



CASE STUDY

Risk Management of show caves in Greece based on 3D representation of data acquired by handheld & terrestrial laser scanner



Overview

The 'Melissani' and 'Droqarati' caves (Kefalonia island, W. Greece) are two of the most famous and most visited show caves in Greece. The Department of Geology and Geoenvironment of the National and Kapodistrian University of Athens, was employed by the Greek Ministry of Culture, to elaborate a study to meet high safety standards for both caves.

The scientific team, led by Prof. Emmanuel Vassilakis, scanned both caves not only to compile a highly detailed map but also to identify structural discontinuities and faults that could cause rockfalls and damage in the caves as they happen to be located at an area of very high seismicity, where large earthquakes occur very often. In addition, the results will be considered by the authorities for the maintenance or design of the tourist routes and the 3D model will be included in scientific studies.

During this study each hazard throughout the cavities had to be mapped in high detail and accuracy and this could be accomplished with the synergy of equipment in different working levels since the cave environment is by far one of the most difficult cases to survey. The use of state of the art laser scanners either terrestrial or handheld accompanied by total station measurements on a series of ground control points, has resulted in the scanning and mapping the entire areas of the caves including hidden cavities.

For the data acquisition the team used:

- Leica ScanStation P50
- Leica BLK2GO
- Leica total station





The application

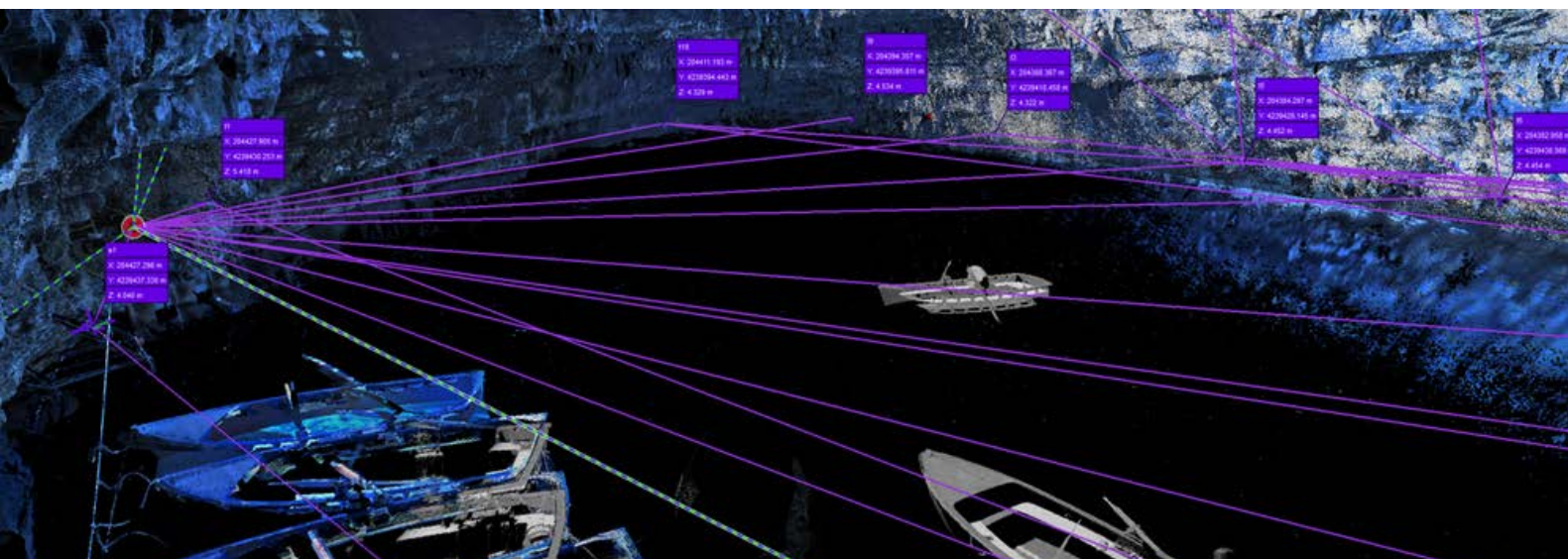
The combination of the georeferenced point cloud data acquired by the above mentioned instruments is innovative, and the generated outcomes are quite impressive. The Leica ScanStation P50 was used mainly for the great halls and the Leica BLK2GO for the smaller cavities and the narrow passages. The latter was also used for scanning the limestone walls around the lake within the Melissani cave which was rather helpful as there were limited places where the P50 could be installed. Members of the scientific team were holding the BLK2GO on the front of a boat while it was approaching the lake banks for the point cloud acquisition. Additionally, it was used at Droqarati Cave for scanning narrow passages where the P50 could not fit, or its use would be time consuming due to overwhelmingly many stations needed to cover them all.

The point clouds included the scanning of more than 20 ground control points, the coordinates of which were measured with the use of a total station and were imported into Leica Cyclone Software for georeferencing and merging point clouds into a single one for each cave (-2.7 billion for Melissani and -2.3 billion for Droqarati).

Processing of the data using Leica Cyclone Software

The scientific team used Leica Cyclone software to align the point clouds and generate the 3D models. More specifically the team used:

- Leica Cyclone Core
- Leica Cyclone REGISTER 360
- Leica Cyclone 3DR
- Leica Cyclone JetStream Viewer





Melissani Cave



Droqarati Cave

Both 3D models were combined with point clouds generated after photogrammetric processing of aerial photographs of the open surface above the caves, acquired by UAS.

The data fusion was successful as all the datasets of different origin were registered in the same projection system. This gave the scientific team the ability to estimate the rock thickness between the cave and the open surface with high detail and accuracy, contributing to the risk management to ensure the health and safety of visitors. Especially at Melissani cave where the roof has already collapsed during the past revealing the mystic underground lake, a future collapse is quite possible. Plausibly this will happen at the northern side of the cave where the rock thickness above the lake is decreased to less than 3 meters due to rockfalls.

On the other hand, the rock cap above Droqarati cave exceeds the thickness of 10 meters providing good safety conditions in the main hall, which is frequently used for music concerts.

INFORMATION

Authors:

Vassilakis Emm., Konsolaki A.

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