

DIGITAL TRANSFORMATION • MADONIE UNESCO GLOBAL GEOPARK

From virtual experiences to 3D digital stewardship

Digital transformation for geoheritage valorization in Madonie UNESCO Global Geopark

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Madonie Geopark UGG





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MADONIE • TERRITORY AT A GLANCE

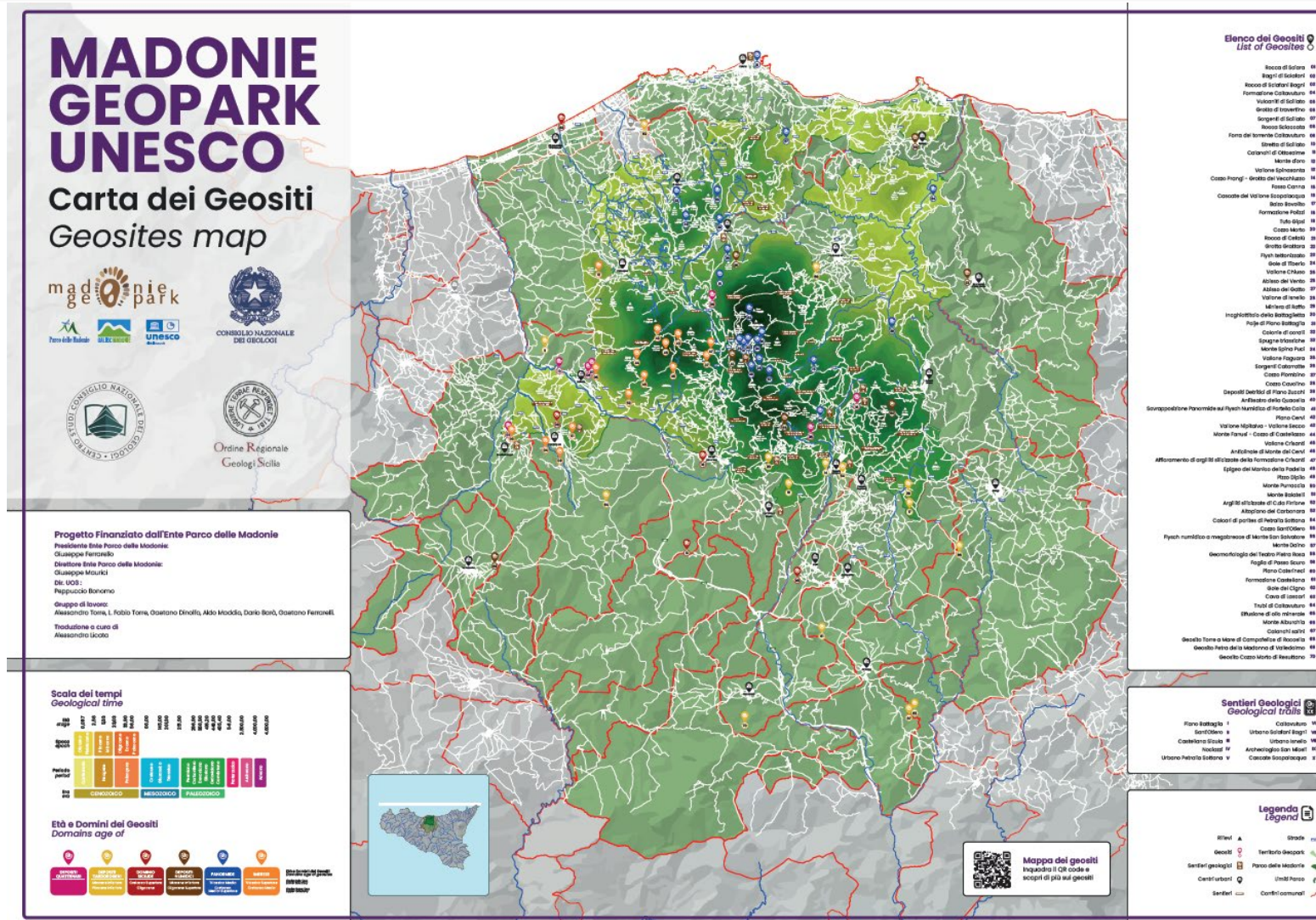
Madonie UNESCO Global Geopark

An extraordinary territory in Sicily,
recognized for exceptional geodiversity and
biological heritage.



SICILY • UNESCO GLOBAL GEOPARK

A protected landscape where geological time and
living heritage converge.





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MADONIE • TERRITORY AT A GLANCE

Madonie UNESCO Global Geopark

An extraordinary territory in Sicily, recognized for exceptional geodiversity and biological heritage.



SICILY • UNESCO GLOBAL GEOPARK

A territory shaped by three dimensions

A protected landscape where geological time and living heritage converge

KEY FACTS



AREA & COVERAGE

22 municipalities · 161,800 hectares · 39,679 ha Regional Natural Park.



GEODIVERSITY

Over 40 geosites and seven internationally recognized type-locality formations.



BOTANICAL HERITAGE

Sanctuary of *Abies nebrodensis* and centuries-old monumental trees.



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DIGITAL TRANSFORMATION

Two complementary paths to a digital Geopark

Public engagement and scientific monitoring converge in one stewardship strategy.



VR@GEOPARKS



IMMERSIVE ACCESS

Virtual reality, 360° imaging,
UAV and SfM photogrammetry.



GEMMA



**PROGETTO
GEMMA**

DIGITAL STEWARDSHIP

Satellite observation, LiDAR, rovers
and interactive WebGIS.



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VR@GEOPARKS · ERASMUS+

Immersive access brings geosites into the classroom

VR • 360° • UAV • SFM

A strategic partnership focused on digital dissemination and inclusive accessibility.

PROGRAM Erasmus+ Strategic Partnerships.

PURPOSE Make fragile or remote geosites explorable.

THE TOOLKIT

VIRTUAL REALITY Immersive learning environments.

360° IMAGING Remote visual exploration.

UAV + SFM High-precision models from overlapping images.



THE VALUE

Digital access expands participation without increasing pressure on fragile sites

STUDENTS Explore geological strata from the classroom.

VISITORS Overcome physical and geographic barriers.

GEOPARKS Share heritage through inclusive interpretation.



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DIGITAL STRATEGY · MADONIE

Education and monitoring form one digital strategy

OUTREACH + CONSERVATION

Two complementary programs connect public engagement with evidence-led stewardship.

PILLAR 1 Inclusive access and immersive learning.

PILLAR 2 Scientific monitoring and digital twins.

VR@GEOPARKS

Immersive access to geosites

Virtual Reality, 360° imaging, UAV surveys and SfM photogrammetry support digital dissemination.

GOAL Inclusive e-learning and barrier-free geotourism.



GEMMA · PNRR CHANGES

Multi-level monitoring for monumental trees

Sentinel-2, 3D LiDAR, terrestrial rovers and interactive WebGIS connect observation with management.

GOAL Phytosanitary monitoring and 3D digital twins.



PROGETTO
GEMMA



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ERASMUS+ STRATEGIC PARTNERSHIP

VR@Geoparks makes geosites immersive classrooms

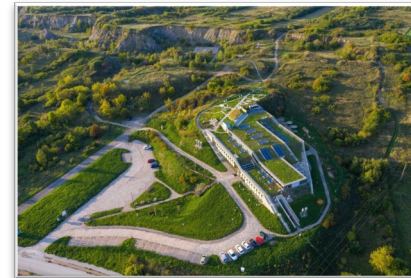
2 YEARS • 7 INSTITUTIONS • 6 COUNTRIES

Italy • Hungary • Poland • Croatia • Turkey • Portugal

NETWORK Two Geoparks, three schools, INTERACTIDEAS and the University of Reggio Calabria.

BUILDS A VR application and 3D datasets for representative geosites across five UNESCO Global Geoparks.

OUTCOME Teachers gain immersive e-learning tools; Geoparks become more inclusive educational sites.



PARTNERS		STAKEHOLDERS	
 Parco delle Madonie Madonie Geopark	 Kudret Demir Ortaokulu	 PAPUK Park periods • Nature park	 KULA-SALİHLİ GEOPARK
 INTERACT IDEAS	 Stowarzyszenie Gmin Geopark Świętokrzyski	 Szechenyi Istvan Baptista Technikum, Szakképző iskola és Gimnázium	 Bakony-Balaton Geopark
 Matije Petra Katancica	 Osnovna skola Matije Petra Katancica Valpovo	 Università degli Studi Mediterranea di Reggio Calabria	
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ISTITUTO NAZIONALE DOCUMENTAZIONE INNOVAZIONE RICERCA EDUCATIVA

Erasmus+

European Union



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VR@GEOPARKS • IMMERSIVE EXPERIENCES

Geosites become accessible beyond physical boundaries

3D MODELS • 360° VR • INCLUSIVE LEARNING

Developed with European Geopark partners to transform geological heritage interpretation.

PURPOSE Remote exploration of steep or fragile terrains.

AUDIENCE Schools and visitors with physical or mobility constraints.

FROM FIELD DATA TO IMMERSIVE LEARNING

THE EXPERIENCE



3D Surveys & SfM

High-precision modeling of key geosites in the Madonie Geopark.



360° VR Platform

Interactive virtual environments enable remote exploration.



Inclusion & Education

Tailored tools turn geological heritage into accessible learning.

SFM IN PRACTICE

Hundreds of drone photos become precise 3D geology

INPUT Overlapping aerial images of cliff faces and fossil beds.

OUTPUT Sub-centimeter 3D meshes for detailed inspection.

CLASSROOM Students inspect geological strata as if standing on the mountain.



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VR@GEOPARKS · ARCHITECTURE

Data, exploration and learning in one ecosystem

5 GEOPARKS • 6 LANGUAGES • 360° TOURS

International collaboration turns research infrastructure into an accessible learning experience.

ECOSYSTEM Data, software and teaching modules work as one.

REACH The app supports IT, EN, HR, PL, PT and TR.

FROM RESEARCH TO SCHOOL CURRICULA

THE THREE LAYERS



1. Geospatial Dataset

Drones and laser scanners build a 3D database across five European Geoparks.



2. Multilingual VR App

Interactideas connects six languages with interactive 360° tours.



3. Educational Modules

Lesson plans, experiments, 2D quizzes and geocaching support school curricula.

LEARNING EXPERIENCE

The platform turns exploration into participation

EXPLORE Navigate immersive 360° panoramas.

DISCOVER Complete virtual geocaching activities.

LEARN Answer educational quizzes embedded in the experience.



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NATURAL HERITAGE • MADONIE PARK

Old-growth forests, a living memory of the landscape

In areas that are often difficult to access, centuries-old trees of exceptional size preserve the ecological history of the Park.

UP TO 20 M is the height reached by giant hollies.

ABOUT 1,000 YEARS is the estimated age of a monumental downy oak.

maples • beeches • ash trees • olive trees • hawthorns • pear trees • wild apple trees

POMIERI • sessile oak • field maple • sycamore maple





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DIGITAL MONITORING · GEMMA PROJECT

Measuring the health of monumental trees

The monitoring integrates satellite observation, field surveys and three-dimensional models.

OBSERVE Sentinel-2 and UAV surveys.

DETECT 3D LiDAR and ground-based rovers.

SHARE Interactive WebGIS and digital twins.

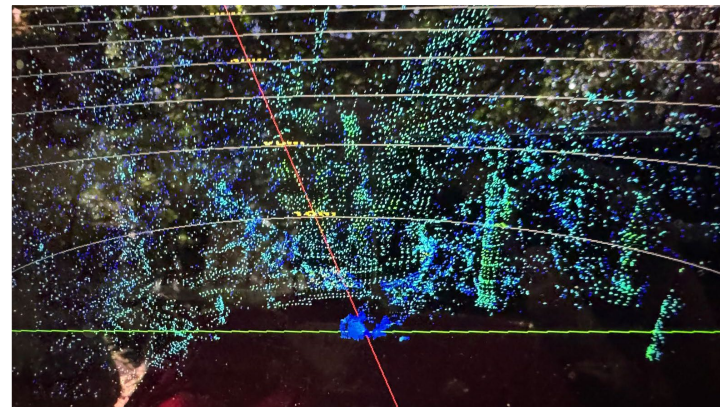
More readable data to protect a living heritage.



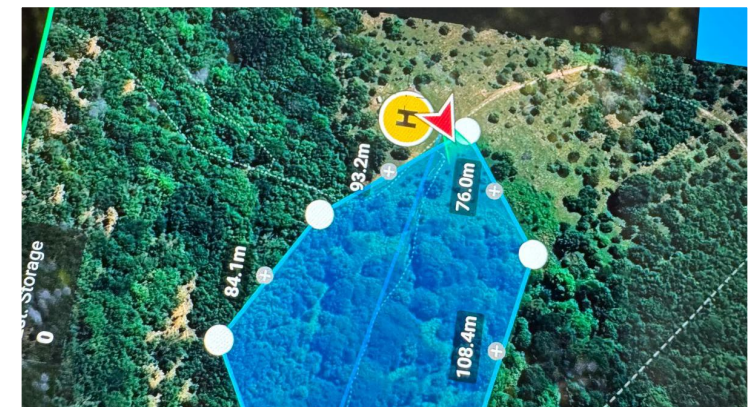
SURVEY IN THE FIELD



GEOREFERENCED ACQUISITION



3D POINT CLOUD



WEBGIS PLATFORM



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GEMMA • TECHNICAL STACK

A multi-scale stack turns observations into decisions

SATELLITE • DRONES • LIDAR • WEBGIS

Each layer adds detail—from regional canopy trends to trunk geometry and bark integrity.

MACRO Regional multispectral indices reveal canopy trends.

MICRO LiDAR, thermal and hyperspectral surveys capture tree condition.

ONE PIPELINE • ONE MANAGEMENT VIEW

THE THREE LAYERS



1. Satellite Remote Sensing

Sentinel-2 data supports continuous NDVI and EVI calculation.



2. Drones & Ground Rovers

LiDAR, hyperspectral and thermal sensors generate detailed 3D point clouds.



3. WebGIS Platform

Euro.soft integrates the data in a Virtual Museum and management dashboard.

FROM DATA TO ACTION

One repository connects field evidence and real-time management

CAPTURE Ariespace and Latitudo 40 process satellite data.

MODEL Drone and rover surveys create precise 3D geometry.

MANAGE The WebGIS turns observations into an interactive operational view.



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INTEGRATED DIGITAL ECOSYSTEM

One 3D ecosystem unites geology and living heritage

ABIOTIC + BIOTIC + SPATIAL DATA

Historically separate inventories now converge in a single information environment.

BRIDGES Rocks, fossils, landscape evolution and ancient trees.

ENABLES Shared stewardship across interpretation and conservation.

ONE DATABASE · TWO HERITAGE SYSTEMS

THE CONVERGENCE

PUBLIC ENGAGEMENT

VR@GEOPARKS makes geosites explorable through 3D and immersive learning.

3D

DIGITAL STEWARDSHIP ECOSYSTEM

STRUCTURAL MONITORING

GEMMA adds satellite, LiDAR and field evidence for long-term conservation.

A SHARED INFORMATION MODEL

One spatial database supports interpretation and protection

GEODIVERSITY Geological sites, rocks and fossils.

LANDSCAPE Evolution, terrain and environmental context.

LIVING MONUMENTS Ancient trees and their changing condition.



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IMPACT · FUTURE OUTLOOK

A scalable model for access, conservation and participation

LOCAL PROOF • GLOBAL POTENTIAL

The Madonie framework can become a repeatable standard for digital natural-heritage stewardship.

200+ MEMBERS Potential reach across the UNESCO Global Geoparks Network.

SICILY Positioned at the forefront of digital conservation.

TEST LOCALLY · SCALE GLOBALLY

FOUR OUTCOMES



Inclusive Accessibility

Remote exploration overcomes physical and geographic barriers.



Proactive Conservation

Early warning reveals phytosanitary stress, erosion and climate threats.



Community Engagement

Schools and visitors connect through education and sustainable geotourism.



Replicable Model

A shared technological standard can extend across the EGN.

WHY IT SCALES

A common framework makes expansion practical

PROVEN Tested in the Madonie UNESCO Global Geopark.

ADAPTABLE Applies to fragile geosites and isolated tree patriarchs.

TRANSFERABLE Designed for the European and global Geoparks networks.

THREE FINAL MESSAGES

Digital stewardship is useful only when it improves real decisions

INCLUSIVE Digital access expands participation without increasing pressure on fragile sites.

EVIDENCE-LED Integrated data supports earlier, better conservation choices.

REPLICABLE A shared architecture makes the model transferable

CLOSING · QUESTIONS & ANSWERS

Thank you for your attention

Q&A SESSION

Madonie UNESCO Global Geopark

ACCESS Bring fragile heritage within reach.

MONITOR Turn observations into timely evidence.

SCALE Extend one tested model across Geopark networks.

DISCUSSION GUIDE

1. Data accuracy

What is the LiDAR spatial resolution?

Sub-centimeter point clouds; approximately 2–5 mm accuracy on tree trunks.

2. Long-term sustainability

How will the WebGIS platform be maintained after PNRR?

By the Madonie Park Authority, using cloud infrastructure and regional heritage funding.

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