan Speed	30 lines/second
Laser Wavelength	532 ± 1nm
Beam Divergence	1.5mrad
Laser Class	Class 1 within 40m AGL Class 3R above 40m AGL
Depth Measurement Capability (at 50m altitude)	R=1.0, Absorption Coefficient= 0.25 (1/m) > 1.4 secchi*1

INS Specifications*2

Position Accuracy	5mm
Heading	0.03°
Pitch/Roll	0.006°
Velocity	0.01 m/s

*1 A 30cm diameter white disk (transparency disk or secchi disk) is submerged in water, and the depth at which it becomes invisible is measured as 1 secchi.
*2 Accuracy after post-processing with the cloud service "POST-PROCESSING CLOUD". A separate subscription is required to use this service.



Field of View Suitable for Drone Laser Surveying

The accuracy of elevation measurement in drone laser surveying is determined by adding the precision of GNSS to the distance measurement accuracy of the laser. However, as the scan angle deviates from the vertical direction, the attitude measurement accuracy during laser emission significantly affects the elevation accuracy. The TDOT 3 GREEN R limits the field of view (FOV) to 90° to prioritize obtaining elevation values with minimal influence from attitude measurement accuracy. Additionally, the narrower the FOV, the more challenging it becomes to survey vertical surfaces, as illustrated above.

Real-Time Display of Survey Data and Status

You can view cross-sectional data in real time during the survey. This allows you to verify in-flight the acquisition status of ground surface data beneath vegetation in densely wooded areas, or the extent to which the laser light reaches the seabed in underwater areas, enabling efficient surveying operations without rework. Additionally, the status of the TDOT 3 GREEN R can be checked via smartphone.

*To view cross-sectional data during the survey, the drone must be equipped with an image transmission device that can connect to HDMI. In the case of DJI's DJI MATRICE 350 RTK, viewing is possible through DJI SkyPort.

TDOT™ 7 SERIES

DRONE LASER SYSTEM

Compatible Drones

Compatible Drones

AMUSE ONESELF

GLOW.H HYBRID DRONE

Maximum 4-Hour Flight Time
Japanese Hybrid Drone

The GLOW.H is a hybrid drone equipped with a range extender developed to extend the driving range of electric vehicles. By continuously charging its built-in battery during flight, it can achieve significantly longer flight times compared to traditional battery-powered drones.

AMUSE ONESELF

GLOW.L Li-ion BATTERY DRONE

Superior Portability and Enhanced Mobility
Standard Platform for Industrial Drones

The GLOW.L is an industrial drone equipped with a highly reliable, intelligent battery. To maximize the functionality of the sensors mounted on the drone, unnecessary components have been eliminated, and the drone's weight has been reduced based on optimized weight balance. This allows for stable programmed flights.

Build Flyer chrome
by Ishikawa Energy Research

PD4B-M
by PRODRONE

Aurelia X6 MAX
Aurelia Technologies Inc.

Compatible Drones (Example)

		TDOT 7 GREEN	TDOT 7 NIR-S	TDOT 7 NIR	TDOT 3 GREEN R
amuse oneself	GLOW.H	●	●	●	●
amuse oneself	GLOW.L	●	●	●	●
Ishikawa Energy Research	Build Flyer chrome	●	●	●	●
PRODRONE	PD4B-M	●	●	●	●
Aurelia Technologies	Aurelia X6 MAX	●	●	●	●
DJI	Matrice 350 RTK	—	●	●	●

AMUSE ONESELF™

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