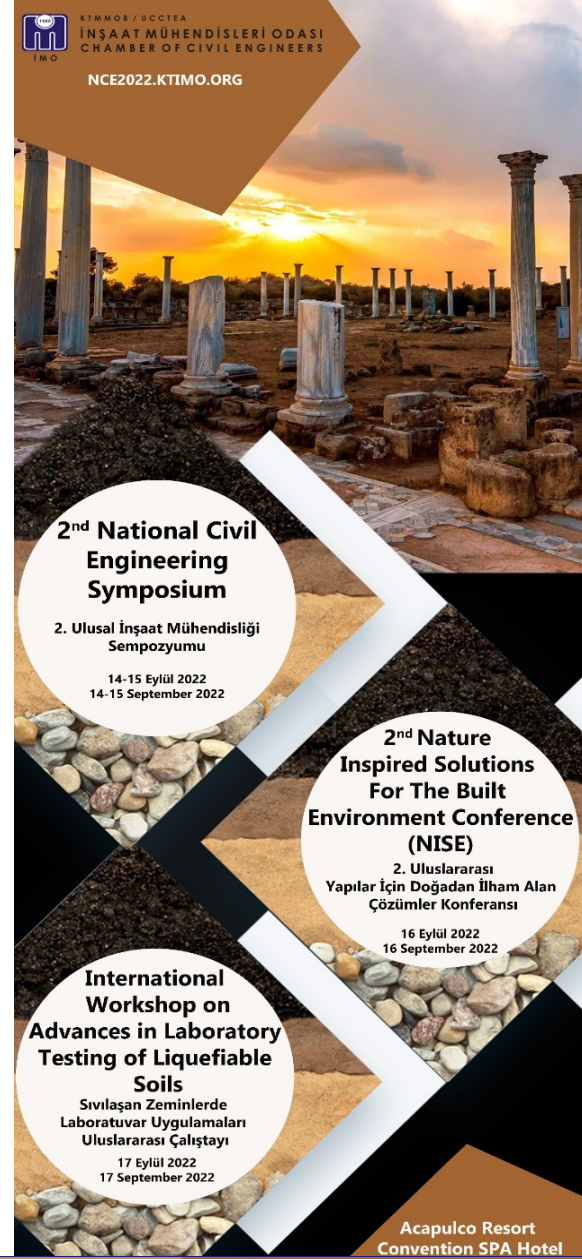


A NOVEL APPLICATION OF CLOSE RANGE PHOTOGRAMMETRY FOR EARTH RETAINING WALL AND SLOPE STABILITY ASSESSMENT

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2nd National Civil Engineering Symposium
2. Ulusal İnşaat Mühendisliği Sempozyumu
14-15 Eylül 2022
14-15 September 2022

2nd Nature Inspired Solutions For The Built Environment Conference (NISE)
2. Uluslararası Yapılar İçin Doğadan İlham Alan Çözümler Konferansı
16 Eylül 2022
16 September 2022

International Workshop on Advances in Laboratory Testing of Liquefiable Soils
Sıvılaştan Zeminlerde Laboratuvar Uygulamaları Uluslararası Çalıştayı
17 Eylül 2022
17 September 2022

Acapulco Resort Convention SPA Hotel



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North Cyprus

14 -17 Eylül 2022
14 - 17 September 2022

Content

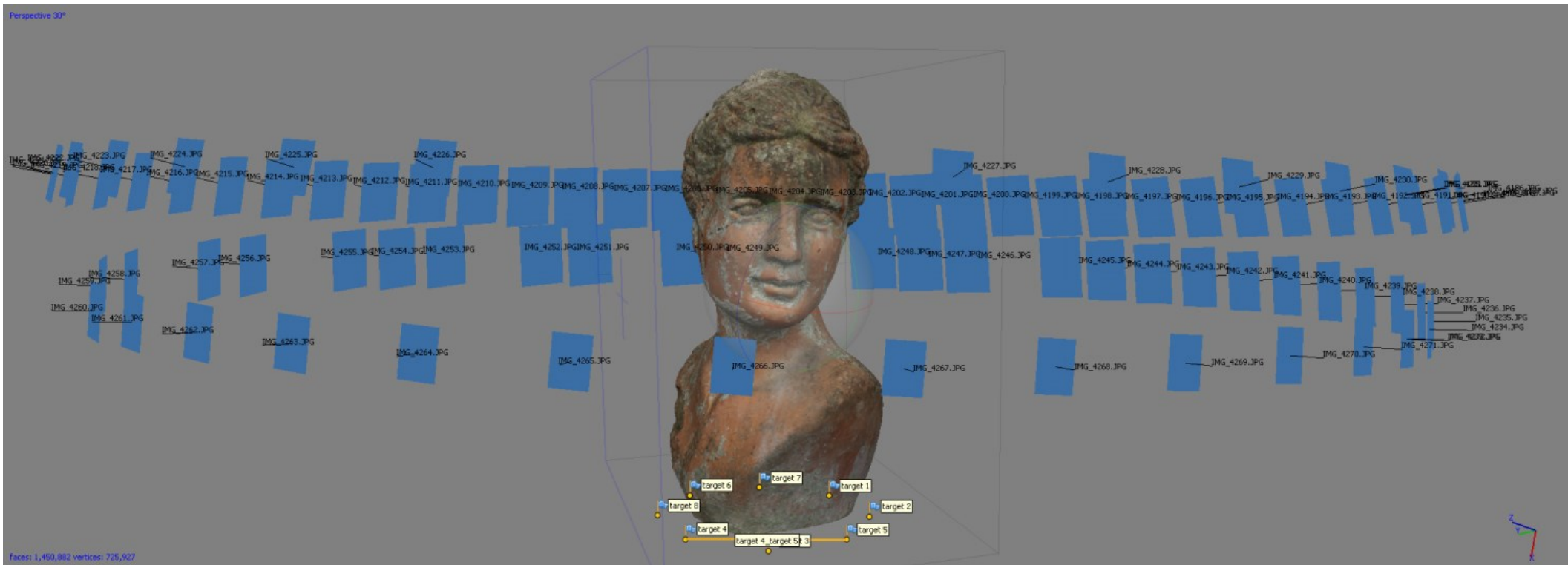
- **Introduction**
- **Methodology**
 - Image Collection
 - Image Processing
 - Data Processing
- **Case study**
- **Conclusion**

Monitoring of geotechnical assets

- Geotechnical assets can fail during construction or along with their service life,
 - lack of proper design or maintenance,
 - deterioration of materials (insidious decline),
- Monitoring of these structures is necessary for construction and to inform asset management.
- Various monitoring techniques for deformations.
 - Conventional measuring methods (Precise leveling or total station surveying),
 - Positioning system methods (Global Positioning System (GPS) measurement),
 - Satellite radar system methods (Interferometric synthetic aperture radar (InSAR) observation),
 - Photogrammetry (Satellite, aerial or earthbound imaging),
 - More traditional methods such as inclinometer, strain meters, and more recent item just like fiber optics

Close-Range Photogrammetry

- Photogrammetry relies on the reconstitution of objects simultaneously from different images from different perspectives.



Pros and Cons

Advantages:

- Cost effective
- Reduced time of field work
- Accessibility to difficult locations
- Can be atomized
- 3 dimensional results
- Contact free with the scanned object
- Numerous data points

Disadvantages:

- Affected by weather conditions
- Accuracy is camera dependent

SITE WALKOVER

- Potential Risks & Hazards, Potential target & GC locations, Visual assessment

FLIGHT PREPARATION

- Flight Plan, Target & GC locations, Battery and flashcard

PLACING TARGETS AND GROUND CONTROL POINTS

- Site visit, Insert Targets and GCs, Coordinates of GCs with GNSS or GPS

DATA COLLECTION

- At least 70% overlap, Different Angles, Distance to the asset, L-200m H-10m wall 25min, Camera

IMAGE PROCESSING AND ALIGNMENT

- Poor quality, Dislocated and blur images delete, Calibration, Alignment, Point Cloud Generation. (PhotoScan, Photo Modeller, Photosynth)

DATA PROCESSING

- Export as LAZ, Alignment of point clouds, Remove noise, Change detection, Process data (CloudCompare, I-Site Studio, 3Dresaper)

VALIDATE RESULTS

- Depending on asset Inclinometer, GNSS, Laser Scanners

Three-stage process for the images provided by the UAV

- **3D cloud formation**

- PhotoScan (Agisoft) & PhotoModeler

- **Georeferencing**

- CloudCompare, I-Site Studio, 3DReshaper

- **Point cloud comparison**

- These software packages actually allow point cloud comparison by aligning the different epochs using existing reference points in different 3D models

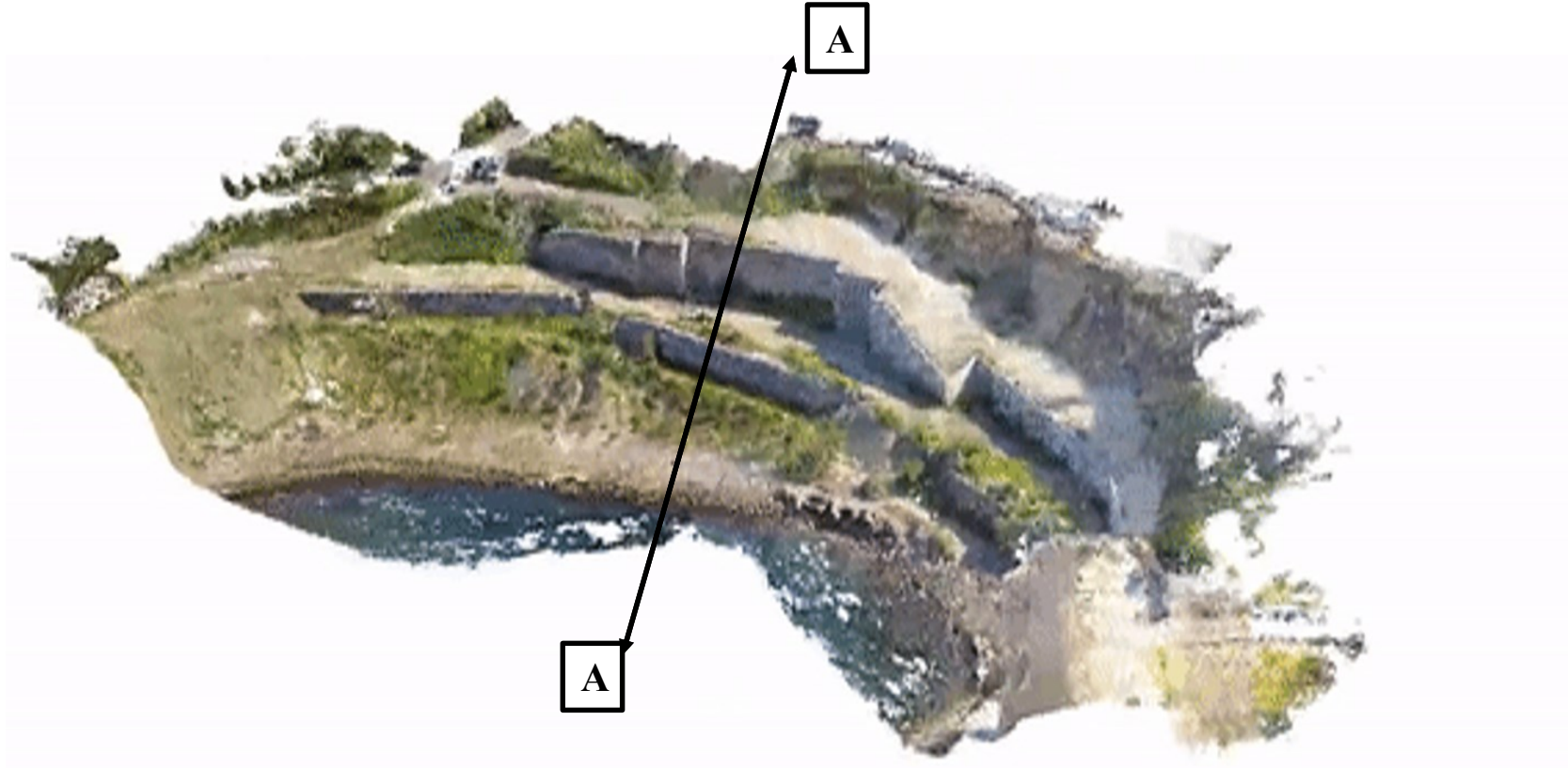
**120 photos were
taken at every epoch**

Study Area



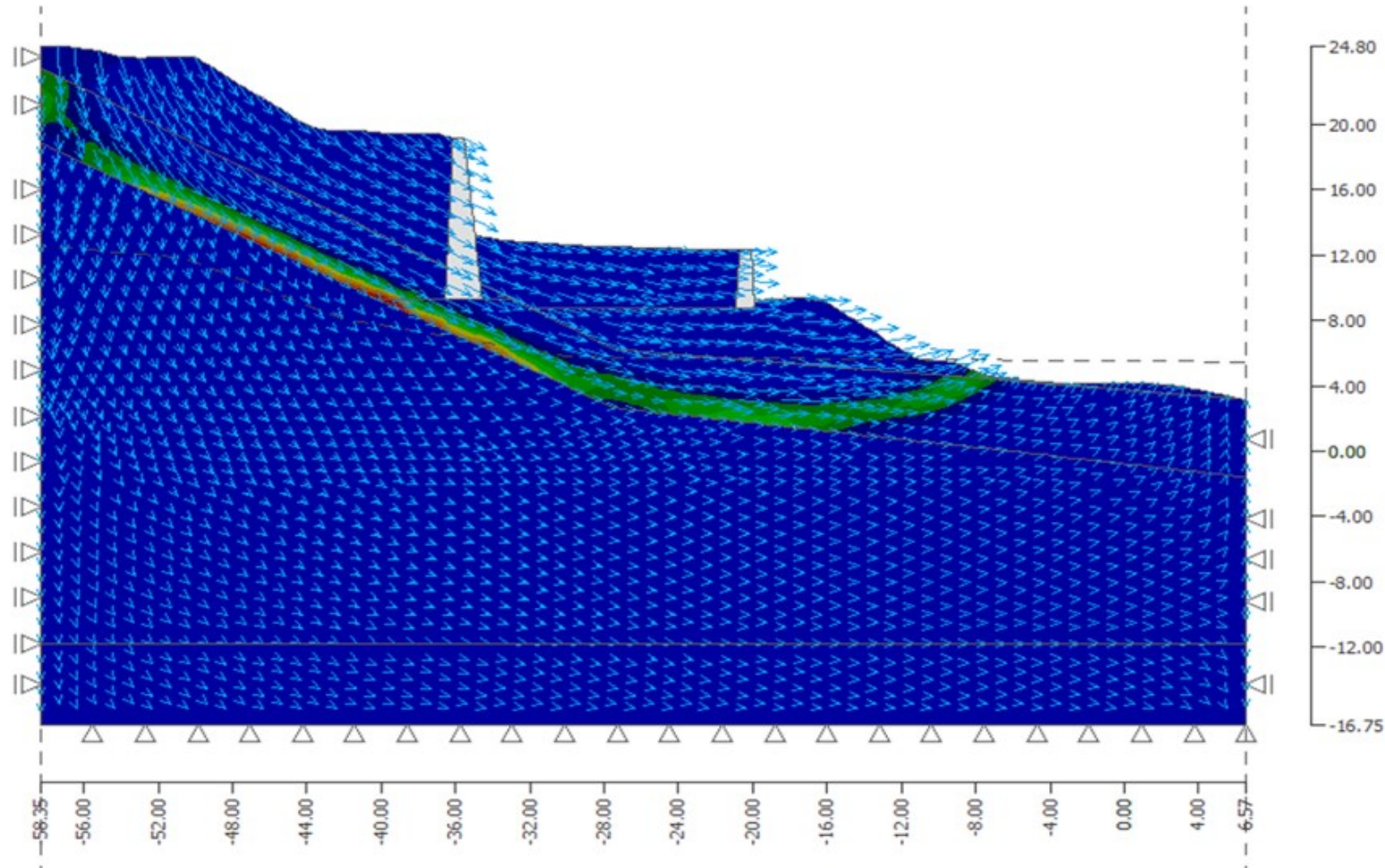
A&B- Gravity Wall
C – RC Wall
D – No Wall

Close-Range Photogrammetry

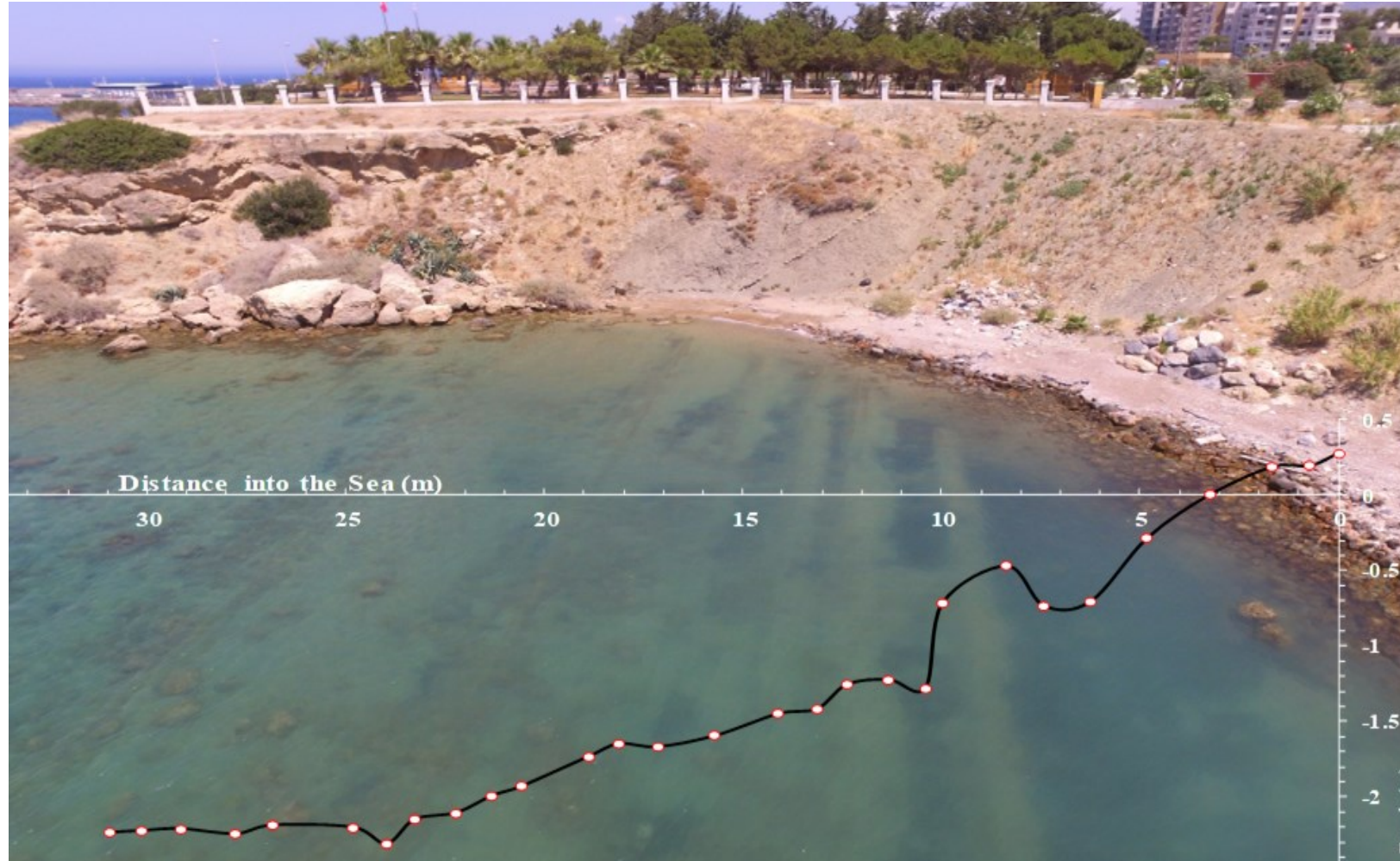


Numerical study (FEM)

- Plaxis 2D
- Geo5



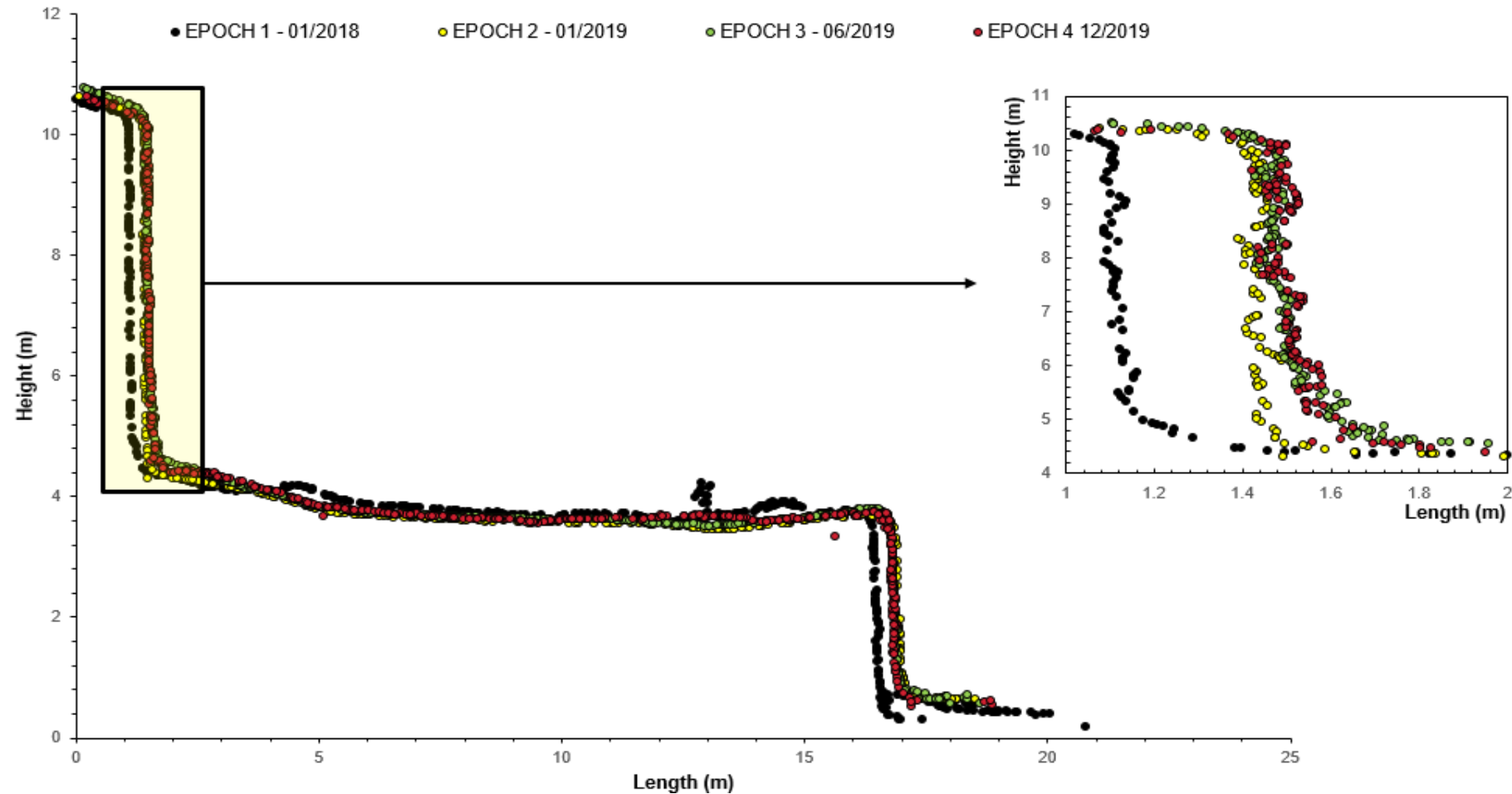
Toe of the Slope in the Sea – Cross Section A-A



The satellite photos of the study area in different years



Data Processing – Plot of Strip – Cross Section A-A



Conclusion

- The constructed retaining walls on the slope adjacent to the Kyrenia Castle obviously increase the process of sliding and this improper design is still there and the sliding process is continuing.
- The close-range photogrammetry method which was adopted for monitoring the slope, provides valuable results and these outcomes endorse with high accuracy by the numerical analyses studies conducted with the geo5 and Plaxis 2D.
- The comparison between the epochs in a 2 years' period (from Jan 2018 to Dec 2019) revealed that the slide movement at the first year was about total movement in two years. It can be found that after 8 years of sliding, the sharp movement still can occur.
- As it is obvious from the numerical analyses, the toe of the slide is placed in the sea and this phenomenon has been proved again by the bathymetric survey in the sea with the GNSS. This important fact expresses that the retaining walls are not a proper protection even with an appropriate design.
- It can be found from the current study that close-range photogrammetry is a safe, cost-effective, non-destructive and accurate method for monitoring the geotechnical assets just like retaining walls and the slopes and also this can be considered as a precise and routine method through any other issues in the geotechnical engineering

THANK YOU FOR YOUR KIND ATTENTION

