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ARCHEOLOGY AND CONSERVATION. DIGITAL TOOLS AS DIGITAL BRIDGES BETWEEN DISCIPLINES: THE RISK MAP OF THE *IN SITU* MOSAIC AND MARBLE FLOOR SURFACES OF THE PARCO ARCHEOLOGICO DEL COLOSSEO

1. Arguments for the project

Since 2018, the Parco Archeologico del Colosseo has been engaged in the project "Risk Map of the *in situ* mosaic and marble surfaces of the Parco Archeologico del Colosseo" (Lugari, Rinaldi 2020). The archaeological area of the Palatine, the *Domus Aurea* and the Roman Forum include more than 200 floor pavements. The list includes cocciopesto floors used in the service rooms, but also, and most importantly, black and white tessellated and *opus sectile* marble floors for the representative rooms. Some of these floors can be seen inside the houses and palaces on the Palatine hill (the House of the Gryphons, the House of Livia, the House of Augustus, the *Domus Transitoria*, the *Schola Praeconum* and the *Paedagogium* on the southern slopes of the Palatine), the civil buildings (*Basilica Aemilia* in the Roman Forum and *Curia Iulia*) and in places of worship (the Church of S. Maria Antiqua).

Open-air floors are particularly abundant and amongst these are the *sectilia pavimenta*, artfully constructed with a combination of coloured marbles, clearly recognizable in the gardens and rooms of the Flavian Palaces (*Domus Flavia* and *Domus Augustana*) and in the *Domus Aurea*. These are the most fragile floors because they are subject to thermal stress of high summer temperatures and winter frost and to the trampling of the 20,000 tourists who visit and literally walk through this extraordinary compendium of history and architecture every day, not always aware that they are walking inside a representative space, a corridor, a portico frequented in ancient times by ordinary Roman citizens or emperors. Most of these mosaics were catalogued and studied in the 1960s by M.L. Morricone Matini (Morricone Matini 1967; D'Alessio *et al.* 2018) and in recent years have been digitised by the University of Padua in the context of the TESS project (http://tess.beniculturali.unipd.it).

2. A multidisciplinary team for mosaics and sectile heritage maintenance

In order to maintain this cultural heritage *in situ* and to tell its story, the Parco Archeologico del Colosseo has been carrying out a monitoring and maintenance programme since 2018. The first results were made known

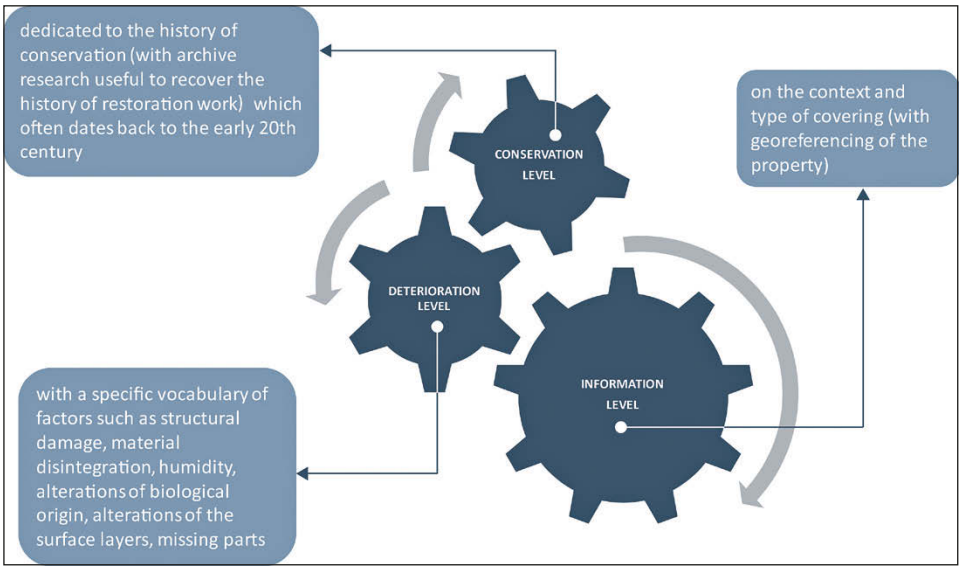

Fig. 1 – Brief description diagram of the adopted multi-level approach.

on 21th March 2019 in *Curia Iulia* at an international workshop (Rinaldi 2020). Specific and relevant monitoring and prevention measures, to counter the risk of decay or loss, have been designed for this particular category of materials. Three types of extreme events, in particular, were taken into account: 1) biological attacks by weed vegetation; 2) climate change; 3) the "social" context, i.e., the impact of tourism that undoubtedly ranks among the primary causes of "wear and tear" of pavement levels. A multidisciplinary team of archaeologists, architects, restorers and computer scientists was set up to deal with and manage this complex task in the best possible way, which first tested a multi-level sheet (Fig. 1):

1. information level on the context and type of covering (with a detailed georeferencing of the property),
2. conservation level dedicated to the history of conservation (with archive research aimed at recovering the history of restoration work – which often dates back to the early 20th century),
3. deterioration level from specific factors such as structural damage, material disintegration, humidity, alterations of biological origin, alterations of the surface layers, missing parts.

The combination of these levels provides the severity index and therefore the urgency of the intervention.

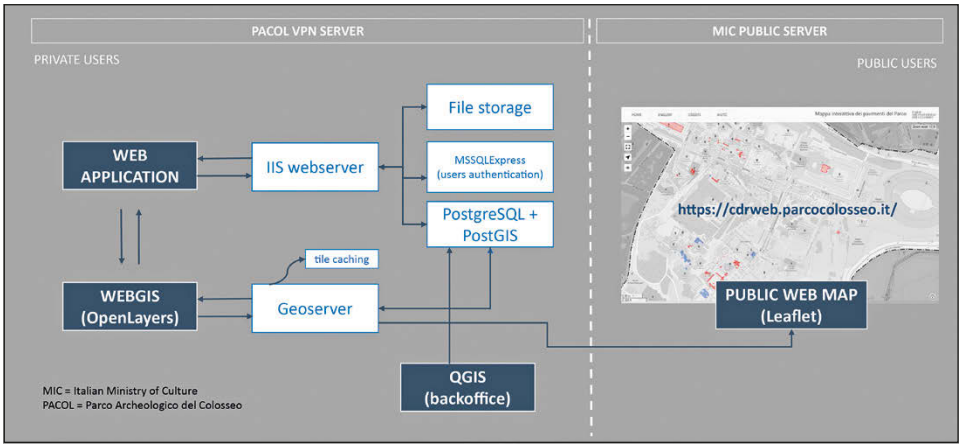

Fig. 2 – Diagram of the logical architecture behind the web platform.

Fieldwork has made it possible to move from emergency maintenance to periodic routine maintenance involving scheduled monitoring for each floor unit according to its criticality, reducing the "risk" of damage and turning it into "value". This monitoring made it possible to draw up a direct pavement intervention plan, which included a status report, followed by cleaning operations, stabilising mobile elements, restoring and preserving the perimeter edges of the preserved fragments and, where necessary, applying systems to prevent the regrowth of infesting vegetation, and periodic biocide treatments on the surfaces. Seasonal coverings with Delta® Lite sheets have been arranged for a selection of floor coverings for when temperatures reach alert levels both in summer and winter (Lugari 2017). Finally, a treatment of the *lacunae* was studied and tested, aimed at both restoring the original design with the chromatic alteration of the *breccia* placed to fill the *lacunae* and isolating them from weed roots, thus better preserving the mosaic or marble floor (Rinaldi *et al.* 2022).

3. From field maintenance to the "Risk Map" webGIS platform

Once this initial stress test phase was completed, which also served to identify and codify the treatment of the gaps and the aesthetic and final presentation of the floors after restoration, it was decided to proceed with data digitization and management inside a comprehensive webGIS environment (Fig. 2). Inside the webGIS platform – daily updated with running activities and new images – a historical-archaeological section for each building together with a dedicated "floor unit form" was prepared, divided into:

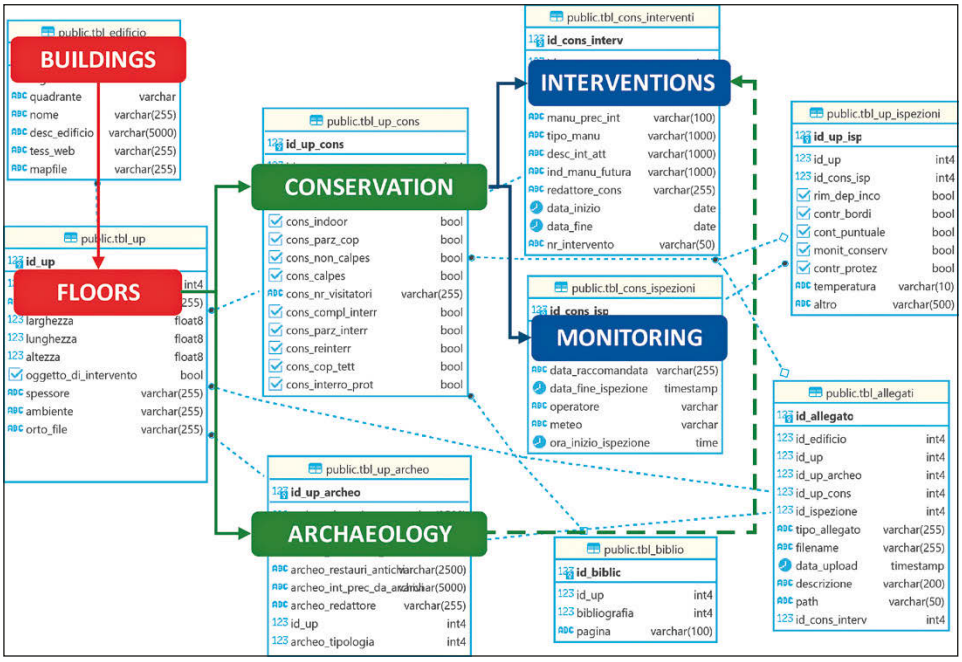

Fig. 3 – Database schema and its main entities.

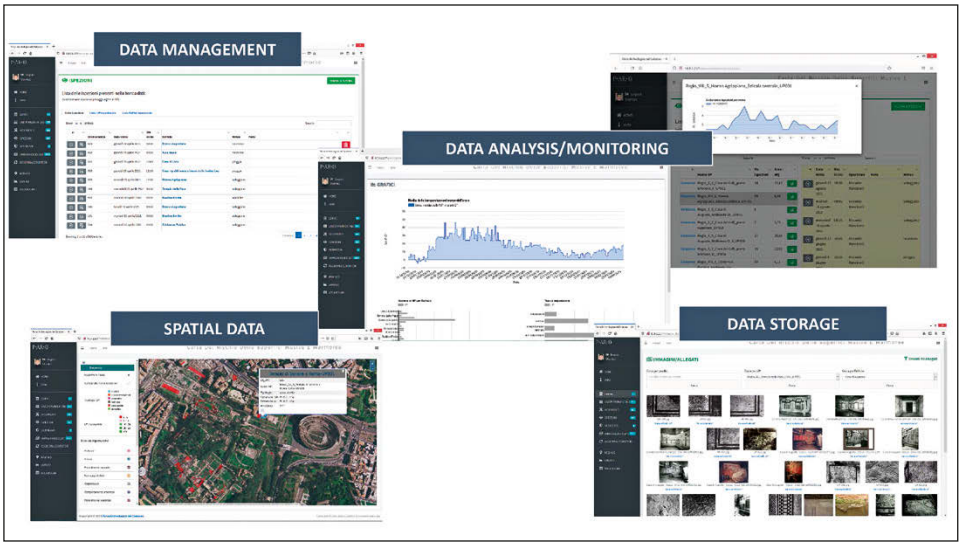

Fig. 4 – Main features and tools available inside the web application.

1. the archaeological part, including a description of the floor, the decorative type (cement floor, mosaic, paved, *opus sectile*, *opus spicatum*), dating, bibliography when available, photographic attachments, and all information gathered from archives research;
2. the conservation part, where the state of the art is described, and therefore the type of exposure to degradation, the presence or absence of covering and protection, both stable and seasonal.

The web application works as a back-office repository and management system for data manipulation and storage, whereas users on a PostgreSQL/PostGIS database record spatial and attribute data daily (Boldrighini *et al*. 2021). The interaction with the webGIS section, based on OpenLayers, is delegated to Geoserver services running on the same server. In order to manipulate spatial data, a secure connection to the geodatabase is established directly through QGIS tools. The public server, based on Apache web server, connects to Geoserver web services and is used mainly to allow public users to interact with a selection of data extracted from the main database. We can summarise the main aspects by entering the geodatabase and its relations (Fig. 3). Buildings and floor pavements are the two main entities: several tables are related to these entities in terms of archaeological information and conservation data. Daily activity concerning monitoring and interventions is stored dynamically in specific tables related to main entities.

The web application illustrates what we have observed regarding the data schema. Its main features can be summarised as follows: 1) sections for data management (inserting, updating, uploading, etc.); 2) sections dedicated to secure data storage and indexing; 3) webGIS section for spatial data interaction and visualisation; 4) a custom section for data analysis based on Google graph libraries; graphs are dynamically connected to the database and are updated automatically. The information system has been designed based on the real needs of professionals and is proving to be a valid tool for the optimization and integration of conservation and archaeological data with operational activities, with a view to medium and long-term action and programming. The improvement achieved with this kind of digital tool must be seen mainly in regard to its dynamic approach to user demands oriented data collecting, in order to connect, relate and inform conservation practices to archaeological information of the ancient floors. This kind of "connected" approach was able to trigger the correct awareness of heritage values and significance in order to create the right balance between conservation and enhancement needs (Fig. 4).

The webGIS constitutes the back office of our daily work; it is accessible to "employees" using passwords, and is aimed at sharing and enabling access of this heritage to all visitors, both *in situ* and online.

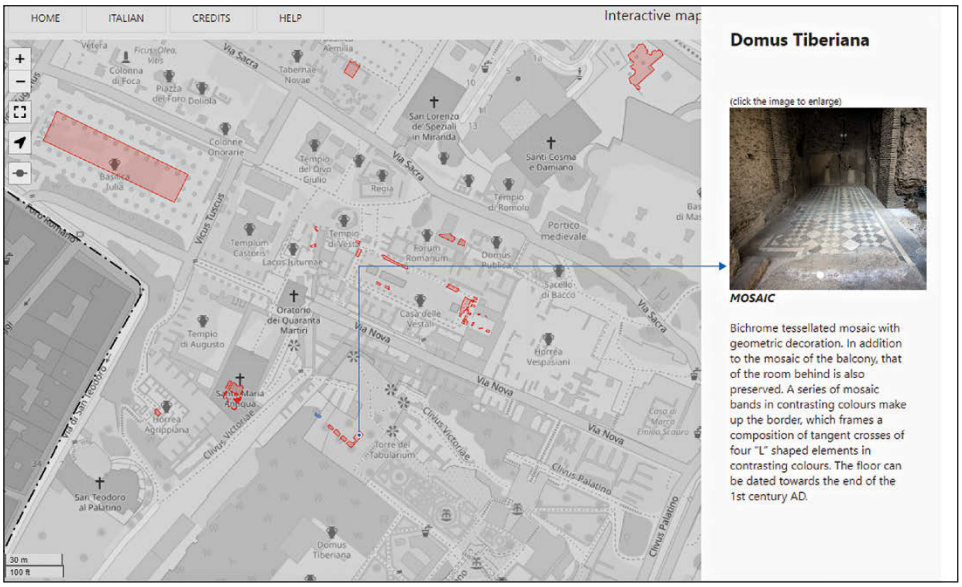

Fig. 5 – Public web map (https://cdrweb.parcocolosseo.it/).

4. From maintenance to educational and enhancement approaches

At the end of the first three-year phase of the project, an interactive web map was published online in May 2022 to share selected data regarding the ancient floors of the Parco with public users (Rinaldi *et al.* 2023). At this stage the web map (https://cdrweb.parcocolosseo.it) allows access to descriptive texts and image galleries of the ancient floors and there are plans to improve data sharing through API and web map services (Fig. 5). The polygons regarding the floors have been digitised on the map using the available archival graphic documentation (maps, rasters, orthophotos, detailed vector surveys where existing), and the same polygons have been made interactive, allowing immediate access to the simplified files of each floor.

By clicking on each polygon the floor's file is displayed along with a gallery of images that visually provide historical and archive data and information, as well as information on how the floor was restored and conserved and the type of floor and therefore its dating. The descriptive texts are in Italian and English and are being implemented progressively. The floors included in the ordinary visiting routes of the public of the Parco Archeologico del Colosseo were published first covering the sectors of the Roman Forum (House of the Vestal Virgins, Fountain of Giuturna, *Basilica Aemilia*, *Curia Iulia*, *Horrea Agrippiana*) and of the Palatine (*Domus Flavia*, *Paedagogium*

and *Schola Praeconum*). Over time the map will also be updated with data from the so-called "super" places (Church of Santa Maria Antiqua, House of Augustus, House of Livia) or from the areas where visits are not permitted except for study and conservation reasons.

The goal is to offer an exhaustive panorama of decorated floor surfaces, to convey the value of these precious indicators of luxury (or service) in ancient residences, and to reduce the risk of indiscriminate and "misunderstood" trampling. If used appropriately the map lends itself not only as an interactive guide to deepen the knowledge of covering techniques, but also as a tool to build itineraries on a chronological or thematic basis.

Federica Rinaldi, Alessandro Lugari
Parco archeologico del Colosseo
federica.rinaldi@cultura.gov.it, alessandro.lugari@cultura.gov.it

Francesca Sposito, Ascanio D'Andrea
Consultant Parco archeologico del Colosseo
francesca.sposito@gmail.com, ascaniodandrea@gmail.com

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ABSTRACT

In 2018 the Parco Archeologico del Colosseo set out on a three-year basis project, the 'Risk Map of Floors Surfaces', with the aim of preserving and monitoring all the in situ floor coverings of the Roman Forum and the Palatine Hill areas (mosaics, sectile, cement floors, spicata). In order to systematically address this methodological approach a team of archaeologists, architects and restorers designed and created a comprehensive and functional information management system, the 'Risk Map of the Mosaic and Marble Surfaces', together with a web-based application with integrated webGIS tools. The platform is used daily to record historical-archaeological and archival data and it has become an essential tool in planning interventions in the field. This approach brings the Parco to move from emergency maintenance to a continuous cycle of systematic maintenance. At the end of the first three-year phase of the project, an interactive web map was published online in May 2022 to share selected data related to the ancient floors of the Parco with public users. At this stage, the web map (https://cdrweb.parcocolosseo.it/) allows to obtain descriptive texts and a gallery of images of the ancient floors; there are plans in the next future to improve data sharing through API and web map services.