The SUNRISE Summer School. A Report on the First Two Editions

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Abstract

The SUNRISE Summer School (Seashore and UNderwater documentation of aRchaeological herItage palimpSests and Environment) has reached its second edition. The school was co-organised by the Politecnico di Torino and the Italian Society of Photogrammetry and Topography (SIFET) and supported by the International Society of Photogrammetry and Remote Sensing (ISPRS), CIPA HD and several other Italian institutions. The second edition of the summer school took place in the municipality of Porto Cesareo (LE - Italy) from September 8 to 14, 2024, and involved 24 students – architects, engineers, archaeologists, and marine ecologists from Europe, the United States, Latin America, and Asia. The school started from the experience built in the first edition, and throughout the entire duration of the event, the students were guided by 23 tutors, ensuring an almost one-to-one student-tutor ratio. The school offered theoretical activities with lectures and fieldwork, applying a learning-by-doing teaching approach. Two sites were the focus of the fieldwork: Torre Chianca (a 16th-century defensive building) and the Roman marble columns (a submerged archaeological site). Both sites are part of the protected marine area of Porto Cesareo. Field data collection was supported by representatives from various companies: Images, Microgeo, Stonex, Pix4D, Geomax, Leica, Dynatech, and 3DTarget (the companies were also sponsors of the initiative), who demonstrated the latest technologies for integrated multi-sensor surveying of cultural heritage, such as drones, terrestrial and aerial laser scanners, and mobile mapping systems.

1 . Introduction

The SUNRISE (Seashore and UNderwater documentation of aRchaeological herItage palimpSests and Environment) summer school have reached its second edition in 2024. The first edition was held between the 3rd and the 9th of September 2022 in Marina di Ragusa, while the second edition took place between the 8th and 14th of September 2024 in Porto Cesareo. The focus of the second edition was again on the documentation of both emerged and submerged cultural heritage, precisely archaeological heritage, with the key objective of connecting the needs of the different stakeholders involved in the study, safeguarding and dissemination of heritage, with the idea of making them communicating together to define a common language. Both editions were made possible thanks to the support of different actors, as will be better described in the next sections. Nevertheless, ISPRS (International Society for Photogrammetry and Remote Sensing) and CIPA HD, together with SIFET (Italian Society for Photogrammetry and Topography) were the main supporters of the initiative. SIFET was the national facilitator and economic supporter of the summer school organized together with several Italian Universities and Research centres. ISPRS supported both editions economically: the first edition was supported by the ISPRS Student Consortium[1], while the second edition was supported by the ECBI 2024[2] (Education and Capacity Building Initiative). Finally, also CIPA HD[3] supported economically the second edition of the school.

For the organizing committee, the support of these international societies was particularly important, especially for the common ground and vision in the educational approaches and in transferring and disseminating the geomatics technologies for heritage documentation. Both CIPA HD and ISPRS are engaged in these activities and particularly exploiting the possibilities offered by learning-by-doing approaches. These approaches are not a novelty, but have gained a growing popularity in the last

[1] https://sc.isprs.org/home
[2] https://www.isprs.org/society/ecbi/default.aspx
[3] https://www.cipaheritagedocumentation.org/

decade (Freeman et al., 2014; Solomon et al., 2011; Thompson, 2010).

The implications of adopting the learning-by-doing approaches in fields like geomatics and their applications to cultural heritage documentation are various and very effective. The effectiveness of these approaches is related to the importance of hands-on experiences that are typical in the operations of metric surveys, both in the field for data acquisition and in the subsequent phases for data processing, management, use and dissemination.

Transferring the contents learnt during the theoretical lectures to practical activities, like the on-site field data acquisition, students and professionals can reach a deeper understanding of both the technologies, techniques and cultural contexts targeted by the survey. Finally, this approach also fosters the dialogue between disciplines, cooperation, independent thinking and problem-solving. ISPRS and CIPA HD are involved in the organization of several activities that foresee the adoption of these teaching approaches, whose effectiveness was also confirmed by the results of the first edition of the SUNRISE summer school. More information on this topic are reported in (Balletti et al., 2023) and in a dedicated page of the SUNRISE website (https://www.sunrisesummerschool.com/2022-edition/). Both editions of the school were aimed at connecting the needs of the various stakeholders involved in the study, preservation, and dissemination of heritage, fostering communication with the goal of defining a shared language. For this reason, the connection with the local communities and the entities involved in the management and protection of these heritage sites was crucial. In both editions, several stakeholders were involved: local municipalities, the *Soprintendenza* (the Italian national entities for the protection and valorisation of Cultural Heritage), non-profit organisations working in heritage promotion, museums, professionals, etc. Nevertheless, the second edition incorporated feedback and suggestions from participants of the first edition to further enhance the learning experience and the overall school organisation.

The project for the second edition of the school was written targeting specific aims and objectives:

1. to disseminate among the participants the best practices for the documentation of the coastal heritage, adopting the latest geomatic techniques;
2. to experiment with the participants new usage of the data derived from the documentation activities to solve specific needs related to coastal heritage;
3. to create the base for a common language between the operators involved in the study, management, and safeguarding of coastal heritage and the operators in charge of the documentation processes;
4. to fine-tune already existing teaching approaches based on the Learning by Doing
5. to create online freely available documents (in the form of a report) that could contribute to the debate on the definition of best practices for the documentation of this and other types of heritage;
6. to promote the activities of the two involved societies: CIPA HD, ISPRS and SIFET;
7. to foster the interaction and cooperation between the different ISPRS WGs involved in the school (ICWG II/Ia, WG I/8, WG II/2, WG II/6, WG II/7, WG IV/1)
8. to promote and disseminate ISPRS activities

More information on the school are available on the website: https://www.sunrisesummerschool.com/

1.1 First edition (2022)

The first edition of the SUNRISE summer school was carried out in Marina di Ragusa in Sicily (Italy) from the 3rd to the 9th of September 2022. Politecnico di Torino jointly organized it with IUAV, the University of Sassari, FBK, the University of Udine and the University of Modena and Reggio Emilia with the support of SIFET (Italian Society of Photogrammetry and Topography), ISPRS Student Consortium, private surveying companies (Images, Microgeo, Stonex, Leica and Geomax) and the municipality of Santa Croce Camerina.

The five days of summer school were attended by 20 students (selected from 41 applications) from Europe, Asia and the USA, divided into 4 groups led by 17 tutors (Figure 1).

The schedule of the course was organized in:

- 1 day of theoretical lectures;
- 2 days of "in the field" data acquisition;
- 2 days of data processing;
- final presentation of achieved final products.

Figure 1. Students and Tutors of the 1st edition of SUNRISE.

Some results of the participant's works from the 1st edition of the summer school are reported in the following Figure 2.

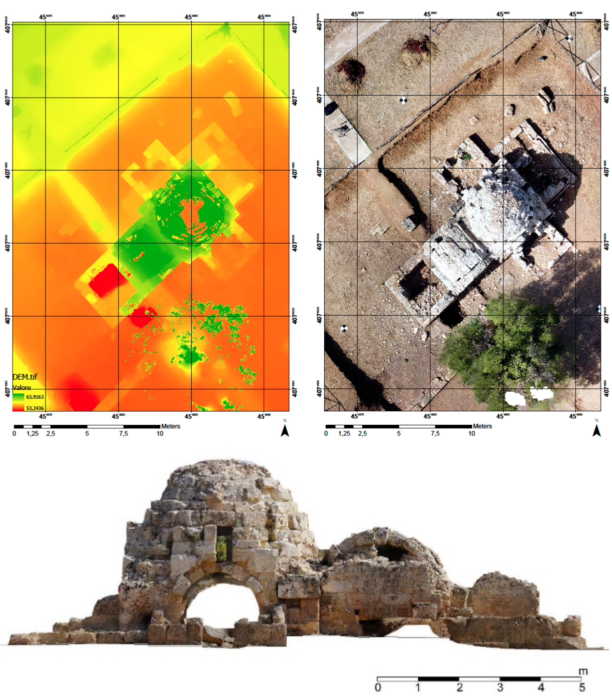


Figure 2. Some results of the 1st edition of the summer school (from Balletti et al., 2023).

1.2 Second Edition (2024)

The second edition saw the participation of 24 students (architects, engineers, archaeologists, and marine ecologists) from Europe, the United States, Latin America, and Asia.

The 24 participants were selected by the school's scientific committee among 53 applications received and have diverse backgrounds: Master's students, PhD candidates, research fellows, and researchers.

Guiding the participants throughout the entire training program were 23 tutors, chosen with the goal of ensuring a near one-to-one student-mentor ratio (Figure 3).

Field data collection was supported by representatives from various companies: Images, Microgeo, Stonex, Pix4D, Geomax, Leica, Dynatech, and 3DTarget (the companies were also sponsors of the initiative), demonstrating the latest technologies for integrated multi-sensor surveying of cultural heritage, such as drones, terrestrial and aerial laser scanners, and mobile mapping systems.

Figure 3. Tutors and students of the 2nd edition of the SUNRISE summer school

The educational and research activities were coordinated by Filiberto Chiabrando and Lorenzo Teppati Losè (Politecnico di Torino), with support from Andrea Lingua, Elisabetta Colucci, and Francesca Matrone, and collaboration from tutors Beatrice Tanduo, Alessandra Spadaro and Paolo Maschio from the Geomatics for Cultural Heritage Laboratory of the Department of Architecture and Design-DAD and the Geomatics Lab of the Department of Environmental, Land, and Infrastructure Engineering-DIATI; Caterina Balletti, Francesco Guerra, Paolo Venier, Andrea Martino and Enrico Breggion from IUAV of Venice; Giuseppe Furfaro from SIFET; Erica Nocerino, Fabio Menna, and Alessio Calantropio from the University of Sassari; Domenico Visintini from the University of Udine; Alessandro Capra from the University of Modena/Reggio Emilia; Rita Auriemma, Luigi Culuccia, Cristiano Alfonso from the University of Salento; and Dominique Rissolo from the University of California, San Diego.

The selected archaeological sites for the second edition were of particular historical interest; participants worked on two sites in the Porto Cesareo area (Puglia, Italy): Torre Chianca (a terrestrial site) and the Roman columns located on the seabed in front of Torre Chianca (an underwater site). Both sites are set in extraordinary natural and historical environments, as the area has been a National Marine Park since 1997 (Figure 4).

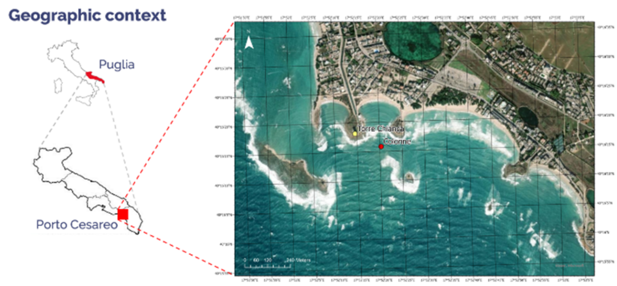
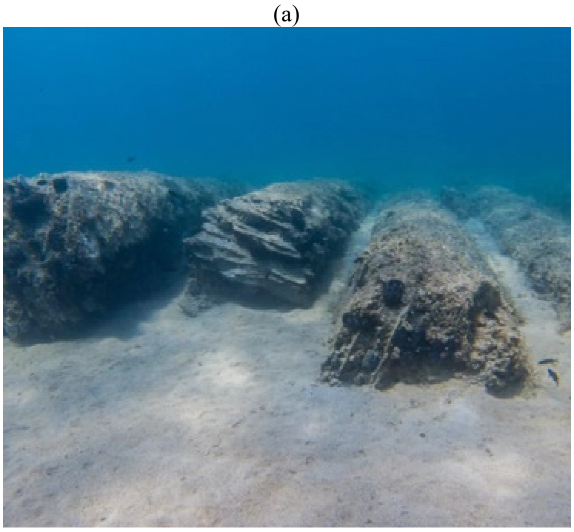


Figure 4. Location of the summer school test sites

Torre Chianca (Figure 5-a), also known as Torre di Santo Stefano, is now a seaside destination along the Porto Cesareo coastline. It stands not only as a historical symbol but also features a beautiful beach (Alfonso et al., 2012). Located midway between Porto Cesareo and Torre Lapillo along the Ionian Sea coast, the tower was built as part of the defensive system against Saracen invasions between 1527 and 1598. It has a square plan, with a base supporting a 15.60-meter structure and a total height of 18 meters. The tower was designed to communicate with both Torre Cesarea and Torre di San Tommaso. Its exterior lacks access stairs. During World War II, the tower was used as a military base by Italian soldiers. After the armistice, it became a target for German pilots based in Leverano, who dropped concrete bombs, causing damage that is still visible today. Today, the fortress has been repurposed as a Marine Turtle Rescue Center, playing a crucial role in the conservation of the region’s marine wildlife.

The five monolithic Roman-era columns are located in the waters surrounding the tower (Figure 5-b). They are part of the remains of a Roman navis lapidaria (Auriemma et al., 2021), which was transporting five monumental cipollino marble columns and a marble block. These materials originated from the quarries of Karystos on the island of Euboea, Greece. The columns, measuring 8.5–8.8 meters in length and weighing a total of 78 tons, lie at a depth of 4.5 meters within the Porto Cesareo Marine Protected Area (Italy). The ship ran aground due to its draft (3 meters) exceeding the site's depth, considering that at the time, sea levels were approximately 3 meters lower than today.

(a)



(b)

Figure 5. Torre Chianca (a) and the roman marble columns (b)

Throughout the organisation of the school's activities, it was crucial the involvement of the young communities of the international societies such as the CIPA HD Emerging Professional and the ISPRS Student Consortium. These communities helped us in sponsoring and promoting the summer school.

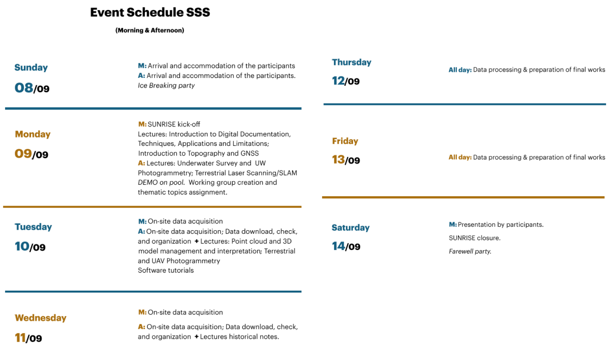
2. Teaching methods and school organization

As in the first edition of the school, and as reported in the introduction, also the second edition was structured to facilitate participants' learning through a hands-on, learning-by-doing approach, with a predominance of practical activities over theoretical ones. To maximize the effectiveness of the lectures, they were structured according to the participants' backgrounds, aiming to create a new, shared educational and learning environment. The lectures were not solely focused on presenting different geomatics techniques and their application in the field, but specifically emphasised their contribution to the documentation of coastal heritage (both emerged and submerged). Additionally, they explored how derived metric products can be effectively used for its study, management, preservation, and dissemination. After an overview of the possibilities and limitations of digital documentation approaches, several specific techniques were briefly examined, starting from traditional topographic methods (such as GNSS and Total Station), moving through terrestrial, aerial, and underwater photogrammetry, and also including both static and mobile LiDAR techniques (Figure 6).

Figure 6. Participants attending one of the lectures.

The lectures were not concentrated into a single dedicated day but were distributed throughout the week. This organization was revised in comparison to the first edition of the school, thanks to the feedbacks received from the post-survey questionnaire of the first edition's participants. Two half-days were dedicated to field data acquisition, while two full days were devoted to data processing by the students with the support of tutors. On the final day of the school, the individual groups presented the results of the activities carried out during the week.

As already mentioned, the followed approach was adopted to foster a major effort from both participants and tutors in a pragmatic approach: only 20% of the time was dedicated to frontal lectures while the remaining 80% was spent in the on-site field acquisition, data processing, and interpretation, report preparation by the participants supervised from the tutors. The lectures proposed to the participants of the summer school were held by recognised researchers and Professors who are also actively involved in both the ISPRS, CIPA HD and SIFET societies. An overview of the programme and organisation of the summer school is reported in Figure 7.



Event Schedule SSS

(Morning & Afternoon)

Sunday 08/09	M: Arrival and accommodation of the participants A: Arrival and accommodation of the participants. *Ice Breaking party*
Monday 09/09	M: SUNRISE kick-off Lectures: Introduction to Digital Documentation, Techniques, Applications and Limitations; Introduction to Topography and GNSS A: Lectures: Underwater Survey and UW Photogrammetry; Terrestrial Laser Scanning/SLAM *DEMO on pool.* Working group creation and thematic topics assignment.
Tuesday 10/09	M: On-site data acquisition A: On-site data acquisition; Data download, check, and organization + Lectures: Point cloud and 3D model management and interpretation; Terrestrial and UAV Photogrammetry Software tutorials
Wednesday 11/09	M: On-site data acquisition A: On-site data acquisition; Data download, check, and organization + Lectures historical notes.
Thursday 12/09	All day: Data processing & preparation of final works
Friday 13/09	All day: Data processing & preparation of final works
Saturday 14/09	M: Presentation by participants. SUNRISE closure. *Farewell party.*

Figure 7. Short programme of the summer school.

3. Data acquisition

The Underwater activities were mainly devoted to the documentation of the submerged archaeological heritage and the surrounding marine environment. The students were introduced to learn how to deal with photogrammetric acquisition underwater, understand the pros and cons of different approaches, and get a first-hand experience on how to deal with common problems when photogrammetric acquisitions are conducted in marine environments; those are mainly related to geometric calibration of the camera and radiometric correction of the acquired images. Moreover, to help the comprehension of the physical properties of the underwater environment and its challenges, POSER, a 3D simulation framework developed under the 2024 ISPRS ECBI initiatives (Menna et al., 2024) was used as computer-aided teaching material.

For example, camera calibration is essential for the accurate estimation of the image locations and dimensions in the object space; in underwater photogrammetry, it is crucial to take into account the refractive effects introduced by the water medium and the camera housings. During the camera calibration and image orientation step, it is crucial to verify the consistency of the focal length, use a separate calibration certificate for each of the cameras, and opportunely place the scale bars or the measured markers around the scene. For the radiometric correction of the acquired images it needs to be considered that underwater images are usually affected by lack of contrast, poor visibility, water caustics and inconsistency in radiometry. In order to solve these issues, it is possible to run a pre-processing step to use the generated enhanced images only for the tie-point extraction phase. Different enhancement algorithms can improve several aspects of underwater imagery, and some of them were presented to the participants and applied during the data processing phase. Based on the expertise, knowledge, and previous experience of the participants, both snorkeling and scuba diving activities, conducted at different depths were organized.

To ensure a smooth acquisition phase and train participants to underwater acquisition in a controlled environment, some activities were organized in the swimming pool before fieldwork (Figure 8). These activities were used to show to the participants how to: i) position and measure control points underwater; ii) set up the camera parameters, iii)define communication methods when underwater, etc.

Figure 8. Training for the underwater acquisitions in a controlled environment

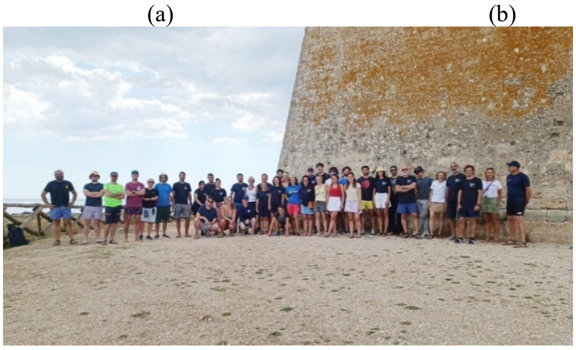
Technical briefings before and after the acquisitions in the field allowed students without diving certification to actively participate in the the data collection (given the shallow water environment in which the archeological remains are located), providing, at the same time, young divers the opportunity to increase their confidence in scientific diving for photogrammetry purposes.

Since the GNSS signal is not able to penetrate the water surface, different georeferencing strategies were followed; at first, a more traditional approach involving the use of the total station by acquiring side shots measurements from the shore. A long aluminum pole with a prism was used to measure the displaced GCPs and CPs and other important points of the archaeological remains. Another method consisted in measuring the reference points using the same pole with a GNSS antenna featuring tilting compensation functionality (Figure 9 - a,d). In this way, participants were able to stand-alone measure the positions of the points without relying on from-the-shore topographic support. Another experimental approach that was presented and tested underwater was based on the use of pressure and inertial measurements (Menna et al., 2020, Menna et al., 2021). The proposed methodology allows for a full 3D levelling transformation comprising three angles, a vertical translation and a scale factor with high potential accuracy (1:5000 on the length measurement and 0.1 degrees in the horizontal levelling).

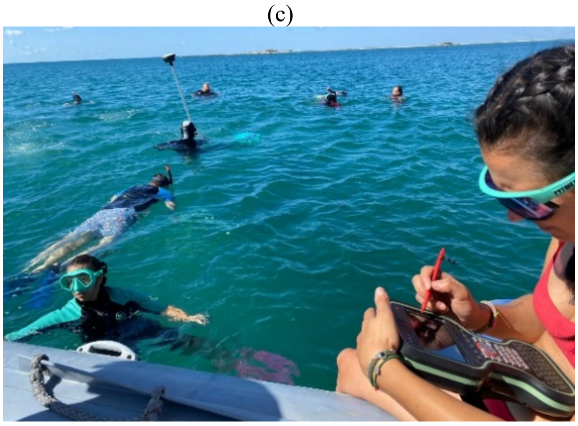
The terrestrial acquisitions were conducted in parallel with the underwater ones and followed consolidated strategies. The first step consisted in the creation and measurement of the first-order control network using traditional topographic techniques such as GNSS and total station. Thereafter, thanks to the support of the survey companies involved in the school different range-based and image-based techniques were showcased to the participants. The Torre Chianca was documented using Terrestrial Laser Scanner, Mobile Mapping Systems, Solid State Lidar, UAV and Terrestrial photogrammetry. The participants were active actors of the data acquisition in the field, testing and evaluating the advantages and limitations of each instrument and technique used (Figure 9 -b,c).

(a)

(b)



(c)



(d)

Figure 9. Some images of the field activities. Underwater data acquisition (a and d) and terrestrial (b and c)

4. Data processing

After the theoretical lectures and the field acquisition, two days were dedicated to data processing (Figure 10). Different student groups explored various tools, techniques, and topics, and some groups focused on analysing the differences between products derived from various techniques, while others focused on how survey data could enhance the understanding of the studied artefacts. Additionally, some groups used the data derived from the 3D metric survey for further analyses (e.g., developing new architectural solutions to optimize the use of unused spaces within the tower). Examples from the participants' presentations of the second edition are shown in Figure 11 and in Figure 12 for the first edition.

Figure 10. Data processing phase was organized in groups and supported by the tutors

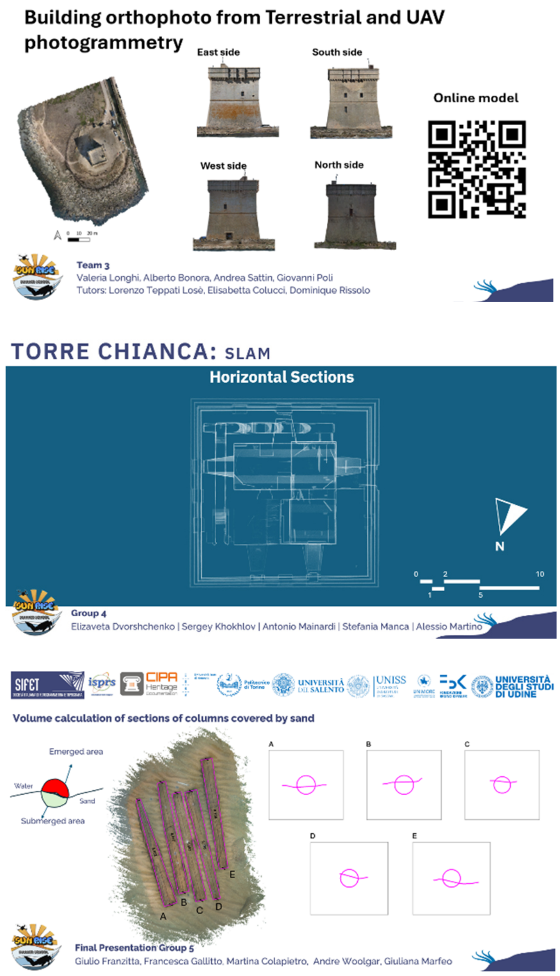
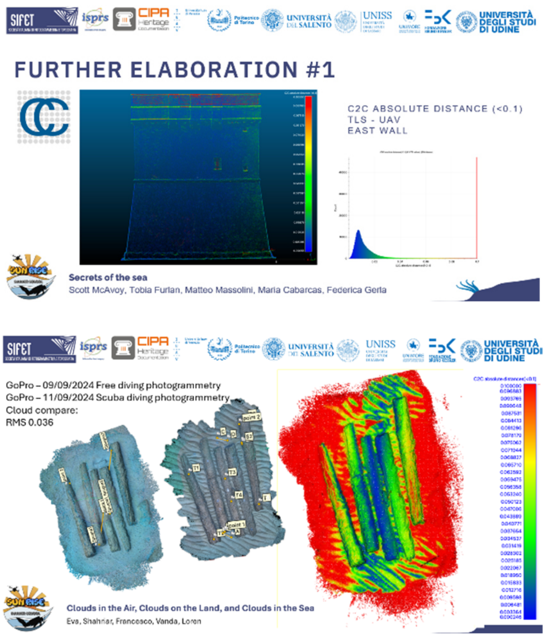


Fig. 11. Some examples extracted from the participants’ final presentations of the second edition



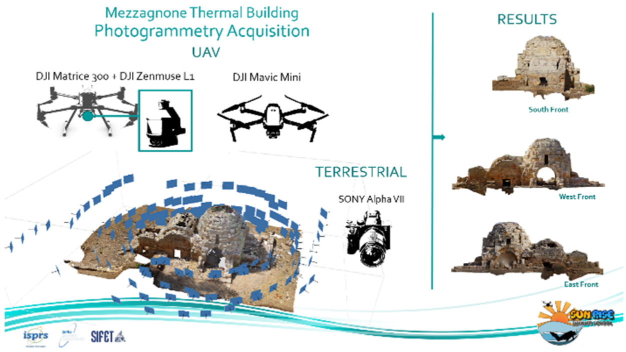


Figure 12. Some examples extracted from the participants' final presentations of the first edition (from Balletti et al., 2023)

5. Final consideration and future perspectives

The SUNRISE summer school experience confirmed also in the second edition its potential to connect researchers, scholars, national public entities, private companies, professionals and students. It was possible to engage the different stakeholders that are locally involved in the protection, safeguarding and promotion of the built heritage and showcase the possibilities offered by the latest technological developments for the documentation of emerged and submerged cultural heritage. The takeaway for both students and tutors consisted of the creation of a common language among scholars and researchers working and studying in different domains of knowledge. For the participants, the hands-on approach was once again crucial to better understand the technologies and the instruments deployed in the field. Both the field acquisition and the data processing allowed them to better understand the possibilities offered by geomatics in supporting the documentation and study of coastal heritage and how data can be used in this scenario. The involvement of international societies like ISPRS and CIPA HD represented the perfect chance to position the summer school in the international context and to open the experience to suggestions derived from these societies. The target for the future is to expand the participants' audience further to include other disciplines and other profiles. Moreover, it is necessary to strengthen the relationship with the national entities in charge of this heritage and to better understand their needs.

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Authors would also like to thank the private survey companies for the financial support and for their kind availability in joining the summer school (IMAGES, MicroGeo, Stonex, Pix4D, Leica, Dynatech, Geomax and 3d Target). The authors would also like to thank the Area Marina Protetta di Porto Cesareo, the municipality of Porto Cesareo and the Coordinamento Ambientalisti di Porto Cesareo.

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