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European Union | European Regional Development Fund

*Sharing solutions  
for better regional policies*



# Digitization of Natural Cultural Heritage

from natural to digital world

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ΠΑΝΕΠΙΣΤΗΜΙΟ  
ΠΑΤΡΩΝ  
UNIVERSITY OF PATRAS



# **4<sup>th</sup> Thematic Seminar**

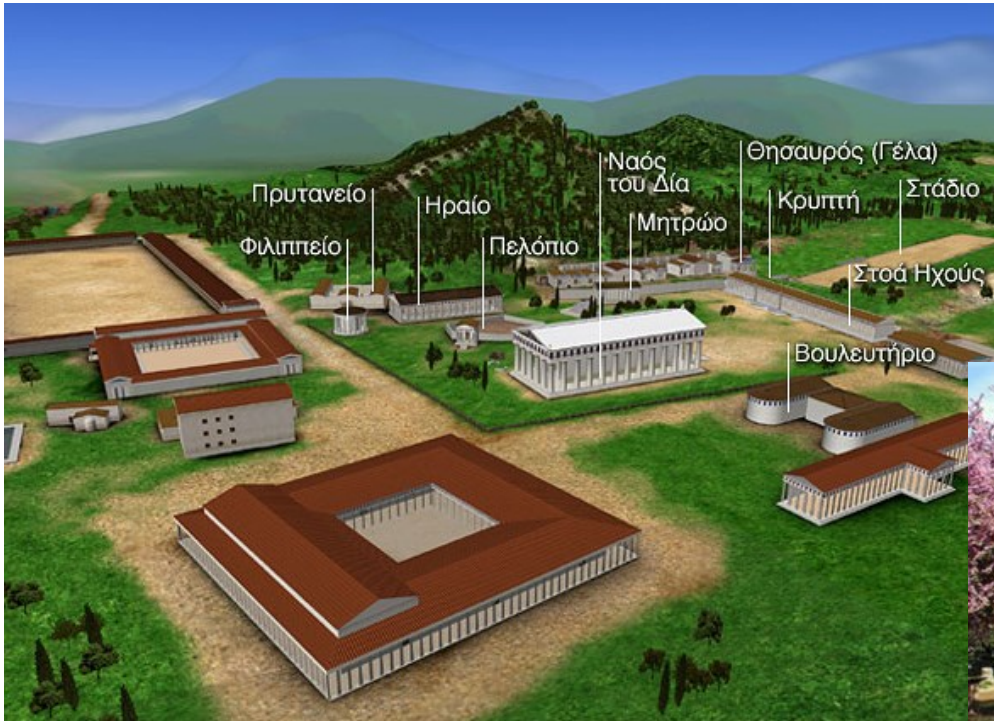
## **“Digitization of Monuments and Archaeological Sites”**

**13<sup>th</sup> – 15<sup>th</sup> March 2018**



# Monuments & Archaeological Sites

A "**Historical Monument - Location - Space**" may be any building, landscape, region or structure that is local, regional, or nationally significant. A "**Historical Monument - Location - Space**" or "**Cultural Heritage Monument**" is an official geographical location where pieces of political, military, cultural, or social history are preserved and which have been preserved due to the value of their cultural heritage.



# **...Monuments and Archaeological Sites in a Digital World**

## **... Monuments & Archaeological Sites in Greece**



# Monuments & Archaeological Sites

## List of the declared archaeological sites and monument of Greece

([listedmonuments.culture.gr](http://listedmonuments.culture.gr))

**ARCHAEOLOGICAL SITES - 138**

**ANCIENT MONUMENTS – 208**

**HISTORICAL PLACES – 29**

**MONUMENTS OF MODERN CULTURE HERITAGE – 712**

## REGION OF WESTERN GREECE

**ARCHAEOLOGICAL AREAS** - Olympia, Therma, Kalydon, Aipidos, Alifeira, Epitalia, Ilida

**ANCIENT THEATERS** - Makinea, Oiniades, Pleuron, Stratos

**ANCIENT ACROPOLS** - Samia

**ANCIENT CITIES** - Paleros, Oiniades, Skala, Psafida, Eliki, Kyrenia, Dymi, Egira, Lepreos, Alikirna

**ANCIENT GRAVES** - Agia Triada, Dafni, Kakovatos, Lefkos, Vounteni, Skillountia

**AQUEDUCTS** - Roman Aqueduct of Patras

**ANCIENT TEMPLES**- Temple of Epicurius Apollo





# Underwater Monuments & Archaeological Sites

## Region of Western Greece

- Gulf of Patras – **Battle of Lepanto (1571)**
- Gulf of Patras – **Battle of Patras (1772)**
- Aitolokarnania & Ionian Islands – **Army and Submarine battlefields during World War I and World War II**
- Gulf of Patras – **Over twenty (20) recognized and documented World War I and World War II Wrecks**



# **...Monuments and Archaeological Sites in a Digital World**

**...what is digitization of monuments and  
archaeological sites**



# Digitization

Digitization of Monuments or Archaeological Sites is the exact recording and documenting its geometrical characteristics in a way that reliably represents its geometric form and location in space/area using **diagrams, two dimensional (2D) or three dimensional (3D) models** with the use of personal computers.

## Representation – Capturing or Digital Reproduction





# Most used Digitization techniques

- **Photogrammetry** (Photogrammetry is the technique that aims to extract reliable metric information of natural objects and the environment through the processes of recording, measuring and interpreting photographic images)
- **Scanning using laser-triangulation techniques** (Using laser-based instruments which are commonly known as terrestrial 3D laser scanners. In addition to 3D laser detectors there are also devices that scan only horizontally or vertically a monument and space, and can be used to record the geometric characteristics of cultural heritage objects. The devices are called laser profilers and are used with great success in creating contour patterns interiors and sections of the monuments.)



# Laser Scanning vs Photogrammetry

## Laser Scanning

### • Pro's

- Accuracy within  $\frac{1}{4}$  of an inch for most scanners
- Accuracy over large spaces
- Error rate is fixed based on the capabilities of the equipment
- Automated process after targets are placed and scanner is started; less chance for user error
- Less time spent on site
- Availability of auto-extraction / meshing software for point clouds

### • Con's

- Equipment can be prohibitively expensive to own
- Generally need to upgrade physical equipment to keep up with progress
- Fuzzy point cloud on highly textures / reflective surfaces

## Photogrammetry

### • Pro's

- Significantly cheaper equipment
- Most improvements are on software side so no need to buy new equipment to keep up with progress
- Better visual representation of textures

### • Con's

- Accuracy is lower than laser scanners over large space
- Scale limitations based on camera lenses maintaining clarity over long distances
- Less automated process allows for more user error – results depend greatly on experience of operator
- More time spent on site
- Auto extraction / meshing software not as advanced
- Errors when dealing with reflective/transparent surfaces



# Most used Digitization techniques

- Generally, laser scanning is the right tool if you need a **high level of accuracy** over a **large space**. Photogrammetry is a better tool if you are **documenting smaller spaces** and are looking for **less accuracy** but more visual photo realism.
- This is why photogrammetry is commonly used in the entertainment industry, such as for the creation of environments for games and movies. It is also being embraced by the archeological community because it allows for 3D documentation of individual objects with more realistic textures for a lower price than laser scanning.
- Laser scanning on the other hand is more applicable to the architecture, engineering and construction (AEC) industries because of its level of accuracy over a large distance. AEC professionals are not as interested in photo realistic textures and much more sensitive to accuracy errors over distances which can quickly add up to inaccuracies of multiple feet in a large building using photogrammetry.



# Thematic Areas

It is a multi-dimensional process involving many working groups covering multiple thematic areas ...

- **Recording, Documentation and Information Management**
- **Information Systems of Cultural Heritage**
- **Architecture Photogrammetry (terrestrial & aerial)**
- **Digital image processing**
- **Archeology Surveying**
- **3D Representation**
- **Photography and Management of Cultural Landscapes etc**



# ...Monuments and Archaeological Sites in a Digital World

... why we need digitization ?



# Why Digitization?

- **Digital Preservation**
- **Protection and Maintenance**
- **Research**
- **Education**
- **Dissemination**
- **Accessibility**





# Benefits

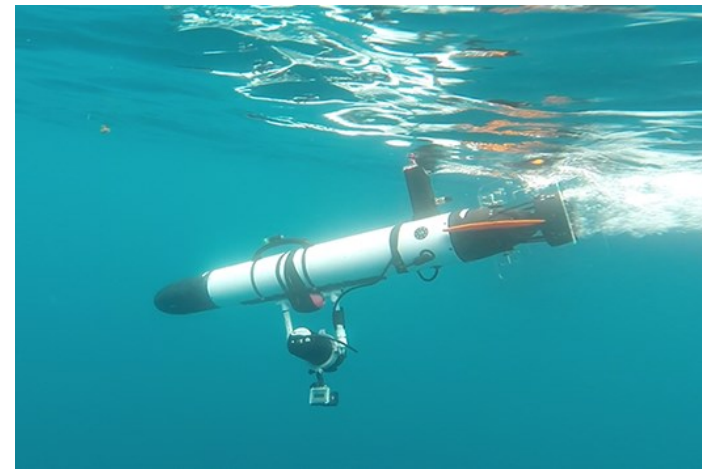
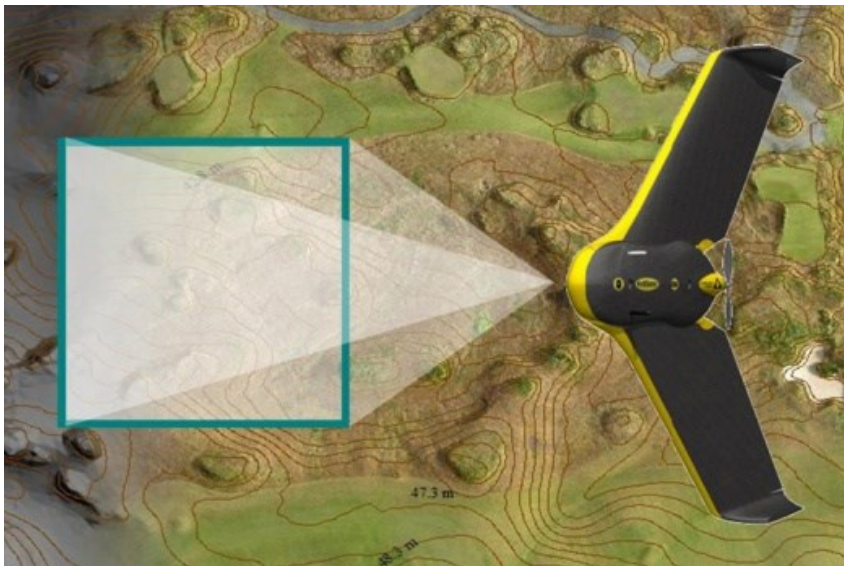
- **Mapping** of morphological information at the time of digitization, as well as providing information on the **pathology** of the monument
- **Enhancing** the educational process with innovative game role playing using VR and AR
- Creating a complete monument **representation** with interactive - experiential experience by adding multimedia (images, videos, content) to the model
- Creation of digital repositories for **awareness and dissemination** to a wide range of audiences specialized or not
- **Increase** tourism
- **Creating** a Cultural Heritage Identity
- **More opportunities** for research activity



# ...Monuments and Archaeological Sites in a Digital World

... digitization tools

# Digitization Tools



# **...Monuments and Archaeological Sites in a Digital World**

**... best practices on digitization of  
monuments & archaeological sites**





# Best Practices - Preservation

## PHOTOGRAMMETRIC REPRESENTATION OF A TRADITIONAL BRIDGE BEFORE THE TOTALLY ALTERATION OF ITS HISTORICAL FACADE AND UTILIZATION OF THE 3D MODEL

- Using the technology of three-dimensional modeling for monuments to preserve our cultural heritage (2017). Digitization and digital representation of a traditional bridge in Lagadia village, which took place only a few days before the alteration of its historical facade.

Starting expansion works



3D Model



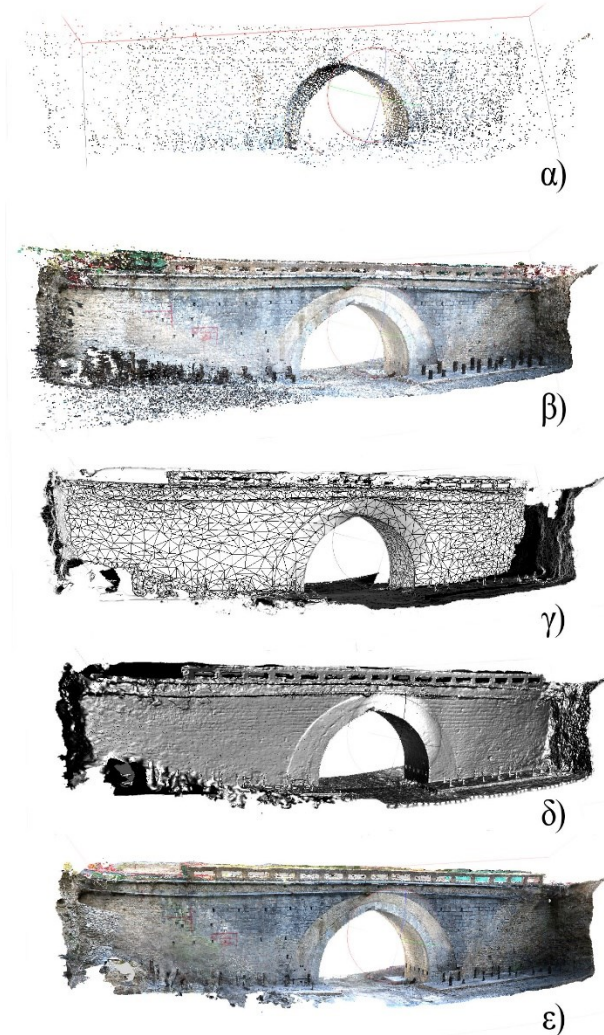
3D Printing result of education purposes



# Best Practices - Preservation

## Utilization of the 3D model at various levels

1. High resolution digital files for scientific study of traditional bridge morphology and pathology
2. Smaller analysis files to use them as representation – dissemination tool to a broader and non-specialized audience with the help of Internet, multimedia, and virtual or augmented reality
3. Using the digital model to transform it to a smaller physical model using 3D printers, thus enhancing the educational and teaching nature of digitization even for people with visual impairment





# Best Practices - Dissemination

## ATHENS Research Center, Democritus University of Thrace & 5th Ephorate of Byzantine Antiquities

Digitization and 3D Representation based on computer techniques / modeling of two Byzantine Churches of Mani (Episkopi in Stavri and Agios Nikolaos in Kelefa). It is in essence a representation for touristic use and presentation and dissemination of two not widely known monuments.



# Best Practices - Preservation

**ATHENS Research Center** within  
3DICONs Project - <http://3dicons-project.eu>

Digitization the Church of the Holy Apostles in Thessaloniki. The on-site work concerned terrestrial and aerial photography of the monument, followed by a measurable survey to capture basic details and damages.

A three-dimensional model of the monument's outer space was created using reconstruction based on motion and point cloud commercial software named (Multi-View 3D).



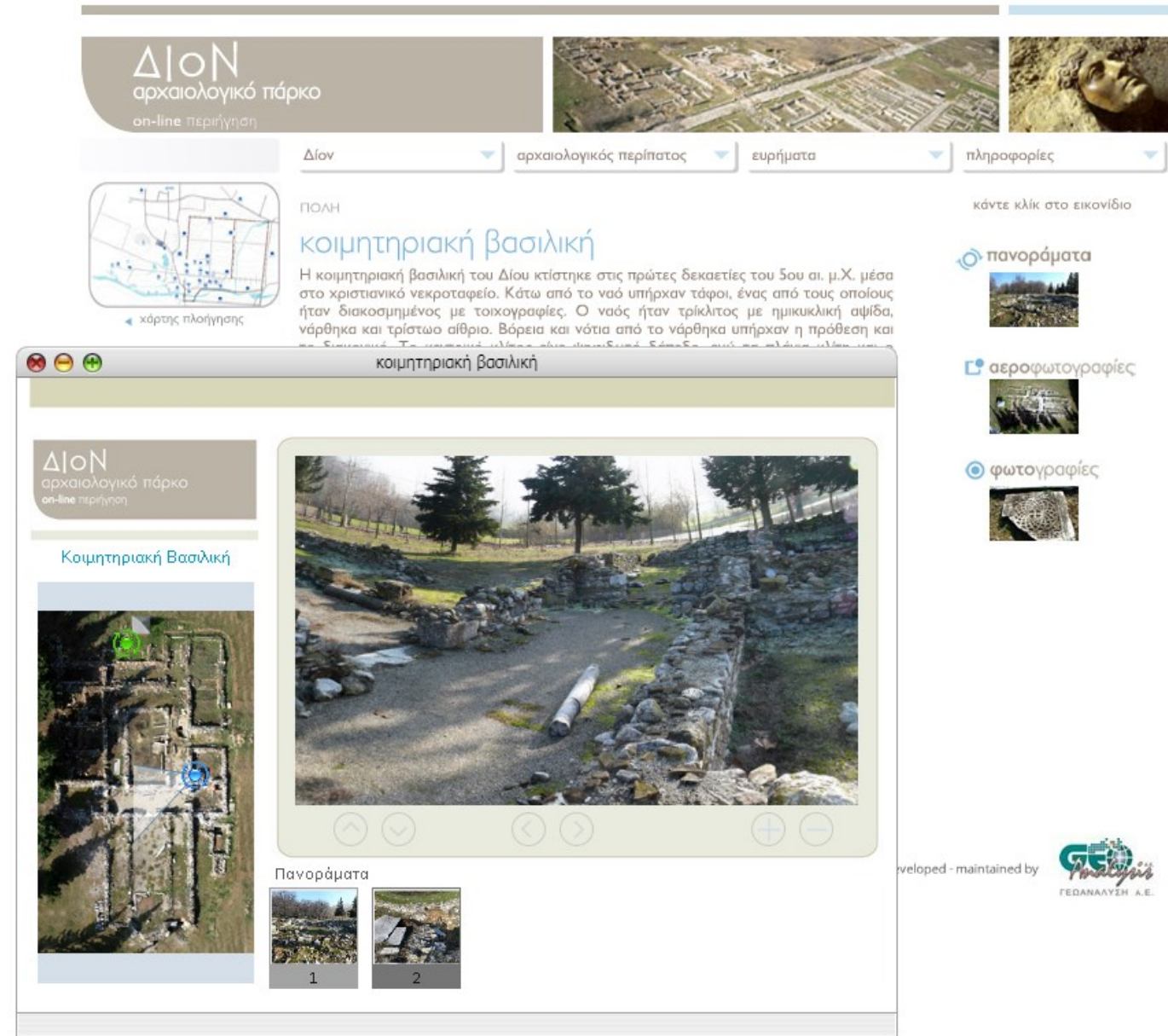
# Best Practices - Accessibility

## Geoanalysis SA

Ancient Dion - Task: «Digitization, Documentation and Dissemination with Digital Methods of Dion Archaeological Park» Measure 1.3 of Project «Digitization and Documentation Monuments Collection of the Ministry of Culture.

<http://www.ancientdion.org/>

(Web Application)



# Best Practices - Accessibility

## TEI of Western Greece

### **thinkCulture – The case of "Heroes of Mesolongi Garden" Monument**

Mobile Application for accessing and presenting monuments and archaeological Sites





# Best Practices - Preservation

TEI OF CENTRAL MACEDONIA - Faculty of Applied Technology – Department of Civil Engineering and Surveying Engineering and Geonformatics

3D Representation of Dodonis' theater and the wider archaeological site (SERRES 03/2017)

- Studying area
- Area recognition
- Flight Programming
- Take Aerial photographs
- Editing Aerial photographs
- Results Generation:
  - 3D model
  - Ortho-map
  - DSM model
  - Contour map
  - Html file
- Compare Results







**3D MODEL**







Ortho-map

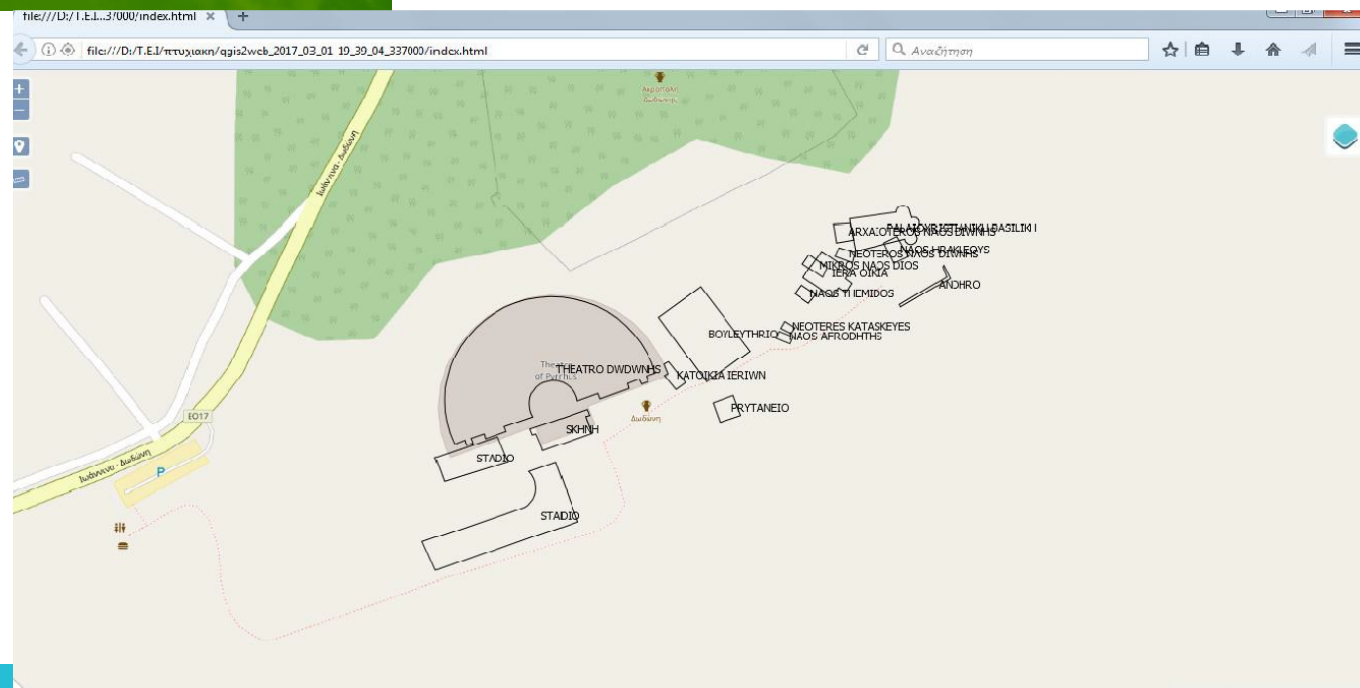




DSM

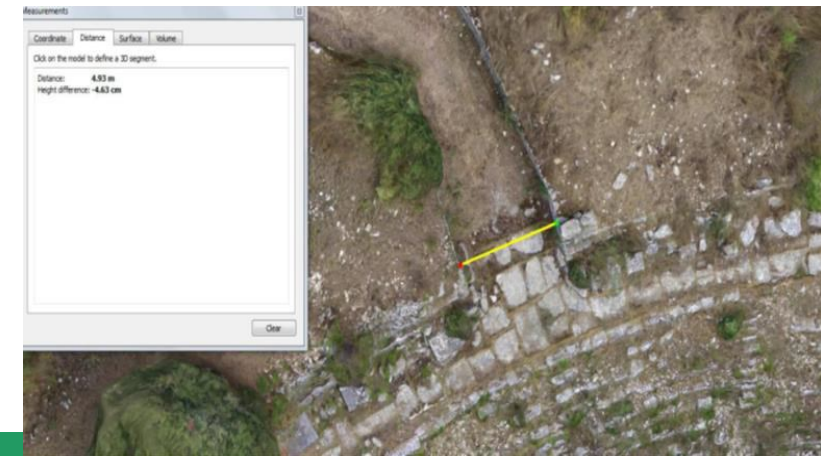
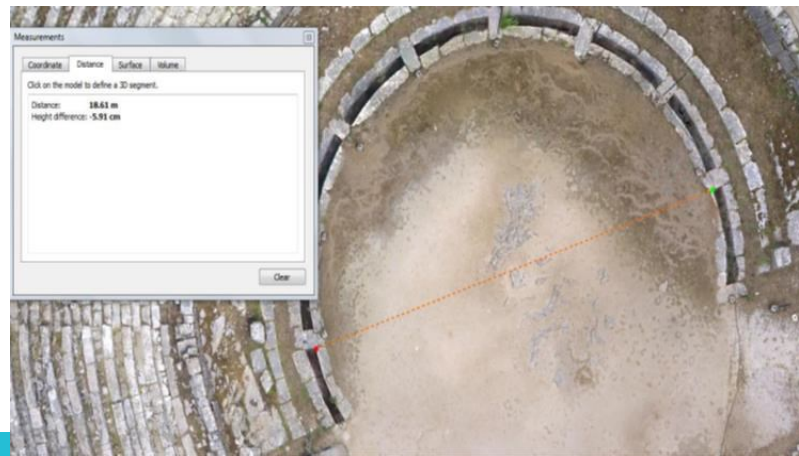
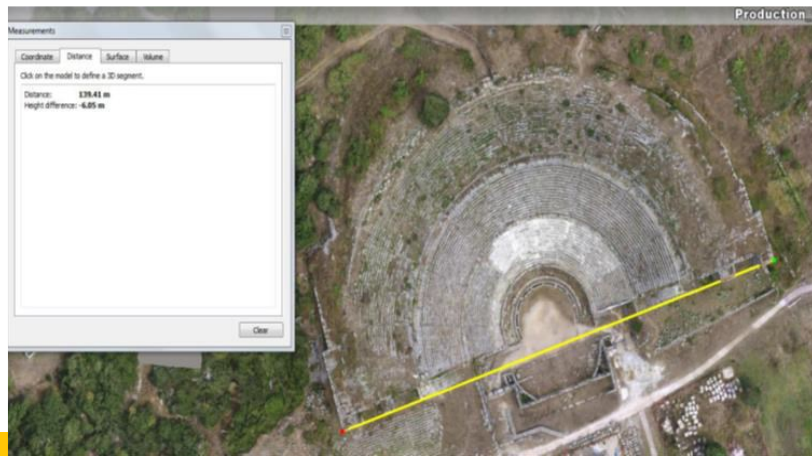


HTML



# Compare Results

	1 <sup>st</sup> Measurement	2 <sup>nd</sup> Measurement	3 <sup>rd</sup> Measurement
Topographical Data	139,33 m	18,67 m	4,93 m
3D Model	139,41 m (0,08)	18,61 m (0,06)	4,93 m (0)
Ortho-map	139,33 m (0)	18,64 m (0,03)	4,97 m (0,04)





# Best Practices

## Ephorate of Achaia

Representation of Patras' Castle (3D, DSM, Contour, OrthoMap) to be used as input for mobile app within **H2020 Freewheel project (Patras 04-09/2018)**.

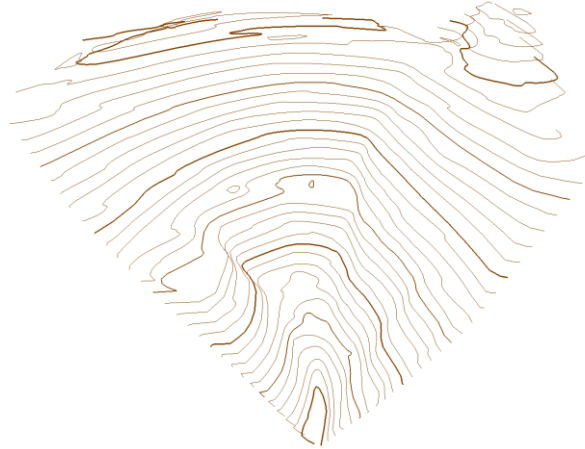
Patras' Castle will be the basic demo site for the result of the project – Lifecycle reconfigurable Smart Mobility Platform to enable autonomous and cost effective personalized solutions for social inclusion of disabled and elderly.



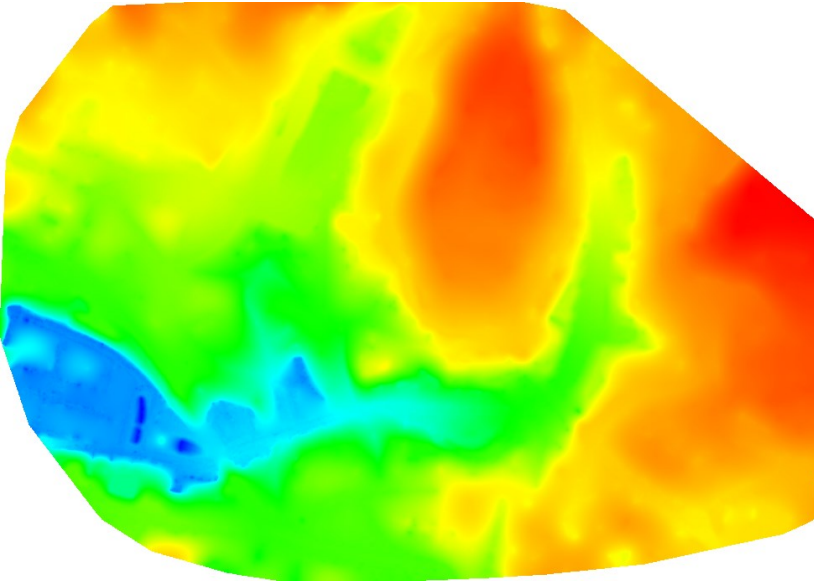


# Best Practices

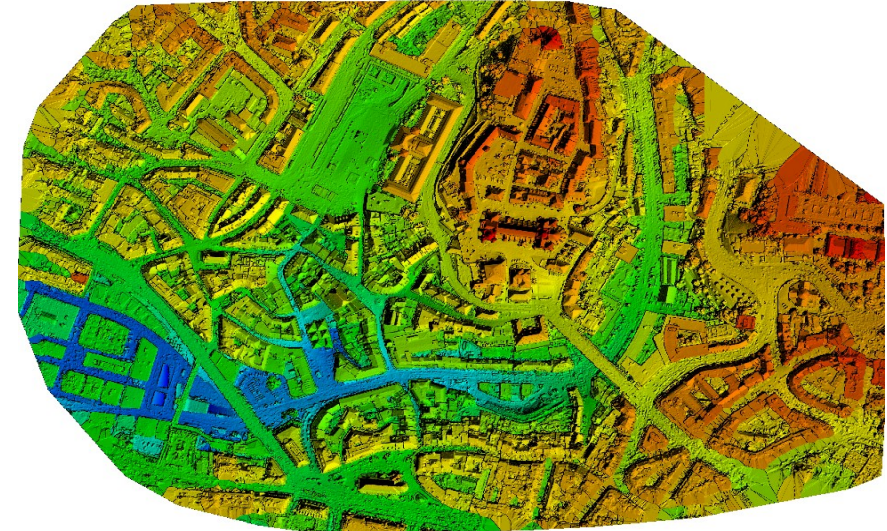
Contour Map



Digital Surface Model (DSM)



Digital Terrain Model



Orthomosaic



# **...Monuments and Archaeological Sites in a Digital World**

**... indicative proposals to Region of  
Western Greece**





# Indicative Proposals to RWG

1. 3D Representation of recently renovated, difficult to reach, Byzantine churches (Palaio Monastira of Agia Lavra, Agios Nikolaos Agridiou and Agios Dimitrios Bada) **(education, dissemination and accessibility)**
2. Digital Integration and Promotion of the Ancient Fortification Developments of the Region, includes Patras Castle, Dymes' Fortification Walls, Rion & Antirion Castles



# CD-ETA PROJECT

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