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ENIGMA

Endorsing safeguarding, protection, and
provenance management of cultural heritage

Earth Observation Toolkit Manual

User Guide of cultural heritage authorities,
LEA Officers and Experts

ENIGMA Project

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Tool name	Earth Observation Toolkit
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Abbreviations

Term	Explanation
CGs	Cultural Goods
CH	Cultural Heritage
DO	Demonstration, Dissemination & Exploitation Objectives
EC	European Commission
PC	Project Coordinator
TG	Target Group
WP	Work Package

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1.1 INTRODUCTION

ENIGMA is a cutting-edge geospatial monitoring platform designed to detect and prevent illegal excavation activities using advanced remote sensing automation. By leveraging satellite imagery, advanced image processing, and GIS technology, ENIGMA enables authorities and experts to monitor high-risk areas across multiple regions.

With an intuitive interface, users can:

- Identify and mark suspicious areas – Easily highlight regions of interest to guide the remote sensing analysis algorithms to focus on specific areas.
- Analyze multitemporal satellite imagery and pinpoint potential illegal digging for enhanced situational awareness.
- Get alerts and reporting – Receive instant updates on unusual land activity and ground anomalies.

The ENIGMA Earth Observation (EO) toolkit empowers governments, LEA authorities and archaeologists, with the EO toolkit needed to safeguard cultural heritage and support the prevention of illegal excavation.

1.2 THE PLATFORM

• BACKEND DETAILS

The backend of the EO toolkit is hosted on the ECoE server, where all computational operations are processed. It is built using scalable and efficient server-side technologies, optimized for handling large-scale geospatial data and complex computational workflows. The backend is designed to integrate seamlessly with EO datasets and analysis libraries, ensuring high performance and reliability. Key functionalities include data ingestion and fetching, processing, and storage, powered by advanced algorithms and frameworks tailored for EO and remote sensing tasks. The

system also features robust APIs for interoperability and extensibility, allowing for smooth communication between the server and client-side components.

• FRONTEND DETAILS

The frontend is integrated within the ENIGMA platform, offering a clean, intuitive web-based interface for user interaction.

Built with modern web technologies, the frontend provides a responsive and dynamic user experience.

System's access is provided to two main categories of users:

- **Authorities responsible for cultural heritage monitoring** can design and define specific areas that should be monitored in timely manner.
- **End users (LEA officers and archaeologists/experts to monitor the alerts)** can perform data exploration, search and visualize the results directly through their browser.

Given the sensitivity of the processed information, a key component of the frontend is its robust authentication system, which ensures secure access to the platform.

User credentials are verified through a secure authentication process, integrated with the ENIGMA platform's role-based access control system. This ensures that only authorized users can access specific features and datasets, safeguarding sensitive operations and data integrity.

1.3 GETTING STARTED

The EO toolkit is a web based, accessible interface with no specific system-based requirement for use.

The only prerequisite is to register on the ENIGMA platform and be assigned an appropriate role (CH authorities, LEA or Expert) by the system administrator.

• GETTING ACCESS TO THE SYSTEM

The users have to register through the main ENIGMA platform web interface. The landing page is the following (Figure 1):

<https://enigma.cellock.com>

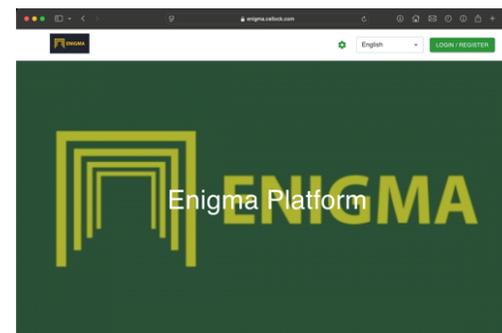


Figure 1: Main ENIGMA platform landing page

The users have to select the “Login/register” option on the top menu to access the section regarding the signing up process or login (Figure 2).

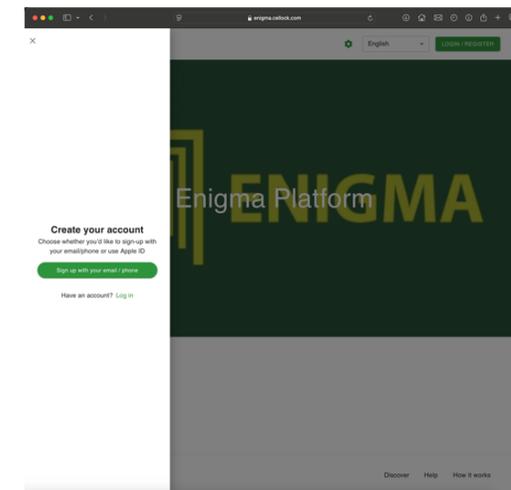


Figure 2: Signup and login option tab

If the users get access to the interface for the first time, they need to sign up and the administrator will assign the appropriate user role (cultural heritage authority, LEA officer or Expert).

• Sign up process

The users need to provide the following information to request access:

5. First Name
6. Last name
7. E-mail
8. Password

The prerequisites for the password are the following:

- Password has at least 8 characters.
- Password has special characters.
- Password has a number.
- Password has a capital letter.
- Passwords match.

The user interface for the signup process is presented in the following image (Figure 3).

Signup with your email
Please fill in the details below

- ✘ Password has at least 8 characters.
- ✘ Password has special characters.
- ✘ Password has a number.
- ✘ Password has a capital letter.
- ✘ Passwords match.

Sign Up

By pressing Send request, you agree that we may contact you via phone/text and/or email about your inquiry, which may involve the use of automated means. You also agree to our [Terms of Use](#)

Figure 3: Signup form

2.1 USER INTERFACE OVERVIEW

The users, based on their role, are granted access to different interfaces. CH authorities receive access to the EO toolkit management interface whereas LEA Officers and archaeology/experts to the interface that highlights the results-alerts generated by the remote sensing scientific analysis.

In the left panel, users can access the tools available to them based on their assigned role. If users are designated as responsible personnel from CH authorities to manage the monitored areas, they will have access to the Remote Sensing Management tool.

Experts having access to the provenance research tool they can also find the remote sensing alerts interface integrated. In parallel the same interface is provided as stand-alone application (Figure 4).

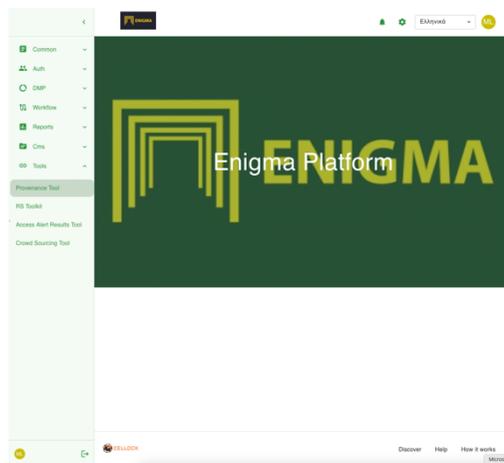


Figure 4: Navigation panel for Experts access

DESCRIPTION OF THE MAIN SECTIONS OF THE REMOTE SENSING MANAGEMENT INTERFACE

The interface consists of:

- **Left Panel:** Navigation menu with options such as "Checking Areas" and "Alert Areas".
- **Main Map View:** Displays near-real-time satellite imagery of monitored locations.
- **Right Panel:** A list of regions categorized by geographical areas, such as Cyprus, Malta, and Greece etc.

EXPLANATION OF ICONS, BUTTONS, AND MENUS

The interface has two main sections. One which allows to manage and navigate the interactive map and the second to edit and manage areas of interest (Figure 5):

- **Home Icon (🏠):** Returns to the initial extent of the map.
- **Search Icon (🔍):** Allows users to search for specific locations or coordinates.
- **Basemaps Icon (🗺️):** Toggles between different map views (satellite, terrain, hybrid).
- **Zoom In (+) and Zoom Out (-):** Adjust the map view for better level of detail.

Manage and edit areas Interaction buttons

- **Select Region:** Click on a highlighted area to view additional information and analysis.
- **Edit Feature:** Opens a dialog box to annotate or update information on a flagged area.
- **Create Feature:** Allows users to mark and document a suspicious activity on the map.

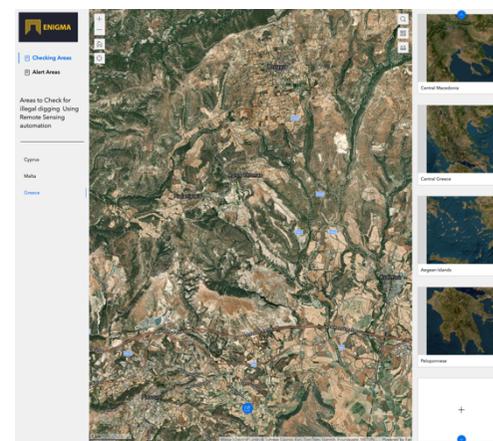


Figure 5: General overview of the authorities' management user interface

2.2 BASIC OPERATIONS

The responsible authority users can add, remove or edit specific polygons on the map to designate areas for monitoring by the EO toolkit. Moreover, they have the ability to get an overview and navigate to the pinpointed areas. The basic operations that the authorities can access are the following:

- **MANAGE AREAS OF INTEREST**
- **VIEW ALERT AREAS THAT HAVE BEEN CREATED THROUGH EO TOOLKIT BACKEND**

2.3 BASIC OPERATIONS – CULTURAL HERITAGE AUTHORITIES

The end users can navigate the map, manage monitored areas and review the alerts provided by the automated remote sensing process.

- **MONITORED AREAS MANAGEMENT FORM**
- The experts can navigate the map using the buttons provided (zoom, change basemap, search areas) and, as soon as they find an area of interest (AOI), they can use the edit button (Figure 6).

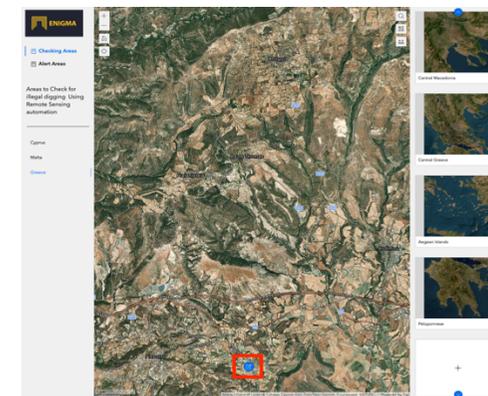


Figure 6: Edit areas for monitoring

The end users should select whether to edit an existing AOI (A) or add a new one (B) (Figure 7).

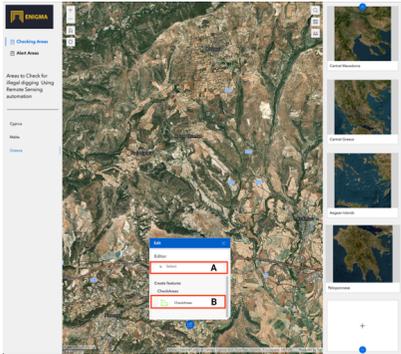


Figure 7: Button to select or edit monitored areas

In the case that they are going to draw a new AOI they should go to the map →, draw a polygon, and add a short description (Figure 8).

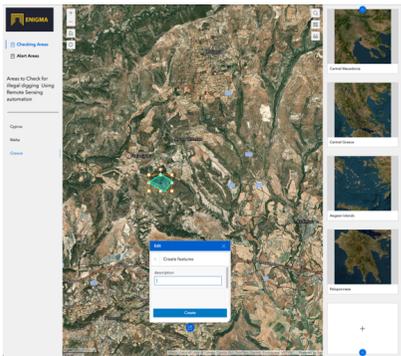


Figure 8: Form to edit description of the Area of Interest

Although the EO toolkit will compute the change detection according with the users' input, and regardless the extension of the AOI, it is highly advised to define the boundaries of the archaeological sites as precise as possible.

Once the areas of interest are defined, the backend automatically process them as scheduled. Algorithms process the selected data and provides the alert results, which are then made available for visualization.

- **VIEW ALERT AREAS THAT HAVE BEEN CREATED THROUGH EO TOOLKIT BACKEND**

The users have the ability to review the Remote Sensing analysis outcomes selecting from the left side panel the map with the alerts (Figure 9).

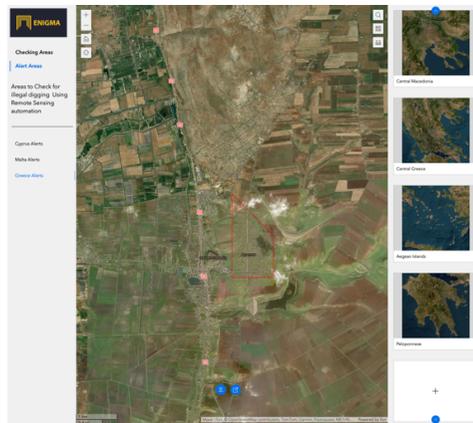


Figure 9: Map accessing the alerts provided by the EO toolkit

2.4 BASIC OPERATIONS – THE END USERS LEADERS AND ARCHAEOLOGISTS/EXPERTS

The users that manage the CG recognition and documentation using the provenance tool can access only the alerted areas from the provenance web interface.

The EO tool focuses on areas that are provided from the expert as the possible provenance of the object. The areas are highlighted by red boundary polygon (Figure 10).

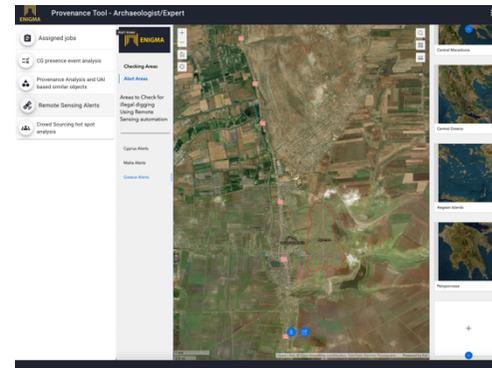


Figure 10: Remote Sensing analysis alerts for possible illegal excavation areas

The EO toolkit incorporates several additional features for searching location and/or navigating through the map such as zoom in, zoom out, previous view, measurement tools and changing basemaps option (Figure 11).

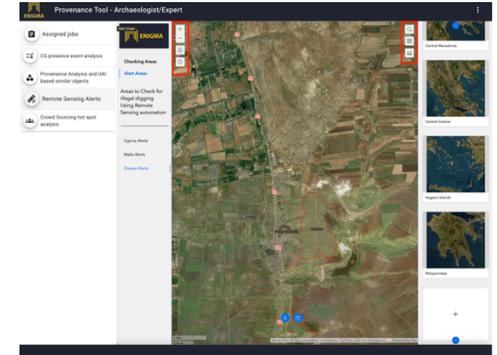


Figure 11: Map navigation and searching tools