

HERITAGE
WATCH.AI

ASSESSMENT AND 3D DOCUMENTATION OF 12 MONUMENTS IN ALEPPO

2023 - 2024

with the support of

iconem



ASSESSMENT AND 3D DOCUMENTATION OF 12 MONUMENTS
IN ALEPPO
2 0 2 3 - 2024

Authors:

Yves Ubelmann

Architect

Bachaar Tarabay

Conservation Architect

Lynn Jabri

Conservation Architect

with the support of



ASSESSMENT AND 3D DOCUMENTATION OF 12 MONUMENTS
IN ALEPPO

2 0 2 3 - 2 0 2 4

PHASE I – MARCH 2023

with the support of



SUMMARY

Despite the challenges of this type of mission, it went well as Iconem managed to conduct the first phase of this project. Yves Ubelmann and its 10 trainees from the DGAM successfully scanned 12 monuments including the Citadel and its walls.

INTRODUCTION

The goal of this project was to conduct an emergency 3D digitization of the Old City of Aleppo and some of its monuments in order to assess the damage in the aftermath of the earthquake.

To accomplish this, Yves Ubelmann travelled to Damascus with all the necessary equipment where he joined the DGAM team to travel with them to Aleppo. During his 4-day long stay, he conducted very high-resolution scans of the Citadel and its walls, as well as 12 monuments located both in the citadel and in the Old City (listed below).

While conducting the scanning, he delivered an advanced on-site training to a group of 10 trainees from the DGAM team (6 from Damascus and 4 from Aleppo). Those cultural heritage professionals had previously received training from him years ago. This new training focused on in-depth on data acquisition techniques, including drone and camera surveys.

List of sites scanned		
Name	Location Map	Date
Citadel and its walls	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Mosque Jami' al-Kabir and its square minaret	https://goo.gl/maps/xzboHMuPvZ7koyM99	10.03.2023
Collapsed Ottoman buildings in the Citadel	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Ottoman Mill Tower	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Entrance block (Madkhal Qal'a Halab) and its bridge	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	11.03.2023
Bab Antakiyya	https://goo.gl/maps/DEsL211Xx9WHjtr2A	12.03.2023
Bayt Ghazaleh	https://goo.gl/maps/ShLA3B8DFqMTUMGb8	11.03.2023
Madrasa al-Halawiyya	https://goo.gl/maps/CSAeHZGSbWxv6dUS7	12.03.2023
Madrasa al-Shadhbakhtiyya	https://goo.gl/maps/q7Q4hTPxApDhmVxW8	13.03.2023
Bimaristan Nur al-Din	https://goo.gl/maps/y5BEkL5G3UGQTs7CA	13.03.2023
Khan al-Jumruk	https://goo.gl/maps/oY3M5FAHdcUuHcGa8	13.03.2023
Khan al-Sabun	https://goo.gl/maps/nim4m1nsggeZYMNa6	12.03.2023

CHALLENGES

The recent earthquake and its aftershocks have resulted in a significant humanitarian crisis in Syria. The pre-existing conflict had already weakened the institutions, making it difficult to fulfill basic needs through official channels. Many people have to resort to the black market to obtain essential supplies such as gasoline. Additionally, due to the lack of electricity, generators are needed to charge the drone's and camera's batteries, making access to cash imperative. In this situation, the initial budget of \$5,000 was not sufficient to cover all the costs.

OUTCOMES

The main outcomes are:

Reliable team on the ground: Despite these challenges, we were able to successfully digitize 12 monuments in a short period of time and continue the training of a team of 10 dedicated local professionals. Having been trained by Yves in the past, he was pleased to see that they continued practicing on their own and had developed a high level of proficiency in photogrammetry.

More monuments to scan: It's crucial to have a capable team on the ground to conduct surveys and digitization independently because the need is abyssal. It is imperative to scan the Old City of Aleppo before it collapses completely. During the 4-day period, we were able to digitize 12 monuments in very high resolution. However, there are hundreds of additional monuments that require scanning.

NEXT STEPS

The next steps are:

Data processing: All the collected data will be processed in Paris. Once the recent data has been processed, we will compare the new architectural documentation with the 2017 scans of the Old City of Aleppo to evaluate the damage caused by the earthquake.

Extraction of documentation: The architectural documentation will be extracted and shared with relevant organizations to prepare for consolidation and emergency conservation work. The processed data may also be used in the future for the preparation of restoration work in a second phase.

Scale up the model: This model of data acquisition has proven to be successful as a small team was able to digitize a large number of monuments in very high resolution within a short period of time. This approach could be scaled up to include more urban centers and heritage sites that have been impacted by the earthquake across the country. The quick implementation of this model is crucial, with the emergency data acquisition taking priority. The processing of these images can be done in the second phase of the mission.



Yves Ubelmann with a part of the DGAM team



Preliminary work before data acquisition - Laser focussing



Setting up a georeferenced point



The Citadel and its walls



The Citadel and its walls



Battery recharging with generator



Mosque Jami' al-Kabir and its square minaret



Mosque Jami' al-Kabir and its square minaret



Ottoman Mill Tower



Bridge linking the outer gate (Madkhal Qal'a Halab) to the inner gate of The Citadel



Entrance block (Madkhal Qal'a Halab) and its bridge



Bridge linking the outer gate (Madkhal Qal'a Halab) to the inner gate of The Citadel



Bab Antakiyya



Bayt Ghazaleh



Bab Antakiyya



Bayt Ghazaleh



Bayt Ghazaleh



Madrasa al-Halawiyya



Bayt Ghazaleh



Madrasa al-Halawiyya



Madrasa al-Shadhbakhtiyya



Bimaristan Nur al-Din



Madrasa al-Shadhbakhtiyya



Bimaristan Nur al-Din



Khan al-Jumruk



Khan al-Sabun



Khan al-Jumruk



Khan al-Sabun

ASSESSMENT AND 3D DOCUMENTATION OF 12 MONUMENTS
IN ALEPPO

2 0 2 3 - 2 0 2 4

PHASE II – MAY 2023

with the support of



CONTENTS

- Context of the mission
- Framework of the mission
- Goals of the mission
- Preparation of the mission
- Course of the mission
- The trainees
- Data collection
- First results
- Challenges
- Outcomes
- Observations
- Recommendations
- Objectives of the next phase
- Annexes

CONTEXT OF THE MISSION

The earthquake of the 6th of February 2023 and its aftershocks in the Turkish region close to the Syrian border caused significant destructions of major cultural heritage sites in the region, including the Old City of Aleppo. Following this event it was crucial to properly assess the damages as the cultural heritage was already weakened by the pre-existing conflict. To implement emergency measures and plan the next steps, it was urgent to carry out the necessary analysis using new technologies.

To do so, Iconem turned to ALIPH to receive an emergency grant to urgently document the remaining structures relying on photogrammetric scans. We decided to opt for a pilot mission focusing on 12 buildings in addition to the citadel. This first part of the mission allowed Iconem quickly collect data, which was a key-aspect to the implementation of the overall project.

FRAMEWORK OF THE MISSION

Description: Supported by Aliph, Iconem launched its mission of 3D documentation of the citadel and 12 monuments of the Old City of Aleppo. Member of the mission from Iconem: Yves Ubelmann, Architect and CEO of Iconem, Paris (France)

Duration and dates: 8 days, from 8 March 2023 to 15 March 2023.

GOALS OF THE MISSION

The main goal of the mission was to urgently digitize 12 monuments in order to document the damage caused by the earthquake. This was achieved through specific objectives, which included:

- Coordinating with the DGAM and traveling to Syria with data acquisition equipment.
- Providing in-depth photogrammetry training to the trainees to strengthen their technical skills.
- Rapidly assessing the context to adapt the survey methodology and team training.
- Collecting data for 3D reconstruction of the monuments.
- Taking GPS points for geo-referencing the models to be generated.

PREPARATION OF THE MISSION

Due to the urgent situation in Syria, we had to organise the mission in a short period of time. Fortunately, all the necessary equipment was ready to go in the first few days following the event.

We were in daily contact with Houmam Saad, Director of Archaeology at the DGAM, who was responsible for transportation, planning, as well as finding suitable trainees and arranging their accommodation. We were fortunate to find a local drone pilot could obtained authorization for a flying the drone.

However, obtaining a visa for Yves was a major constraint for the entire mission. Thanks to Yves' prior experience traveling to Syria, he was able to secure a visa relatively quickly.

Yves' extensive network in Syria was proved invaluable in enabling us to plan and execute the mission within a matter of days.

COURSE OF THE MISSION

The mission went on 8 days, including 4 full days of scanning, from 8 March 2023 to 13 March 2023.

08/03/2023	Departure from Abu Dhabi at 7AM	- Arrival at Beirut at 12PM - Arrival in Damascus at 5PM - Booking of the drivers and cars to travel to Aleppo
09/03/2023	Departure from Damascus to Aleppo at 10AM	Arrival in Aleppo at night-time
10/03/2023	Global scanning of the Citadel, its mosque, the Ottoman remains, and the mill tower 10.03.2023	
11/03/2023	Global scanning of the rest of the Citadel, its entrance block and its bridge, and its towers	Scanning of the Beit Ghazaleh
12/03/2023	Scanning of the Bab Antakiya and its tower	Scanning of the Madrasa al-Halawiyya and the Khan al-Sabun
13/03/2023	Scanning of the Bimaristan Nur al-Din and the Khan al Jumruk	Scanning of the Madrasa al-Shadhbakhtiyya
14/03/2023	Departure from Aleppo to Damascus at 10AM	Night in Damascus
15/03/2023	Departure from Damascus to Beirut	Departure from Beirut to Paris at 3PM

Over the course of four full days dedicated to data collection, Yves and the team of trainees managed to digitize a total of 12 monuments, including the citadel and its walls. Thanks to their efficient efforts, we were able to achieve our objectives within a remarkably short period of time.

THE TRAINEES

Houmam Saad selected the trainees, of which some were from Damascus, and some were from Aleppo.

- Ahed Diab
- Balsam Hassan
- Mariam Hamouda
- Fares al-Araj
- Houmam Saad
- Shiren Nabo
- Amnie Sabouni
- Khaled Hamazh



Yves Ubelmann with trainees.

DATA COLLECTION

Data collection involved the use of various techniques at different scales.

- Data captured by drone at a height of 25 m:
Despite regulatory limitations, our drone operator, Khaled Hamazh, managed to capture images of all the monuments, including the citadel, its walls, and the large entrance gate with its bridge. This technique enables us to conduct an external survey of the monuments.
- Data captured on the ground at human height:
During ground capture, the trainees were able to demonstrate their knowledge and skills. The team used cameras provided as part of the mission to take high-resolution shots, while practicing under the supervision of Yves. This technique allowed us to capture more details and scan the interiors of the monuments.
- Data captured on the ground with a pole:
The capture height ranged from 7 to 9 meters in order to obtain high-resolution images of elevated spaces. These shots enabled us to inspect the floors and connect the walls together.
- Laser scanning:
The team used laser technology alongside photogrammetry to build the point clouds.
- Georeferenced points:
GPS points were also taken during the data acquisition to georeference and scale the 3D model. This step is tedious but essential to generate a high-quality result.



Data acquisition by drone.



Laser scanning by trainees.



A trainee taking a GPS point.

Thanks to ALIPH's support, the purchased equipment was left with the team so that the trainees could continue to practice as they did in the past. The equipment used during the previous missions of Iconem in Syria was in good condition because the members of the previous workshops took good care of it and continued to practice on their own.

FIRST RESULTS

During the mission, we collected a significant number of photos that allowed us to generate a preliminary point cloud of the citadel. This initial model is highly satisfactory as we were able to gather high-quality data in a short period of time. Although the data processing is still ongoing, the preliminary results are promising for the next phase of the mission.

- The Citadel

Initial calculations have generated a preliminary point cloud of the Citadel. Our objective is to overlap this model with the previous one from 2017, in order to compare and evaluate any damage that may have occurred.



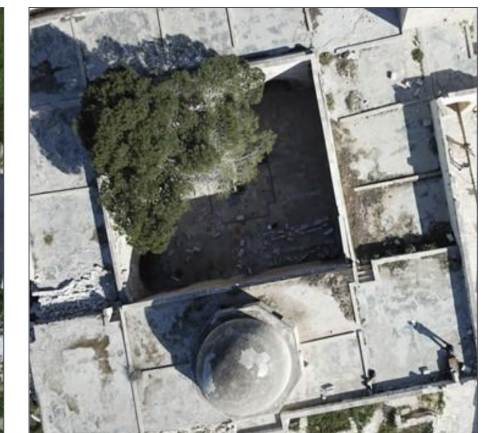
Preliminary point cloud of the Citadel, 2023.



2016



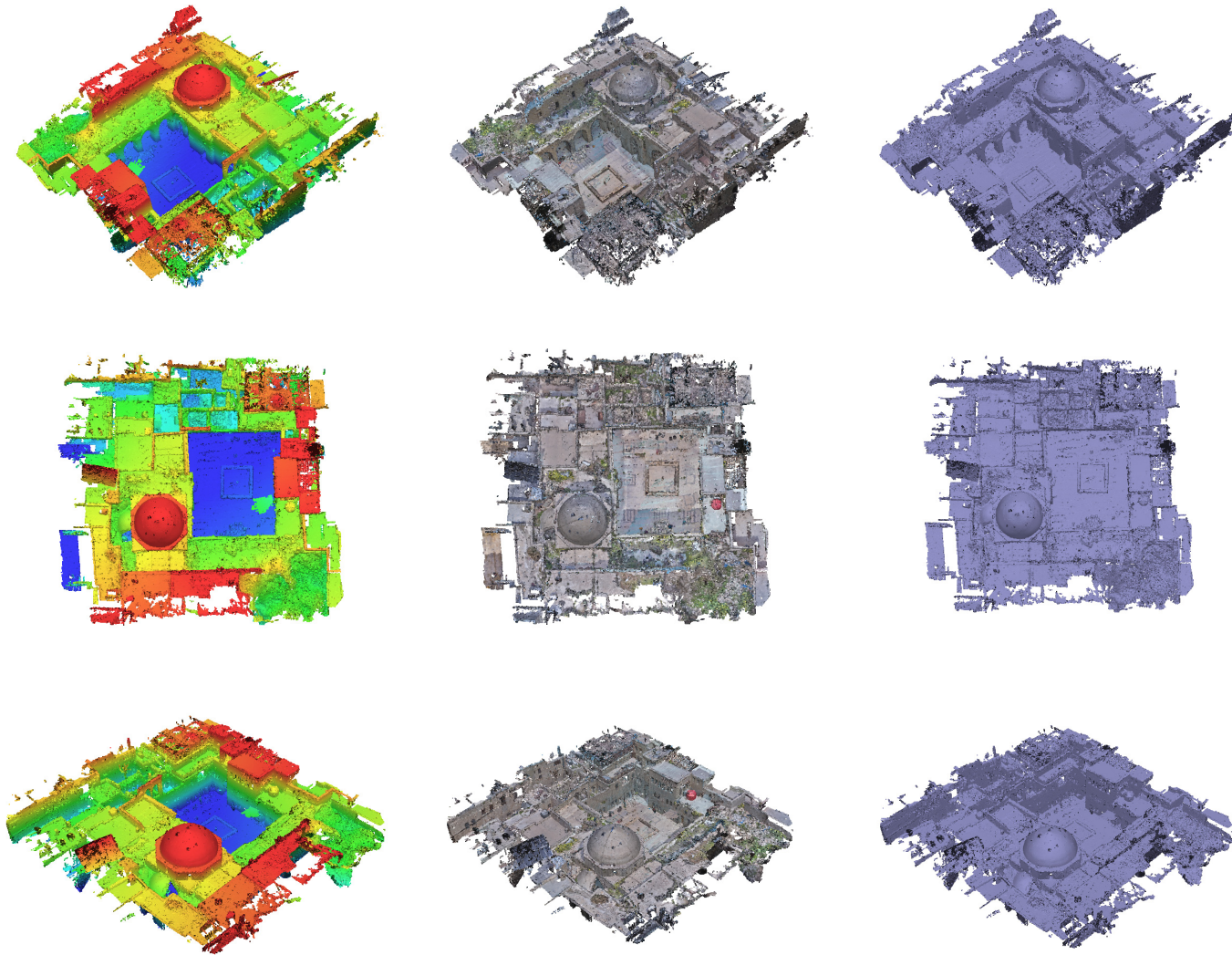
2019



2023

- The monuments

The 3D models of the monuments will not only help us analyse the damage caused but also identify any areas of weakness. In collaboration with emergency consolidation experts, our objective is to develop a plan for conserving these buildings that are at risk of collapse.



Preliminary point cloud of the Citadel, 2023.

The photogrammetric surveys will allow us to model the shoring process and create accurate simulations of the proposed measures. In addition, these surveys will enable us to extract valuable architectural information that can be shared with both experts and the wider scientific community.

CHALLENGES

The preliminary report mentioned that local economic instability posed a challenge, with a large margin of contingencies. The recent earthquake and pre-existing conflict have resulted in a significant humanitarian crisis in Syria, making it difficult to fulfil basic needs through official channels.

The black market has become a necessary source for essential supplies such as gasoline, and generators are needed to charge equipment batteries due to the lack of electricity. As a result, the initial budget of \$5,000 was not enough to cover all the costs.

OUTCOMES

The lessons learned from Iconem are:

- **Reliable team on the ground:** Despite these challenges, we were able to successfully digitize 12 monuments in a short period of time and continue the training of a team of 10 dedicated local professionals. Having been trained by Yves in the past, he was pleased to see that they continued practicing on their own and had developed a high level of proficiency in photogrammetry.
- **More monuments to scan:** It's crucial to have a capable team on the ground to conduct surveys and digitization independently because the need is abyssal. It is imperative to scan the Old City of Aleppo before additional damages occur. During the 4-day period, we were able to digitize 12 monuments in very high resolution. However, there are hundreds of additional monuments that require scanning.

The valuable insights gained from this mission will undoubtedly have a significant impact on future projects in Aleppo.

OBSERVATIONS

The pilot mission proved to be a resounding success, as we were able to collect high-resolution data and witness first-hand the extent of the damage to Aleppo's cultural heritage. It is evident that without swift action, further destruction is inevitable.

Therefore, there is an urgent need for a comprehensive project to assess the damage, provide recommendations for consolidation, and implement them quickly on the ground. The insights gained from this mission will be invaluable for future efforts to preserve and protect the cultural heritage of Aleppo.

RECOMMENDATIONS

This mission can serve as a pilot project for the development of a methodology that can be scaled up to the whole city of Aleppo.

We are currently collaborating with experts in consolidation to devise such a methodology. Our goal is not the full restoration of a few monuments, but the urgent shoring up of a large number of buildings to prevent further damage.

List of sites scanned		
Name	Location Map	Date
Citadel and its walls	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Mosque Jami' al-Kabir and its square minaret	https://goo.gl/maps/xzboHMuPvZ7koyM99	10.03.2023
Collapsed Ottoman buildings in the Citadel	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Ottoman Mill Tower	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Entrance block (Madkhal Qal'a Halab) and its bridge	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	11.03.2023
Bab Antakiyya	https://goo.gl/maps/DEsL211Xx9WHjtr2A	12.03.2023
Bayt Ghazaleh	https://goo.gl/maps/ShLA3B8DFqMTUMGb8	11.03.2023
Madrasa al-Halawiyya	https://goo.gl/maps/CSAeHZGSbWxv6dUS7	12.03.2023
Madrasa al-Shadhbakhtiyya	https://goo.gl/maps/q7Q4hTPxApDhmVxW8	13.03.2023
Bimaristan Nur al-Din	https://goo.gl/maps/y5BEkL5G3UGQts7CA	13.03.2023
Khan al-Jumruk	https://goo.gl/maps/oY3M5FAHdcUuHcGa8	13.03.2023
Khan al-Sabun	https://goo.gl/maps/nim4m1nsgeeZYMNa6	12.03.2023

Annex 1: List of sites scanned



Annex 2: Map of sites scanned

ASSESSMENT AND 3D DOCUMENTATION OF 12 MONUMENTS
IN ALEPPO

2 0 2 3 - 2 0 2 4

PHASE III – APRIL 2024

with the support of



CONTENTS

Context of the mission

Framework of the mission

Goals of the mission

Course of the mission

- Data Processing
- Technical Documentation

Challenges

Annexes

CONTEXT OF THE MISSION

The earthquake of the 6th of February 2023 and its aftershocks in the Turkish region close to the Syrian border caused significant destructions of major cultural heritage sites in the region, including the Old City of Aleppo. Following this event was crucial to properly assess the damages as the cultural heritage was already weakened by the pre-existing conflict. To implement emergency measures and plan the next steps, it was urgent to carry out the necessary analysis using new technologies.

To do so, Iconem turned to ALIPH to receive an emergency grant to urgently document the remaining structures relying on photogrammetric scans. We decided to opt for a pilot mission focusing on 12 buildings in addition to the citadel. This first part of the mission allowed Iconem quickly collect data, which was a key-aspect to the implementation of the overall project.

The first mission allowed Iconem to collect essential data for twelve buildings in the Old Aleppo and visually evaluate the extent of the damage. To continue this important work, it was imperative to proceed with the second phase of this project, which involved data processing and the extraction of architectural documents. These documents serve as robust scientific content, reinforcing the credibility of our first assessment.

FRAMEWORK OF THE MISSION

Description: Supported by ALIPH, Iconem launched its mission of 3D documentation of the citadel and 12 monuments of the Old City of Aleppo. The second phase of this project, involves data processing and the extraction of architectural documents of 6 of these monuments. These documents serve as robust scientific content, reinforcing the credibility of our first assessment.

Member of the mission from Iconem are:

Marjorie Coulin, R&D Engineer, Photogrammetry expert, Paris (France)

Bachaar Tarabay, Architect - Scientific Project Manager, Paris (France)

Duration: from 1 October 2023 to 29 April 2024.

GOALS OF THE MISSION

The on-site data acquisition proved to be successful. Relying on Iconem's extensive 10-year expertise, our team efficiently digitized a total of 12 monuments over the course of four full days, including the citadel and its walls. Yves and the team of local experts employed various techniques, including photogrammetry methods such as drone, ground, and pole-based captures, along with laser scanning and GPS points, to gather high-quality data.

With our well-established methodology in data acquisition, we were able to generate precise and detailed 3D models.

Thanks to the first Emergency Relief Grant, we were able to launch the initial calculations to control the quality and assess the alignment of our collected data. These initial calculations were satisfying. However, these preliminary point clouds could not be directly used to extract architectural documents in their current form. The collected data required proper processing to make it usable.

Iconem, with the support of ALIPH continued its efforts by:

1. Processing the collected data in our offices in Paris. The raw pictures (RAW) had already been sorted out and they needed to be de-rawed. With our expertise and specialized equipment, we were able to process the data into point clouds for each monument within 2 months. The 3D models were uploaded to our platform.

2. After the data processing, we picked with the collaboration of ALIPH and AKTC, 6 monuments according to their level of damage visible on the models and our observations to produce for each one orthophotographs (.tiff) and architectural drawings (.DWG) of:

- A Plan by level.
- A Mass Plan.
- 4 Elevations.
- 2 Sections.

COURSE OF THE MISSION

Data Processing

Upon Yves' return from Aleppo, our photogrammetry specialist, Marjorie Coulin, organized all the collected data and began processing it before initiating the next steps. This initial phase is crucial for maximizing the data extracted from each photograph, thereby optimizing the quality of the final 3D model.

Following the completion of this preliminary phase, all models were processed using Reality *Capture software, incorporating GPS points to scale and rectify the verticality of each monument. For the citadel, we conducted a comprehensive processing of all data to ensure a cohesive model integrating all its components.

Once the processing phase was complete, we began identifying the most significant architectural elements for extraction, focusing on relevant elevations, sections, and plans.

Orthophotos were processed at two resolutions, depending on the quality of the model processed. The rationale behind this choice will be elaborated in the "Challenges" section of the report.

To facilitate the usability of these orthophotos, both full-resolution documents and reduced versions are included in the list of deliverables.



Mass Plan of Khan El Jumruk



Elevation of the Jami' Al-Kabir Mosque



Section of the Main Entrance of the Citadel

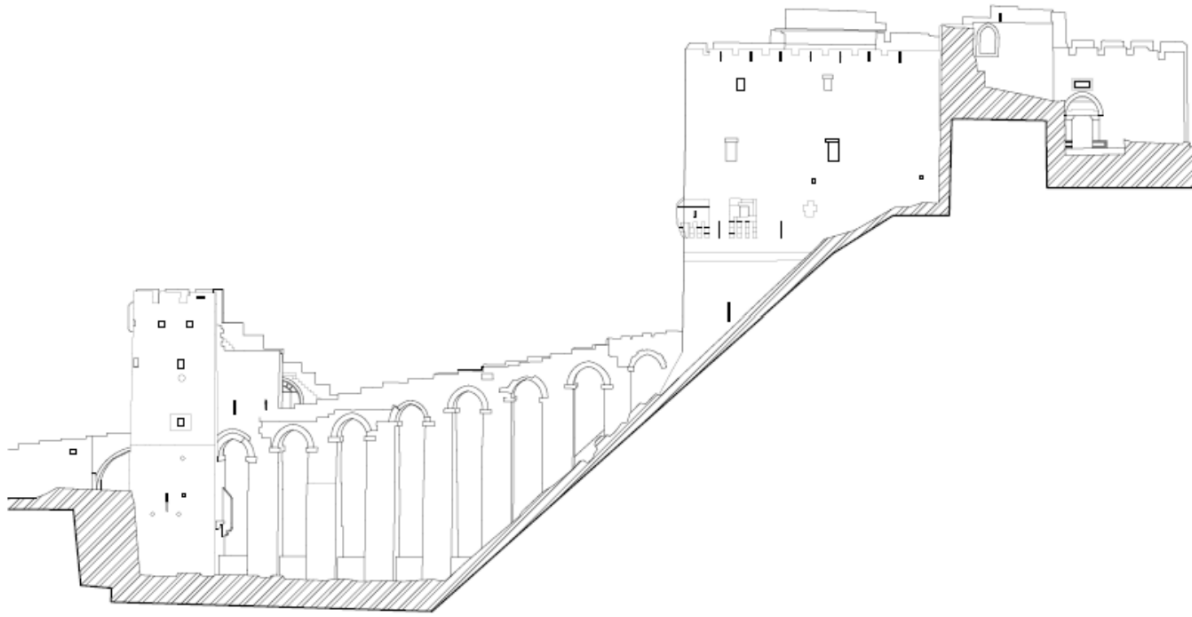


Section from Khan El Sabun

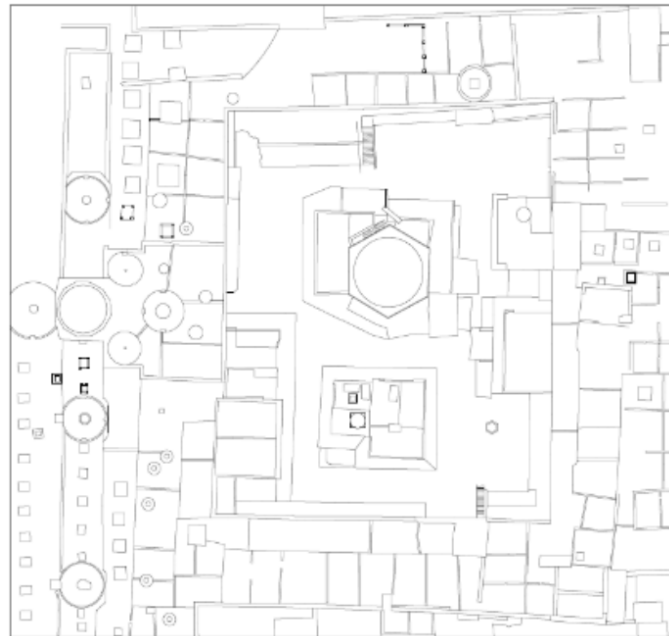
Technical Documentation

After the scaled orthophotos were prepared, they were imported into AutoCAD software. The architectural documents produced were meticulously crafted to adhere to the proposed scale by AKTC (1:200). Utilizing the observation and analysis of the 3D model, each part of the monument was meticulously defined to capture the most representative elements and components.

- 4 Elevations.
- 2 Sections.



Section of the Main Entrance of the Citadel



Mass Plan of Khan El Jumruk



Section from Khan El Sabun

CHALLENGES

During the mission, one of the challenges we faced was recording the Ground Control Points (GCP). This posed a potential risk of slight scale discrepancies in the documents. These challenges stemmed from the urgency of the mission and the difficult conditions in the city following the earthquake. Obtaining precise georeferenced points for the initial 3D model was particularly challenging due to the state of the city.

To mitigate these challenges and ensure the accuracy of the plans, we meticulously cross-referenced the measurements with architectural archival documents and detailed satellite imagery. Despite the obstacles posed by the damages and rubble, we were able to overcome them and successfully cross-reference the models with our previously acquired and processed models from 2018, as well as archival imagery.

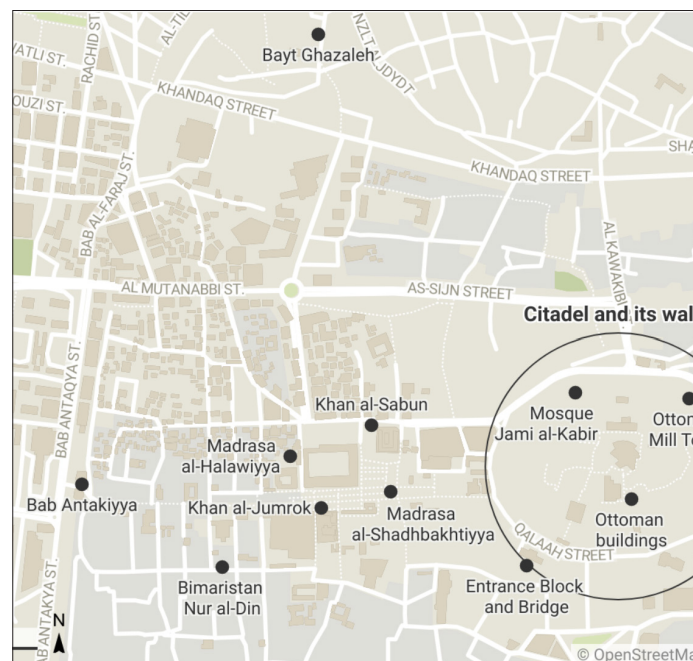
OUTCOMES

During this second phase, we achieved the following:

- Processed 12 monuments.
- Extracted orthophotos for 6 monuments in .tiff format.
- Created architectural technical documentation in .dwg format, which was then sent in PDF.

List of sites scanned		
Name	Location Map	Date
Citadel and its walls	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Mosque Jami' al-Kabir and its square minaret	https://goo.gl/maps/xzboHMuPvZ7koyM99	10.03.2023
Collapsed Ottoman buildings in the Citadel	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Ottoman Mill Tower	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	10.03.2023
Entrance block (Madkhal Qal'a Halab) and its bridge	https://goo.gl/maps/VpGKu5Jr2G8yb2uD8	11.03.2023
Bab Antakiyya	https://goo.gl/maps/DEsL211Xx9WHjr2A	12.03.2023
Bayt Ghazaleh	https://goo.gl/maps/ShLA3B8DFqMTUMGb8	11.03.2023
Madrasa al-Halawiyya	https://goo.gl/maps/CSAeHZGSbWxv6dUS7	12.03.2023
Madrasa al-Shadhbakhtiyya	https://goo.gl/maps/q7Q4hTPxApDhmVxW8	13.03.2023
Bimaristan Nur al-Din	https://goo.gl/maps/y5BEkL5G3UGQts7CA	13.03.2023
Khan al-Jumruk	https://goo.gl/maps/oY3M5FAHdcUuHcGa8	13.03.2023
Khan al-Sabun	https://goo.gl/maps/nim4m1nsgeeZYMNa6	12.03.2023

Annex 1: List of sites scanned



Annex 2: Map of sites scanned

CONTACTS

contact@heritagewatch.ai

Yves Ubelmann

Architect

yu@heritagewatch.ai

Titien Bartette

Archeologist

titien.bartette@heritagewatch.ai

Jonathan Chemla

Computer graphics Engineer

jonathan.chemla@heritagewatch.ai

Bachaar Tarabay

Conservation Architect

bachaar.tarabay@heritagewatch.ai

Lynn Jabri

Conservation Architect

lynn.jabri@heritagewatch.ai

Charlotte Fafet

Disaster Risk Specialist

charlotte.fafet@heritagewatch.ai

Mehraïl Saroufim

Remote Sensing Analyst

mehrail.saroufim@heritagewatch.ai