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3D Scanning Technology in the Transportation Infrastructure: Case Studies from Around the Globe

Overview

- What does 3D Scanning have to do with Economic Growth?
- Evolution of 3D Scanning in Construction
  - What are the keys to success?
  - Innovative Technologies lighting the way
- International Examples

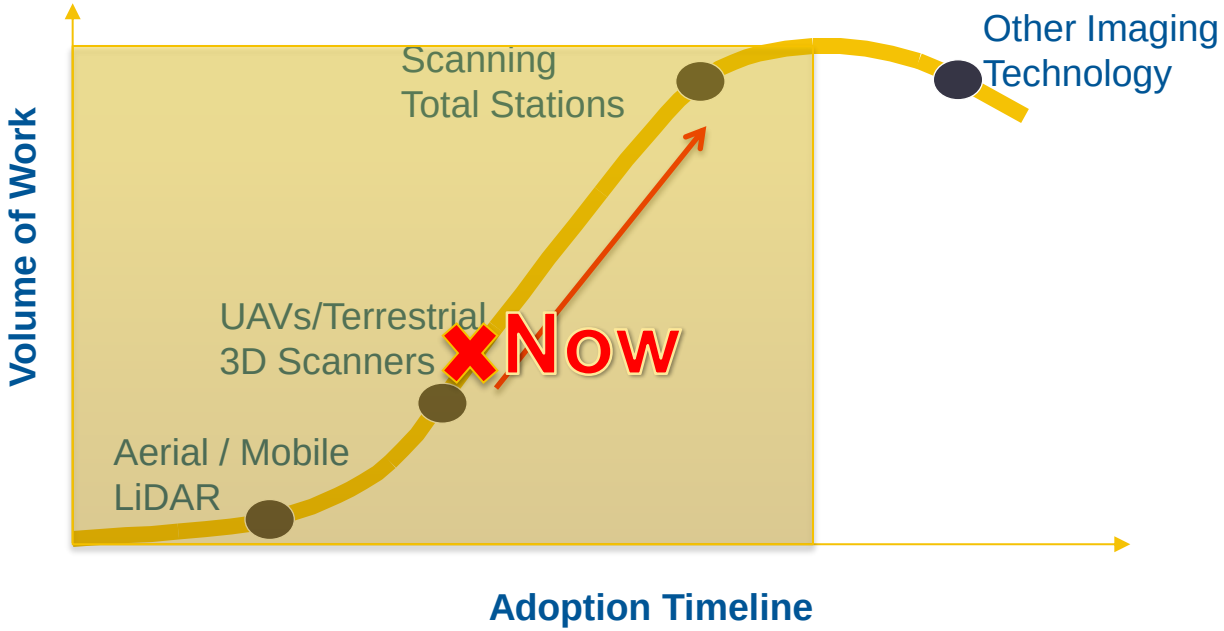
3D Scanning and Economic Growth

- Economic Growth happens when total output relative to the total capital and labor inputs grows – in other words, we find ways to be more productive – usually we look at Total Factor Productivity

$$TFP_t = \left(\frac{Y_t}{L_t}\right)^{[1-a_t]} \left(\frac{Y_t}{K_t}\right)^{a_t} \qquad [1-a_t] = \frac{W_t L_t}{P_t Y_t}$$

- 3D Scanning in infrastructure development was not helping productivity until very recently due to high cost of the technology, including labor
- With the introduction of low-cost scanners, improvements in field and office work flows, UAVs, mobile scanning, and scanning total stations, adoption rates are rapidly increasing

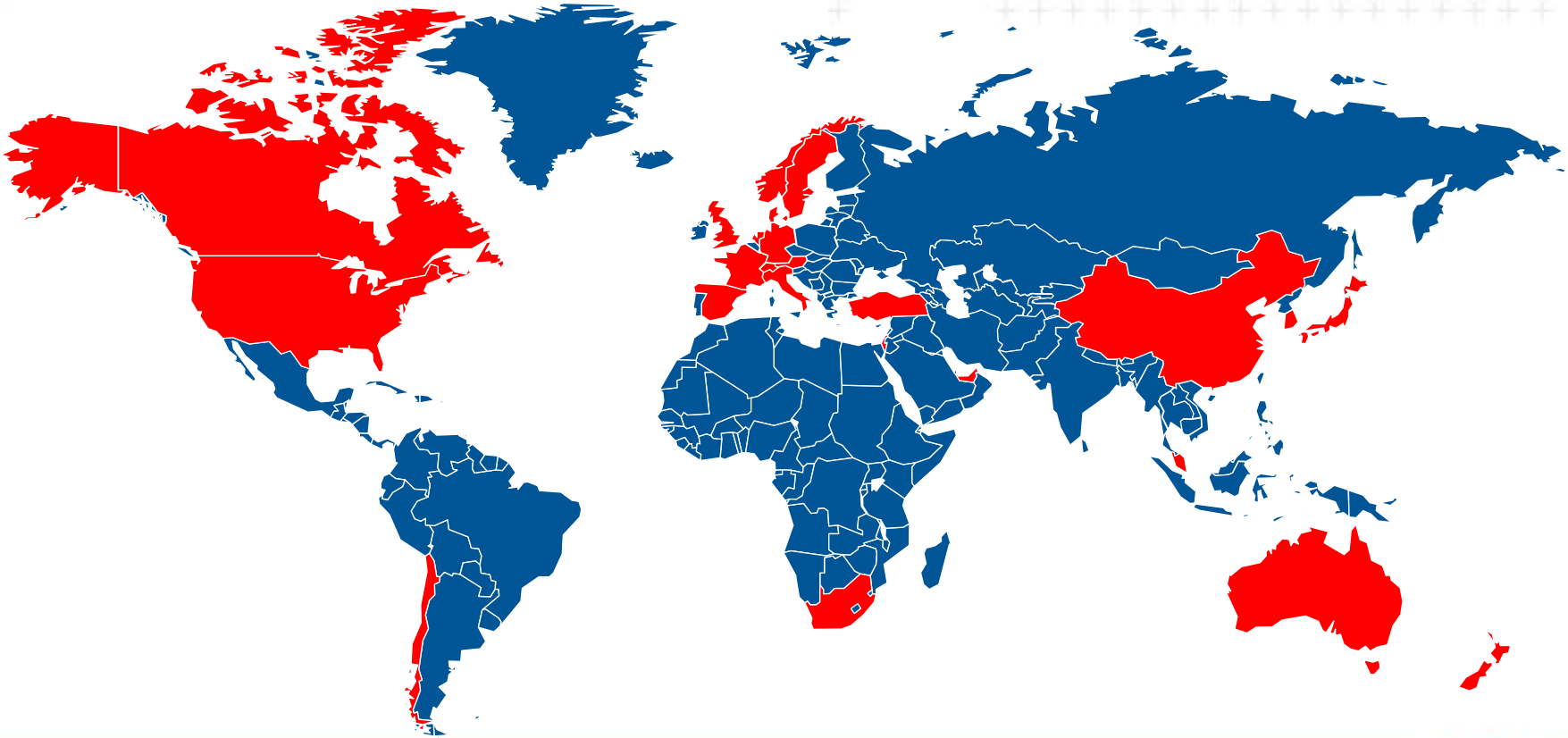
Global Adoption of 3D Scanning



Recent Advancements in 3D Scanning Technology

- Aerial
- Mobile
- **Terrestrial, Onsite, Anytime…..**
  - **Innovation in how the scanning is done faster while accounting for the slower speed of the total station: Scanning Total Stations**
- **Software that makes sense to the Surveyor and Geospatial Professional**
  - **This is KEY!!! You need combined workflows and processing capabilities**
  - **Revolution in 3D Scanning only happens if it can easily be adopted by those who can easily understand its uses**
- **Deliverables that meet the need for today's customers and can act as the "Connective Tissue" of a project throughout its life**

International Examples – where is the action?



Case Studies: Japan's "i-Construction"

Case Studies: Japan's "i-Construction"

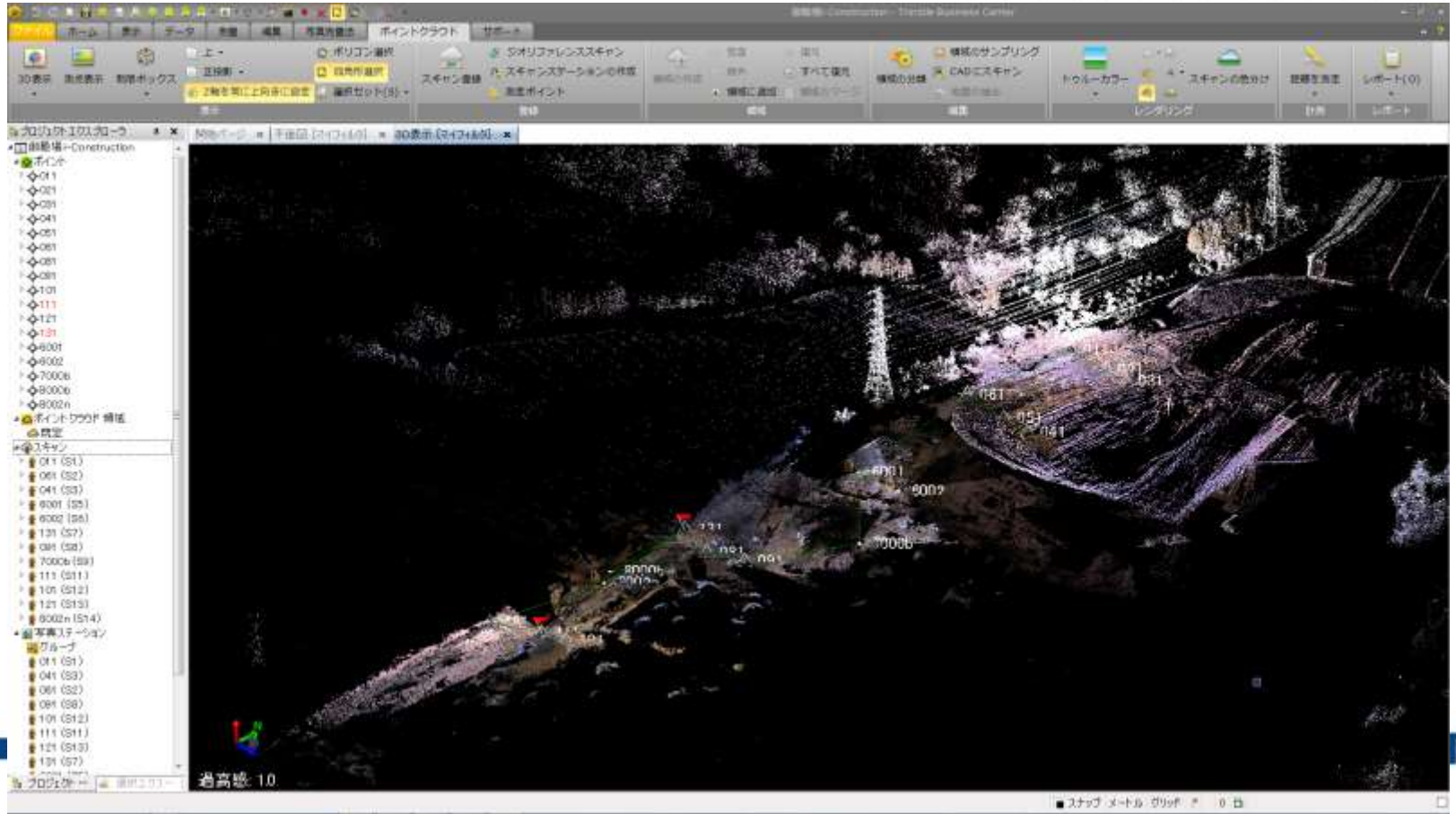
- Cash is King! – "i-Construction" has its roots in the need for financial resources to be used more efficiently and more effectively
  - 3D Scanning technology supports "Just-In-Time Financing" of construction projects, allowing banks and project owners to deploy capital at a lower cost
- **3D "Quantification"** of the work done = **Quantification of Payment**
- Most projects include
  - site planning, modeling
  - Volumetrics, As-Built surveys
  - Constructible Models for maintenance and asset management
- Government drives the requirements, market is responding by employing new technologies of which 3D scanning is a principle component

Case Studies: Japan (1)

- Site : Shizuoka Gotenba-shi
- Date : 13 January 2017
- Work type：Groundwork 3D Survey using Trimble SX10
- Number of Control Points：known 12
- Area:100m × 500m
- Number of Staff : 1

Survey Area on Google Earth

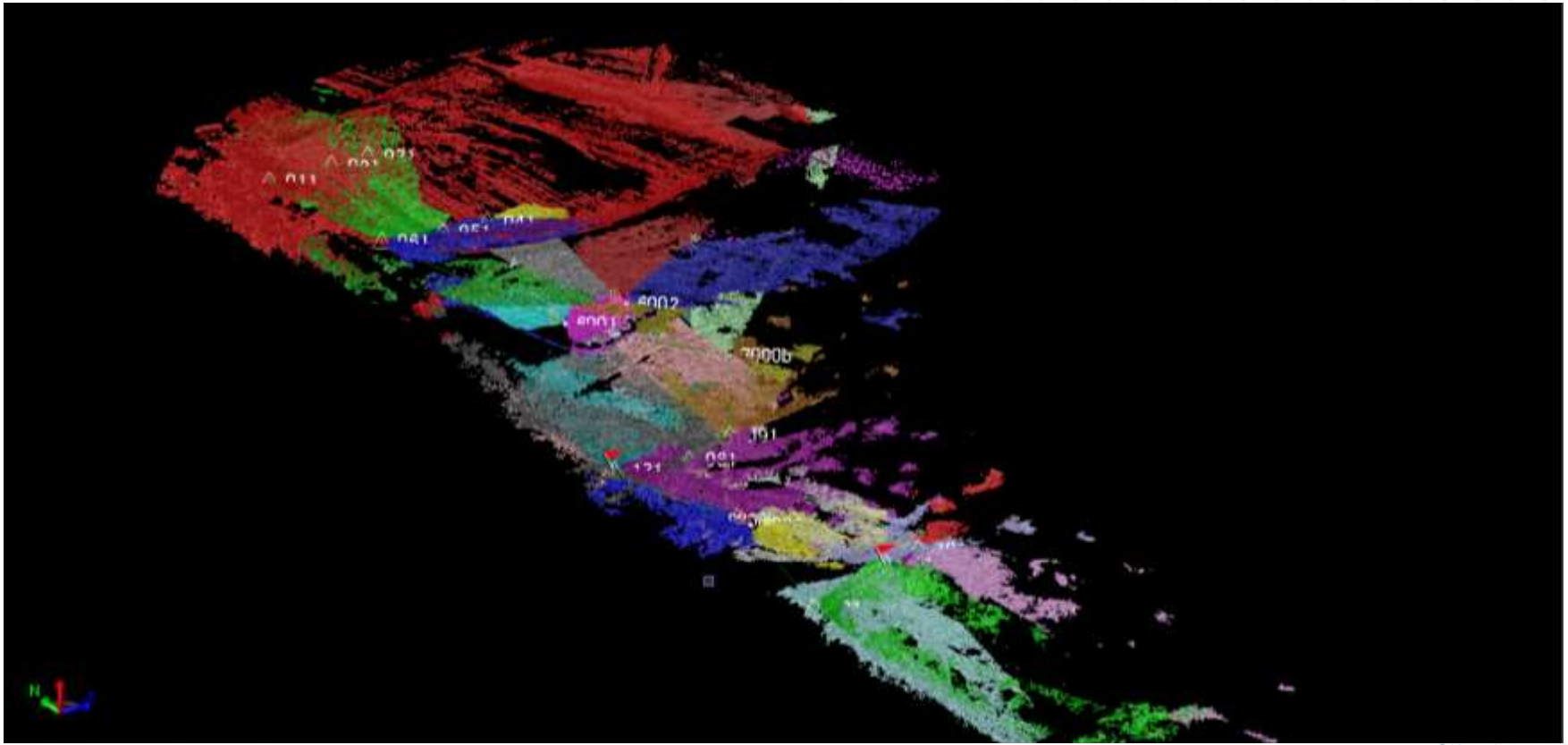
Point Cloud（All）



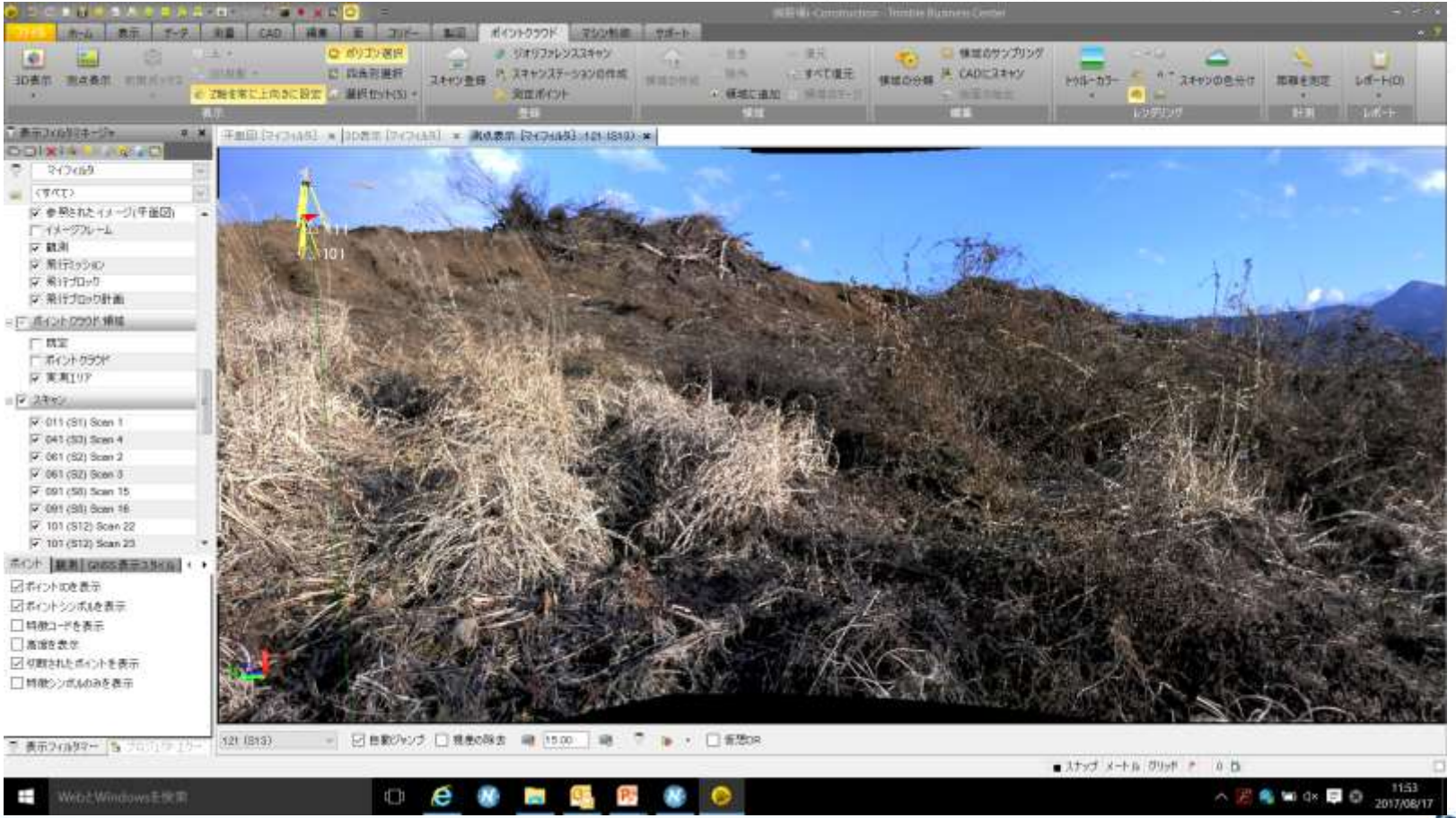
Trimble.


Area for first Scan
Area for 2nd Scan

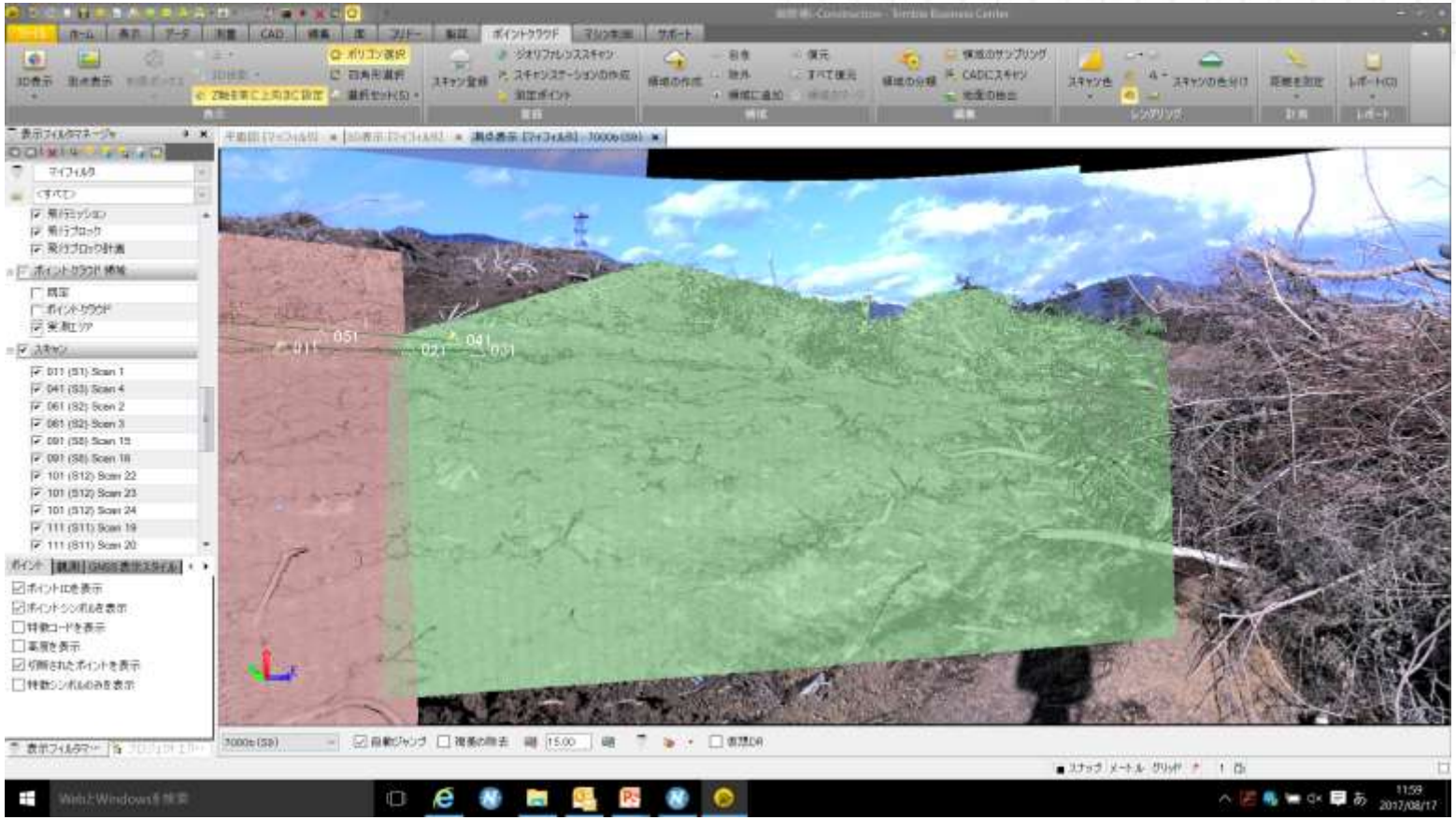
Point Cloud（Color by station after noise reduction ）



Station Panorama View on TBC



Station Panorama View and Point cloud on TBC



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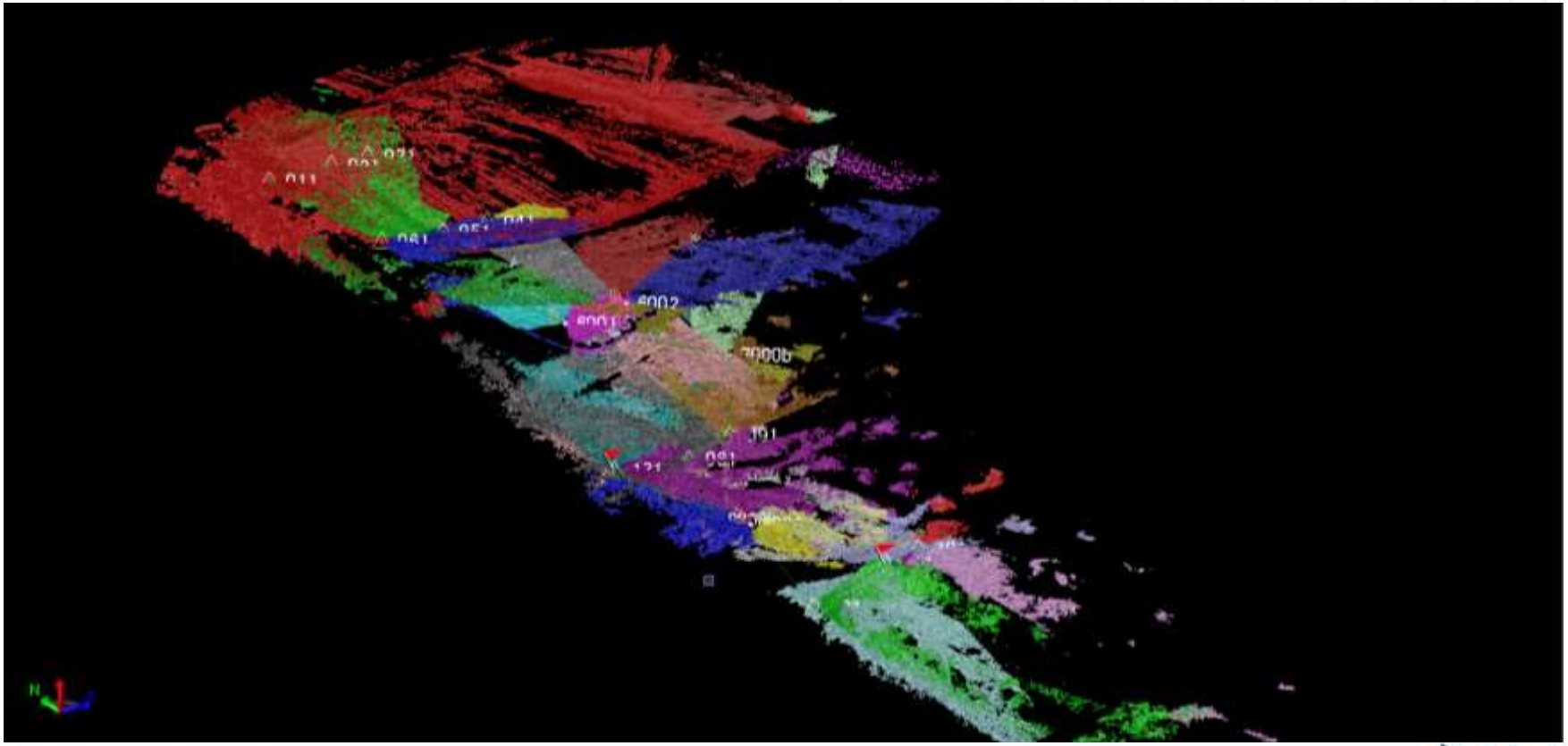
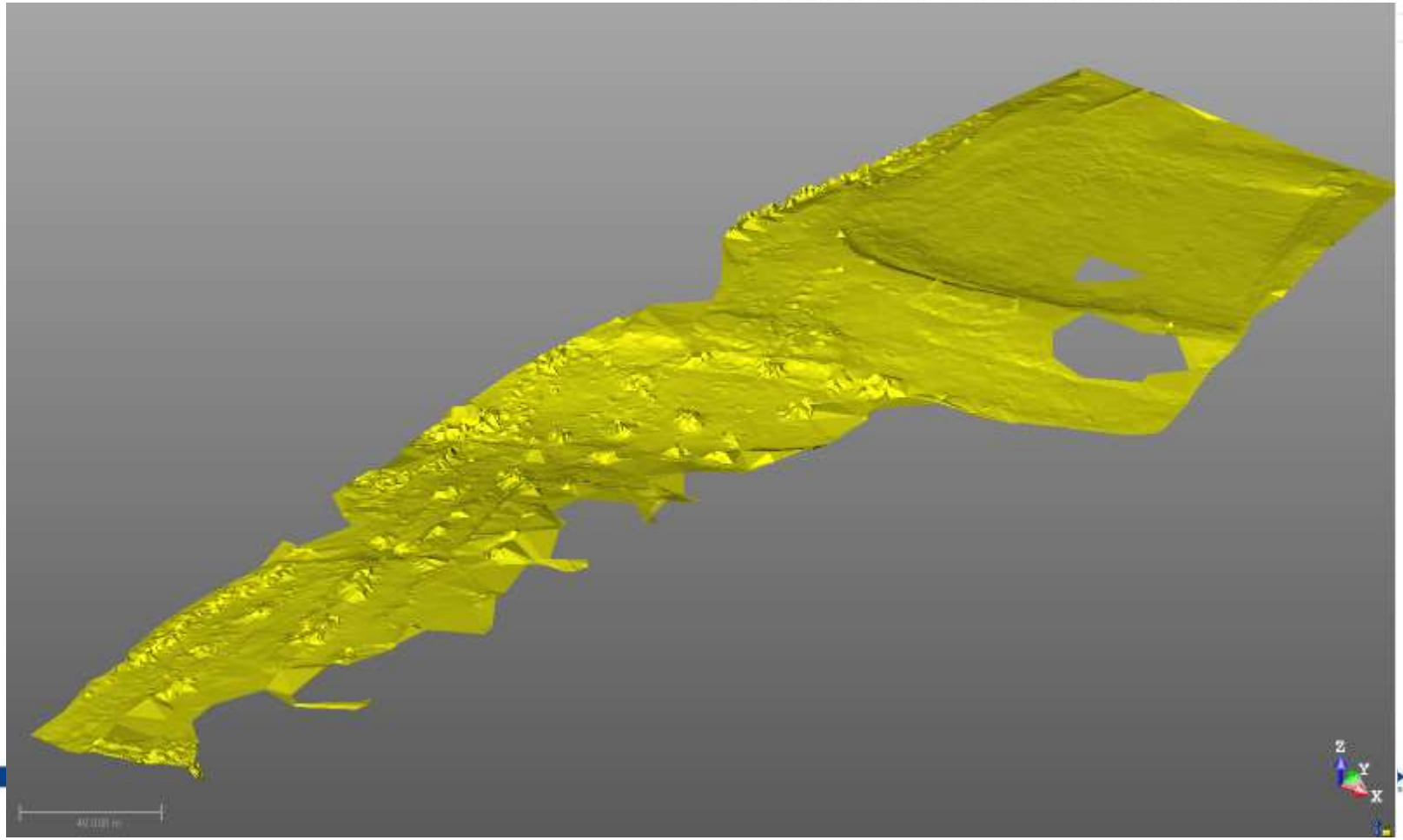


TIN Mesh data from Point cloud



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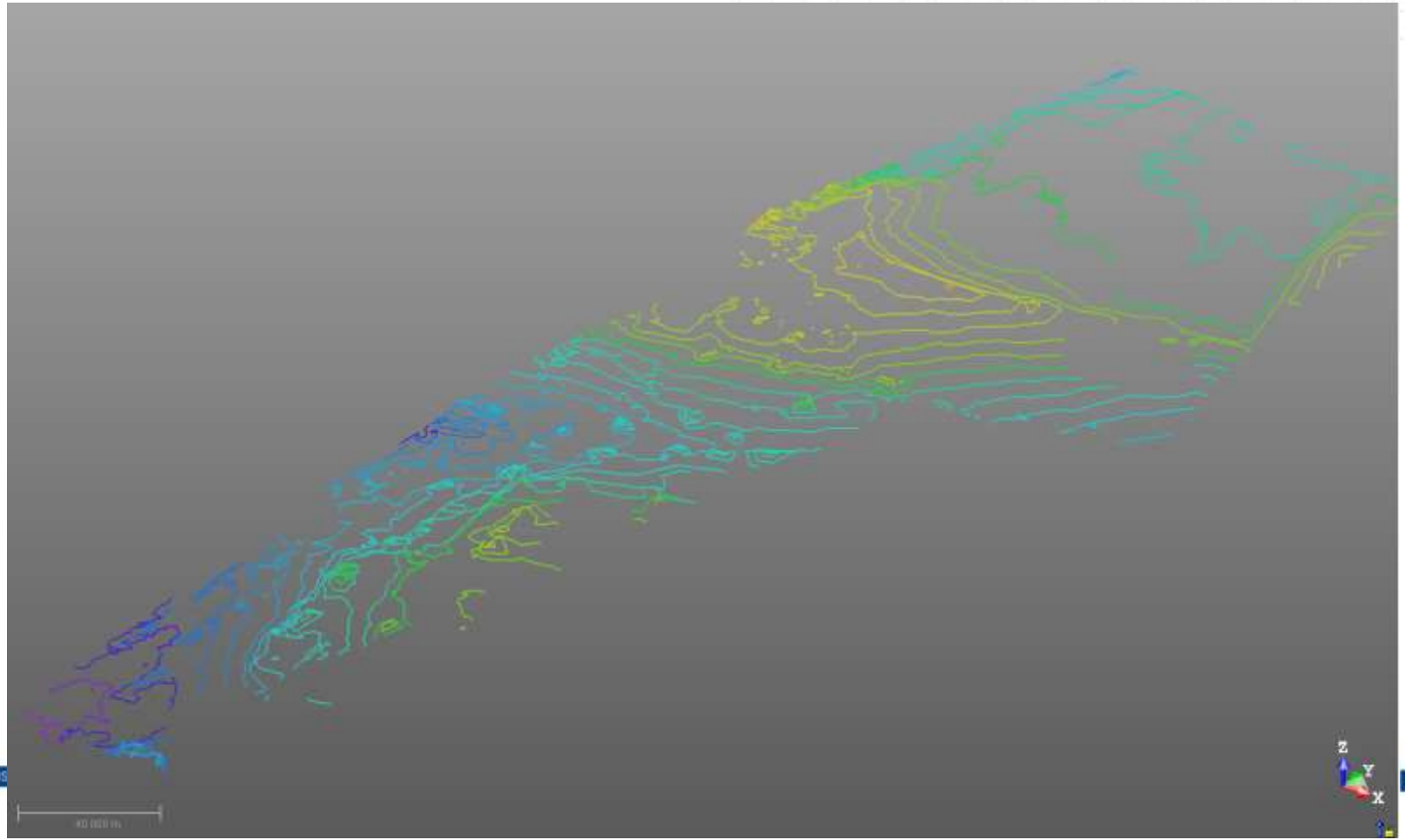
Contour from TIN mesh data

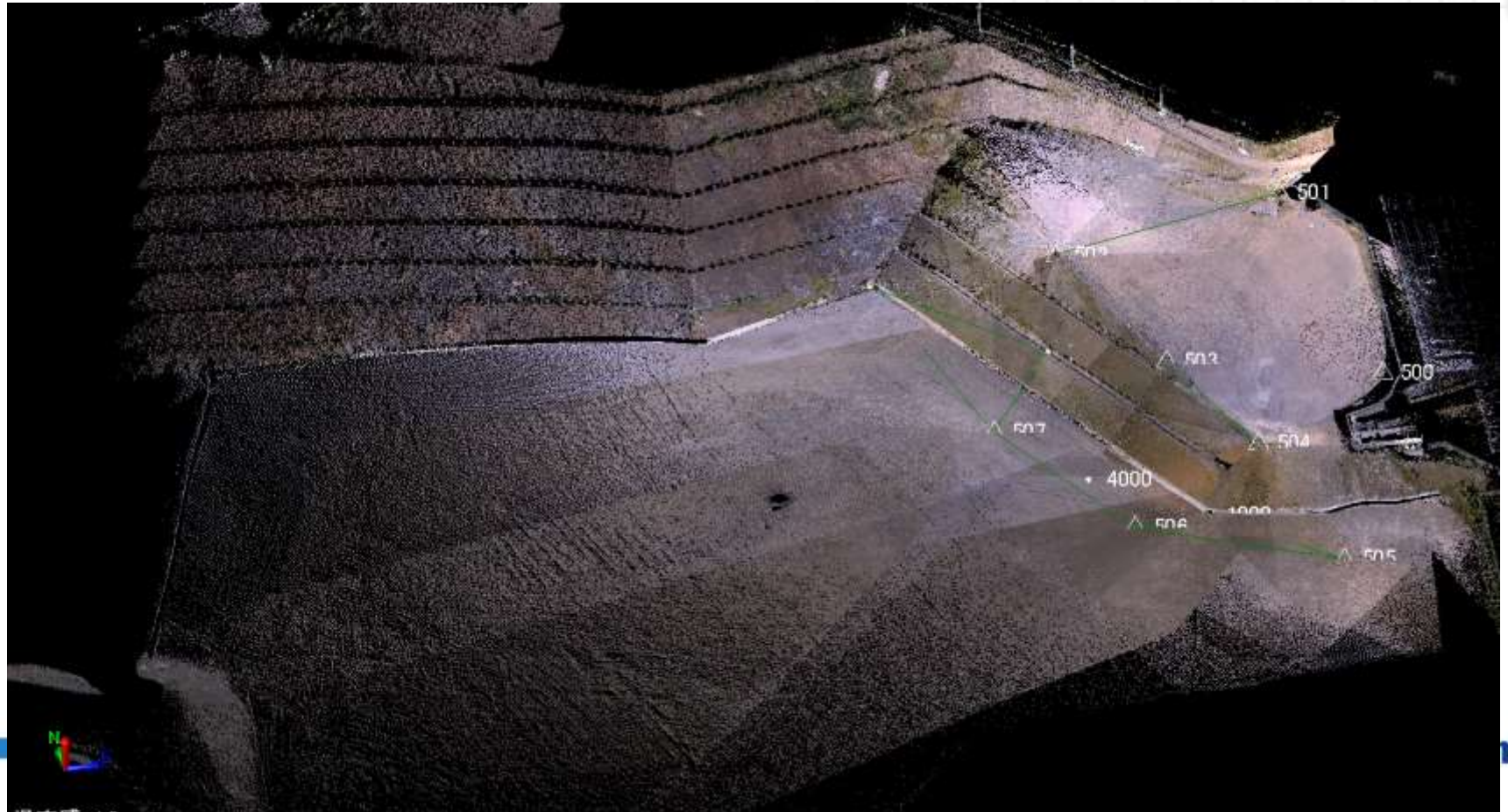


Case Studies: Japan (2)

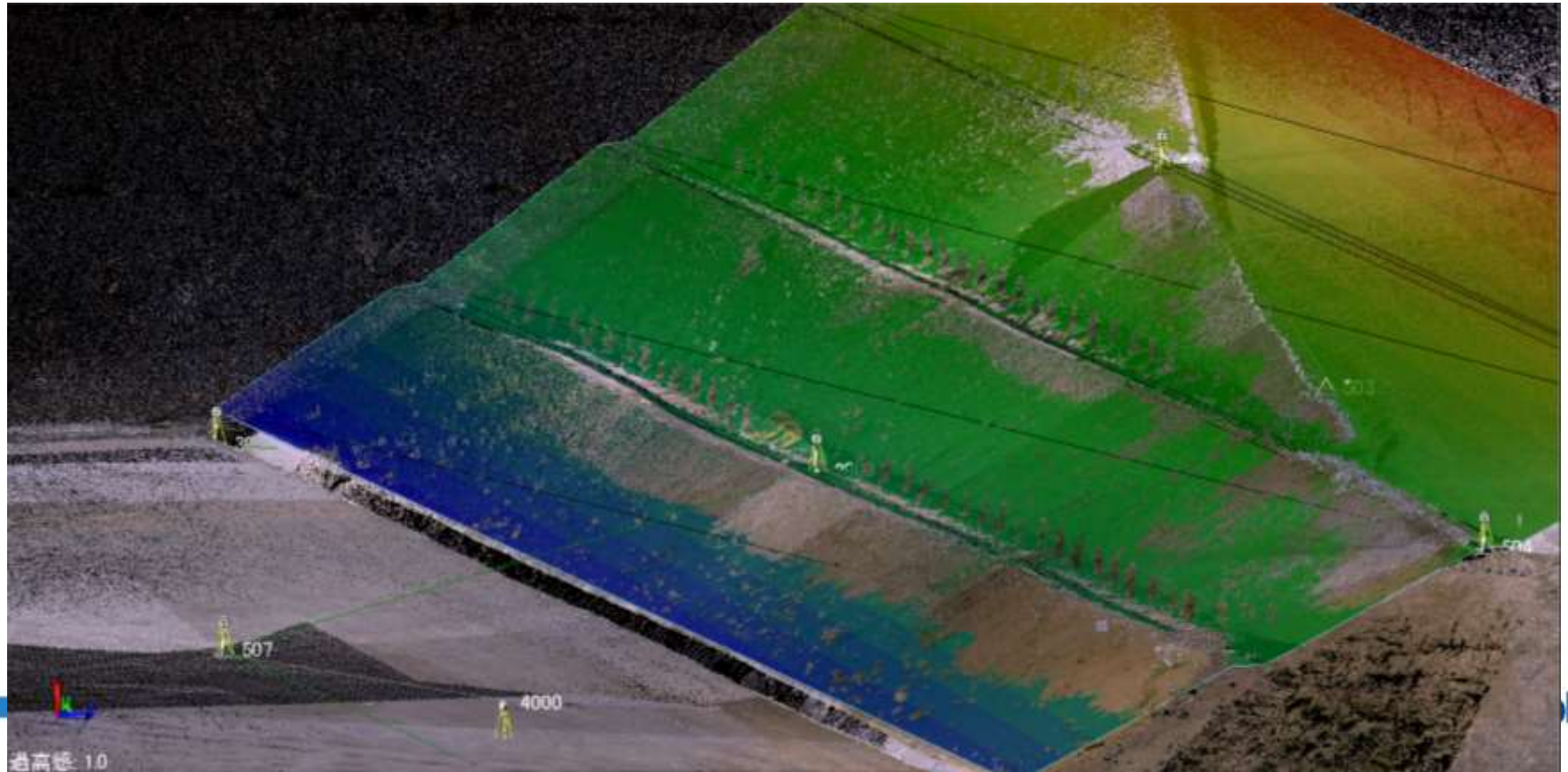
- Site : Wakayama Iwade
- Date : 1 August 2017
- Work type : 3D Survey using Trimble SX10
- Number of Control Points : Known 6 by Trimble R10
- Total Volume of point Cloud : Around 30 million
- Area: 300m × 500m
- Number of Staff : 2
- Working hours : 8 h

Survey Area on Google Earth

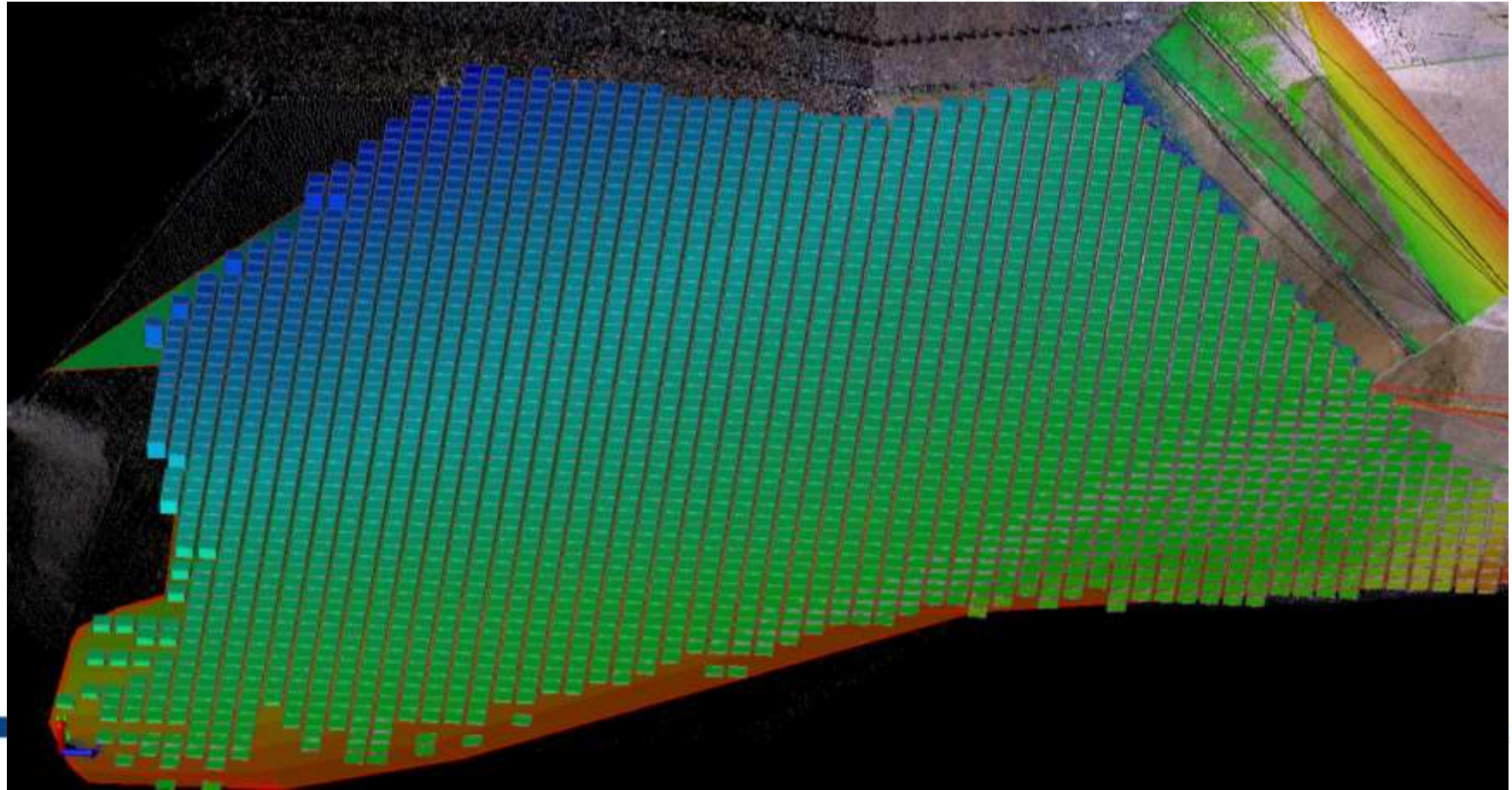
Point Cloud（All）



Inspection between 3D design(LandXML) and landform(Point Cloud of After work)



Volume check from 3D design(LandXML)



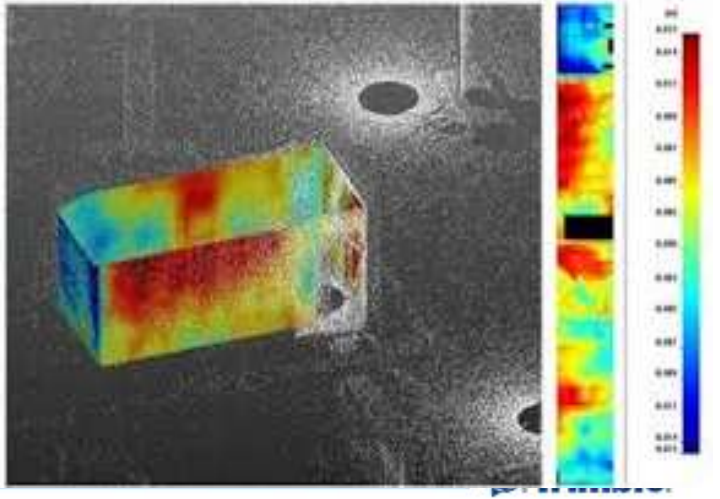
Case Studies: South Africa

- Trimble SX10 Scanning Total Station used by one of South Africa's leading building construction companies, based in Johannesburg

- During the on-site demonstration, approximately 8,5 million points were collected, in 12 minutes from a single set-up, reducing field work
- Besides impressive features like 1" accuracy, high-speed robotics and the ability to perform 3D laser scanning at a rate of 26600 points per second, when used in conjunction with Trimble Realworks office software the SX10 proved its worth in three key areas: Productivity, Quality and Workforce Management.

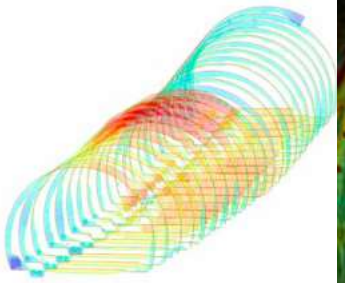
Case Studies: South Africa

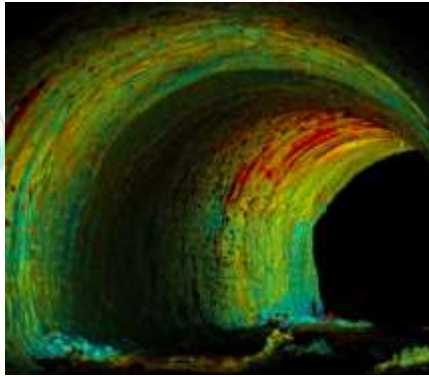
- In one day, a one man crew and one instrument was able to cover the field work of 3-4 2-man crews working with total stations and scanners
- Identify missing or out-of-tolerance construction work for immediate remedial action and avoiding costly delays
- Floor flatness inspections to ensure prescribed accuracy tolerances and optimal use of expensive materials
- Slab deformation due to post stressing or load deformation to find out who is liable for additional expenses
- Lift shaft verticality analysis for best fit and setting out of façade & curtain wall systems.
- Optimisation of plaster on vertical surfaces
- Software easy to use and can produce deliverables accepted by multiple levels of contractors and owners in the project



Case Studies: Turkey

- Istanbul tunnel construction – marquee project
- as-built surveys, as-built-to-model analysis, cut/fill analysis, quality control all key to success
- Prime contractors and site managers can now use 3D scans to manage subcontracte work, QC and pass on data to peer contractors
- Site does not need to shut down using scanning total stations, field workflow enables huge cost savings to the entire project due to this fact





Case Studies: Turkey

- Istanbul tunnel construction – field and office software plays a key role
- Surveyor-friendly software in the field, powerful processing and modeling software in the office enabled reduction in data collection and more advanced, meaningful deliverables for prime contractors

Aks, tipkesit ve nokta bulutu seçilerek tünel projesinden analiz modeli oluşturulması

İç yüzey grafiği, 3B kesit görüntüsü ve çizgisel farklar grafiğinin aynı anda incelenmesi

Case Studies: Norway

- Trimble SX10 used in bridge construction
- Scans of
  - Bridge support pillars (complex geometry of Farris bridge)
  - Areas along the road where the terrain has been excavated/blasted
  - Deposit area for surplus material (reverse volumetrics)
  - Tunnels to verify/control scans from other contractors
  - Concrete support walls and the zig-zag-‘wall’ coming up from the water
- Field work flow covered standard campaign structural monitoring as well as engineering-oriented scans for structure construction, data was processed in Trimble Business Center and viewed in Gemini for visualization and comparison to 3D models
- Scans were repeated on a regular basis to determine if deformation was occurring

Case Studies: China

- Readying China's Rust Belt cities for urban reconstruction
- What buildings stay, what buildings go, where do existing roads need repair, what roads need reconstruction or demolishing

Field data collection

Point clouds registration

CAD drafting

Points clouds export

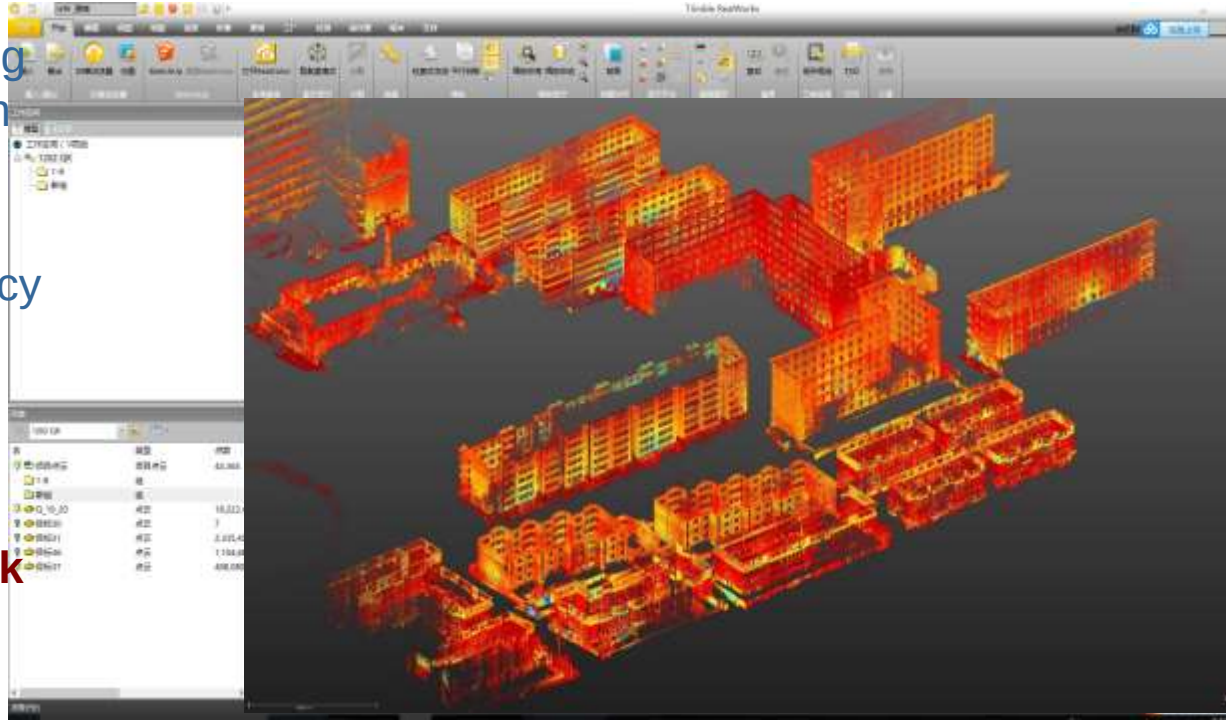
Case Studies: China

- Project Scope: Complete a 5cm survey of 900 buildings in Changchun city for quality assessment, timeline 1 month
- Traditional workflow using total stations required one 2-man crew to survey 3 buildings per day, field work needed to be done in 10 days to allow for office processing and deliverable creation, that meant 90 buildings per day would require 30 crews (60 surveyors) at a huge cost
- Using the Trimble SX10 and TX8 an average of 30 buildings per day could be surveyed with a one-man crew, reducing the field crews from 30 to 5 dedicated crews – some work being done for quality control
- data was processed in Trimble Business Center and Trimble Realworks and export to AutoCAD for sectional elevation

Case Studies: China

Case ROI

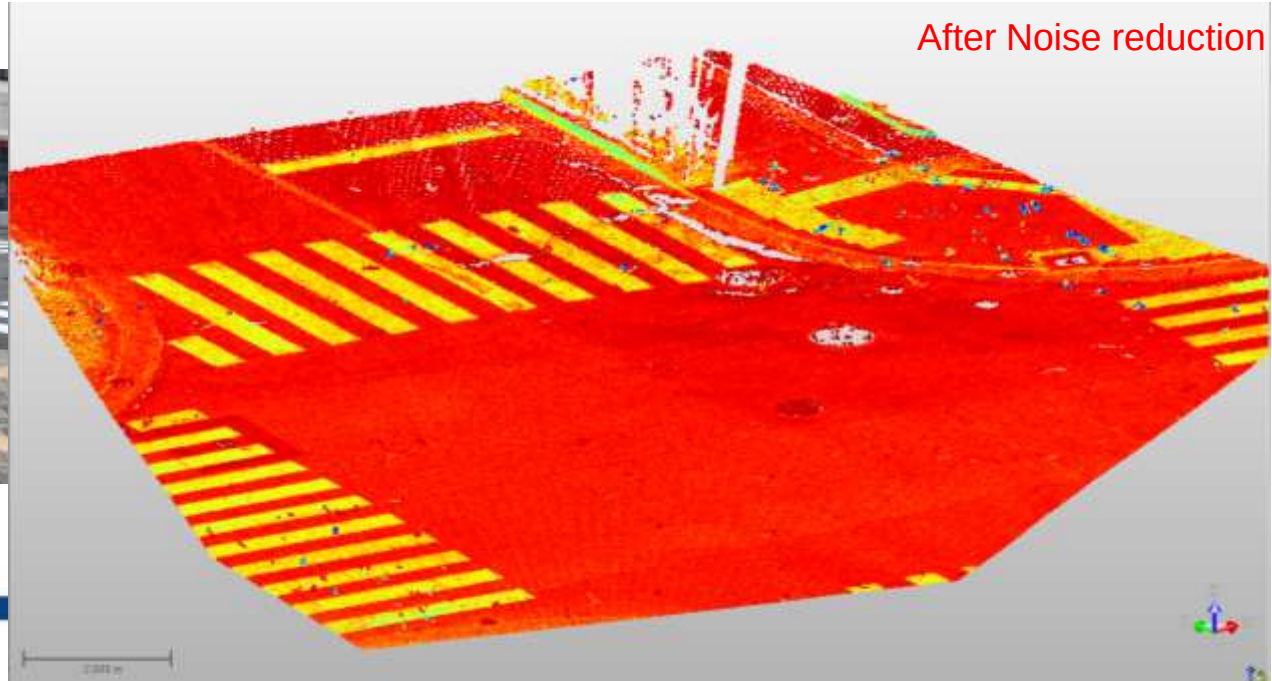
- Field work and data processing done under budget, well within the deadline
- Separation of labor between field and office gained efficiency and quality
- **Overall cost of collection saved the contractor approximately 50% on fieldwork and 75% on rework**
- Project data shared with downstream contractors



Case Studies: Japan (3) Play Video

Road surface scanning at intersections with heavy traffic for maintenance purposes

Enable reliable road surface scan using the “Band scan” of Trimble SX10
(Scan mode : Fine)



Summary

- We are at the beginning of a 3D Scanning revolution, Scanning Total Stations are speeding the revolution up because of the harmonization of 3D scanning technology and traditional optical surveying work flows
- Our target user should be someone who can understand the data's value to the customer
- Large contractors and small firms alike can take part in this change because the cost and complexity of the tools needed has come down so much
- Asia-Pacific, notably China, Japan, Singapore, Korea and Australia are all early adopters, so keep on adopting!

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Thank You

ありがとうございました

谢谢

고맙습니다

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