A Series of Photogrammetry for Protection of Syrian Cultural Heritage

ʿAin Dārā Temple

By

Yoko Taniguchi
Nobuya Watanabe
Mariko Makino
Sari Jammo

Contribution: Idleb Antiquity Center

Agency for Cultural Affairs, Government of Japan

University of Tsukuba

Research Center for West Asian Civilization

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Acknowledgments

All photographs used in this publication were taken by our Syrian friends. Without their effort, our project was never completed. We deeply thank them who carried out photography for our project regardless of serious danger in the great difficulty under the ongoing conflict.

Contents

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Human Resource Development Project for the Protection
of 'Ain Dārā Site in the Syrian Arab Republic
2021

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1. Background of the Project

More than ten years after the turmoil of spring 2001, much of Syria's cultural heritage is at risk. Many archaeologists and conservators have fled Syria, and the lack of heritage professionals in the country is a serious problem.

The 'Ain Dārā site is located in north-west Syria, 70km from Aleppo and 5km from the Afrin area. It is an Iron Age, Syrian-Hittite site dating back to the first millennium. The site is known for its basalt temples (1300-740 BCE), sculptures and the remains of limestone footprints. The 'Ain Dārā site consists of upper and lower sections.

The 'Ain Dārā site was excavated in 1980-85 by the Directorate-General of Antiquities & Museums (DGAM) (Prof. Ali Abu Assaf). In 1994-1998, the DGAM and the National Research Institute for Cultural Properties, Tokyo carried out conservation and restoration work. At that time, a lion statue made of basalt was restored.

Facilities have been built near the site to house archaeological artefacts and to manage the materials and equipment required for excavation. During the Syrian civil war, the site became a stronghold of the Kurdish forces (YPG) and military exercises were held here. As a result, the area was bombed several times by the Turkish Air Force and in January 2018, it was reported that the 'Ain Dārā site was destroyed in an airstrike. It is estimated that around 60% of the site was destroyed during this time. A basalt lion statue was destroyed in the bombing and its fragments were reported stolen at least as far back as 2019.

Portico Antecella Cella reports that the bombing left two large holes in the temple and severely damaged the limestone footprints. The worst damage was to the walls, floors, sculptures and the south-eastern façade of the temple (http://www.asor.org/chi/reports/special-reports/tell-ain- dara-temple).

The vaults were also ransacked during the civil war. They contained not only artifacts from the 'Ain Dārā site, but also artifacts from Tel Koshak Shamali, excavated by the University of Tokyo (Prof. Yoshihiro Nishiaki), and from Dederiye Cave. Most of the artifacts comprised stone tools and bones which were not stolen, in contrast to the clay figurines or cuneiform documents at other sites, which are easily bought and sold for profit. However, the boxes in which they were stored were stolen and the artifacts are now scattered on the floor.

2. Objectives of the Project

The University of Tsukuba established the Centre for the Study of West Asian Civilizations, which has been positioned as an international research center within the university and has been working as a base for projects related to archaeological research and conservation in the West Asian region since 2021.

From 2021, the center began activities for the conservation and restoration of the ‘Ain Dārā archaeological site with the support of the Agency for Cultural Affairs' International Exchange Program. This project works on the following three main activities.

1. Recording of the destruction of the ‘Ain Dārā site and the assessment of its state of conservation by means of 3D measurements.

The monuments and temples, which are made of basalt and limestone, have been destroyed by aerial bombardment and fragments of stone structures are scattered throughout the monuments. For full-scale restoration work such as joining and reinforcing, stone conservators require a considerable amount of time, and large equipment such as compressors are necessary. Currently the conditions are not right for such full-scale conservation work. As such, it was necessary to make a record of the destruction in order to understand the site’s current condition.

Based on the excavation and documentation by Maurice Dunand, Feisal Seirafi and Ali Abu Assaf in 1956, 1962, 1964 and 1976 (Fig. 1), a plan of the site was prepared. A 2-meter square grid was set up on the site. The cleaning of the site and the 3D measurement of the remains using a drone were carried out. Online methods (MS Teams, zoom, etc.) were used to advise colleagues working at the site. The 3D measurements using drones were carried out with the help of a drone technician available in Syria, and the 3D data were analysed in the laboratory of Associate Professor Nobuya Watanabe at Chubu University.

2. Online training on urgent conservation and restoration by German and Japanese conservation experts was conducted.

To develop human resources for conservators of stone cultural heritage, online training was carried out for Syrian archaeology students and young specialists.

The training included basic training in the mechanisms of stone deterioration and methods of condition survey, as well as chemical knowledge of restoration materials. The training was given by a German conservation expert, Mr. Bert Praxenthaler, who provided the expertise to recover and protect the fragments of the Eastern and Western Giant Buddhas of Bamiyan, which were blown up in Afghanistan. For the

conservation of masonry objects in general, Takashi Oikawa, a freelance conservator, gave a training course on conservation methods and materials.

Mr. Bert Praxenthaler is a stone conservator who has worked for ICOMOS Germany for many years on the conservation of the destroyed Eastern and Western Giant Buddhas at the Bamiyan site in Afghanistan. He has a wealth of experience in the conservation of cultural heritage destroyed by war, which made his training course ideal for the conservation of the ‘Ain Dārā site.

Mr. Takashi Oikawa has not only carried out the conservation of many sculptures and masonry objects in Japan but has also recently been involved in the documentation of the mosaics at Hisham Palace in Palestine as part of a JICA project. This experience provided a valuable training opportunity for the conservation documentation of the ‘Ain Dārā site and for the provision of basic knowledge on the conservation of stone cultural heritage.

The contents of the online lectures were recorded as videos so that they could be used as teaching materials in the future. The contents of each training course were made into a textbook in Arabic for use in the field.

3. Preparation of a booklet to raise awareness of the historical and archaeological value of the ‘Ain Dārā site

As the involvement and understanding of the local community is essential for the long-term protection and preservation of cultural heritage, a booklet will be produced in Arabic, English and Japanese to raise awareness of the archaeological and historical value of the ‘Ain Dārā site and conservation issues and will be distributed in schools and museums in Syria and other countries. Fifty textbooks and two 1,200 booklets have been produced.

A website in English, Japanese and Arabic has been set up under the Centre for the Study of West Asian Civilizations to provide information on the activities of the project. PDF files of the textbooks and booklets are also available for download.

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Damage Assessment and Current Condition
of 'Ain Dārā Temple

Sari Jammo (University of Tsukuba)
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1. Introduction

'Ain Dārā is an archaeological site located approximately forty kilometers northwest of Aleppo city, and about 6 kilometers south of Afrin city in Northwest Syria (Figure 1). The site is situated along the east bank of the Afrin River close to the Turkish border and consists of an Akropolis and lower city to the north and east (Abu Assaf 1990). The importance of the site was recognized when a massive basalt lion statue was discovered by accident in 1954. Excavations at the site were first undertaken by the Department of Antiquities and Museums in Damascus in 1956, 1962, 1964 under the direction of Seirafi, and later under the direction of Abu Assaf in 1976, 1978-1986 (Abu Assaf 1990). Later, an American team under the direction of Stone and Zimansky carried out a survey in the lower town (Stone and Zimansky 1999). The most significant find at 'Ain Dārā site is the Neo/Syro-Hittite temple built in the 1st millennium BC on the top of the Acropolis and overlooking the surrounding plain. The 'Ain Dārā temple is recognized as one of the most important and best-preserved monuments built in Ancient Syria. In 1994-1996, Tokyo National Research Institute of Cultural Properties and Aleppo Museums and Antiquities carried out a conservation project for 'Ain Dārā Temple. The temple remained safe until news agencies circulated reports of the destruction of the temple in early January 2018 by Turkish airstrikes. Later ASOR CHI satellite imagery analysis indicates the destruction of the temple on or before January 22, 2018 (Danti et al. 2018).

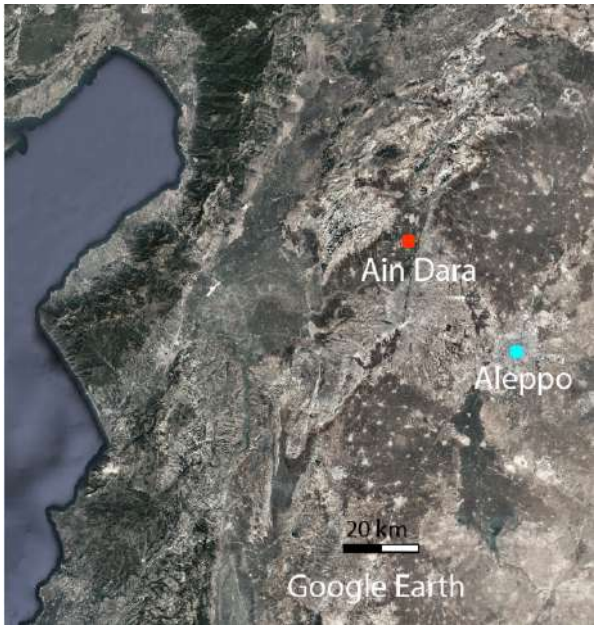

Fig. 1 Location of Ain Dara

2. Description of the Temple

'Ain Dārā temple is located along the northwestern edge of the Akropolis and is oriented in a northwest-southeast direction. The temple is rectangular in plan and measures approximately 23.5m wide by 30 meters long (Figure 2).

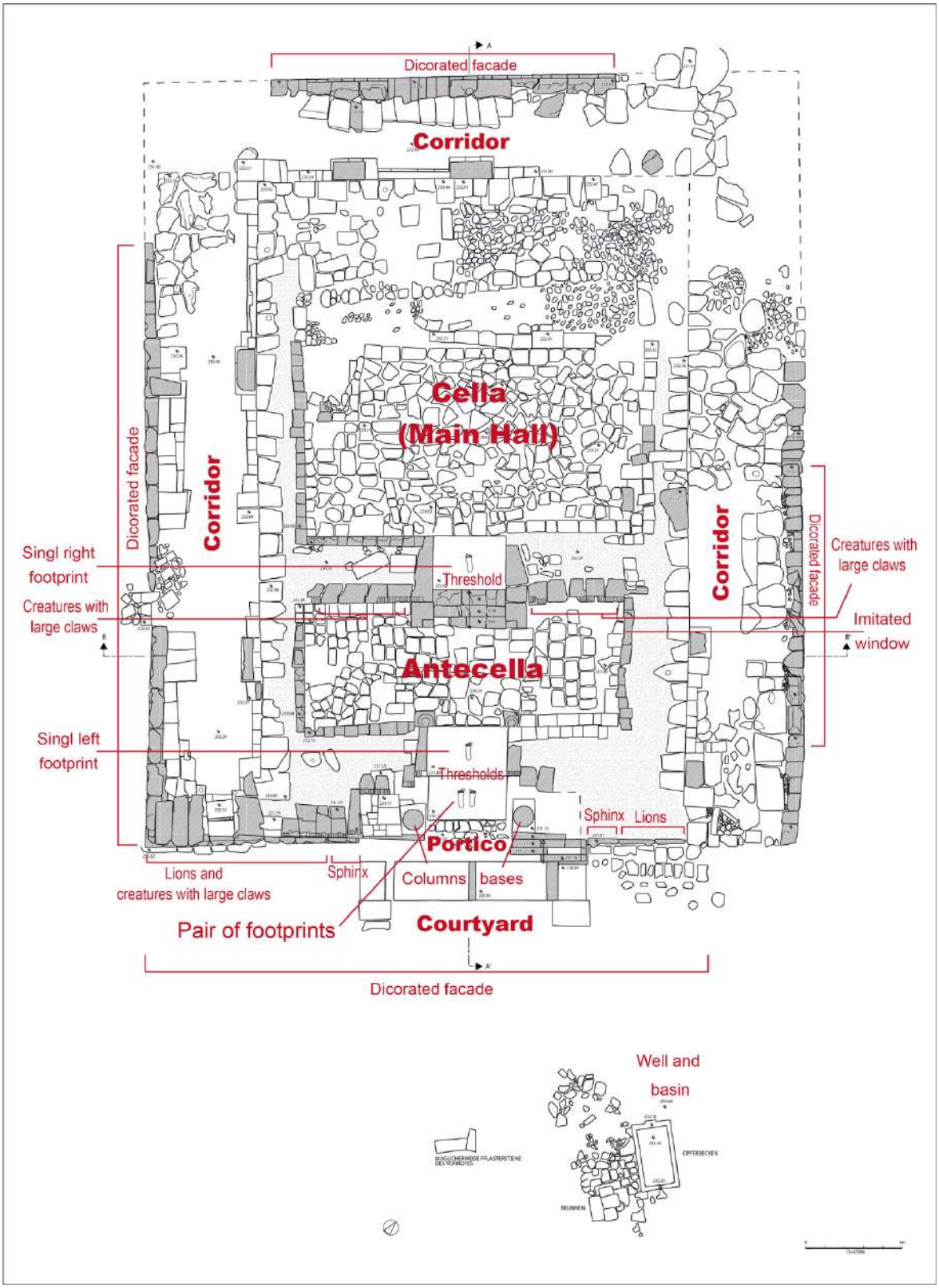

Fig. 2 Plan of the Ain Dara temple (adapted from Abu Assaf 1990)

It was built on a low platform and consisted of a portico, an *antecella*, and a *cella*. The building's exterior and interior facades are decorated with a series of Syro-Hittite style basalt reliefs of sphinxes, lions, animal protomes, and creatures with large claws and their remaining feet (Abu Assaf 1990). The temple was surrounded by corridors on three sides. The southeast, southwest and northwest exterior facades are well preserved and decorated with lions and sphinxes with turned heads and faces (Figure 3).

In the courtyard near the entrance, located to the southeast, there was a well and a large stone basin probably used for washing or for ceremonial purposes (Nova´k 2012) (Figure 4).

Fig. 3 Upper: Northwest facade.
Lower: Southwest facade. Photos taken by T. Hayashi in 2007

The temple was built on a raised limestone platform and it can be entered by climbing 3-4 stairs decorated with intertwined curves. The entrance facade was lined with large basalt blocks engraved with lions, sphinxes and mythic creatures.

A staircase with a sphinx and two lions on either side led to the portico entrance of the temple (Figure 5).

Fig. 4 Well and stone basin in the temple's courtyard.
Photo taken by K. Shimogama in 2006

Fig. 5 The entrance of Ain Dara temple. Photo taken by T. Hayashi in 2007

A series of three limestone thresholds at the front entrance of the temple were adorned with carvings of giant human footprints. These unique footprints were one of the distinctive features of the temple. One pair of footprints were carved on the floor of the portico, followed by a single footprint at the entrance of the *antecella*, and another single footprint at the threshold of the *cella* (main hall) (Nova´k 2012). The *antecella* and the *cella* floor were paved with limestone, and the interior walls consisted of basalt stone blocks. The lower part of the *cella* was decorated with intertwined curves, above which there are carvings of creatures with large claws and their remaining feet. Further, there were rectangular slabs that might represent imitative windows uncovered elsewhere in Aleppo citadel temple (Kohlmeyer et al. 2005).

3. Brief Review

According to locals and news agencies, the site of ‘Ain Dārā was subjected to damage caused by ongoing clashes in the area at the beginning of 2018 attributed to a Turkish airstrike. Later, the destruction of the site was confirmed. According to ASOR CHI Digital Globe imagery analysis, the attack on ‘Ain Dārā temple took place on or before January 22, 2018. Since then, the temple has been left to its fate for a long period of time. The satellite analyses using Google Earth showed that the Akropolis, especially in the southeast corner of the temple, has been subjected to heavy bulldozering at the beginning of 2019, and the giant basalt lion statue has disappeared.

Due to the extent of vandalism and destruction at the ‘Ain Dārā site, a documentation project was initiated. The goal of this project is to estimate the damage at ‘Ain Dārā Temple and review the preservation status of reliefs and sculpture, reported in the past by a Japanese team. The project will utilize photogrammetry to generate a 3D model of the temple after destruction. A digital archive has also been created containing about 1000 photographs taken between 1993 - 2010, reports, and old drawings. These materials will be utilized to create a new 3D model for ‘Ain Dārā temple before destruction that might help Syrian experts to rebuild the temple in the future.

The site was covered with long grass and bushes covered most of the stones and stone fragments. Therefore, the site was cleaned before photography began. In total, about 1,700 photos using a handle camera and UAV have been collected. The photographs were processed using SfM software, Metashape Ver.1.5.0 (Agisoft), and a 3D model was successfully generated (See following chapter).

4. Damage Assessment at ‘Ain Dārā Temple

The attack at the site caused massive destruction, especially in the area between the entrance and the main hall, and to the right of the temple's entrance. Whereas, the sculptures of lions and creatures with large claws on the left side of the entrance have been partially destroyed those at the southeastern corner of the building remained intact as shown in photos published in the ASOR CHI report.

The attack left two large craters in the temple (Figure 6). The location of the first crater was at the entrance where two thresholds are located between the portico and *antecella* (one threshold is carved with pair of two footprints and the other is carved with a single left footprint). The second crater was on the third threshold carved with a single left footprint and located at the entrance of the main hall. The strike appears to have hit the southwestern half of the threshold; however, the other half was severely fragmented. These three thresholds have been completely reduced to rubble and the famous monumental footprints carved into them are gone.

Fig. 6 General view of Ain Dara temple showing two craters

The first crater was larger and deeper than the second (Figure 7). The first is about 6 meters in diameter and the second is about 4 meters in diameter, and the depth of both is more than 1.5 meters. Fragments of the stones were scattered throughout the site. The density of small fragments was high in the southeast corner.

Fig. 7 Craters 1 and 2 caused by the attack

The blast has severely destroyed the temple entrance and most of the sculptures and reliefs have been badly damaged. The portico, staircase and columns bases were destroyed. The basalt stairs on the right were damaged and fragmented (Figure 8). The sphinx and lion blocks on the right of the entrance have been destroyed and only the lower parts near the base remained, where the sphinx and lion's legs can be seen. Further, the basalt blocks above and to the right of these sculptures were fragmented and moved from their original location due to the explosion.

Fig. 8 The two sphinxes on the right side of the entrance

The left side of the entrance consists of several basalt blocks. To the left of the entrance, there is a wide basalt block decorated with intertwined curves. Behind this decorated block is a column base, and behind it, there is a series of at least three blocks carved with creatures with large claws. All these components have been destroyed however, the remaining parts were cracked or fragmented (Figure 9).

Fig. 9 A view from the south corner

Besides the basalt block decorated with intertwined curves, there are a few blocks of the two levels remaining. The lower level comprises nine square-shaped basalt blocks carved with one sphinx and 8 lions. The upper level comprises at least nine blocks of creatures carved with large claws and their remnant feet. The blocks close to the entrance were more damaged and fragmented. The blocks in the far corner to the left of the entrance were relatively intact. It was difficult to ascertain whether these blocks were still in place or missing because this corner was covered by soil when the site was bulldozed (see Figure 6).

The most damaged part of the temple is the *antecella* (Figure 10). As mentioned, the attack left two craters on the thresholds between the entrance of the temple and the entrance of the main hall. Therefore, all the reliefs, sculptures, decorations, and floor paving have been badly damaged. On the right side of the *antecella*, the decorated blocks with intertwined curves, the imitative window and the carved creatures with large claws above have been destroyed. Decorative blocks on this side of the *antecella* do not exist.

The effects of the blast not only damaged this part of the *antecella*, but also the damage reached the outer facade of the corridor in the northeast. The partly decorated facade with lions was affected and several blocks fell down (Figure 11). There were many basalt stone fragments that probably belonged to the outer facade of the corridor or had been scattered by the blast.

Fig. 10 A view from the south showing the two craters and *antecella*

Fig. 11 The corridor's northeast facade

The three basalt steps before the threshold leading to the main hall have been destroyed. Similar to the right side of the *antecella*, the decorated blocks with intertwined curves and the carved creatures with large claws have been destroyed and the stone fragments scattered (Figure 12).

The exterior facade on the southwest and the northwest were relatively intact despite some visible damage including fallen fragments of the decoration, cracks caused by deterioration or the blast (Figure 13). The northern facade was well preserved however, one of the stones carved with reliefs was painted in red. Bullet traces were observed on this facade, likely the painted stone functions as a target as the lower town is used as a military camp by an armed group.

Fig. 12 The corridor on the west side showing the block fragments

Fig. 13 Upper: The exterior facade on the southwest side
Lower: The exterior facade on the northwest side

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3D model and Digital Plan of ‘Ain Dārā Temple

Nobuya Watanabe (Chubu University)

1. Background and Purpose

Recording of the damage to the ‘Ain Dārā site was required before working on its reconstruction. However, recording had to be done as quickly as possible considering the severe damage to the site. In addition, the dislocation of fragmented sculptures and building stones could change the initial post-destruction state of the site. The prior and post destruction condition of the site is important as historical evidence. In this sense, the traces of destruction also represent the site’s cultural heritage through time and its historical development. The record of the site in its destroyed condition should be remembered and utilized as “virtual” heritage even after the reconstruction of the original site. There is much work to do towards future reconstruction of the site. Thus, both speed and accuracy was necessary in the record taking process. Post-processing GNSS measurement and SfM (Structure from Motion) techniques were implemented to fulfill this requirement. Digitized 3D model can be utilized in various ways such as planning, VR, AR, and 3D printing. The aim of the measurement is to support the reconstruction work as well as to submit the base data for the further utilization of the heritage.

2. Method

2.1. Method Flow

The basic flow is 1) Measurement of the benchmarks, 2) Photographing, 3) Processing, 4) Digital tracing. Details of each phase is explained in the following sections.

2.2. Measurement of the benchmarks

High accuracy GNSS was used to collect the benchmarks at the site. These benchmarks are used to give absolute coordinates (e.g., Latitude/Longitude), scale, and orientation to the generating 3D models and plans. However, despite repeated attempts, the post-processing (processing of coordinate values to increase accuracy) did not work as expected. At least four to five benchmarks were well processed (Fig. 1). Four stable benchmarks were used in the processing.

Fig. 1 Location of the set benchmarks

2.3. Photography

Photographs were taken after cleaning and mowing of the site. Approximately 8,000 photographs were taken by Syrian colleagues. Around 7,000 photographs were taken from the ground using a Ricoh GRIIdigital camera, and about 1,000 photographs from the UAV (DJI Mavic 2 Zoom).

2.4. Processing

SfM software, Metashape Ver.1.5.0 (Agisoft), was used for the processing of the photographs to generate a 3D model. The quality of the results was checked, and processing was undertaken, including parameter manipulation until a satisfactory result was reached. The 3D models were constructed from both ground photography and UAV photography. The 3D model from the ground photographs had better detail and a clearer view of the side of the walls. However, there are several sections missing due to a dead spot for filming. On the other hand, the 3D model from the UAV was more consistent overall. In particular, the model of the floor was of better quality than the model from the ground photography. Background noise was removed and integration of the two models were attempted. GIS raster data, DEM (Digital Elevation Model), and ortho-photographs were then generated from the 3D models (GIS raster data and DEM from the UAV model, and ortho-photos for drawing plans from the handheld model).

2.5. Digital Tracing

The ortho-photographs were digitally traced as vector lines and several drawing plans (i.e., top plan, side plans) were generated. The data were separated into several layers, such as “main lines”, “narrow lines”, and “ground level”, which can be switched and displayed as preferred.

3. Results

3.1. 3D model

A UAV derived 3D model and 3D model from ground photographs were created. Three different files with different details (High, Medium and Low) were prepared to match the user’s computer environment. The advantage of a 3D model is the flexibility of the visualization. Unlike a paper-based figure, a digital 3D model can change its view, angle, texture, and lighting. (Fig. 2 - Fig. 13). A 3D model also includes foundation data for various secondary utilizations, such as CG movie, VR, AR, 3D printing, and Ortho-photographs

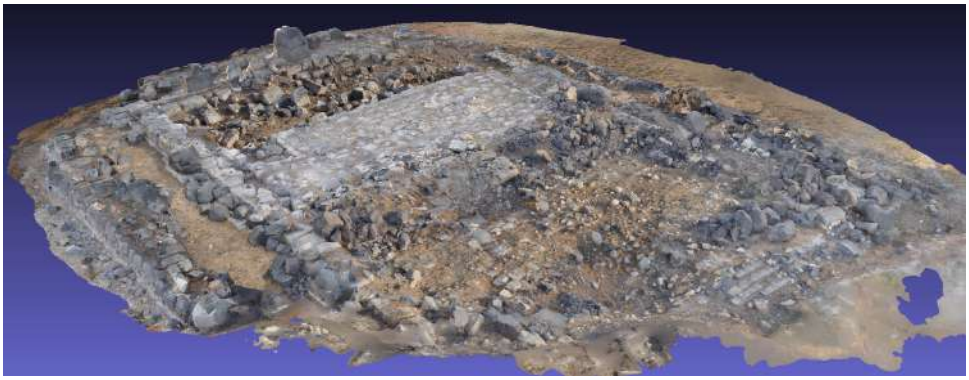

Fig. 2 Changing the FOV (Field of View) (Upper: ortho; Lower: 60)

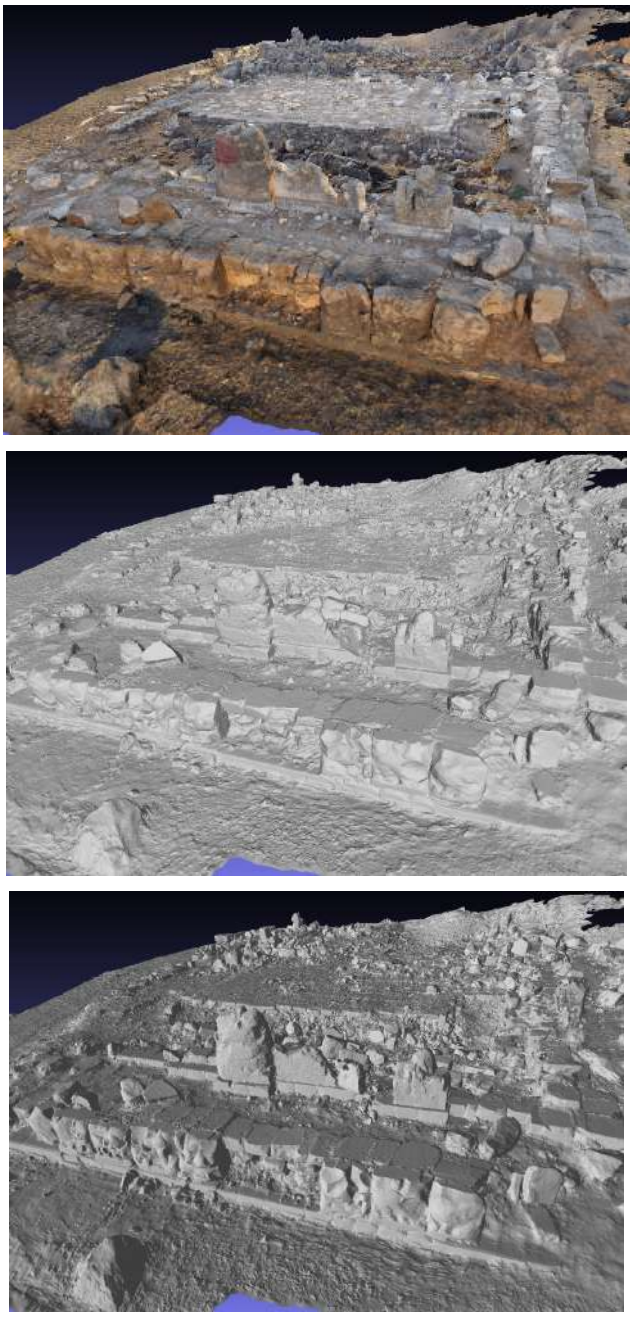

Fig. 3 Changing the texture and lighting

Fig. 4 Comparison with the original state
Upper: Original view (Photo taken by K. Shimogama in 2006)
Lower: 3D model.

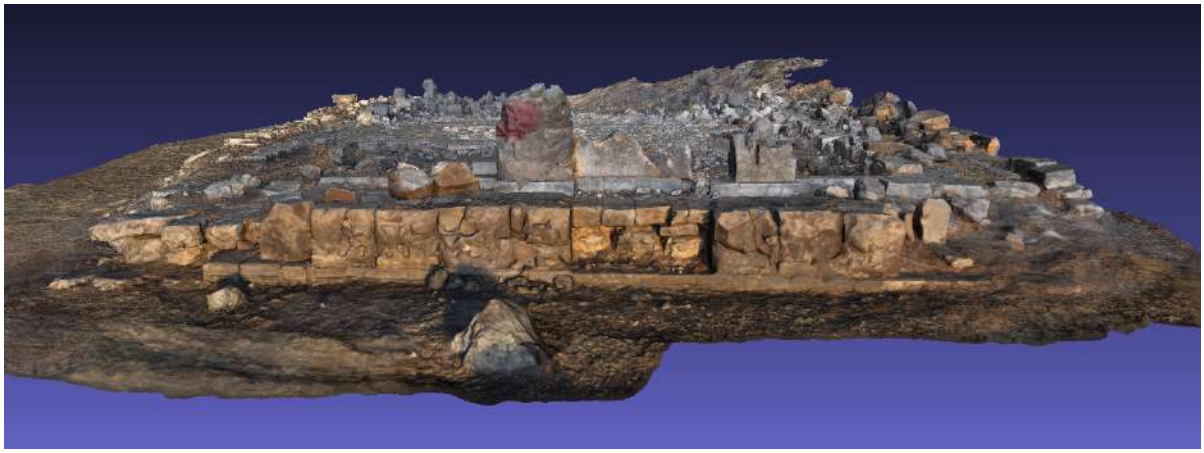

Fig. 5 3D model from ground photographs (View from the northwest)

Fig. 6 3D model from ground photographs (View from the southwest)

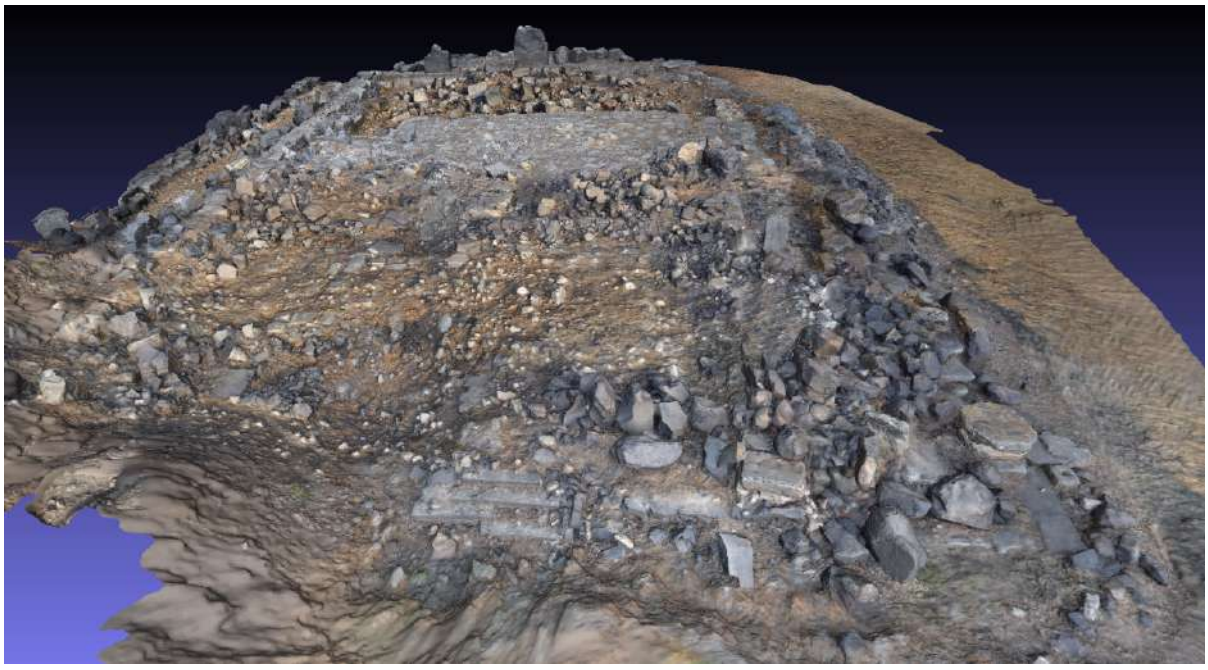

Fig. 7 3D model from ground photographs (View from the southeast)

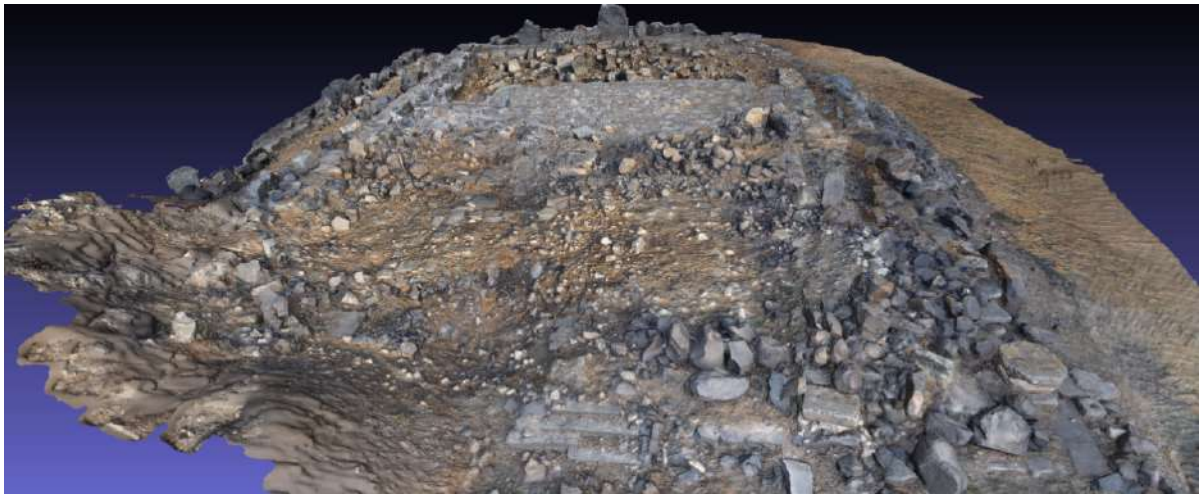

Fig. 8 3D model from ground photographs (View from the northeast)

Fig. 9 3D model from ground photographs (Detail of the reliefs)

Fig. 10 UAV derived 3D model (Top view)

Fig. 11 UAV derived 3D model (slant view from the east)

Fig. 12 Details of UAV derived 3D model

3.2. GIS data

GIS raster data (ortho-photomap) and DEM (Digital Elevation Model) can be derived from the 3D model. These data can be overlaid with satellite images or digital maps, since the absolute coordinates are attached to the model. DEM and GIS raster data were derived from the 3D model generated from the UAV photographs because it had better quality when viewed from above. The detail of the floor stones, remaining walls, and distribution of the fragmented sculptures are visible in the data. GIS raster data and DEM give different impressions and have different advantages. For example, traces of the bombing are clearly visible in the DEM while GIS raster clearly depicts small debris (Fig. 13, Fig. 14).

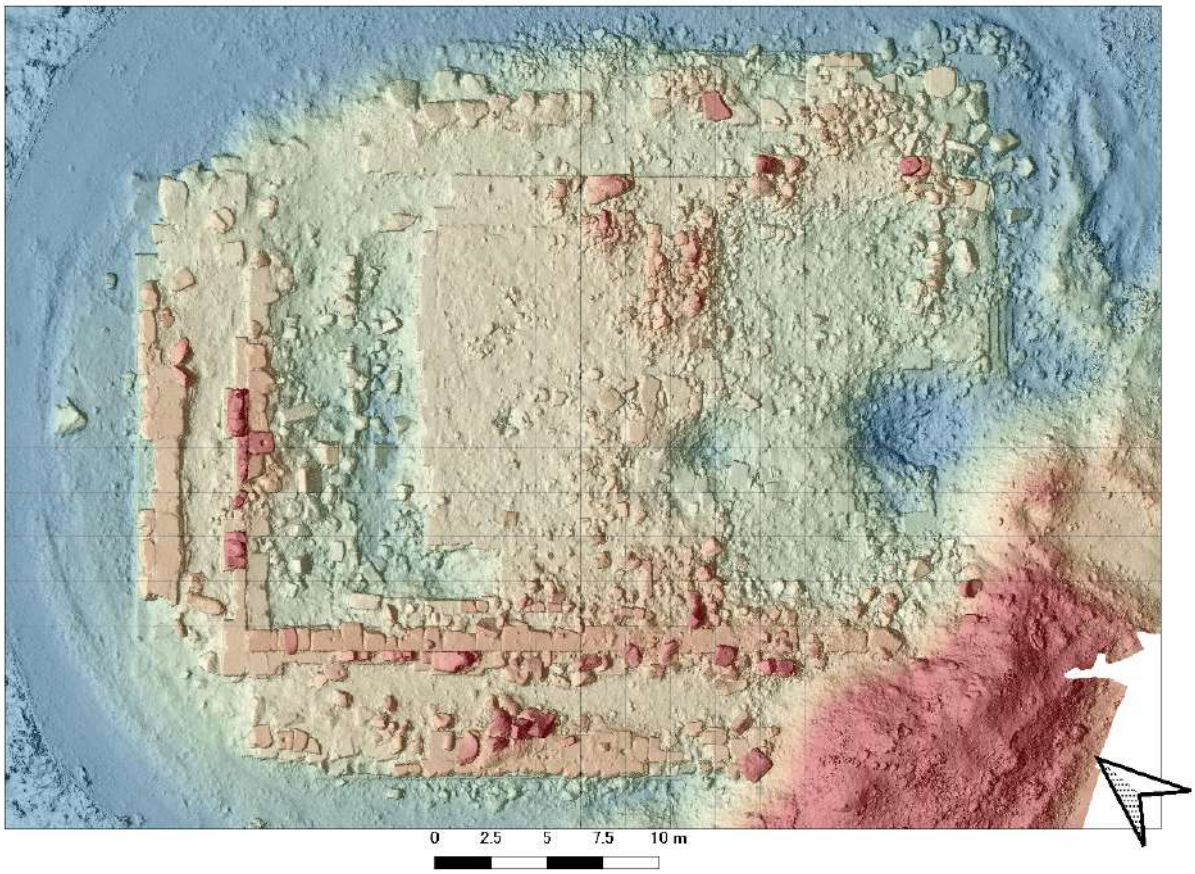

Fig. 13 UAV derived DEM of ‘Ain Dārā

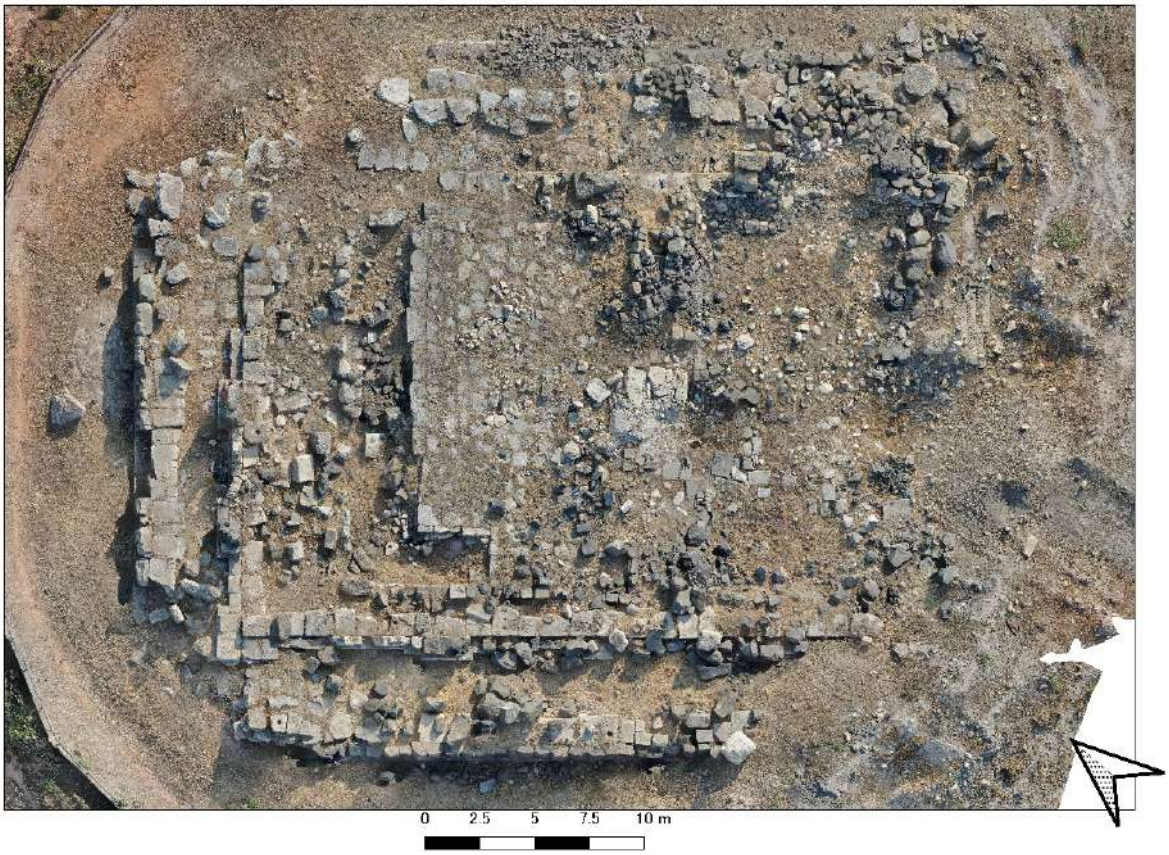

Fig. 14 GIS raster data of ‘Ain Dārā

3.3. Ortho-photographs and Plans

Ortho-photographs for the top plan (same as Fig. 14) and three side plans (Fig. 15) were derived from the 3D model.

Fig. 15 Ortho-photographs for the side plan

Then the ortho-photographs were digitally traced as drawing plans (Fig. 16, Fig. 17). Many small fragments which are debris from the bombing were recorded. This drawing plan will be utilized as one of the base maps for the reconstruction.

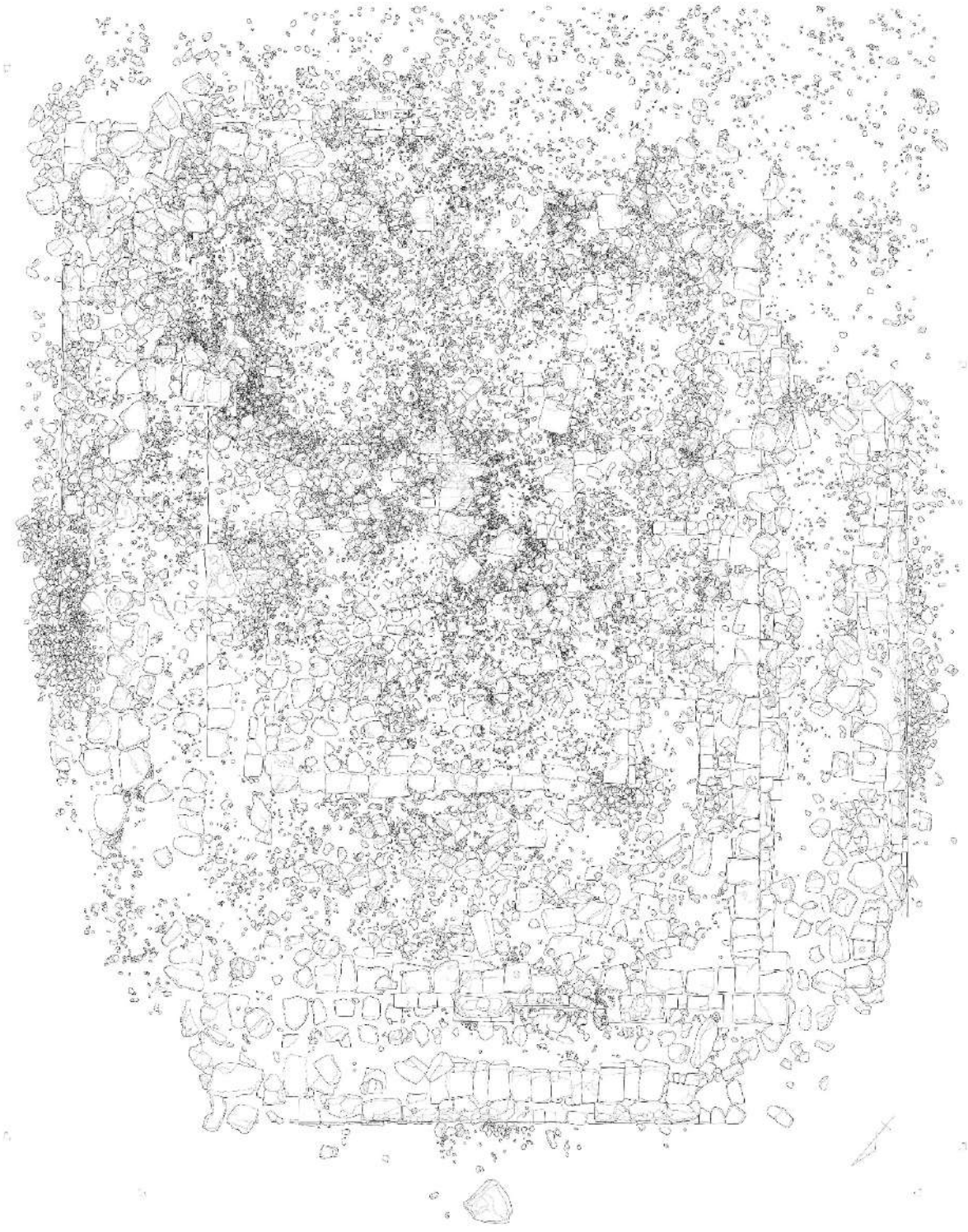

Fig. 16 Top drawing plan

Fig. 17 Side drawing plans (Top: northwest; Middle: southwest; Bottom: northeast)

3.4. Movie

Movie to introduce the damage to ‘Ain Dārā is generated based on the 3D model and DEM (Fig. 18).

Fig. 18 3D CG movie of ‘Ain Dārā

2022