

INFORMATION SYSTEM FOR  
MULTI-LEVEL DOCUMENTATION OF  
RELIGIOUS SITES  
AND  
HISTORIC COMPLEXES  
METEORA



# Geospatial Big Data Management for a Holistic Documentation of Complex Sites

## The case of Meteora, Greece

Dr. Charalabos IOANNIDIS, Professor of Photogrammetry

Dr. Chryssy POTSIU, Professor of Cadastre and Land Management

Sofia SOILE, Rural & Surveying Eng., MSc, Researcher at Lab. of Photogrammetry

Styliani VERYKOKOU, Rural & Surveying Eng., PhD Candidate

Argyro-Maria BOUTSI, Rural & Surveying Eng., PhD Candidate



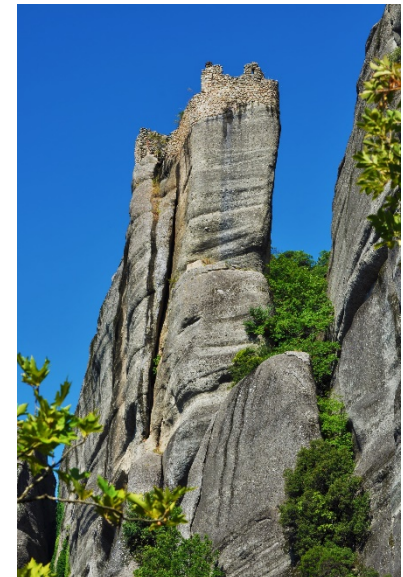
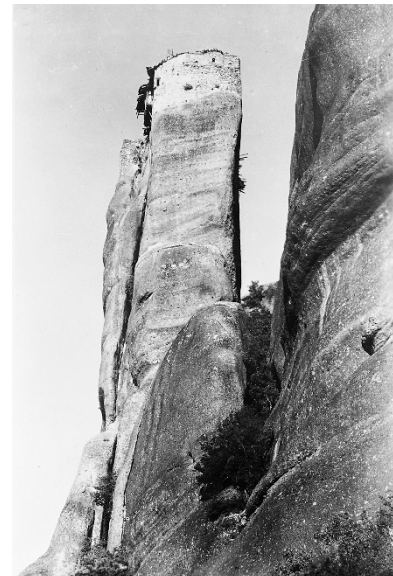
SCHOOL OF RURAL AND SURVEYING ENGINEERING  
NATIONAL TECHNICAL UNIVERSITY OF ATHENS, GREECE  
9, Iroon Polytechniou Str., 15780, Zografou, Athens, Greece

## Research project: **METEORA**

Web-based platform for different users

Multi-dimensional documentation of the natural, religious, historical & cultural heritage of sites

- ✓ visualization of detailed and highly accurate **3D geometric models**
- ✓ differentiation of the details of the 3D models based on **scale**
- ✓ **mixed reality** capabilities
- ✓ link to a **database** with various kinds of information



**Holy Meteora** → the largest monastic complex in Greece after Mount Athos

**Very challenging topographical features** inaccessible giant rocks, cavernous structures

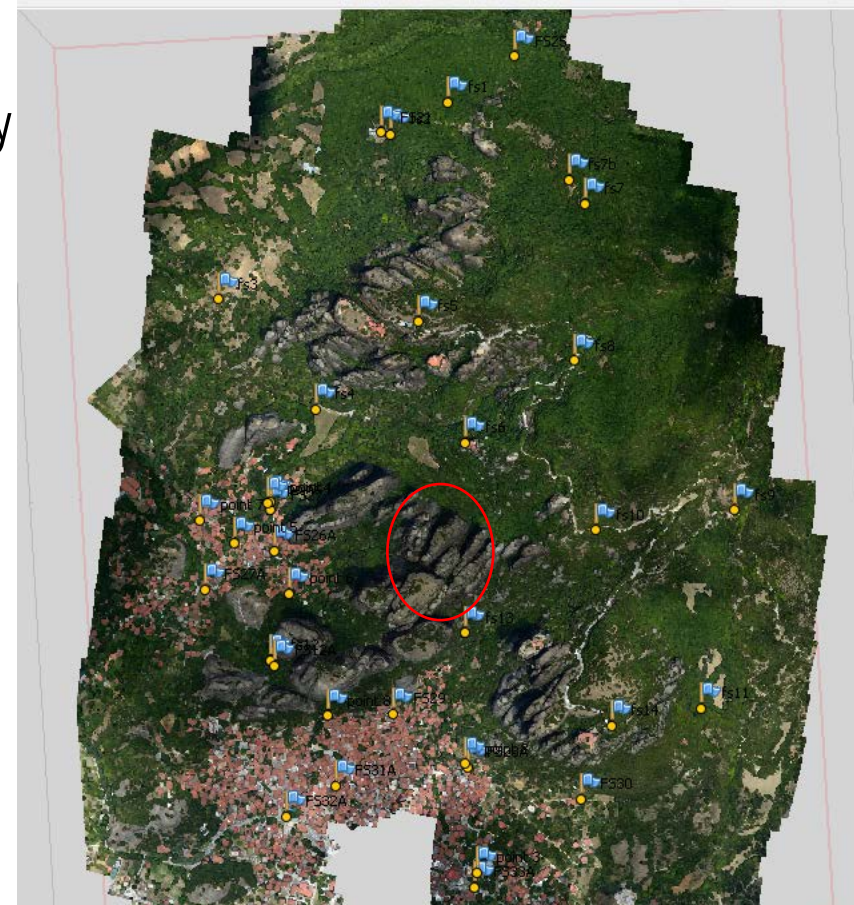


6 monasteries still functioning, ruins for several of the rest monasteries and hermitages

UNESCO’s “Monuments of World Cultural Heritage” list

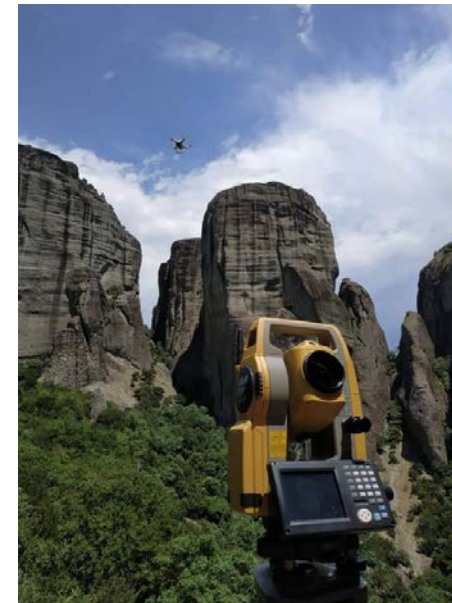
Case study:

- rock of St. Modestos, ruins of an old monastery
  - rock “Alyssos”, ruing of the monastery of the Chain of Apostle Peter
- ~200 m in height both of them



## SPATIAL DATA COLLECTION

- ✓ Acquisition of aerial images from a manned aircraft
  - 2200 vertical and oblique aerial images
  - NIKON D800E, 600m flying height, 5cm GSD
- ✓ Acquisition of GCPs
  - 47 GCPs, dual-frequency GNSS, GGRS '87
- ✓ Acquisition of additional data
  - UAV images from DJI Phantom covering Modi and Alyssos
  - Terrestrial images, CANON EOS 6D, at the bottom and top of Modi and Alyssos
  - Terrestrial laser scans, Additional GCPs
  - Existing LiDAR and imagery data by the airborne system RIEGL VQ-1560i-DW



## 3D MODELLING

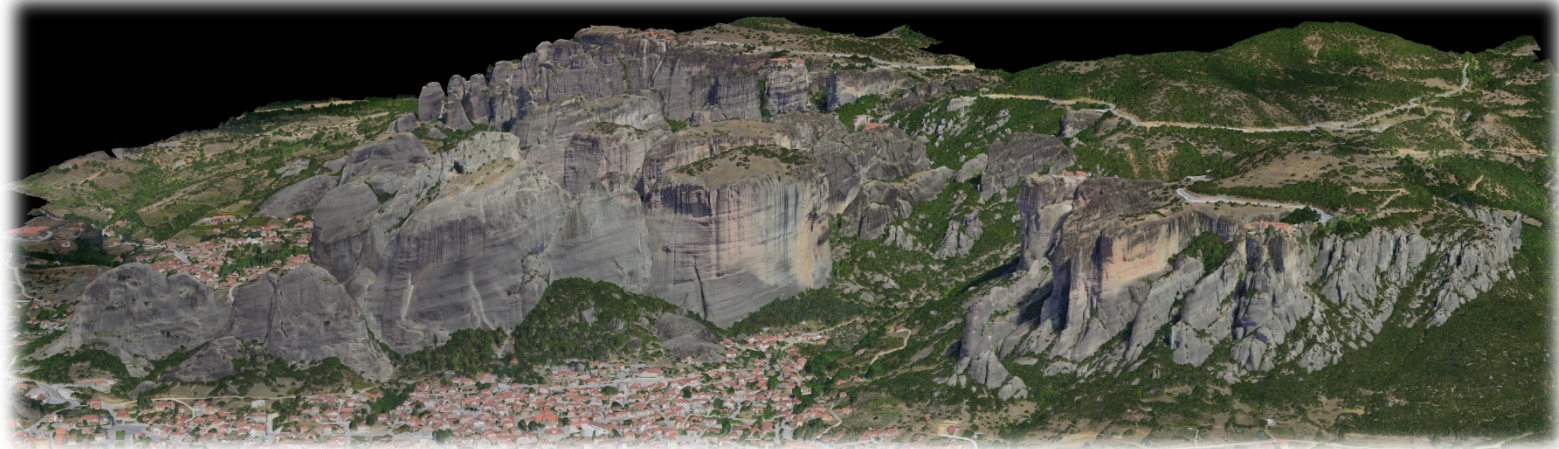
- ✓ Structure from Motion (SfM) – aerial images
  - Agisoft Metashape
  - Camera exterior and interior orientation & sparse point cloud (3,355,189 points)
  
- ✓ Dense image matching
  - Agisoft Metashape
  - Dense point cloud; 353,140,592 points
  
- ✓ 3D surface model generation
  - Agisoft Metashape → Geomagic Studio → Agisoft Metashape
  - 3D textured model: 67,471,539 faces & 34,029,510 vertices



sparse point cloud with GCPs

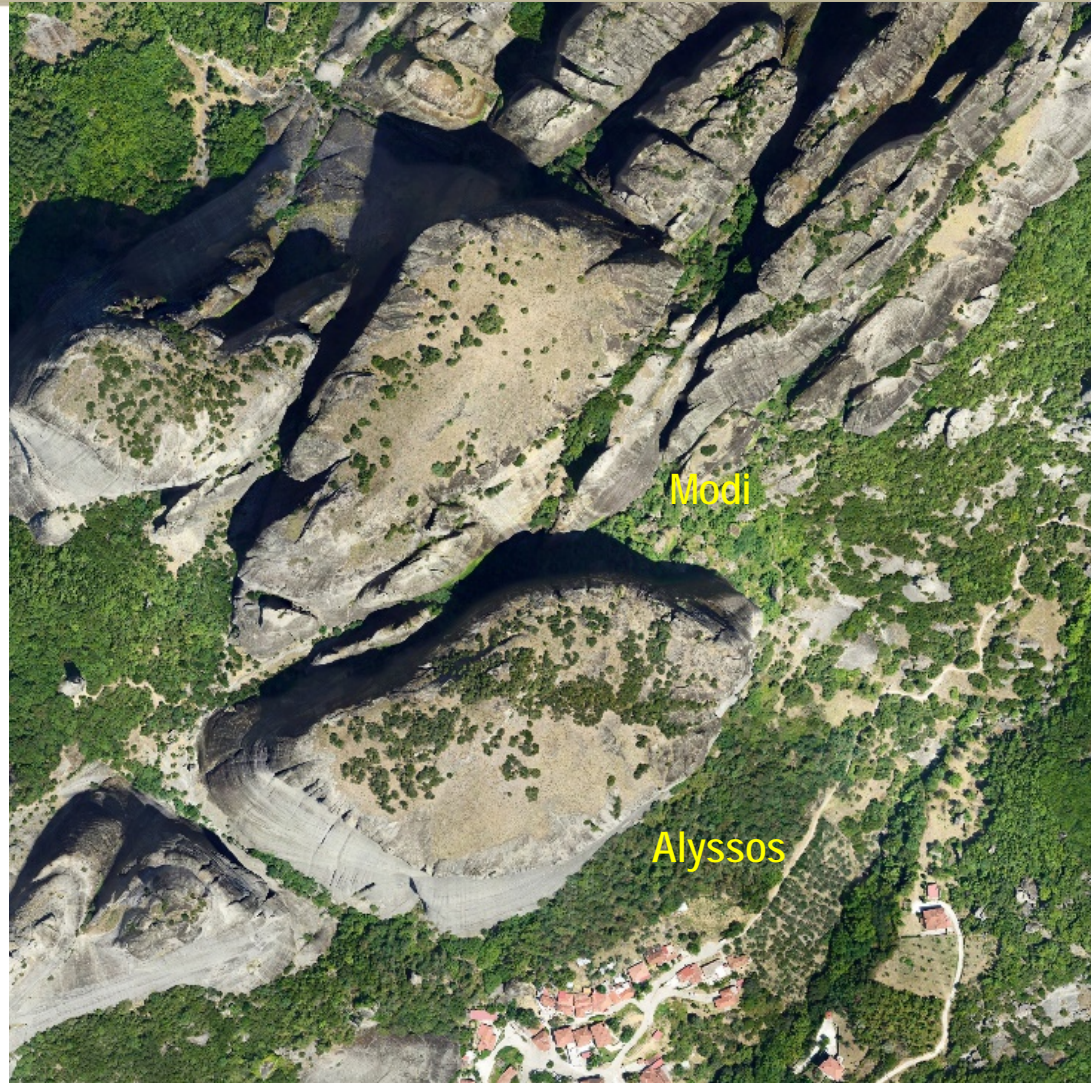
## 3D MODELLING

3D views of the 3D textured model of the Holy Meteora site



## ORTHOIMAGE

Part of an orthoimage of  
the Holy Meteora site  
depicting the rocks Modi  
and Alyssos

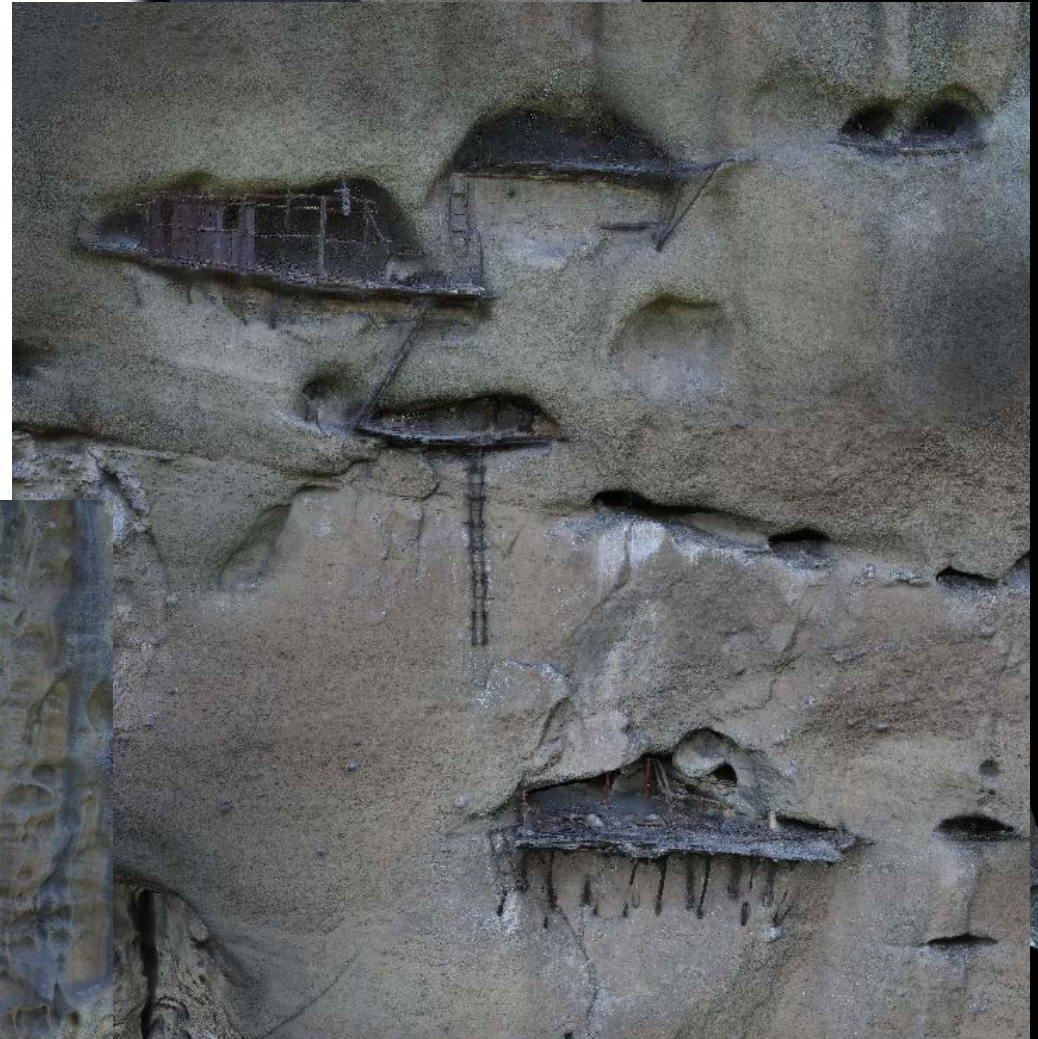




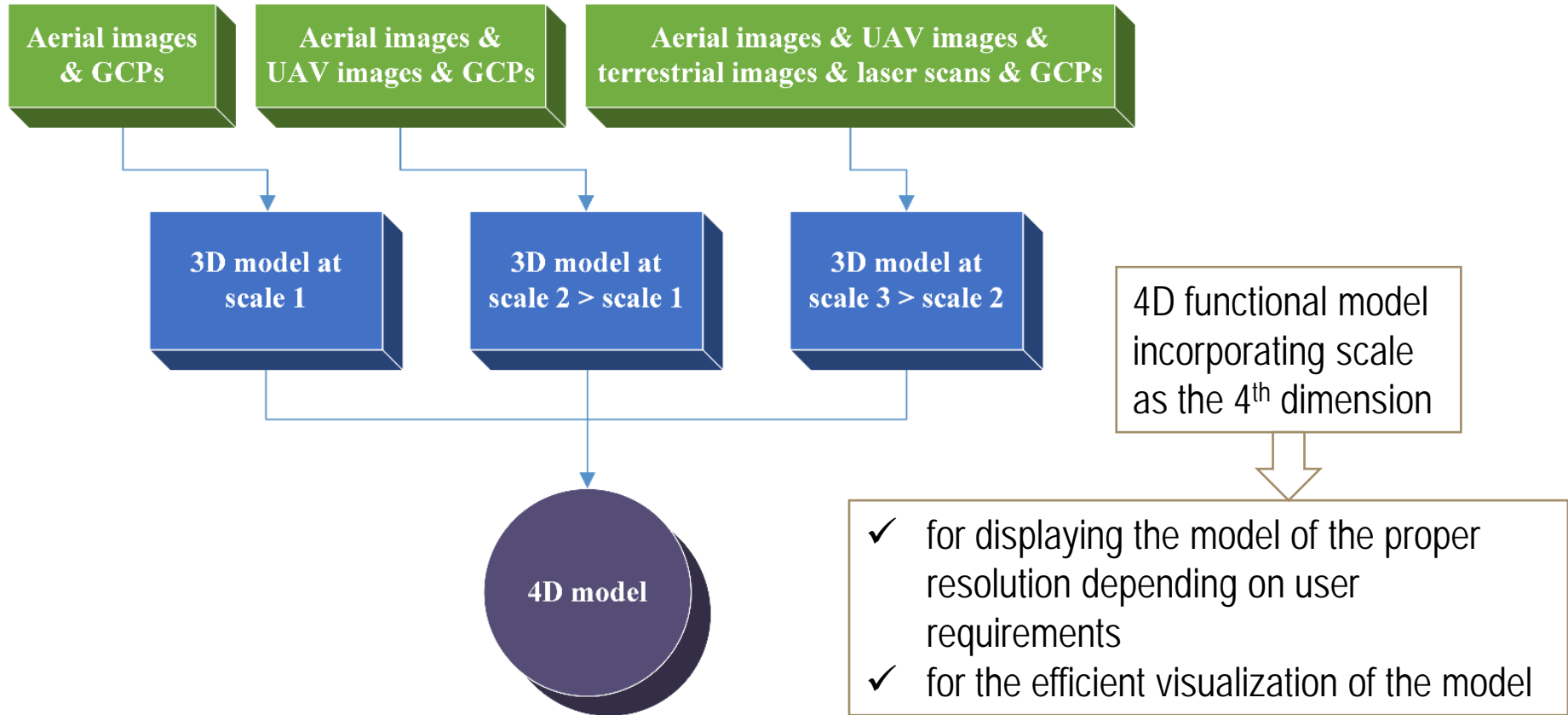
## CREATION OF 3D MODELS OF DIFFERENT SCALE

✓ Future creation of 3D models of the rocks of interest, Modi and Alyssos, **in higher levels of detail** using:

- UAV images
- optionally terrestrial images
- Optionally laser scans
- the collected GCPs



# 4D MODELLING



## ENRICHMENT WITH NON-SPATIAL DATA

The 4D model of the area of interest will be linked to a **database** with various kinds of information

- ✓ Collection of literature of **historic** interest
- ✓ Study of **hagiological**, **etymological** and **laographic** data
- ✓ Visits of the project consortium to **local parishes, municipalities and communities**, for the collection of laographic information and religious data
- ✓ Interviews with **local actors** concerning traditional customs.
- ✓ Collection of **old photographs** from the locals



## MANAGEMENT OF GEOSPATIAL BIG DATA

- Back-end infrastructure of the “METEORA” platform
  - ✓ MySQL, MongoDB and PostgreSQL database types will be investigated
- Front-end infrastructure of the “METEORA” platform
  - ✓ The viewer will enable the visualization of the 4D model and will incorporate data interaction and retrieval tools and a user-friendly GUI
  - ✓ 3DHOP open source framework for desktop PCs
  - ✓ For iOS/Android: viewers of similar technology will be investigated, such as Emb3D
- Establishment and control of the communication between the back-end and the front-end interface
  - ✓ It will be assigned to a web service



## CONCLUSIONS AND FUTURE WORK

- ✓ The preservation of complex cultural heritage sites requires **precise 3D modelling** in a **high resolution** and/or **varying levels of details**.
- ✓ This generates the need for the implementation of **specialized modern procedures** for the **use of big data** derived from **various sources** for multi-dimensional documentation
- ✓ Future steps involve:
  - the collection of different kinds of data
  - their processing for the creation of 4D models of Modi and Alyssos
  - the creation of a database that will include various kinds of information
  - the development of the web-based “METEORA” platform



Thank you for your attention!

Prof. Dr. Charalabos Ioannidis  
E-mail: [cioannid@survey.ntua.gr](mailto:cioannid@survey.ntua.gr)  
Tel.: 0030 2107722686