OREA 21

# Challenges, Strategies and High-Tech Applications for Saving the Cultural Heritage of Syria

## Proceedings of the Workshop held at the 10th ICAANE in Vienna, April 2016

Minna Silver (Ed.)

Austrian Academy of Sciences Press

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for Saving the Cultural Heritage of Syria

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Model of the entrance to Aleppo's citadel (constructed by W. Wahbeh).

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In memoriam Gabriele Fangi

10th ICAANE

# Contents

# Preface by the Series Editor

The 21st volume of the OREA series addresses *Challenges, Strategies and High-Tech Applications for Saving the Cultural Heritage of Syria* and represents the outcome of a workshop held at the International Congress on the Archaeology of the Ancient Near East. The 10th anniversary of the ICAANE took place from 25th to 29th April 2016 in Vienna, hosted and organised by the Institute for Oriental and European Archaeology (OREA) at the Austrian Academy of Sciences. While the publication series can be designated as well-established after having published 20 volumes since 2013, its host institution has undergone some crucial structural reform since the ICAANE conference. The formerly independent OREA institute merged together with other establishments to form the new Austrian Archaeological Institute (ÖAI) on 1.1.2021. We transformed the OREA institute into the Department of Prehistory and West Asian/Northeast African Archaeology, where the well-established research groups continue to pursue their main approach and engage in fieldwork without any changes. This publication series represents one aspect of this continuity, from now on being edited by the Department of Prehistory & WANA Archaeology of the new Austrian Archaeological Institute.

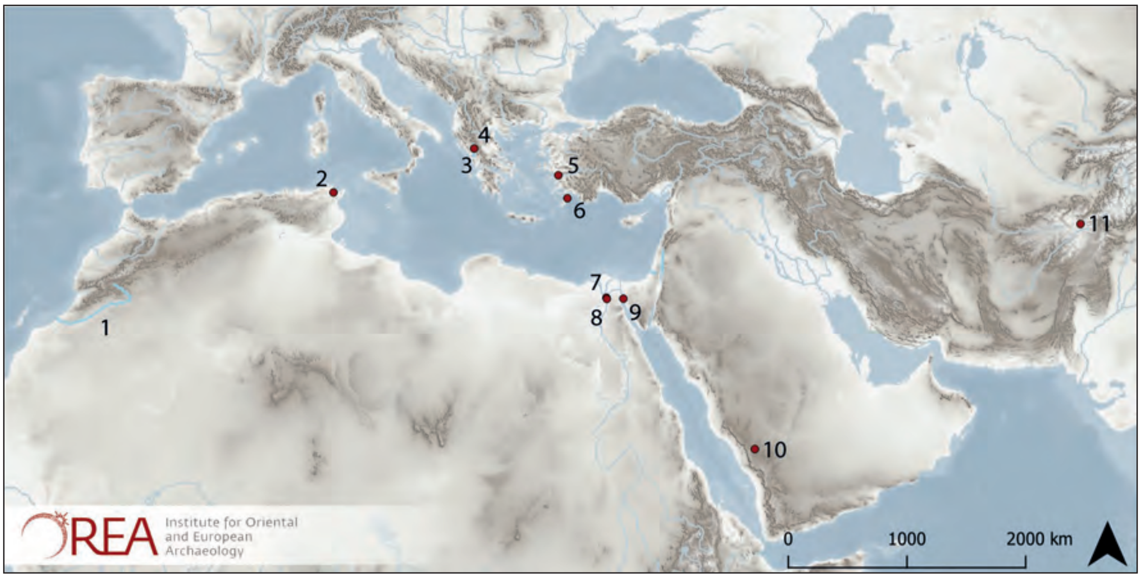
The present volume is edited for our series by Minna Silver, who, together with Michael Doneus, also initiated and organised this workshop about saving the heritage in Syria, one of the most pressing topics in Near Eastern Archaeology. The ICAANE conference offered a good opportunity for the CIPA Heritage Documentation under ICOMOS and the ISPRS board members' initiative to bring experts and stakeholders together in Vienna and focus again on the heritage under threat in Syria. The organisers brought together important organisations and researchers with first-hand experience. They built on already established broader initiatives, collaborations and projects and impressively demonstrated methods and approaches for saving the memory of the cultural heritage in Syria and the neighbouring regions. Altogether, 15 contributions offer a kind of toolkit for tackling the Syrian situation from an archaeological and cultural perspective, aiming at saving Syrian heritage as well as supporting the local archaeology. Of special importance and the wider impact of this volume is the broader view on the human past occasioned by integrating different periods and perspectives, which additionally highlights the Syrian tragedy and its long-lasting consequences.

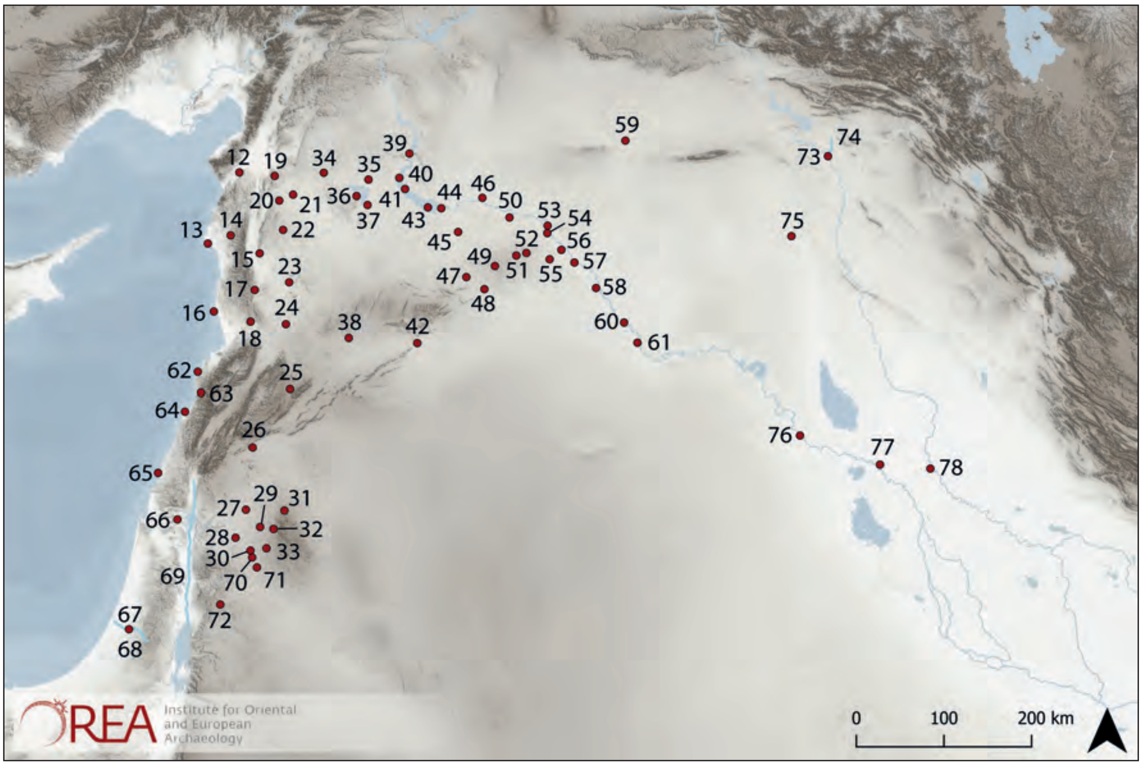
In any case, as the lively and engaged discussions during the workshop in Vienna demonstrated, the global community must take an interest in saving the Syrian heritage for future generations. The enormous and even life-endangering engagement by the local civil society is accompanied by international activities, as presented in this volume, but all of them require peace and a peaceful environment for both the people and the heritage. Five years after the workshop took place in Vienna, we are, unfortunately, still waiting. I warmly thank the editor, Minna Silver, for putting together this important volume and all the contributors for sharing their expertise and fruitful insights with us!

Following the volume editor's suggestion, this book is dedicated to the memory of Prof. Gabriele Fangi, who passed away on January 18th, 2020. He was professor of Geomatics at the Università Politecnica delle Marche, Ancona (Italy) and former member of the CIPA Executive Board. He documented about 30 endangered architectural monuments in Syria in 2010 with the method of Spherical Photogrammetry and carried out numerous documentation projects for cultural heritage in various parts of the world.

My sincere thanks for financial support of the 10th ICAANE conference go to several Austrian and international institutions, which are the Austrian Federal Ministry of Europe, Integration and Foreign Affairs, the University of Vienna, the City of Vienna, the Vienna Science and Technology Fund (WWTF), the Institute for Aegean Prehistory (INSTAP), the Austrian Orient Society Hammer-Purgstall and the Austrian Academy of Sciences. I would like to thank Ulrike Schuh for the coordination and editing, Angela Schwab for the layout and the Austrian Academy of Sciences Press for its kind support.

Barbara Horejs
Scientific Director of the Austrian Archaeological Institute
Vienna, 26 April 2021




Marked Places: 1. Wadi Draa; 2. Tunis; 3. Arachthos river; 4. Plaka; 5. Magnesia; 6. Rhodes; 7. Cairo; 8. Maadi town; 9. Suez; 10. Nimra Mountain; 11. Bamiya; 12. Antioch; 13. Latakia; 14. Citadel Salah al-Eddin; 15. Apamea; 16. Tartous; Arwad Island; Amrit; 17. Mysiaf; 18. Crac des Chevaliers; 19. Qalb Lozeh; 20. Idlib; 21. Ebla; 22. Ma'arat al Numan; 23. Hama; 24. Homs; 25. Tell Humyra, Deir Attiya; 26. Damascus; 27. Shaqra/Wadi es-Saqra; 28. Dar‘a; 29. Hauran/Auranitis; 30. Al-Muta‘iya; 31. Shaqqa; 32. As-Suwaidā; 33. Bosra al Sham; 34. Aleppo; 35. Umm el-Marra; 36. Oum Aamoud Seghir; 37. Lake Jabboul; 38. Wadi Tafha; 39. Jerf al-Ahmar; 40. Habuba Khabira/Tell Qannas; 41. Mureybet; 42. Palmyra/Tadmor; 43. Abu Hureyra, Lake al-Assad; 44. Tabqa Dam; 45. Resafa/Sergiopolis; 46. Tell Bi‘a/Tuttul/Raqqa; 47. El Kowm basin; 48. Qasr al-Hayr ash-Sharqi, Shanhas and Ash-Shujiri; 49. Tar as-Sbai; Tell Tletuat; 50. Tell Abu Hamed/Ghanem Ali; 51. Darakhlia; 52. Jebel Bishri; 53. Fortress of Zenobia/Halabiya; 54. Tell Tibne; 55. Nadra; 56. Tell Kharita; 57. Deir ez-Zor; 58. Bouqras; 59. Al-Hassake; 60. Dura Europos; 61. Mari; 62. Kūbbā; 63. Azra ou el-Azr; 64. Beirut; 65. Tyre; 66. Nimra; 67. Tell es-Safi/Gath; 68. Elah Valley; 69. Jordan River; 70. Umm iz-Surab; 71. Umm idj-Ğimāl; 72. Amman; 73. Nineveh/Mosul; 74. Khosr River; 75. Hatra; 76. Hit; 77. Fallujah; 78. Baghdad

(Maps: D. M. Blattner /OREA 2020)

# Introduction

*Minna Silver*[1]

Hazards for tangible cultural heritage, such as historical and archaeological remains, can vary from natural catastrophes and environmental changes to human-caused mismanagement and destruction. The importance of the detailed recording and documentation of landscapes, sites and structures becomes particularly acute in the areas and cases that have become neglected or face destruction and/or loss. The Near East has suffered severe turmoil over the past decades, and Syria, like Iraq, has been the battlefield of various groups. This cradle of human civilisation has faced war, destruction and the looting of its heritage, the heritage that also belongs to the whole of humankind.

CIPA Heritage Documentation under ICOMOS (International Council on Monuments and Sites) and ISPRS (International Society of Photogrammetry and Remote Sensing), is providing expertise in developing the best technical means for heritage documentation. The aim of the workshop on saving the heritage of Syria in Vienna, Austria, on the 28 April 2016 during the 10th ICAANE (International Congress of Archaeology in Ancient Near East), was to bring together various stakeholders that are working to safeguard the tangible heritage of Syria. As a CIPA executive board member I organised the workshop together with my colleague Professor Michael Doneus from the University of Vienna, who was then also a member of the CIPA board. He has acted both as CIPA's vice-president and as its general secretary in the past. The purpose was to discuss challenges, find strategies and provide technical expertise to save and revive heritage and to share ideas for the benefit of various cases.

Besides the mentioned CIPA organisers of the workshop, Prof. Andreas Georgopoulos, president of CIPA; Prof. Peter Waldhäusl, former president of CIPA; Prof. Gabriele Fangi; Assoc. Prof. Grazia Tucci; Prof. Pierre Grussenmeyer and Prof. Fulvio Rinaudo, all members of the CIPA board, participated in the workshop. Here the proceedings consist of 15 papers, most of which were presented during the workshop. A few presenters did not participate in the final proceedings, and new ones contributed instead, such as Prof. Ahmet Denker and Prof. Karel Pavelka, the latter also from the CIPA board.

Several scholars from CIPA have worked in Syria and collected first-hand data. We have co-operated in designing databases for saving the heritage that is presented in this volume and Gabriele Fangi, Ahmet Denker and I authored a book on Palmyra that came out in March 2018 titled *Reviving Palmyra in Multiple Dimensions. Images, Ruins and Cultural Memory* (Dunbeath 2018). Later on in autumn 2018, an exhibition in this field, *Cités Millénaires. Voyage virtuel de Palmyre à Mossoul,* opened in Paris at The Arab World Institute, running from October 2018 to February 2019. The exhibition also produced a book with the same title.

Besides individual researchers, important organisations such as ICOMOS, Shirin, ASOR and CyArk, as well as projects such as SYGIS, Coupoles et habitats, the Mare Nostrum heritage trail, EAMENA and Anqa, contributed to the present volume. We had hoped that Dr. Cristina Menegazzi from the UNESCO project for safeguarding the Syrian heritage would be able to attend, but during the workshop she had to travel to Palmyra between the conquests of the site by ISIS/

[1] Universities of Oulu and Helsinki; minna.silver@helsinki.fi.

ISIL in 2015 and 2017. There was a unique window of opportunity then to observe and monitor the situation. Unfortunately ISIS/ISIL returned to carry out more destruction in 2017.

I wish to express my delight and appreciation for all those who in one way or another participated in the workshop lectures, either as presenters, listeners or commentators in discussions and/or as authors in these proceedings. The aim of the workshop and its proceedings is to respond actively to the challenges that we face in saving the memory of places in Syria. In their studies archaeologists address the sequence of remains representing various cultures and ages that shaped Syria. The strata of cultural impacts all need to be recorded and documented to revive a cultural tapestry of the past. Also, the process of destruction belongs to our experience and is to be recorded. Remote sensing, Geographic Information Systems, 3D recording and imaging technologies and methods based on laser and digital-based data capture are increasingly showing their potential and applicability for tracing, retrieving and saving valuable information to be studied and left for posterity. A strategy that can adapt the heritage documentation into 3D form is still needed.

The proceedings of this workshop bring together various initiatives and projects concerning the case of Syria. This rallies cultural heritage professionals and engineers around the same subject in order to present various ways to tackle the challenges. They can be mental as well as physical. We can fuse various aspects together and form a multifaceted view to better understand and take into account the aspirations of the people who constructed the sites. There is data that was already collected long ago by travellers who drew or photographed monuments and described them in their travelogues. These inventories preserve some remains that have vanished. New technologies add ways to see the world beyond what is possible with the naked eye; they can record and document in microscopic detail.

However, the human eye always remains an important tool which we depend on while capturing and analysing the data. Also, a touch from a human hand can still produce different approaches with its human interpretation and ways of visualisation. In countries where there is a lack of resources for all the latest technological means, working by hand can achieve good results. In any event, technologies are here to stay and we need to apply them as best we can to protect and preserve the heritage.

These papers aim to present examples of problems and challenges and suggest various ways to protect and preserve the tangible cultural heritage in Syria. Here we do not generally present archaeological and historical research problems but rather methodological aspects and tools for dealing with the recording and documentation, how to protect and preserve – the problems that are present in Syria in connection with the cultural heritage. Consequently, several papers are in the form of a report on the work in situ in Syria and on-going projects and provide valuable information on the technical choices used elsewhere that can be applied for heritage sites in Syria. It is important to collect and also preserve this valuable information and learn from various approaches. We need to hope that peace will ultimately come to Syria and that the reconstruction work can start properly under a regime that protects both the people and their heritage.

# Some Syrian Views and Challenges in Saving Cultural Heritage

# Archaeology in the Shadow of the Crisis in Syria

*Ammar Abdulrahman*[1]

**Abstract:** It is not actually news to mention how important the antiquities of Syria are, and how truly they share major elements of the world's cultural heritage. In Syria we have a sequence of history that continues from prehistory to modern times without interruption. It is also bears witness to major economic and cultural revolutions such as the invention of agriculture and the first signs of alphabetic writing in cuneiform. After the Arab uprising of 2011, a lot of archaeological sites and monuments in the Middle East had been affected. The continuing conflicts also became harmful for archaeology as a science. All the archaeological missions in Syria, foreign and national, had to be cancelled. Also a lot of professors lost their positions. For various reasons they were not able to attend their lectures, and after a while they were fired. On the other hand, the students were also not able to attend seminars and other educational activities, and in some hot areas, especially in those which were no longer under government control, the whole educational system collapsed. The harmful destruction that has occurred in the present decade was due to several reasons and the most important is what ISIS/ISIL has done, especially after their troops seized 50% of the landmass of Syria. The local society faced a high degree of responsibility, and some of them succeeded in safeguarding a lot of sites and museums. Unfortunately, all this would continue without international interference in order to prevent this cultural massacre.

**Keywords:** archaeology; universities; cultural heritage; Syrian crisis; safeguarding Syria's culture; museums in Syria

In 2011 some countries of the Arab world were occupied by an uprising that affected all aspects of human lives. Even if the uprising was not similar in all countries, unstable aspects of life were common features.

Nevertheless, I do not wish to analyse this phenomenon and its motives, nor the results on the Arab society, but I will shed some light on a specific theme, which is archaeology in Syria and especially the effects of the political uprisings and civil war on archaeology as a discipline and an interdisciplinary field.

Syria was a lovely place for an archaeologist who has an interest in the area of the Middle East or the Near East, and in any period of prehistory and history. It is, for example, possible to find sites rich in finds dating from prehistory such as the place of al-Nadawieah in the El Kowm basin north of Palmyra, where a complete part of a *Homo erectus* skull was discovered,[2] and other sites where tools were introduced nearly one million years ago.

During the Epipalaeolithic period, in around 12,000 BC, a new horizon of the first adventure started, namely settling down and dwelling at sites throughout the year, and not only visiting them seasonally. This trial resulted in the invention and practice of planting seeds, which enabled humans to be independent in respect of resources for food supplies, besides adapting wild animals to benefit from meat and later from leather, wool and other secondary products.[3] Based on these vital innovations from foraging to food production, this period in the human past is called the

1 Institut für die Kulturen des Alten Orients, Institute for Ancient Near Eastern Studies (IANES), Universität Tübingen, Schloss Hohentübingen, D-72070 Tübingen, Germany. Former professor in archaeology at Damascus University and former director of archaeological expeditions at the General Directory of the Antiquities and Museums (GDAM) in Syria.

2 Schmid et al. 1997, 87.

3 Mithen 2006, 40–41.

'Neolithic Revolution' following V. Gordon Childe. The evidence is clear in Syria in several sites such as Jerf al Ahmar[4] and Mureybet[5] and Abu Hureyra[6] on the Euphrates.

During the transitional phase towards urbanism in the Chalcolithic period, the second important phase in our human past takes place. Quite interesting evidence for this can be found in the Euphrates region at sites such as Habuba Khabira and Qannas,[7] where the first administration monuments and temples can be witnessed. First came the invention of the iconography which was subsequently the basis for the cuneiform script, and finally alphabetic writing. In addition, the famous Bronze Age kingdoms such as Ebla and Mari have provided us with thousands of tablets which describe, as in Ebla, the linguistic development of cuneiform writing and also provide a bilingual dictionary, even teaching students how to read and write.[8] Mari enriches our knowledge of the political map and the rise of the Assyrians alongside the Amorites in the time when kingdoms struggle during the second millennium BC. There, amazing culturally flourishing endeavours are represented in architecture, namely in constructing palaces and temples, which include a unique development in city organisation and water supply.[9]

This extraordinary development continued in the classical period. The flourishing centres such as Palmyra,[10] Apamea,[11] and Dura Europos were established. There, an obvious and early clue for religious tolerance appeared, as the ancient religions represented through the temples of Ishtar and others goddesses and gods stand side by side, together with the Jewish synagogue and Christian home churches.[12] This is an amazing view of the variety of believers, and one of the first examples of various religious groups living a peaceful life in harmony.

In the Byzantine period new settlements were established in various parts of Syria,[13] and the dead cities form one of the most important areas. The development continues in the seventh century AD, when a new religion arrives and Islam established a number of cities and centres, such as in Damascus, Aleppo, and the castle of Salah al-Eddin and Mysiaf. These cities were the result of the accumulation of several layers of time in the Islamic period. It lasted over 1300 years, and the density of monuments inside the cities is huge. In most of the cases, the expansion of houses and other structures spread outside the city walls. Finally this development and growth resulted in producing the unique style of an Islamic town.[14]

This quick overview of the history of Syria is well known and emphasises the importance of the Syrian heritage, both the tangible and also the intangible.

From this point on I will try to address the main issue in this paper. So, if we go back to 2011 to see the dramatic situation and its impact on archaeology as an interdisciplinary field, we can look at what happened, what were the real causes and the actual situation in the land. Finally we can discuss the expected measures to safeguard the Syrian heritage and future plans for restoration and rehabilitation.

During the crises in Syria, the departments of archaeology in various city centres such as Damascus, Aleppo, and Idlib suffered as much as the other fields of sciences from the unstable situation that resulted from the uprising. At the beginning it was acceptable, and the teaching process continued, in spite of some difficulties. Nevertheless, the situation after two years had

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4 Stordeur 1998, 132.
5 Cauvin 2000; Ibáñez Estévez 2008, 125–135.
6 Moore et al. 2000, 50–164.
7 Akkermans – Schwartz 2003, 154–181.
8 Matthiae 2007, 186.
9 Margueron 2013, 138–139.
10 Schmidt-Colinet 2005, 5–38.
11 Balty 1984, 290–294.
12 Rostovtzeff 1935, 155–304.
13 Shahid 1984, 170–171.
14 Runciman 1995; Heidemann 2006; Burns 2009.

become more difficult, and it created more pressure on both the teachers and the students. The uprising established an unstable situation, and later on this was a cause for violence through radical movements such as ISIS/ISIL (the Islamic State in Iraq and Syria, the Islamic State in the Levant) and the Al-Nusra Front, which banned all activities with governmental institutions including universities. They regarded professors, other administration employers and students as traitors who must be punished, and in some cases they were killed or assassinated. This situation created an unstable environment, and safe accommodation became the main problem in the overlapping area controlled by the different parties. Furthermore, transportation from the countryside to the cities, where the universities, other institutions and administration centres existed, became risky. That forced most of the archaeologists to rent housing in another safe area, or to find a way to emigrate abroad to the west, where at least a place of safe heaven could be found. This was noticeable from the decrease in the number of students and also the absence of some professors. Nevertheless, some of the professors, even in the so-called safe areas were a target and they had been threatened or sometimes assassinated. That happened with one deputy scientist from the Humanities Faculty at Damascus University. And others were shot dead on their way to their workplace.

Despite the situation, the teaching and other activities were carried out, and the archaeological departments continued their work, except in Raqqa, Idlib and Deir ez-Zor, but not in the manner that had been usual or in normal circumstances. For example, the need for libraries was enormous because of the embargo, and it was not permitted to import books into the country. There was also no access to new editions of books and chronicles in the digital version. In addition, all those foreign archaeological institutions were closed which had previously filled a big gap for the researchers and students. In fact, we had had several active foreign archaeological institutions in Damascus, such as the DAI i.e. the German Archaeological Institute, and the IFPO i.e. the French Institute for the Near East, as well as the American and Danish cultural institutes. These institutions, especially the French and the German ones, used to offer a lot of help for experts and students through their libraries, always updated with new publications in the field of archaeology.

Due to the security situation, the practical teaching/learning of archaeology which took place in summer seasons, was banned, except for the coastal region and Sweeda, which was dedicated mainly to teaching students field techniques and other basic skills.[15] However, there were also some national excavations in the coastal region, in Hama and in the countryside of Damascus. The most extensive excavations took place in Tell Humyra in Deir Attiya 100km north of Damascus, where an important Iron Age settlement was uncovered, with a good number of seal impressions.[16]

Here I would like to mention the difficult situation regarding antiquities in Syria under these challenging circumstances, especially at those sites and monuments located in the opposition areas, outside the control of the central administration in Damascus. They suffered from systematic looting and smuggling. When ISIS/ISIL and the Al-Nusra Front practised the destruction of ancient artefacts which they considered to be idols, at the same time they financed their military organisation with deposits from illegal antiquity smuggling, from which the western antiquities market has flourished in the last three years.[17] Ancient monuments were also targeted during the clashes between the Syrian army and ISIS/ISIL – and other radical opposition groups, but it may be the subject of another paper to deal with and provide accurate reports about the actual situation regarding antique artefacts in Syria.

15 Directorate-General of Antiquities & Museums, Syrian Arab Republic – Ministry of Culture <http://www.dgam.gov.sy/> (last accessed 18 Feb. 2020).

16 Hammoud 2017.

17 UNESCO Conference on 3–4 May 2016 in Berlin for Emergency Safeguarding of Syria's Cultural Heritage; see also Danti – Prescott 2014.

In this regard I would like to mention that the level of the damage varies and could be divided into three categories:

1. The destruction and damage in this first category concerns the deeds carried out by ISIS/ISIL and other radical groups. This category is the worst. The actions were inspired by the religious background, as the groups consider the antiquities as idols that must be demolished, and this was done with explosive materials. These actions took place in Raqqa, Palmyra and Deir ez-Zor. This brutal damaging and destruction was also a way to hide the organised looting and smuggling of artefacts that made their way onto the European markets in order to earn money for financing military activities.
2. The second category is the individual illicit digging in the archaeological sites in the area mostly outside the control of the Syrian government. Due to the absence of monitoring and control by the central administration, the local population starts looting in order to secure their daily lives by selling artefacts. This action doesn't necessarily require complete demolition of the sites but the aim is to obtain mobile artefacts to sell them to the local dealers and smugglers at cheap prices. They in turn sell them on the international market. Such illicit digging is mostly found in Daraa, Idlib and the Jazira region.
3. The third category is the damage that has occurred as the result of clashes between the fighters. Even if the Syrian army is a party to this, it is not always possible to avoid some damage, as has occurred recently in 2016 in the fights for and recapturing of Palmyra, especially in the Arab citadel because of its strategic location on the top of the mountain. All these events have had a disastrous impact on archaeology in Syria, and the need to stabilise the military situation is very urgent. We need to collect all the required data in the form of a database to carry out the next step. The database offers a platform for the strategy for the restoration and rehabilitation of the archaeological sites and monuments. This procedure would need a number of restorers, archaeologists and other experts with the aid of students at all levels.

All the background measures need to be prepared as soon as possible, and indeed we also need to facilitate the return of the professors, who left their posts for various reasons such as the lack of safety. There is a need to provide the necessary material for the follow-up process of teaching the methodology of the archaeological work with the participation of students to gain experience.

There is a vital need for the initiatives of all scientific parties in the field of cultural heritage, both the tangible and the intangible, and to provide support for this hard time for the science of archaeology.

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# Reconstructing Syrian Cultural Heritage: Mapping Challenges and Impacts

*Nibal Muhesen*[1]

**Abstract:** This article comes as many indicators point towards the final phases of conflict in Syria, and suggest that peace and semi-stability is currently returning progressively to the country after more than eight years of war and violence. In fact, the Syrian crisis brought with it tremendous human suffering combined with severe damage inflicted on Syrian heritage in all its components (both tangible and intangible). Even if destruction has been covered to a large extent by various agencies (both official and non-official bodies), the focus on aspects related to the reconstruction of the country has received less attention. Yet I consider the question of the revival of Syrian heritage as a critical and important issue to be put on the agenda, since reconstruction will be the pillar of fruitful post-war recovery polices in Syria. Indeed, this article surveys the challenges that the rehabilitation of Syrian heritage will encounter in the aftermath of the conflict. The paper will first address the strategic importance of Syrian heritage (local, global) and explore features connected to its colonial or post-colonial past. Secondly, the paper will dwell on the threats to the survival of Syria's heritage in the post-conflict phase and to the carrying out of a 'National Reconstruction Strategy'. Moreover, the paper will reveal the impact of the conflict on the collective memory and on the identity of the country. It presents remarks on the difficulties of reconstruction in Homs, and Aleppo. Although the paper highlights the fragile and unstable conditions around Syrian heritage, it concludes by pointing towards a way forward, by carefully considering certain 'recommendations' on the application of successful reconstruction strategies with relation to Syrian heritage.

**Keywords:** cultural heritage; conflict; Syria; reconstruction; cultural identity; collective memory; displacement; reconciliation

## Introduction

The paper deals with the current challenges provoked by the destruction of Syria's cultural heritage and it aims to address some of the aspects related to the relationship between heritage and reconstruction in Syria in the post-conflict period. It has to be stated clearly that the subject approached here is very complex and that questions and arguments developed here are far from being exhaustive. Some of the issues addressed (e.g. the constructed Syrian identity) are objects for current debates between Syrians of various backgrounds and foreign researchers. However, the objective here is to look at how these impacts affect the reconstruction strategies. In fact, though the paper emphasises the tangible aspects of Syria's cultural heritage, it has to be remembered that the importance accorded to intangible cultural heritage among Syrian and international experts is growing.[2] Also, heritage contributes to the shaping of the individual or collective memory and to the building up of a national identity or actually different identities, bound to various backgrounds (religious, sectarian, ethnic, and socio-cultural, etc.).

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2 A project to inventory elements of Syrian intangible cultural heritage was created in 2014 in collaboration with the Ministry of Culture represented by the Directorate-General of Antiquities and Museums of Syria (DGAM), and the National Committee of UNESCO as well as a Syrian NGO. The project has led to the publication of a volume that was welcomed in the local press. It deals with Syrian intangible heritage, specifically the local crafts and professions, in addition to the listing of many aspects of intangible heritage in Syria; cf. Syria Trust for Development 2016.

Fig. 1 Damage of an iconoclastic nature to the funerary statues at the Tybol cemetery in Palmyra (photo produced with the authorisation of DGAM, Syria)

First, it is necessary here to contextualise very briefly the question of Syria's heritage reconstruction by drawing broad lines of the Syrian conflict and by mentioning some of the important losses of Syria's heritage, that have occurred over years of war. As a matter of fact, the significant death toll combined with major devastation qualifies the conflict as an open international armed conflict.[3] The issues touched upon in this paper cannot be isolated from this sad context.

Since the early stages of the conflict in 2011–2012 many heritage sites and monuments (including UNESCO World Heritage sites such as the Ancient City of Aleppo or the Crac des Chevaliers in Homs) have been damaged, partially or totally.[4] In some cases, sites were simply destroyed by fire, or were severely damaged because of shelling and clashes and were beyond repair. In the years 2012–2016, a raging war and severe destructive acts were committed by various parties in the conflict. From 2013 until the present day, the actions committed by fanatic militants, in particular militants of 'Islamic State' (e.g. in Palmyra), have to be seen as a systematic cultural erosion reflected in wide-scale looting activities and as an assault of an iconoclast nature on Syria as a nation and as heritage (Fig. 1).

Despite the severity of the destruction, the international community has recently suggested tools that could save the targeted places:[5] namely, the UN resolution regarding humanitarian

3 The point at which a conflict moves beyond an internal disturbance and International Humanitarian Law (IHL) becomes relevant was not officially declared until June 2012, cf. Arimatsu – Choudhury 2014. Subsequently the conflict has gradually become a proxy war between superpowers and their regional allies.

4 The different types of damage can be attributed to the fact that the sites were destroyed, looted, poorly protected, or used directly or indirectly in the ongoing military conflict, cf. Kila 2013; DGAM 2014; Cunliffe – Perini 2014a; Cunliffe – Perini 2014b; Cunliffe – Perini 2015. For the most recent reports see Syrian Archaeological Heritage 2016.

5 For a survey of the response by the international community, including official and unofficial bodies and heritage protection initiatives, to the destruction of Syrian heritage see Cunliffe – Perini 2014a; Cunliffe – Perini 2014b; Cunliffe – Perini 2015.

assistance in Syria,[6] in addition to another UN resolution that banned the trafficking of cultural heritage from Syria and Iraq.[7] Furthermore, in 2014 UNESCO established an observatory for the protection of Syrian heritage with an office in Beirut, and carried out, through ICOMOS, a number of activities that are building up the skills of the Syrian professionals in fields of heritage. This step, beside many others, has helped significantly in the efforts to save the Syrian heritage.[8]


Fig. 2 The walls of the Ancient Citadel of Damascus on which the poster for the national campaign for protecting cultural heritage in Syria is posted (photo produced with the authorisation of DGAM, Syria)

It is also worth mentioning the state board of antiquities known as the Directorate-General of Antiquities and Museums (DGAM), which is considered as the highest official Syrian institution authorised to oversee the country's heritage and archaeology. It was established shortly after Syria's independence in 1946, and got its first Syrian leader at its head in 1950. It was placed under the central supervision of the Ministry of Culture established in 1958. Even in war conditions, DGAM has held workshops and carried out public campaigns inside Syria in order to emphasise the importance of saving Syria's heritage and to raise awareness of this heritage as a shared ground for all Syrians, in addition to a number of other programmes.[9] Moreover, the local communities have taken certain steps towards the preservation of their heritage, in spite of the terrible conditions in the affected zones.

## The Main Features of Syrian Cultural Heritage

Before I discuss the main cultural attributes that characterise Syria's cultural heritage, it is necessary to clarify what is meant by cultural heritage here. A new term specifically for cultural heritage is emerging – in Arabic *al-turāṯ al ṯaqafī*. The use of the term is relatively new in Syria, but reference to it is increasing as it complies with international standards, and it promotes engagement in international debates about heritage (Fig. 2). Even though all forms of heritage are deeply-rooted within the Syrian culture, the term cultural heritage is still more commonly understood

6 See UN – Syria, Humanitarian Assistance 2014.

7 See UN – Syria, Fighting the Funding of ISIS 2015.

8 See UNESCO, Emergency Safeguarding of the Syrian Cultural Heritage Project. Online <http://www.unesco.org/new/en/safeguarding-syrian-cultural-heritage/> (last accessed 18 Feb. 2020); see UNESCO 1970 Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transport of Ownership of Cultural Property and its meetings; UNIDROIT Convention on Stolen or Illegally Exported Cultural Objects; activities of INTERPOL and The World Customs Organization (WCO); see also the ArThemis database on return and restitution.

9 See Syrian Archaeological Heritage 2016.

by Syrians in a more literal sense of archaeological sites and monuments. Syrians refer to and use their heritage in a much more diverse and complex way, beyond the traditional framework of the Western understanding of the term. For instance, in Aleppo, Damascus, Palmyra, and Homs, ancient monuments have been an integral part of everyday life in Syria, thus it can be said that there are no borders between the past and the present. There is, among Syrian experts, a dominant inclusive approach towards heritage in all its aspects, combining intangible aspects, taken as integral aspects, with the more tangible ones.

Syria's cultural heritage is governed by the following characteristic features:

1. Purely local Syrian dimensions and uses.
2. Eastern Mediterranean dimension.
3. Universal significance and multi-strategic influences.
4. Generator of economic profit through the sector of tourism and related activities.
5. A builder of identity and a shaper of collective memory.
6. Highly diverse in quality and quantity.
7. Represents a living cultural heritage (in fact, the still-inhabited cities of Damascus and Aleppo, where everyday life continues side by side with cultural heritage, are the best reflections of this).
8. Represents an interaction between tangible and intangible cultural heritage (for instance, the monuments and mosques play host to a considerable body of oral traditions and practices).
9. Represents a major challenge with regard to its preservation and proper rehabilitation or management in the post-conflict phase.

Understanding of heritage in Syria also has an internal political dimension. Indeed, in the period since gaining its independence, archaeological and heritage concepts have been used to demonstrate the legitimacy of the newly drawn-up borders not only in Syria but in other areas as well.[10] This nationalistic discourse is opposed to the discourse of Pan-Arabism based on a concept of shared Arabic-Islamic history that calls for the demolition of borders between the Arab states.[11] These claims have sometimes resulted in the use of heritage in political debate, whereby Syrian heritage is manipulated in the service of nationalistic tendencies.[12]

## The Situation of the Archaeological and Heritage Sectors in the Period before the Conflict

It is not possible to approach the situation of archaeological and cultural heritage components amid the reconstruction business, without addressing briefly their status in the country before the conflict, as reflected in the work of DGAM as well as other Syrian universities, mainly Damascus and Aleppo.

Obviously, the Syrian cultural heritage was already under-protected and faced various serious threats in the period before the conflict (before 2011). The full analysis of these problems, with their different natures and severity, would go beyond the scope of this paper. Some of them have been studied by Syrian and international experts.[13] However, they could be briefly described as follows:

1. The under-qualified staff within the Syrian institutions or the lack of state authority combined with insufficient government funds.[14]

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[10] Cf. Larsen 1989, 229–239; Porter 2010, 55–56.

[11] Cf. Porter 2010, 55–56.

[12] As reflected in the ideological writings of the Syrian Socialist National party known as SSNP, see Gillot 2010, 6–8.

[13] Cf. Muhesen 2011; Muhesen 2012; Cluzan 2014.

[14] During the crisis the local press in Syria has published a number of articles dealing with the issue, cf. Syria Steps 2012. Also, a regional Arabic NGO named 'Cultural Resource', which has an office in Damascus, has published a

2. The insufficient building-up of skills programmes and the lack of efficient coordination between various stakeholders.
3. The high degree of centralism and heavy routine of state institutions, especially the very slow routine in the decision-making process.
4. The lack of convenient legal back-up designed to protect Syria's heritage and to fight against the illicit trade in antiquities. Yet it should be noted that the Syrian Law of Antiquities, voted in in 1961, forms a solid basis; the problem resides in its application.[15]
5. The varying ideological agendas of the various officials in the fields of archaeology and heritage, including colonial, neo-colonial, Orientalist and neo-Orientalist positions that were current.[16]
6. The lack of social awareness about the importance of heritage and public ownership of heritage. Before the crisis, most Syrians were alienated from heritage; this was attested by the small numbers who visited key heritage features such as Palmyra, or the National Museum of Damascus.[17] Also, educational tools were seriously deficient.
7. The spread of irregular building activities in the vicinity of archaeological sites or even inside them. Also, the unplanned 'urban heritage management', where heritage was a victim of the greed of investment companies (e.g. the old cities of Damascus and Aleppo).[18] I expect this problem to acquire even greater importance in the post-conflict phase.[19]
8. The suspected agendas of various international institutions who try to force their standards on the local forms of heritage, and interfere to a point that could be described as imposed trusteeship.

Finally, concerning the heritage research environment and platforms, it can be said that heritage professionals suffered from weak research platforms and lack of means. Indeed, the leading universities of Damascus and Aleppo had considerable difficulties in their efforts to offer students the best courses, and updated knowledge. Universities had economic and administrative problems and one could even speak of mismanagement between the universities educating the students and DGAM as a prospective employer. It is worth mentioning that the departments of archaeology were first established in Damascus University 1999, and in Aleppo University in 2004, and plans were made to open further departments in Idlib and Al-Hassake, although this has been prevented by the current conflict.[20] Moreover, scientific laboratories were annexed to the established departments (e.g. Damascus in 2010). The libraries of Western research institutions (mainly French and German) offered platforms for study and research to Syrian students and professors. The closing of these institutions in the early stages of the war has prevented Syrian students and scholars from acquiring updated knowledge and from profiting from scientific exchange programmes.

significant article on the cultural policies in Syria, addressing a number of issues related to the work of DGAM in Syria till the start of the conflict, cf. Cultural Resources in Syria 2012.

15 Cunliffe et al. 2016, 15–16.

16 Colonial and neo-colonial heritage practices are closely related to the phenomenon of 'Orientalism' that had sealed the understanding of the Middle East and its past for centuries, cf. Chevalier 2002. Such a close link between the two concepts, heritage and Orientalism, has largely affected the field of research on Arabic-Islamic heritage, where cultures and pasts of the region were studied primarily from a Western perspective. This has stamped archaeology in the Middle East with a racist and religious character that can still be observed in some cases. About Orientalism and related issues see: Said 1978; Meskell 1998, 4–6.

17 One could see the statistics given, cf. Cultural Resources in Syria 2012.

18 Cf. Muhesen 2011; Muhesen 2012.

19 Indeed, the UNESCO listing of the old cities of Damascus and Aleppo, for example, came as a response to the wild modernisation of the city centres, and that shows already the threats to heritage in modern Syrian cities, cf. Muhesen 2012.

20 Pers. comm. Dr. Ammar Abdulrahman, September 2016.

Furthermore, there are plans to introduce these elements in the educational system. It is obvious that educating local communities in Syria about their heritage will enable them to appreciate it more and to have a better understanding of its uses (e.g. in the sector of tourism). Also proper educational programs on heritage will provide locals with theoretical and technological skills that will be of great importance when the local reconstruction strategies start to be implemented and when skills are being sought.

## Syrian Heritage in the Post-Conflict Phase

If the challenges and national or international responsibilities and the impacts of the Syrian conflict have been huge in war conditions, the list of difficulties and the nature of challenges will be even more momentous in the reconstruction phase (Arabic: *iʿādat al iʿmār*). In my view, we have an urgent need to prepare now the best methods and strategies adapted to local needs that can be activated on the ground immediately after the end of violence.

Moreover, it is obvious that a failure in the post-war reconstruction strategies or insufficient implementation of rehabilitation programmes may lead to severe threats to the existence of the Syrian state. Further, the application of inefficient reconstruction strategies would lead to the resumption of the war activities or revive scenarios of friction,[21] especially taking into account the increasing fears of a possible partition scenario that might be applied in the Syrian case.[22]

The post-conflict reconstruction phase in Syria will be challenging on a number of levels. As mentioned before, there is an ongoing debate on this between Syrian researchers, reflected in heated debates on TV and in other media. International researchers have contributed to this discussion. The current estimates from experts on the cost of reconstruction vary, but one thing is sure: it will be an overwhelming and complex economic task.[23]

Also, in my opinion, a number of obstacles will be encountered during the recovery phase, related particularly to the protection of heritage. They can be described as follows:

1. Unless new legal tools designed for heritage protection are enforced, the current laws will not be efficient in protecting heritage from threats.
2. Unless specific funds are dedicated for this, the economic shape of heritage institutions is going to suffer and they could be qualified as dysfunctional in the future.
3. There are still a considerable number of little-known heritage features in Syria, including many archaeological sites and historic monuments, that await discovery or documentation.[24]
4. Syria will witness intensive rebuilding activities and the country could be qualified as an open-air working platform for local and foreign companies; these companies, in my understanding, will look at Syria's heritage largely (if not only) through the eyes of economic benefit and will show little consideration for the fragility of Syria's heritage. Therefore, heritage protection or public consultation will not be at the top of their agenda, unless they are forced to make it so.[25]
5. There is a close link between projects of economic revival and those aiming at the preservation of Syrian heritage, including assessing the damaged sites and responding to the most urgent needs.[26]

21 Cf. Lostal – Cunliffe 2016, 4.
22 Cf. Stavridis 2016.
23 According to the World Bank president, the changing price of oil in the region might affect the funding that will be dedicated to the recovery phase, taking into account that the cost for the rebuilding of the housing sector alone amounts to $6 billion, see World Bank 2016.
24 See Syrian Archaeological Heritage 2016.
25 Cf. Lostal – Cunliffe 2016, 6.
26 If some sites cannot be restored, the loss of their role in attracting tourism will be catastrophic for the population, as in the case of Aleppo. Specifically, we will see a decrease in income gained from all tourism-related economic activities.

6. The partial dependency of the Syrian economy on tourism, mainly ‘cultural tourism’. This sector has received a devastating blow as a result of the current conflict.[27] Moreover, it is obvious that heritage faces the danger of being exploited significantly for economic ends. The most obvious case will be the reconstruction of Old Aleppo and other UNESCO World Heritage sites. There the desire to resume tourist activities quickly and to increase the attraction of the sites will be high.
7. The rebuilding will be an overwhelming task, and regional experiences have shown that the most destructive period for cultural heritage often comes in the aftermath of the conflict. This was attested by the destruction that took place in Beirut after the civil war in Lebanon.[28]
8. Cultural heritage sites in general and public museums or archive collections in national libraries could be targeted because of their symbolic function as makers of state identity, as was seen in the Iraqi case.[29]
9. International organisations such as ICOMOS and ICCROM will carry out measures for heritage preservation that will be in line with international standards but do not necessarily respect the specific situation in Syrian.[30] In fact, there is a real risk of packing and labelling Syrian heritage instead of carefully documenting its diversity and protecting it, or ensuring its sustainable protection.
10. The reconstruction of damaged sites and monuments will inevitably pose the dilemma of how to maintain the authenticity of targeted sites whilst at the same time employing ultra-modern documentation and protection techniques. The widely disputed use of 3D reconstruction in the case of Palmyra clearly attests to that.[31]
11. Urban heritage will be affected by the new demographic realities. For instance, cities such as Damascus and Latakia have almost doubled their populations in terms of refugees. Such a new reality must always be remembered. Obviously, the reconstruction of the old towns of Aleppo and Homs will encourage the return of the refugees and the displaced former residents.[32]
12. Heritage will play a central role in the building of the nation’s identity, and in the economic revival. The phase after the current war will raise questions related to the role of the past in the shaping of a ‘new’ Syrian identity or identities. Such an identity should have two basic features: diversity and inclusivity. Actually, one could imagine that it will be necessary to deconstruct the historical monolithic Syrian identity.
13. A shared usage and understanding of heritage in all its aspects will pave the way towards a process of reconciliation among Syrian factions. Heritage might here serve as a determining factor for eventual social stability and the long process of reconciliation by uniting Syrians around common values and a shared history. It may perhaps offer opportunities for internal dialogue in a shattered community.[33]

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27 In 2010 tourism accounted for 12 percent of the country’s GDP and by late 2011 the conflict had cost the tourism industry \$1.5 billion, cf. according to prominent Syrian officials. The losses caused by the war in Syria’s tourism sector stand at (USD 2.3 trillion) in today’s conditions. ANBA 2019.

28 Cf. Al Radi 1996; Seif 2009, 287–288; Sandes 2013, 303–301; Schwartz 2016.

29 Cf. Isakhan 2011.

30 In February 2016, Syrian officials have suggested to UNESCO that Damascus can join the list of the UNESCO Creative Cities Network. Also there are attempts in Syria to document damage to the intangible Syrian heritage, the work is led by a Syrian NGO and followed closely by ICOMOS. For more information see Syria Trust for Development 2016.

31 Cf. Cunliffe 2016.

32 However, examples from conflicts across the globe suggest that the new population demographic will be forever changed as many people will not go home, and cities will have a higher population density than before. However, it is a real problem that you must rebuild acknowledging the new population, whilst noting the old population in order to conduct rebuilding that may return things to their former state, e.g. displaced minorities will often not go home unless you rebuild their heritage, but they rarely comprise a major element of the current population at the time of rebuilding; see the case of Stolac in Hadzimuhamedovic 2015 and the case of Gernika in Viejo-Rose 2011b.

33 For more information see Viejo-Rose 2013, 144; Lostal – Cunliffe 2016.

14. There is a close link between political solutions and heritage management. This was in fact echoed in a joint appeal by senior UN and UNESCO officials. The mentioning of these two elements points to the importance of Syrian heritage, not only for Syria's present but also for its future.[34] However, one must be aware of the fact that political national actors may be tempted to speed up the reconstruction efforts at the cost of heritage in order to give an impression of a return to normality.
15. There is a close link between heritage protection and the fight against terror funds, since illicit trafficking constitutes an important source of income for ISIS militants; therefore the preservation of heritage might contribute to the peace-building process and maintain such a peace for the long term.[35]

## Heritage within the Rebuilding of Identity and Shaping of Memory in the Aftermath of the Conflict

Regardless of the complex political picture in Syria, rethinking its archaeological and cultural heritage as such by redefining it, facilitating its sustainability and, above all, placing it at the heart of the local communities will require general effort from the state and from the people. There is still ambiguity regarding a future political system, yet one thing is clear: any future political unity will have to deal with huge harm inflicted on the collective memory and the very essence of the Syrian national identity. This identity has been questioned during the conflict, and some consider it as a constructed product imposed by the ruling power.

Cultural heritage is at the heart of a complex process of junction between different aspects that are key elements in any recovery phase. These are the following:[36]

1. Individual or societal identity,

2. Individual or collective memory.

## Heritage and Cultural Identity in Syria

### *The Damage to the National Identity*

The past plays a crucial role in the way people understand themselves and each other, forging their collective social identity.[37] While representations of the past, such as cultural heritage, can create unity, foster reconciliation with past events or form part of educational projects, the past can also serve as a breeding ground for division, hatred and persecution.[38] Researchers have pointed out that an awareness of the past empowers an engagement with the present and allows the future to be envisioned.[39]

The debate about identities reconstructed after conflicts is vast and complex.[40] My objective here is to shed light on some particular aspects. In fact, conflict over the identity of the Syrian state is not a new topic for discussion and it is not necessarily related to the beginning of the war in 2011. Indeed, the consolidation of Hafiz Assad's rule in 1970 ended 24 years of rapid and often violent transfer of power. As pointed out by scholars, during the subsequent 30 years, the ruling class in Syria succeeded in putting down persistent external opposition and sharp internal divi-

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[34] See resolution no. 2139 on humanitarian assistance in the Syrian conflict: UN – Syria, Humanitarian Assistance 2014.
[35] Cf. Fanusie – Joffe 2015.
[36] Cf. Ashworth et al. 2007.
[37] Lowenthal 1998, 105; Ashworth et al. 2007.
[38] Smith 2006; Ascherson 2007, 20; Ashworth et al. 2007.
[39] Cf. Terdiman 1993, 6–8.
[40] Ascherson 2007, 17–25.

sions.[41] Actually one can assume that the composition of the Syrian identity was always governed by the conflict between the pro-secular (Al Baath party), Pan-Syrian (SSNP), Pan-Arabic and Pan-Islamic ideals adopted by conservatives.[42]

Scholars have pointed out that many Syrians remained deeply alienated from their government and cynical about the ideological agenda of the Baath party.[43] It has been stated that the ruling class in Syria was able to navigate across different ethnic and religious divisions of the Syrian society, and to ensure a social balance through adopting policies of cross-sectarianism as reflected in the tolerant attitude of the state to the increasing number of mosques that reflected the growth of conservatism. This contrasts sharply with the state power's attitude towards Islamists, who were smashed in Hama in 1982.

The Syrian identity can be described as composite as it consists of diverse national and regional factors. It refers to a variety of frameworks such as religious community, geographical territory or city. There is even an economic aspect, as can be seen in the constant competition between the inhabitants of Damascus and Aleppo to dominate the Syrian scene.

Presumably a sense of common cultural unity founded on Syrian heritage was fostered (until 2011), and it is still fostered in some places, and will be fostered in the future. Syria's heritage contributes to the shaping of the state discourse on the past, whether it is a nationalistic or a Pan-Arabic or Islamic vision of the past. In Syria, local understanding and sentiment about the past, or taking pride in ancient times of Syria, are reflected in the local discourses in the terms used in the language to glorify the Syrian civilisation, and to argue for its superiority or the superiority of its material culture. While many Syrians take pride in the universal value of their heritage, it is often a more national or local perception of heritage that contributes to a shaping of the common identity.[44]

## Heritage and Individual or Collective Memory in Syria

Memory after violent conflict is a contentious issue and a subject for rich literature.[45] The way in which the past has been remembered has often become the cause for renewed violence rather than creating healing and reconciliation. By the term 'collective memory' this paper refers to the mid-19th century concept of a shared pool of knowledge and information in the memories of two or more members of a social group, as explored and developed by the works of prominent memory researchers such as Maurice Halbwachs.[46] It has been argued that this type of collective memory is established through partnerships with other societal groups and it is passed on through generations.

Exploring individual and collective memory in the Syrian context reminds us that how we remember is more important than what we remember. If the process of remembering is to contribute positively to the post-conflict recovery process, it is still early to say how Syrians will remember their violent past.[47] The new ruling class in Syria has to allow for a variety of possibly conflicting narratives about the past to be in dialogue with one another, and the temptation to prefer one over another should be avoided. The implication of memory suppression could be terrible for the rebuilding of a cohesive Syrian society and its collective memory, as was seen in the post-civil

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41 Heydemann 1999, 2.
42 Heydemann 1999, 3–4.
43 Heydemann 1999, 2.
44 Cf. Cunliffe et al. 2016, 3.
45 Ashworth et al. 2007; Viejo-Rose 2011a.
46 Cf. Halbwachs 1992.
47 It is worth mentioning the work of a Syrian NGO called Homeland Document, focusing on collecting war-related testemonies or records from various sections in the Syrian society, forming sort of an oral history database of the conflict, a step that will show its impact in the reshaping of both indvidual and collectvve memories; cf. Wathiqat Wattan 2018.

war period in Spain.[48] It should be said that in any reconciliation process memories should be expressed and people should have access to the information of the reality during the Syrian conflict, but given the role of the external players in the war, this is not likely to happen.

In the Syrian context, the most important threat to memory is represented by the death of thousands of people, but also through the flow of emigrants who have left their homelands. Even if displaced Syrians stayed in contact with their heritage by documenting any damage to it, it could be stated that the Syrian migration is the most dangerous factor for the collective memory. Displaced people have lost not only their physical attachment to their cities and places, but also often even lost their psychological links. This happens not by forgetting but through traumatised and distorted memories they carry with them of their homes – the homes that they now see in the news reports as tons of rubble. Also, the Syrian collective memory is traumatised and its healing will require Syrians to be given the right to mourn those who are lost; otherwise deaths will continue to accumulate in the hearts and minds of the Syrians. Further, each group or component of Syrian society will remember the conflict from its own perspective. Moreover, it is very important that the 'memories of diasporas',[49] i.e. memories of refugees regarding the lost or idealised places, be taken into account, and only carefully conducted surveys and interviews will show what refugees still remember of their heritage. It is important that the rebuilt structures conserve the identity of destroyed places such as souqs, mosques, churches, or public spaces. Indeed, the documentation of local memories could contribute actively to the recreation of an acceptable urban cultural landscape.

### *Social Reconstruction*

Syrian heritage provides the framework for a common peaceful co-existence that has been the case for many centuries. In Syria, several mosques have been built side by side with churches or other places of worship. It could be said that Syria has a long history of cross-sectarian social harmony, although the history of the country has been marked by some state violence.[50]

It has been pointed out that reconstruction of fractured communities is even more difficult when the societies are characterised by deep ethnic, religious, cultural, and socio-economic divisions.[51] In the Syrian context, stable relations between communities can be created through efforts to rebuild political, economic and socio-economic structures that have collapsed or are seen as defective. Moreover, studies have pointed out that cultural protection is increasingly seen as the integral part of a psychological recovery programme and efforts to establish peace in the post-conflict phase, in addition to the economic benefits generated by the revival of tourism.[52]

Concerning social reconstruction and the Syrian conflict, there are numerous examples of popular solidarity in Syria, as seen in the hosting of a large number of internally displaced refugees in Damascus and on the Syrian coast. Therefore, it could be said that such solidarity could lead to future cohesion and pave the way towards social healing. An observing eye would notice that the core of the Syrian society has perhaps succeeded in regenerating new forms of life, as well as a new sense of community, much less dependent on the state and much more geared towards everyday needs. In other words, it can be said that the conflict has reinforced the Syrian-self-awareness and enhanced the sense of common cultural background and collective identities. This does not mean that I underestimate the persistent feelings of fear, hatred, anger, and bitterness that dominate wide sections of Syrians.

The end of the Syrian conflict must be accompanied by significant changes in the socio-economic institutions. This reaches beyond monitoring an end of military activities and the con-

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48 For more information see Viejo-Rose 2013, 128.
49 Kleist – Glynn 2012, 11.
50 Heydemann – Leenders 2013.
51 Aiken 2008.
52 Viejo-Rose 2013; Viejo-Rose – Sørenson 2015.

version of fighting groups into socio-political interest groups. The overall aim of the working institutions in the post-conflict period should be to engage actively in the vital nation rebuilding project. Also, it is important to mention that one cannot imagine the start of the peace-building process without the return of displaced persons and refugees. The resettlement of the refugees and social rehabilitation are essential elements that make a peace process durable and sustainable. With respect to wounded identity, one has to highlight the emotional dimension of the conflict. In fact, the pain surrounding the conflict remains evident and will be an obstacle to a return to normal life. Overcoming emotional challenges remains crucial for those who have to rebuild their own societies. Another point that one should not ignore is that some peace-making agreements that may be concluded within the reconciliation phase will not bridge old and new divisions. Also, the peace process does not necessarily lead to bridging the gaps between fighting communities, as seen in the Balkan War, and it could be said that some peace-making agreements encompass the seeds of their own failure, or could even trigger old feelings of hatred and injustice.[53]

With respect to the place of heritage within the identity rebuilding in the aftermath of the conflict, ultimately the peace-building strategies must be geared toward modifying local concepts and uses of heritage and should focus on creating the necessary legal back-up to protect it. Heritage cannot be isolated from aspects of memory, as I have shown earlier in this article.

## Observations on Reconstruction Cases from Aleppo and Homs

The further rebuilding of the destroyed Syrian cities will have to follow a number of principles. First and foremost the rebuilding will have to involve the still existent locals and respect their traditions of building. Such rebuilding will ensure that the return of the refugees will be fruitful and that the returned population will be able to interact positively with its surroundings. Obviously, the reconstruction of the old districts of Aleppo and Aleppo itself will encourage the return of refugees and one should be ready to respond to their needs in selecting what should be reconstructed first. Also, the reconstruction must seek to ensure that the new demographic groups will be able to reconnect with some of their heritage. As already pointed out by experts, the rebuilding of cultural heritage sites (e.g. after the Balkan War) encouraged the return of displaced communities to their homelands.[54]

In fact, the reconstruction of sites and monuments raises the following questions: should the newly rebuilt monuments look like the old ones, down to the smallest detail as a sign of continuity, or should we build ultra-modern buildings instead as a sign of innovation?[55] Also, where should one place the significant process of memorisation and remembrance within that issue?[56] The shape and type of reconstructed architectural units will probably condition the success of social and cultural interaction among communities in post-war Syria.[57]

### Old Aleppo

The destruction attested on the millennia-old urban and cultural heritage of the Ancient City of Aleppo is tragic (Fig. 3). In the period before the conflict, when UNESCO had listed the city as WHL, the Syrian archaeological authorities recorded buildings in the Ancient City of Aleppo and installed signs prohibiting the demolition or alteration of architectural features without the approval of the archaeological authority, DGAM.[58]

53 For more information, see Viejo-Rose 2013; Lostal – Cunliffe 2016.
54 Lostal – Cunliffe 2016, 3.
55 See the discussion in Ascherson 2007, 23–24.
56 See the discussion in Lostal – Cunliffe 2016, 7.
57 Cf. Al-Sabouni 2016, Ch. 5.
58 DGAM 2014.

Fig. 3 The destruction within the Ancient City of Aleppo, attested by the rubble fills in the district of Sharia al-Sweiqa, Aleppo (photo produced with the authorisation of DGAM, Syria)

Regarding the destruction of cultural heritage, the Ancient City of Aleppo is the most severely affected place in Syria due to ongoing violence, and experts have described the damage to historic buildings and archaeological remains as irreparable.[59]

Reconstruction policies to be followed in Aleppo should start with a careful removal of rubble and cleaning out of the effects of the war. After that, it might be possible to excavate in the old city, but the excavation should be focused, and spot-directed, and it should not delay the rebuilding activities. The authorities should ensure that there will be secure storage for the objects in order to avoid any damage or losses of objects as was attested in the Lebanese case.[60] Further, the new Aleppo should be a continuity of Old Aleppo, in order not to be left at the end of the day with a city without character and that is foreign to the collective memory of the inhabitants.[61] Specific attention should be directed towards the preservation of traditional ways of life and crafts that are seen as part of the city's intangible heritage. Moreover, I subscribe to Emma Cunliffe's concerns on the fact that any rehabilitation plans in Aleppo will have to comply with the demands of its UNESCO-WH sites, which made it subject to restrictions both on the national and international

59 Cf. Cunliffe – Perini 2014a; Cunliffe – Perini 2014b; DGAM 2014; Cunliffe – Perini 2015; Syrian Archaeological Heritage 2016.

60 Seif 2009, 287.

61 Following the damage to the Ancient City of Aleppo, a number of projects and initiatives have started to look over the possible scenarios for reconstruction, and explore what the 'New Aleppo' should look like. Among them it is worth mentioning 'The Aleppo Project' and Brandenburg University of Technology's 'Aleppo Archive in Exile' <https://www.b-tu.de/middle-east-cooperation/research/research-projects/aleppo-archive-in-exile> (last accessed 18 Feb. 2020).

Fig. 4 The destruction within the Ancient City of Homs, attested by the damaged historic building called ‘Khan al-Jamal’, Homs (photo produced with the authorisation of DGAM, Syria)

level.[62] Also, the rebuilding plans should be fully community-driven and should aim at responding to local needs. In this regard it is worth mentioning the recent initiative of the ‘Aleppo Project’ which is conducting surveys of the remaining residents in Aleppo in order to find out what their priorities for reconstruction are.[63]

## Old Homs

Without going into detail, much of the ancient town of Homs, as well as several surrounding urban districts, have been severely damaged and some districts are simply gone (see Fig. 4). Regarding reconstruction policies in Homs, it is worth mentioning that since the Syrian authorities took control over Old Homs, officials have already planned and launched rebuilding activities in the destroyed district. However, these activities do not seem to indicate a focus on heritage issues, which is understandable given the extent of the needs of the population. It is important to state that the reconstruction policies in the post-civil war period in Beirut showed that at least parts of the destroyed town should be kept as a reminder of the atrocities of the war. In the Syrian context, I remain uncertain about such a decision because, on the one hand, preserving remains of the destroyed town or building might always trigger the return of war-associated hostilities, but on the other hand, it would serve to send a message to the children at least not to repeat the mistakes committed by their fathers and encourage them to engage in the national

62 The status of Aleppo should make it subject to the rules of the ‘World Heritage management plan’, which are set by the ‘World Heritage Committee’, and the ‘World Heritage Charter’, both of which have legal implications. On the national level, Aleppo is subject to the domestic heritage laws as well. For more information, see Cunliffe 2015.

63 Cf. the Aleppo Project’s website < https://www.thealeppoproject.com> (last accessed 18 Feb. 2020).

politics of reconciliation and peace building.[64] It is also possible to think that preserving some parts of the memory of the war in Syria would provide some comfort to the community by underlining continuously the importance of avoiding armed conflicts and mutual hostilities, as was seen in the 'Yellow House' of Beirut.[65]

Another difference from the context in Beirut is visible in the fact that in the case of Aleppo, for example, any reconstruction is strictly governed by the roles of UNESCO given the status of the city as a UNESCO World Heritage site, as has been said before.

## Concluding Remarks

### A Way Forward Towards Reconciliation?

In the post-conflict social healing process in the Syrian context, an example to be followed could be the South African experience with the 'Truth and Reconciliation commission', which was created by the South African parliament and operated in post-apartheid rule in South Africa in 1993. During the violent change that took place in South Africa, abuses were committed by all sections of society.[66] The commission, whose work was covered extensively in the local media, offered amnesty in exchange for full disclosure of the truth, and this is regarded as a decisive factor in the reconstruction of a new society in the country. It goes without saying that the principal questions with respect to the Syrian case are how a transitional justice can operate in the country? And who is going to implement it? Also, what are the limits of trials and prosecutions with respect to the offences against cultural heritage, which are also a violation of human rights?[67] Moreover, one has to consider whether justice is still possible or whether it is not better to seal the book of sufferings leaving many questions without any answer. In fact, the application of justice might weaken the already fragile process of reconciliation and peace building. I am aware that my suggestion to follow the above-mentioned example and to leave the past in the past contradicts my previous remark on allowing all the stories to be heard, but at this stage it is unclear who has the credit to answer these questions and what the best way forward is.

### A Way Forward 'National Reconstruction Strategy Concerning Heritage'?

It is important to conclude the current discussion by coming back to the practical level. In fact, Syrians should place the preservation of heritage on the reconstruction agenda that would be implemented at the start of the recovery activities. The reconstruction should not be random actions, driven by ideology or short-term interests, but they should be tailored actions that would take into account the cultural, religious, and ethnic particularities of each of the affected communities and locations.

In my opinion, a multitude of actions present themselves. Some of the more pressing actions to be undertaken could be:

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64 In the Balkan War, the National Library in Sarajevo was shelled and burned. In the 1990s the library was entirely reconstructed and an inscription stating 'Don't forget, remember and warn' was erected. See Sandes 2013, 298.

65 The so-called 'Yellow House' in Beirut is an outstanding historic (Ottoman) structure that was badly damaged in the civil war and then condemned to demolition in 1997. Yet after renovation, and following great efforts from Lebanese heritage experts, it was decided that the house should become a 'war museum', besides recently being a venue for many artistic and cultural activities, cf. Seif 2009; Schwartz 2016, 146–248.

66 Despite some flaws, TRC is generally seen as successful in introducing South Africa to a democratic system and in averting civil wars. For more information, see Hayner 2011; Wielenga 2013; Lostal – Cunliffe 2016, 5.

67 As pointed out already, the outcome of a truth-seeking mission is not always welcomed, and the results could lead to further tensions that are destructive for a fruitful recovery phase. Moreover, there are no indications on how trials (national or otherwise) could grant amnesties for those playing an important role in the peace building and ensuring long-lasting peace in Syria. Cf. Lostal – Cunliffe 2016.

1. To formulate and implement an ambitious, yet realistic ‘national reconstruction strategy towards heritage’. It should incorporate short-term and long-term goals and objectives for the revitalisation of all aspects of the threatened/vanished cultural heritage. A prerequisite for the government strategies to succeed is that the population also takes ownership of the multi-faceted nature of the Syrian heritage.
2. To set up an internal mechanism for the regular exchange of information between various stakeholders. These would include primarily but not exclusively: culture, represented by DGAM; planning; finance; education; tourism, and the authority of religious endowments.
3. To ensure that heritage subjects become a part of the educational programmes of the schools and that proper educational tools are made available to the public.
4. To give priority to local needs and experiences and side-line unjustified international interventions. It is important for the Syrian authorities to manage their strategy, but this should not prevent co-ordination and co-operation with international academic bodies and organisations such as UNESCO, ICCROM, ICOMOS and ICOM.
5. To conduct a national survey of cultural assets and the availability of human resources in conservation and protection management. Here a specific effort should be made to include the academics, heritage scholars and experts who left the country. This could be done by establishing a database of the potential to participate in Syria’s reconstruction.
6. To carry out damage assessment missions and conduct a large-scale restoration and conservation program for the damaged sites and monuments across the country. The realisation of these activities will require international research communities to assist local academics and cultural institutions in setting up an efficient policy for the rehabilitation of cultural heritage sites, as well as developing new means of protection and preservation. But let us underline the internal picture: DGAM and other Syrian bodies should manage and implement the projects. These sectors need different supporting programmes, but at the same time they face the problem of the significant brain drain.
7. The rebuilding strategies must be community-driven and all benefits should be directed to the Syrian people. Also, strategies should not only respect local needs or building traditions and materials, but should also involve local communities in the revitalisation of their cultural heritage. During the conflict, living monuments and sites (e.g. the Old Souq of Aleppo) that fulfilled meaningful roles in the lives of the inhabitants, were affected or totally destroyed. Therefore, in the recovery phase, communities should be encouraged to take pride in and accept responsibility for their monuments; otherwise, the lesson could be lost.
8. Reconstruction should take into account the specific social and cultural aspects of the society. Also, the new functions of the urban heritage should underline creative interaction between the various components of Syrian society. The returned refugees and the displaced people should find themselves in front of structures that speak for them and not in front of structures that have no meaning and the only purpose of which is securing people’s immediate needs.
9. Reconstruction strategies should provide a responsible revival of tourism in the tourist attractions that were destroyed. Such a revival should ensure sustainable protection for heritage sites.
10. To rethink all components of heritage concepts and practices. All categories of heritage must be included, studied, conserved and developed for the future. Therefore, there is, in my opinion, a pressing need for a ‘systematic decolonisation process’, during which the draft laws, studies, and schools of research that have operated in the fields of heritage and archaeology in Syria over the past 70 years have to be revised in the process of shaping a new total awareness about Syrian cultural heritage. There is a need for a paradigm shift in the perception of Syria’s heritage and to instruct new visions that reflect as far as possible the diversity and richness of it as well as its inclusive character.

11. To incorporate the decision about Syria's heritage in any justice establishment or transitional justice measurements to be implemented in the country, as echoed already by studies.[68]

Finally, I believe that Syrian archaeology and heritage finds itself at a critical juncture. Its origins in colonial and postcolonial practices and concepts must be revised for a future decolonisation of the discipline. Having recognised the fragile nature of the heritage and, at the same time, the important role of the Syrian heritage in identity forming, some Syrian as well as international scholars have started to explore new approaches for dealing with heritage. An active collaboration between various stakeholders inside and outside the country, in addition to a tangible involvement of Syrian people in the task of preserving and promoting heritage, offers a good framework for progressing in the discipline. Only the future will tell whether such a move away from the politics of research in fields of heritage or the functions of cultural institutions that have been dominant in the Arabic region for at least the last century will be fruitful.

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# Past Documentation Projects in Syria

# Late Antique and Early Byzantine Architectural Monuments in the Hauran: Results of Two Expeditions to Syria (1978, 1980)

*Johannes Koder*[1] – *Marcell Restle †* – *Peter Waldhäusl*[2]

**Abstract:** During the years 1978 to 1980 Marcell Restle and Johannes Koder undertook surveys of late antique and Early Byzantine monuments in southern Syria, in the ancient landscape of Auranitis (Hauran). They investigated the extended remains of prestigious buildings, churches, monasteries and farmsteads, which at that time were partially still in good condition. The project was carried out with financial support by the Austrian Science Fund and in cooperation with researchers from the Austrian Academy of Sciences and Vienna University of Technology. The monuments and inscriptions from Azraʿa and Šaqrā were published in part 1 (2012). In 2016, just before his sudden death, Marcell Restle submitted the final part 2, the documentation of the monuments in Shaqqa. The edition then had to be finished by Annegret Plontke-Lüning. Part 2 contains especially in-depth analytical comparisons of the basilica in Shaqqa with the pillar basilicas in Tafḥā, Bosra, Hīt and Nimra and the column basilicas in Šaqrā, Umm idj-Ǧimāl, Umm iz-Surab, Mutāʾiya and Suwaidā. The fact that some of the monuments published in parts 1 and 2 were severely damaged during the last 30 years, gives to this documentation an additional exceptional importance. In this paper, a short overview over the geodetic and analogue-photogrammetric documentation work and the types of architectural targets that were documented is given.

**Keywords:** Syria; Hauran; early Christian and Byzantine monuments; documentation; photogrammetry

## The Two Expeditions and their Membership

During and in consequence of the recent wars in the area of Israel, Jordan, Egypt and Syria, known as the Palestine or Independence War (1948/49), the Suez-Crisis (1956), the 6-Day War (1967), and the Yom Kippur War (Ramadan-War, or October-War) (6–25 October 1973),

Fig. 1 and 2 On the left we see Buraq in 1904/05, as photographed by Howard Crosby Butler (Restle 2012, fig. 1, after Butler 1909, ill. 103), and on the right, the Buraq of 1973, as documented by Marcell Restle (Restle 2012, fig. 2 photographed in September 1978)

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Fig. 4 H. Godowitsch with WILD P32 on WILD T2 (photo: P. Waldhäusl)

Fig. 3 The Hauran in Syria, the ancient landscape of Auranitis

thousands of refugees entered Syria and needed new homes. They took what they could find for building emergency housing, so the well-formed basalt stones of the numerous ancient Roman and Byzantine ruins in the Hauran region were also taken for reuse. Two pictures of one and the same area will demonstrate the situation (Figs. 1–2).

Consequently Marcell Restle and Johannes Koder planned and organised two expeditions to Syria to the Hauran area (Figs. 3–4) for fast photogrammetric documentation of the remaining ancient monuments. The project 'Surveys in the Hauran, the antique Auranitis, in Syria' was financed by the Austrian Science Fund which strongly recommended that the two experts in art history should be accompanied by a group of surveyors and photogrammetrists, and recommended the Technical University of Vienna (TU Wien) in Austria to take up the work.

As a result, Prof. (photogrammetry) Dipl.-Ing. (surveying) Dr. Peter Waldhäusl and Dipl.-Ing. (surveying) Hans Godowitsch from the TU Wien, as well as Herbert Gaudernak (Byzantinologist) as an experienced assistant, took part in the first expedition from 9 September to 17 October 1978. During the second campaign from 7 September to 20 October 1980 the participants again included Hans Godowitsch; further, Dipl.-Ing. (FH) Friedrich Mayer as a surveyor-photogrammetrist and Rupert Gebhard, a historian from the University of Munich, joined the team as new participants. All these details are well reported in Marcell Restle's DVD ebooks.[3]

## Aims, Tasks, and Means

In the research project the plan was to precisely survey all the still existing early Christian and Byzantine monuments of the Hauran within the shortest possible time with the aim of preparing art-historic documentation, including of details, for later research or reconstructions by art historians or architects. The Golan Heights in the west were controlled by Austrian UN troops, thus the expeditions could profit from the good military connections for the logistics. Austrian airplanes

[3] Restle 2012; Restle 2016.

Fig. 5 P. Waldhäusl with the WILD C120 (1978) (Restle 2012, fig. 4)

Fig. 6 H. Godowitsch with 2 WILD P32 on a Wichmann vario-base for normal-case photogrammetry (1980) (Restle 2012, fig. 4)

safely brought in and out what was technically needed, in agreement of course, with the Syrian counterparts of the project.

Digital methods were not yet possible in photogrammetry, but analogue methods, especially normal-case photogrammetry, were readily available and already widely used thanks to the ambitions of Hans Foramitti and others within ICOMOS-CIPA, the Comité international de la photogrammétrie architecturale of ICOMOS, the International Council on Monuments and Sites. The Institute of Photogrammetry of TU Wien provided several cameras and the surveying instruments for this Syrian emergency project, but had no electronic distance meters at that time.

Hand-measurements, traditional traverses and intersections were used, as well as stereo-photogrammetry with WILD C120, or WILD P32 on WILD T2 (Figs. 3–5). The computations were executed by means of single-task software with a programmable HP 41. But – very advanced! – bundle photogrammetry could already be envisaged, enabled by the photogrammetric universal software ORIENT developed by Helmut Kager of TU Wien. For the photogrammetric stereorestitution everything had to be planned for the available restitution instruments JENA Topocart, WILD STK1 or ZEISS Planicomp. For several special large-scale close ups, and for many single image or stereo documentations, normal system cameras could also be used – taking appropriate account of restitutionability by ORIENT or by rectification devices. Consequently, the field work took much more time than is needed today. It is astonishing how the electronically driven technology has advanced since then.

## Types of Architectural Targets, Examples

Buildings of architectural or historical interest (outside as well as inside) consisted of several churches, towers, houses or just walls with many spoils, with old details on doors, windows, interesting stone sizes, proportions, designs, interesting construction elements or those typical for their time (Figs. 6–18).

Fig. 7 Elias church in Azra‘a, photographic documentation
(Restle 2012, fig. 22)

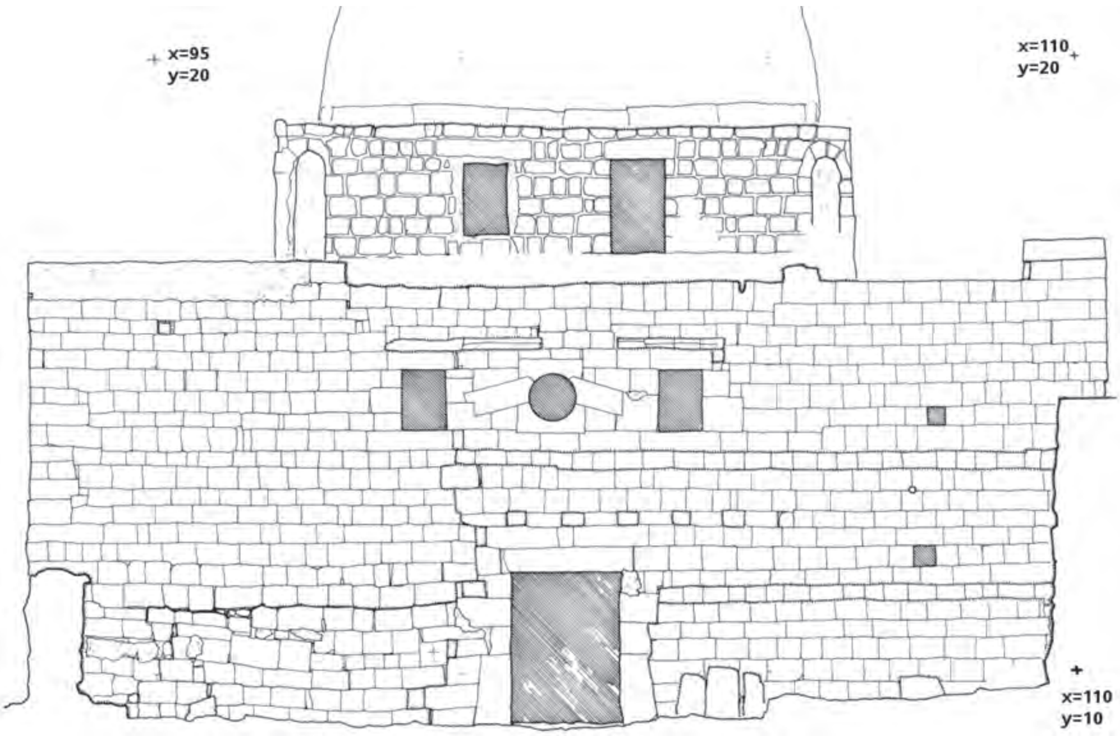


Fig. 8 Elias church in Azra‘a, draft restitution
(Restle 2012, fig. 25)

Fig. 9 Constructive cleverness (door (stock?) lintel depressurisation by force redirection) decorated with beautiful Christian symbols (vine and branches) (Restle 2012, fig. 33)

Fig. 10 A sister building of the Elias church is the Martyrion of Saqra in 1980 (Restle 2012, fig. 67)

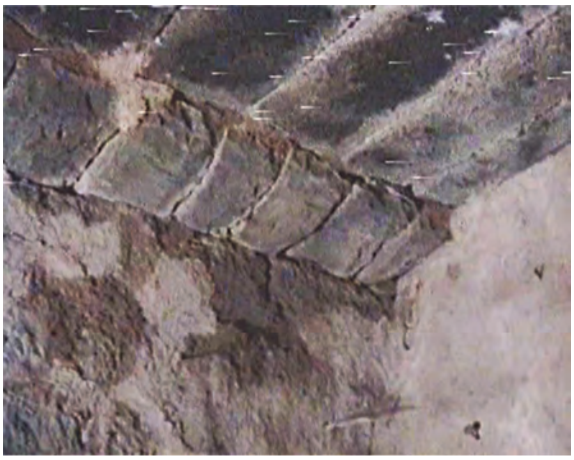

Fig. 11 The Martyrion of Saqra in 1992 with interesting constructive details (consoles support ceiling plates) (Restle 2012, fig. 74)

Fig. 12 Tower Tomb of Saqra in 1980 (Restle 2012, fig. 91)

Fig. 13 St. George’s Church in Azra‘a (Restle 2012, fig. 112)

Fig. 14 Interior of St. George's Church in Azra'a (Restle 2012, fig. 132)

Fig. 15 Details of a door of St. George's Church (photo: P. Waldhäusl)

Fig. 16 Details of a window of St. George's Church (photo: P. Waldhäusl)

Fig. 17 Johannes Koder reads an ancient foundation stone (September 30, 1978). Stone carved inscriptions are unique and important historical documents in the region (Restle 2016, fig. 1a)

Fig. 18 Surveying of the interior of the basilica in Shaqqa and a photographic documentation of the western façade (1980) (Restle 2016, fig. 18)

Fig. 19 The western façade of the basilica in Shaqqa (1980)
(Restle 2016, fig. 26)

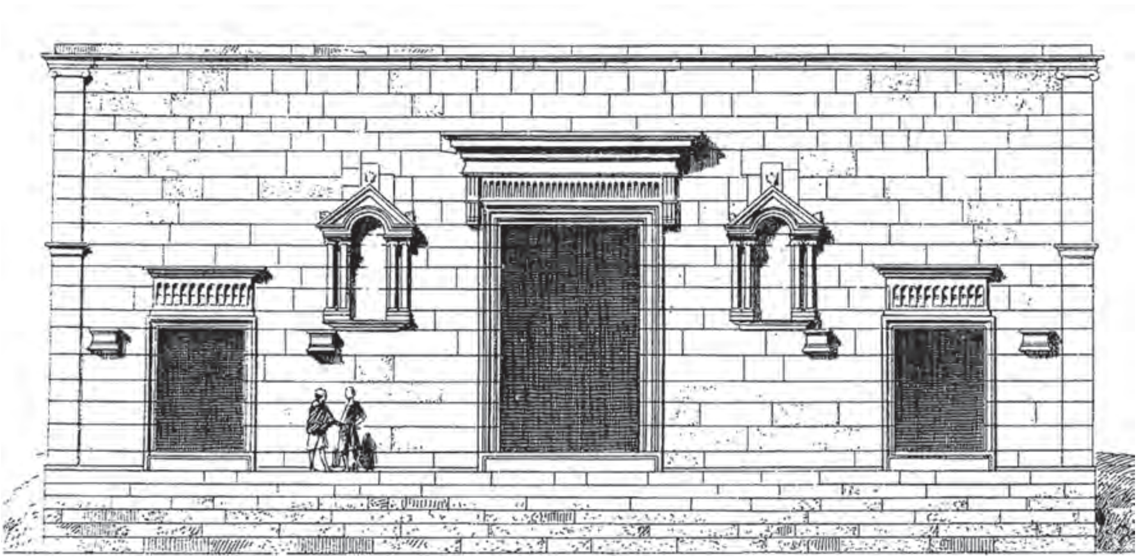

Fig. 20 The basilica in Shaqqa, a drawing from 1900 of the western façade (with incorrect stone sizes)
(Restle 2016, fig. 21 after Vogüé 1865–1877, pl. 15,4)

Fig. 21 The façade of the pillar basilica of the monk Bahira in Bosra in 1978
(Restle 2016, fig. 45)

Fig. 22 The interior of the pillar basilica of the monk Bahira in Bosra in 1978
(Restle 2016, fig. 56)

Fig. 23 Measuring photograph of the pillar basilica of Il-Hit (1978)
(Restle 2016, fig. 68)

Fig. 24 Interior detail of the pillar basilica of Il-Hit in 1992
(Restle 2016, fig. 90)

Fig. 25 Romanos Basilica in Saqra in 1978 (Restle 2016, fig. 97)

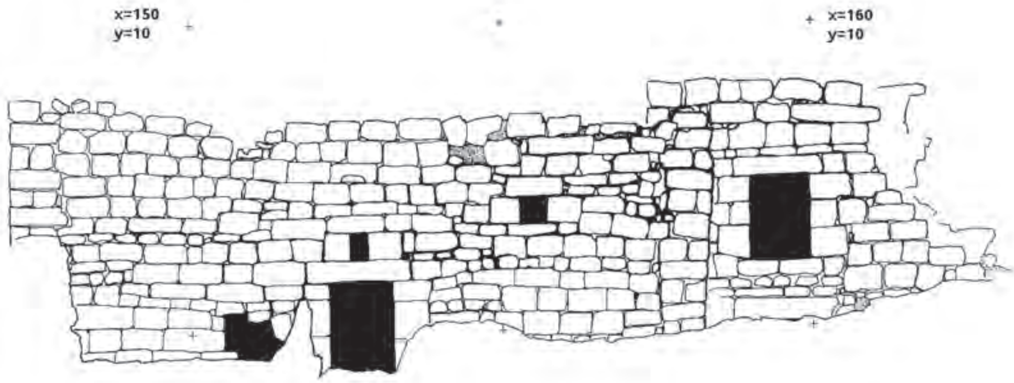


Fig. 26 Draft restitution of the Romanos Basilica in Saqra in 1978 (Restle 2016, fig. 98)

Fig. 27 Muta'iya Church no. 3, seen from SW in 1978 (Restle 2016, fig. 137a)

Fig. 28 Muta'iya Church no. 3, seen from SE in 1978 (Restle 2016, fig. 135)

Fig. 29 Muta'iya Church no. 3, an Ionian column capital as spolia in 1978 (Restle 2016, figs. 139 and 142 [detail])

Fig. 30 Modern Hauranian architecture in 1978: a pigeon loft (photo: M. Restle)

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# SYGIS – The Anatomy of the Jebel Bishri Project in Syria: Remote Sensing, Archaeological Surveying, Mapping and GIS Studies with Education in Syria

*Minna Silver (formerly Lönnqvist)*[1]

**Abstract:** The Finnish archaeological survey and mapping project SYGIS worked under the present author in the mountainous region of Jebel Bishri in Syria in 2000–2010 executing remote-sensing methods, fieldwork and GIS in mapping as well as producing 3D landscape models. The aim was to document and study a vulnerable spatial boundary zone between the Syrian Desert and irrigated agricultural fields of the Euphrates Valley. Using the collected data, the purpose was to study nomadic and sedentary cultures, their interaction and how they were affected by those environments. The project was an early initiative regarding use of GIS in Syria, also providing a GIS course to the members of the Syrian antiquities authority. In addition, a research training course and seminar were arranged by SYGIS for Nordic PhD students in Syria. In the 1980s and 1990s new methods, largely based on ethnoarchaeological observations, were developed to study the archaeological remains of the nomads, from which the project was able to benefit by applying these approaches afresh. Satellite imagery was used in studying environmental changes and prospecting ancient sites that were checked and documented in situ. Materials such as Landsat and QuickBird images were used, fusing them with radar data from the X-SAR mission and ASTER-DEM in order to create landscape models. The project highlights the importance of documenting and preserving mobile cultures, such as those of hunter-gatherers and pastoral nomads. Bedouins are part of the Syrian culture and they are the followers of past pastoral nomads in the region.

**Keywords:** remote sensing; archaeology; surveying; mapping; GIS

## Introduction: Photogrammetry, Remote Sensing and GIS

Finnish archaeologists, photogrammetrists, remote-sensing and GIS experts started a project for the archaeological surveying and mapping of ancient sites in their surrounding landscapes in the mountainous region of Jebel Bishri in central Syria in 1999/2000[2] by using satellite imagery and GIS (Geographic Information Systems).[3] In addition to the ancient sites, ethnoarchaeological recording and documentation was carried out in more recent sites among the local Bedouins and village people. The impact of desertification on their livelihood was studied with satellite imagery associated with the fieldwork. According to ACSAD (The Arab Centre for Studies of Arid Zones and Dry Lands), the area of Jebel Bishri covers c. one million hectares and has been a habitat for mobile people between the Syrian Desert and the Euphrates River for millennia (Fig. 1).

The beginning of remote sensing in Near Eastern archaeology is closely associated with Syria, Iraq and Jordan. Sir Aurel Stein had already applied aerial archaeology from balloons in 1906–1908. He recognised the usefulness of aerial archaeology, especially in desert regions.[4] Father

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2 SYGIS – Jebel Bishri, the Finnish Project in Syria. Online <www.helsinki.fi/hum/arla/sygis> (last accessed 18 Feb. 2020).

3 See Lönnqvist – Stefanakis 2009.

4 Gregory – Kennedy 1985


Fig. 1 The location of Jebel Bishri in Central Syria on a satellite map (mapping: Minna Silver)

Antoine Poidebard[5] and Lionel W. B. Rees[6] carried out pioneering remote-sensing studies by photographing areas and sites from aeroplanes in Syria and Transjordan in the 1920s and 1930s. In 1922 Charles Héraud also published his reconnaissance mapping on the Euphrates in Syria.[7] Aurel Stein on his part carried out aerial reconnaissance in Iraq and Transjordan in the 1930s.[8] David Kennedy has since become especially famous in the field of aerial remote sensing in the archaeology of Jordan in recent decades. Robert Bewley has co-operated with him in that work.[9] The lack of thick vegetation cover and long cloudless periods make deserts and steppes convenient targets for aerial remote sensing and remote sensing from space.[10] Several human activities can be detected without removing forests or other vegetation cover by aerial laser-scanning with LiDAR using special algorithms.[11]

Thanks to the interest of Prof. Sultan Muhesen, former Director General of the Directorate-General of Antiquities and Museums (DGAM) of Syria, a co-operation in the field of GIS was started in 1997–2000 between DGAM and Finnish archaeologists. Archaeologist Minna Lönnqvist (now Silver), the present principal investigator, while gathering data for her PhD undertook

5 Poidebard 1934.
6 Rees 1929.
7 Héraud 1988 [1922].
8 See Gregory – Kennedy 1985.
9 See Bewley – Kennedy 2013.
10 Scollar 1990, 1.
11 See Silver 2016b. In the CIPA workshop on Saving the Cultural heritage of Syria in Vienna in 2016 Michael Doneus presented the technical details of LiDAR, see Doneus 2016.

a closer study trip with Swedish theologian Helena Riihiaho around Syria, visiting Palmyra, Mari and the neighbourhood of Jebel Bishri from Deir ez-Zor in 1997. They then met with Prof. Muhesen in his office at the Directorate-General of Antiquities and Museums in Damascus in the late summer of 1997. Already then, Muhesen had in mind the need for establishing a comprehensive GIS-based antiquities information system for DGAM in Syria. He had followed the Finnish initiatives in this field in Egypt. He therefore inquired whether there were special areas that could be used for such a project in Syria, and the present author discussed a possible project based on GIS with him. In this meeting an interest in GIS and Jebel Bishri in the Palmyrides as a target area for a pilot project was expressed.

The choice of the area was based on the fact that the present author was finishing her PhD on the archaeological sites and remains associated with the Amorites in Syria-Palestine. According to the Mesopotamian cuneiform sources, Amorites, a West Semitic group of people,[12] were more or less mobile pastoralists,[13] whose central habitat was located in the neighbourhood of Jebel Bishri.[14] It was also learned that a German development programme in the region was including remote sensing and GIS studies in its work on rehabilitation of the steppe in the 1990s.[15] Observations of the landscape and Bedouin life on the steppe were made along the desert road from Palmyra to Deir ez-Zor and along the route following the Euphrates that leads from Deir ez-Zor to Aleppo. There, village life, as well as irrigated fields, were observed.

After returning to Finland, encouraged by Prof. Muhesen, the present author participated in a full GIS expert programme at the School of Continuing Education at Helsinki University in 1997. The programme was completed in 1998. Consequently, a project application to study Jebel Bishri was submitted to the Academy of Finland in 1999, and research scientist Markus Törmä submitted an application to the German Aerospace Centre for participation in NASA's world monitoring programme, the SRTM 2000 shuttle mission. The new project to study Jebel Bishri was accepted to the SRTM 2000 shuttle mission programme, and also, at the same time, initial funding from the Section of Development Research of the Academy of Finland was granted in late 1999. The aim of the project was to study the relationship of pastoral nomads and the surrounding village life through the ages from archaeological and ethnoarchaeological perspectives based on surveying and mapping. The home institution of the project was the Institute for Cultural Research at the University of Helsinki.

## JADIS and the Egyptian Antiquities Information System (EAIS) as Backgrounds

In the 1990s the American Center of Oriental Research (ACOR) in Jordan produced an electronic database called JADIS[16] that was a basis (nowadays enlarged to MEGA-Jordan[17]) from which to learn electronic inventory building based on Geographic Information Systems (GIS) for archaeological sites in a given country. In early 2000, on behalf of Jaakko Pöyry Soil and Water Ltd. (a Finnish company), a tender for building an Egyptian Antiquities Information System (EAIS) for the Supreme Council of Antiquities (SCA) in Egypt was submitted to the Finnish Foreign Ministry Development Department by the present author with architect Aaro Söderlund. This was an initiative that Finns had been developing in Egypt for some time and was to serve as a basis for a future GIS-based project and GIS training for the staff of DGAM in Syria.

12 Buccellati 1966.
13 See Khazanov 1994
14 See Lönnqvist et al. 2011, 197–212.
15 Hoffman – Geerken 1997.
16 Palumbo 1994.
17 See MEGA-Jordan, The National Heritage Documentation and Management System. Online <http://www.mega-jordan.org/> (last accessed 18 Feb. 2020).

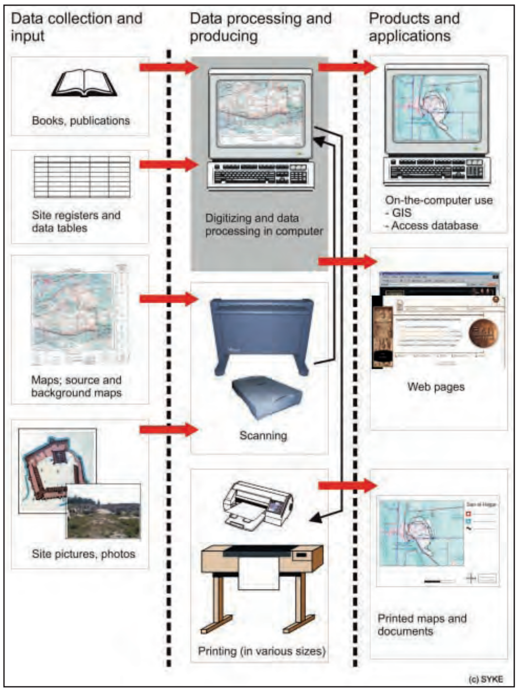


Fig. 2 The process model for the Egyptian Antiquities Information System (courtesy: Finnish Environmental Centre 2000)

An information system based on GIS for supporting the protection, recording, documentation, mapping and preservation of the Egyptian cultural heritage was planned. The purpose of the project was also to teach GIS for the staff of SCA. The EAIS project was to offer an essential institutional link in information flow from SCA to other institutions relating to land use and geoinformatics. This information flow was to offer feedback on the protection, preservation and monitoring system of SCA. The project was to be funded by the Finnish Foreign Ministry development funds.

A fact-finding mission to Egypt was carried out by the present author and architect Söderlund in February 2000 on behalf of Jaakko Pöyry Soil and Water Ltd. It included visits to SCA, interviews with its staff and some staff of the Egyptian Museum and Finnish diplomats in Cairo. A visit to the Giza plateau offices headed by Dr. Zahi Hawass, and Dr. Mark Lehner's Giza Plateau mapping project of the Oriental Institute at the University of Chicago[18] was included. We learned that the Giza Plateau project used the UTM coordinate system and ArcView software in mapping. A special visit was also made to the National Authority for Remote Sensing (NARSS) in Cairo, and included interviews with its head Prof. Mohamed Adel Yehia. NARSS was a pioneer actor in the region in satellite remote sensing, already co-operating with the USA in the 1970s. NARSS became a regional centre for the Arab countries from the Emirates to Morocco. It already had state-of-the-art technology including laser scanning. There was a need to combine GPS (Global Positioning System) coordinates with the available map coordinates. Then the need for accuracy was at least 1:24,000, and for elevation, 1.5m accuracy.[19]

A tender for the Egyptian antiquities information system was presented in Helsinki to the Finnish Foreign Ministry but its development section decided to choose a governmental Finnish Environmental Centre for the project instead (Fig. 2). The data from the tender submitted by Jaakko Pöyry Soil and Water Ltd. remained available for the Finnish Foreign Ministry. However, the

18 The Giza Plateau Mapping Project (GPMP), Oriental Institute, University of Chicago. Online <http://oi.uchicago.edu/OI/PROJ/GIZ/Giza.html> (last accessed 18 Feb. 2020).
19 Pers. comm. M. A. Yehia, 26 February 2000.

Fig. 3 Grazing on the Euphrates side of the Jebel Bishri region, the mountain visible behind the fields (photo: Minna Silver 2003)

EAIS planning and GIS training were valuable experiences that helped to initiate a GIS project in Syria that was also to include training in GIS for the staff of DGAM in Damascus.

## The SYGIS Project as a GIS Initiative in Syria

The SYGIS (the Syrian GIS) project for studying Jebel Bishri was established in 1999/2000, when it was accepted to NASA's world monitoring programme through the German Aerospace Centre. That meant participation in NASA's SRTM Shuttle Mission 2000 data capture that provided elevation data, like DEM (digital elevation model) tiles, from the region of Jebel Bishri. Funding for the pilot project to study Jebel Bishri was received from the Academy of Finland starting from 2000, and thereupon the home institution of the project became the Institute for Cultural Research, Department of Archaeology, University of Helsinki.

Funding was allocated for purchasing satellite imagery and covering the cost of an archaeological pilot field survey on Jebel Bishri. The aim was to study the relationship of the ancient and modern pastoralists of the mountain with the villages of the river valley and the piedmont (Fig. 3). It was known that prospecting with satellite imagery needed complementary research on the ground. Ancient maps and site lists from Antiquity relating to the region such as Ptolemy's *Geography*, *Tabula Peutingeriana* as well as *Notitia Dignitatum* were consulted. Jebel Bishri is a desert steppe, limited spatially to the green valley of the Euphrates River and its agricultural village life, and our interest was in studying the relationship of mobile pastoralists from the desert steppe of the mountain with the sedentary way of life on the river banks and the surrounding oases – also bearing the process and cycle of their sedentarisation and nomadisation in mind.

Jebel Bishri had largely remained *terra incognita* as far as archaeological exploration was concerned. Apart from a trip over Jebel Bishri and along the Middle Euphrates by Alois Musil at the beginning of the 20th century,[20] some aerial detection had been undertaken by Antoine Poidebard

[20] Musil 1927; Musil 1928.

in the 1920s and by Mouterde in the 1940s.[21] Giorgio Buccellati and Marilyn Kelly-Buccellati had also paid an archaeological visit to the area in the 1960s.[22] In his studies on pastoral techno-complexes Juris Zarins also paid special attention to Jebel Bishri in the 1990s.[23] The Euphrates side had been studied by the French, for example René Dussaud[24] and Jean Lauffray,[25] and the Germans, for example Friedrich Sarre and Ernst Herzfeld,[26] who had mapped ancient forts and fortresses on the Euphrates limes. Kay Kohlmeyer[27] later surveyed some of the Middle Euphrates areas as well, and based on personal communications from Andrew Moore, his team surveyed a stretch from Abu Hureyra to Halabiya. Lorraine Copeland also published Palaeolithic findings from the Middle Euphrates beneath Jebel Bishri.[28] A large graveyard was excavated by the Germans at Abu Hamed in the 1990s on the Euphrates side,[29] but it had not been published, and we had no knowledge about it before its publication in 2005.

A fact-finding mission to the region of Palmyra and Jebel Bishri was carried out in April 2000 by the present author, accompanied by the archaeologist Mahmoud Hammoud from DGAM and a driver. The purpose was to plan a field season in the area. Co-operation with the Palmyra Museum was started with the late Dr. Khaled al-As'ad, who was to provide local workers and accommodation for archaeologists in the precinct of Bel's temple. Beside the Palmyra Museum, the DGAM guest house at Qasr al-Hayr ash-Sharqi was visited in a heavy sand storm during the fact-finding mission in 2000. There local Bedouins were interviewed about the possible ancient sites at Jebel Bishri. Bedouins at Qasr al-Hayr told us about Tell Tletuat and the existence of Roman dams or barrages in the area of Darakhlia.

With the guidance of archaeologist Mahmoud Hammoud and a driver, the present author travelled to Jebel Bishri, turning from the main road, deviating from the Palmyra – Deir ez-Zor road to Ash-Shujiri to look at possible archaeological sites and possible ways to work on the mountain. A Syrian asphalt company was active in the area, and oil was also drilled. A desertification-combatting project in co-operation between Germans and Syrians was also under way, planting trees to prevent the expansion of sand cover. First encounters with stone circles identified as pastoral corrals and cairns/*tumuli* were made. Flint tools seemed to be abundantly present.

During the fact-finding trip to Jebel Bishri with archaeologist Mahmoud Hammoud, camps were planned for the working teams: one for the piedmont at Qasr al-Hayr at the guest house, one in the wooden caravans of the asphalt company on the mountain. One camp in the Euphrates River area near the village of Ghanem Ali was also considered. After descending to the area of Ghanem Ali, the mission continued along the Euphrates River to Umm el-Marra and Aleppo, where the group stayed in the DGAM guest house. In Aleppo we met Dr. Waheed Khayata, director of the National Museum of Aleppo and researcher Dr. Muhammed Muslim. In addition, the principal investigator visited Mr. Edouard Megarbane, the honorary consul of Finland in Aleppo.

After the return to Damascus, the application for a research permit to conduct archaeological surveying and mapping in the neighbourhood of Jebel Bishri using GIS was submitted to DGAM. This was the start of an official GIS programme at DGAM and in the area of the Palmyrides focusing on the mountain of Jebel Bishri. Mount Basar, i.e., Jebel Bishri had been identified as the mountain of the Amorites in the Mesopotamian cuneiform sources, and the habitat of the West

21 Poidebard 1934; Mouterde – Poidebard 1945.
22 Buccellati – Kelly-Buccellati 1967.
23 Zarins 1989; Zarins 1992.
24 Dussaud 1924.
25 Lauffray 1983; Lauffray 1991.
26 Sarre – Herzfeld 1911; Sarre – Herzfeld 1920.
27 Kohlmeyer 1984; Kohlmeyer 1986.
28 Copeland 2004.
29 Falb et al. 2005.

Semitic pastoral nomads in the Bronze Age.[30] It continued as the habitat of the Arameans in the Iron Age.[31] The present author, the director of the project, completed a PhD dissertation titled *Between Nomadism and Sedentism: Amorites from the Perspective of Contextual Archaeology* in June 2000.[32] The *Rencôntre Assyriologique Internationale* (RAI) had a reminiscent theme, *Nomades et Sédentaires dans le Proche-Orient Ancien,* in the following July of 2000.[33]

During the 1990s developments in the field of the archaeology of nomadism[34] had opened a new window of opportunity to study pastoral nomads on Jebel Bishri and its neighbourhood with fresh methods and insights by archaeological means. These new approaches were largely based on ethnoarchaeological studies that had been carried out in the 1980s in Syria and Jordan[35] and have provided tools to interpret nomads that were thought to be invisible and make them visible in the archaeological record. The French had also carried out ethnoarchaeological studies among the village pastoralists in the neighbourhood.[36] Therefore, as we were interested in the behaviour of Bedouins, ethnoarchaeology was integrated into the research design of SYGIS as well.

SYGIS purchased CORONA satellite photographs, Landsat-7 satellite imagery and British military aviation maps (1:25,000) for the project in 2000–2003. So, the Finns were already following[37] the guidance of D. Kennedy[38] and applied CORONA photographs, providing at best up to 1.8m spatial resolution, to study archaeological remains in Syria even then. Jason Ur carried out work in Syria identifying ancient road networks using CORONA satellite photographs, also publishing his work in 2003.[39] Landsat-7 provided data for environmental observations and field mapping. QuickBird images, providing high spatial resolution up to 0.6m, were purchased in 2003. In addition, SPOT images were used in the later stage of the Finnish project in 2008–2010.[40]

UK military aviation maps were used as cartographic base maps and for the orthorectification of Landsat satellite images. Also, Russian topographic maps were acquired and appeared to be useful. The acquired relevant CORONA satellite photographs were digitised and used for prospecting as well as images provided by the Landsat-7 panchromatic channel. Google Earth with its high-resolution images did not yet exist when the project was initiated, and the applicability of Google Earth in professional GIS and photogrammetry has been limited until now. The MapSheets Express software was used in producing satellite maps from the panchromatic channel (15m resolution) of Landsat-7 images (Fig. 4). No maps had been granted by the Syrian officials to the Finnish project, apparently for military reasons as the project was not a joint Syrian-Finnish project but an independent Finnish project, and the Finns had exclusive publication rights to the research data.

Landscape modelling was carried out using XSAR-mission SRTM radar data, ASTER-DEM data and Russian topographic maps. ImageDrape software was applied in draping visibility models over the landscape. Helsinki University of Technology (now Aalto University), NovoSAT and its manager, photogrammetrist-research scientist Markus Törmä and photogrammetrist Arto Vuorela were initially co-operators, and geodesist Mervi Saario assisted in the fieldwork in Syria.

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30 Buccellati 1966.
31 See Silver 2019a
32 Lönnqvist 2000.
33 Nicolle 2004.
34 See e.g. LaBianca 1990; Cribb 1991; Bar-Yosef – Khazanov 1992; Finkelstein 1995.
35 See already Aurenche – Desfarges 1983; Jarno 1984; Banning – Köhler-Rollefson 1983.
36 See Aurenche – Desfarges 1983; Jarno 1984.
37 Lönnqvist – Törmä 2003.
38 Kennedy 1998.
39 Ur 2003.
40 See later general studies using space imagery in the Near East in Hanson – Oltean 2013; Comer – Harrower 2013; Hadjimitsis et al. 2020.

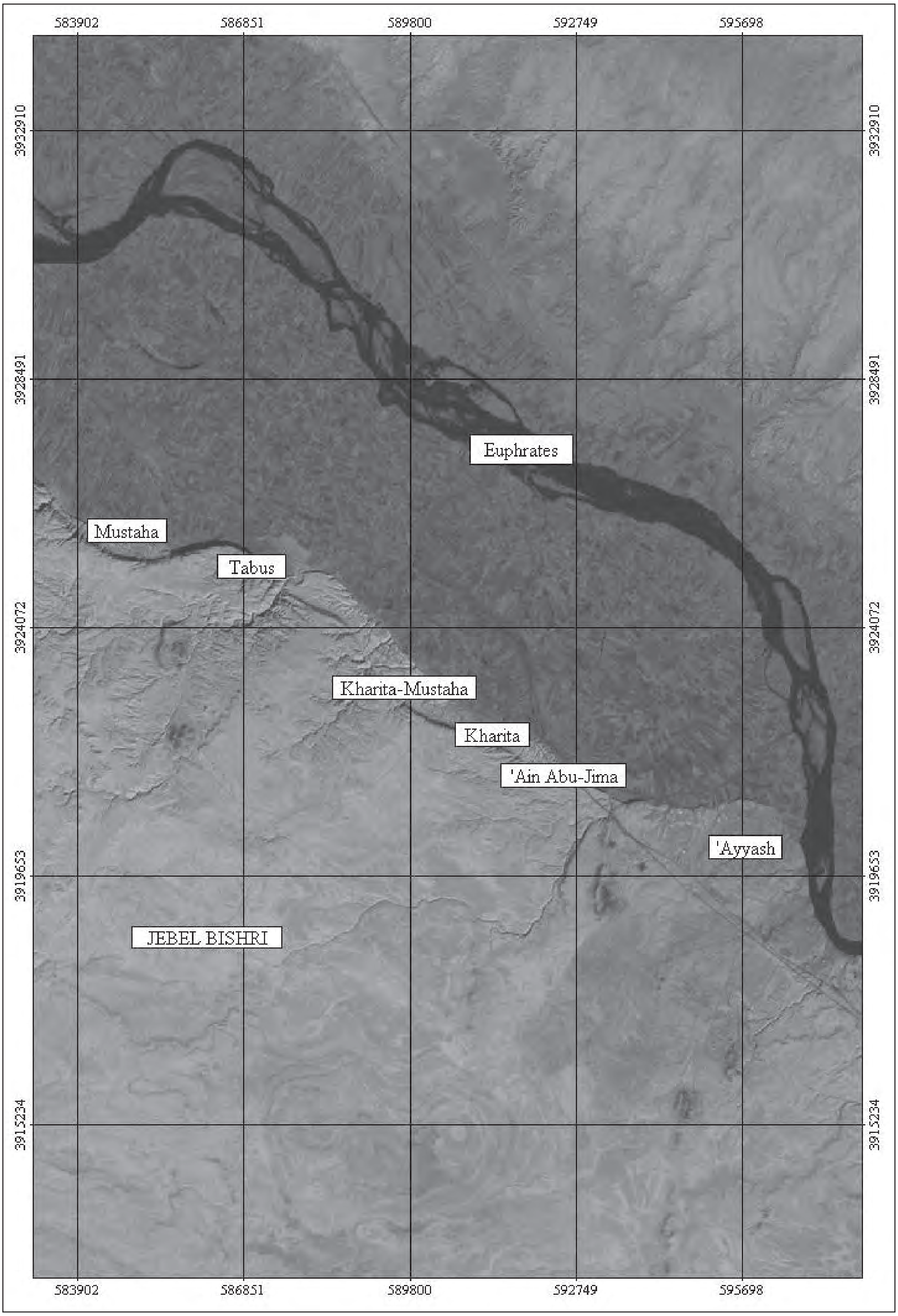


Fig. 4 Satellite mapping on the panchromatic channel of Landsat-7 satellite image. Mapping has been carried out with MapSheets Express software (mapping: Minna Silver)

Research scientist Markus Törmä from the Helsinki University of Technology and the Finnish Environmental Institute continued as the chief expert in photogrammetry until the end of the project, its final publications and other proceedings. The support of GIS professor Kirsi Artimo from the Helsinki University of Technology was crucial as well.

The survey permission for the first field season was received in July 2000 in Syria, but no excavation permission was included, not even any test pits. That, of course, limited the application of any stratigraphical information and use of physical dating methods. The survey strategy was planned to follow a regional survey and its ethical applications[41] to take remains of all the periods into account equally in the areas to be studied. Satellite imagery allowed a total coverage of the area in prospecting by remote sensing, and experimental plots for the surface survey provided evidence from the ground.

## The Fieldwork in 2000

SYGIS used high-tech in satellite prospecting, recording and documentation, and the purpose was to bring remote sensing and GIS-based archaeology to central Syria. The desert-steppe area was especially suitable for remote sensing. July 2000 was chosen as the time for the first field season, and satellite maps were produced for the fieldwork. The weather was very hot. This period was, however, the only break for the university staff in Finland, and therefore provided an opportunity for a field season.

The work was carried out under the Palmyra Museum, and the research team also spent some days in Palmyra at the DGAM guest house inside the Temple of Bel. The headquarters for field work was at a guest house next to Qasr al-Hayr ash-Sharqi on the western piedmont of Jebel Bishri. Dr. Martti Nissinen, Ms. Margot Stout Whiting, Dr. Sanna Aro-Valjus, Dr. Juha Pakkala and students from the Departments of Archaeology and Assyriology and from the Faculty of Humanities and the Faculty of Theology from the University of Helsinki formed the basic staff. Ms. Kirsi Lorentz, then a PhD candidate from Cambridge University, participated in the fieldwork as a group leader. Archaeologist Donald Lillqvist acted as a recorder with geodesist Mervi Saario. In addition, three high school students, Annina Pietiläinen and Tanja Turunen from Askola High school and Marlena Whiting from the English school in Helsinki, participated in the fieldwork. Cars, a four-wheel drive and a van were rented and a group headed to the field with a total station and GPSs. GPS data was captured at sites, but also at road junctions in order to orthorectify satellite imagery for accurate mapping. Apart from Jebel Bishri, the research team had an opportunity to visit other archaeological sites around Syria including Mari, Dura Europos, Homs, Hama, Aleppo and Ebla.

Areas for the field survey were chosen from the western piedmont near Qasr al-Hayr, from the escarpment of Tar al-Sbai and from inner areas of the mountain. Study area sectors were based on satellite map grids that had been produced with MapSheets Express. One group working on the western plateau stayed in the guest house near Qasr al-Hayr, another in a Bedouin house between Tar al-Sbai and Tell Tletuat. Chosen areas in the western piedmont and at a semi-circular edge of Tar al-Sbai were surveyed by 15m-interval field walking. Visits to the inner regions of the mountain were carried out both from Qasr al-Hayr and from Tar al-Sbai.

The amount of Palaeolithic and Epipalaeolithic flint finds was overwhelming in the western areas, as there were numerous sites on the piedmont plateau and at the edge. The centre seemed to be in the El-Kowm basin, where a Swiss team was then working. At the edge of Jebel Bishri there were collapsed *abris*, rock shelters, and flint workshops on top of them. Bases of some prehistoric huts were also identified. Activities in the Neolithic, Chalcolithic and Bronze Age were traced at stone circle sites that included corrals. Some stone circles formed megalithic

[41] Lönnqvist et al. 2006b.

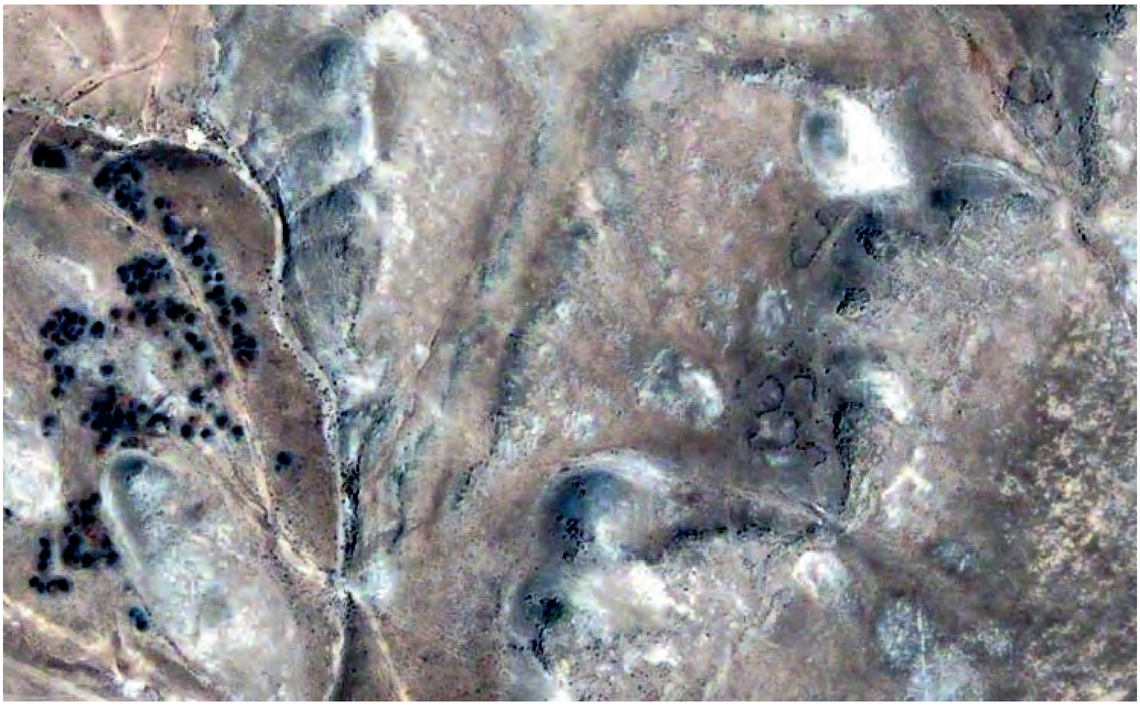

Fig. 5 Animal pens and cairns/*tumuli* on Jebel Bishri visible on QuickBird satellite image (© Digital Globe)

structures and were associated with funerary sites. Hunting blinds, cairns/*tumuli* and stone circles were recorded and documented (Fig. 5). Further up in the inner areas, sites such as Tell Tletuat, three natural hills, were visited and cairn/*tumulus* sites and hunter's blinds recorded on them, as well as a large corral site on the way deviating from the Deir ez-Zor–Palmyra road to the village of Ashujiri on the mountain.[42]

Also, on the western plateau below, Palaeolithic sites were recorded and Roman/Byzantine tombs, apparently associated with the Strata Diocletiana and route to Resafa-Sergiopolis, were documented. Qasr al-Hayr ash-Sharqi was studied; we had previously familiarised ourselves with the reports of Musil's studies and the American explorations there. Italian conservators and a Swiss team were to follow after us in the area, headed by Dr. Dennis Genequand. We concentrated on ethnoarchaeological documentation in Bedouin compounds and villages, such as Shanhas, near Qasr al-Hayr. Roger Cribb's studies of the development of Bedouin tent camps to villages[43] were observed in the village layout and houses at Shanhas. We paid special attention to studying the process of abandonment in the life cycle of Bedouins. This was based on special methodological approaches presented by Michael Schiffer in view of the formation processes of the archaeological record and Catherine Cameron's and Steven Tomka's studies on the process of abandonment were followed.[44] On the plateau beneath Tar al-Sbai, abandoned Bedouin sites were also recorded. Furthermore, later satellite images were used for studying the movement of the desertification line and its impact on the livelihood and movement of the Bedouins in Shanhas, Tar al-Sbai and in the village of Ash-Shujiri the latter situated in the central area of the mountain.[45]

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42 Lönnqvist et al. 2006a; Lönnqvist et al. 2011, 135–195.
43 E.g. Cribb 1991.
44 Schiffer 1987; Cameron – Tomka 1993.
45 Lönnqvist – Törmä 2006; Lönnqvist et al. 2010b; Lönnqvist et al. 2011.

An interim report of the findings from the 2000 season was submitted to DGAM and its director of excavations Dr. Michel Al-Maqdissi in 2001. A paper, *A View over an Ancient Silicon Valley*, dealing with satellite mapping of ancient structures such as stone circles and visibilities offered from them at the edge of Tar al-Sbai towards the western plateau was presented with computer-based visibility models and analyses in Liverpool in the congress dealing with the 5th millennium in the ancient Near East in 2001. Satellite mapping and computer-based visibility analyses were carried out by Arto Vuorela. As the proceedings of the Liverpool congress were not published, the paper was modified and inserted later as an enlarged chapter published in *Jebel Bishri in Focus*.[46]

The website of the project was set up in 2000/2001 with the aid of Dr. Juhana Saukkonen, and the site is currently still working but may be linked to a new site in the future.[47] A published abstract and a poster were presented at RAI 47 in Helsinki in 2001[48] and in autumn 2003 a paper was published in the CIPA[49] symposium in Antalya, Turkey, dealing with the SYGIS project and its 2000 field season.[50]

## The Fieldwork in 2003 and GIS Education

In 2001–2003 the aim was to raise further funding for the project, because the funding from the Academy of Finland was ceasing in 2001. In 2001 the project leader, with the assistance of Nina Turri, engaged in negotiations with the mobile phone company Nokia Co., which had headquarters in Finland, in order to make a sponsorship deal with it. Also, an application for NorFA (under the Nordic Ministries, now NordForsk) funding was submitted and received in 2002 for the principal investigator to plan for Nordic co-operation at Uppsala University in Sweden in 2002–2003. A presentation on the SYGIS project was delivered in Finland in 2003 for the Finnish Archaeological Society and published in 2004.[51]

A ‘Silicon Valley’ approach was attuned to the desert-steppe region with a long-term association with flint/silicon technology, recalling the common material basis with modern computer technology. This high-tech approach, which was at the heart of the project, was stimulating clear interest in Nokia Co. In 2003 co-operation and sponsorship agreements between the project and Nokia Co. were agreed and signed. Initial funding was granted for preliminary archaeological studies on the Euphrates side of Jebel Bishri and on the central areas of the mountain to be conducted from Deir ez-Zor. The work was limited to documenting sites by photographing and gathering information for archaeological mapping in the region in February 2003. Identified tells on the Euphrates side were later mapped on satellite imagery and published in the final report *Jebel Bishri in Focus*.[52] During the 2003 trip a meeting with Dr. Khaled Al-As’ad took place in Palmyra. Dr. Al-As’ad had acquired a large Arabic map of the Jebel Bishri region displaying wells and pastoral grazing grounds drafted by Arab engineers, and he wanted our project to produce a copy of the map. He was especially interested in the toponym of Ad-Didi,[53] and its relationship to the Amorites (cf. *Ad-Didi* to Biblical *Dedan* > *Dothan*) in association with the area of Qasr al-Hayr ash-Sharqi.

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46 Lönnqvist et al. 2011, 179–195.
47 SYGIS – Jebel Bishri, the Finnish Project in Syria. Online <www.helsinki.fi/hum/arla/sygis> (last accessed 18 Feb. 2020).
48 Lönnqvist – Stout Whiting 2001.
49 CIPA is a joint ICOMOS and ISPRS organisation.
50 Lönnqvist – Törmä 2003.
51 Lönnqvist 2004.
52 Lönnqvist et al. 2011, 213–248.
53 See Musil 1928, 76, 81, 174.

In 2003 a GIS training project was planned for the staff of DGAM by the principal investigator of SYGIS, and funding for training was applied for from the Finnish Foreign Ministry development funds. Meetings with the Finnish Embassy in Damascus took place to arrange the co-operation. A grant for the purpose was paid through the Finnish Embassy to ACSAD (Arab Centre of Studies of Arid and Dry Lands) which was a partner and organised the course. In addition, funding for SYGIS was applied for to continue the survey. It included a Nordic research training course and seminar for PhD students that were granted by NorFA in 2003, including GIS and field work. Several Nordic universities, professors and students were to participate. However, in spring 2003 the Iraq war broke out, and the Danish partners considered participation in the fieldwork too dangerous. In consequence, permission was received from NorFA to postpone the course by one year to 2004.

In the spring of 2004 a paper titled *Were nomadic Amorites on the move?* was presented by the principal investigator, dealing with the Amorite migrations including the role of Jebel Bishri, during the ICAANE (International Congress of the Archaeology of the Ancient Near East) in Berlin.[54] In April 2004 the principal investigator also delivered a presentation at the British Museum in the colloquium *The Levant in Transition*[55] that included a round table discussion hosted by then-Curator Jonathan Tubb. In both papers some initial results of the 2000 and 2003 fieldwork were included, dealing with nomadism in the end of the Early Bronze Age, the role of Amorites and their nomadism in transition including various migration theories. A multifaceted picture was emerging from the data indicating the migration patterns that included such phenomena as sedentarisation, invasion and abandonment. Ethnoarchaeological documentation and research in the region had opened up various possible analogies for the impact of the environment on nomadic life and the choices that nomads have during droughts.

## The Fieldwork in 2004 and GIS Education

After postponement of the full 2003 season due to the Iraq war, in May 2004 the Nordic research training course was able to take place in the region. Besides the project leader, the research team consisted of Professor Milton Nuñez (University of Oulu), Professor Gullög Nordquist (Uppsala University), Professor Christian Meyer (University of Bergen), Professor Ingolf Thuesen (University of Copenhagen) and PhD students. However, Ingolf Thuesen was nominated to be the head of the Carsten Niebuhr Institute and was not able to participate in the project, but one of his Danish students did.

The headquarters of the project in 2003–2004 was at the Badiyah Cham hotel in Deir ez-Zor, and a tent camp was erected in the central area of the mountain, where fieldwork that concentrated on the mountain could be carried out. For the fieldwork in 2004 areas beside and on Jebel Bishri were included, and visits were paid to archaeological sites of Palmyra, Bouqras, Mari, Dura Europos, Fortress of Zenobia, Resafa-Sergiopolis and El Kowm. Special research seminars were arranged in Deir ez-Zor that resulted in the publication of the seminar papers in *Jebel Bishri in Context* in 2008 (Fig. 10)[56] as an introductory volume to the final report of *Jebel Bishri in Focus* in 2011.[57]

For the 2004 field season two areas were chosen for the surface survey: one on the Euphrates side of Jebel Bishri and another at Nadra, in the central area of the mountain.[58] At the Badiyah Cham hotel lectures and seminars took place, and the students' papers were published.[59] Two

54 Lönnqvist 2008a.
55 Lönnqvist 2009.
56 Lönnqvist 2008b.
57 Lönnqvist et al. 2011.
58 Lönnqvist et al. 2006a.
59 Lönnqvist 2008b.

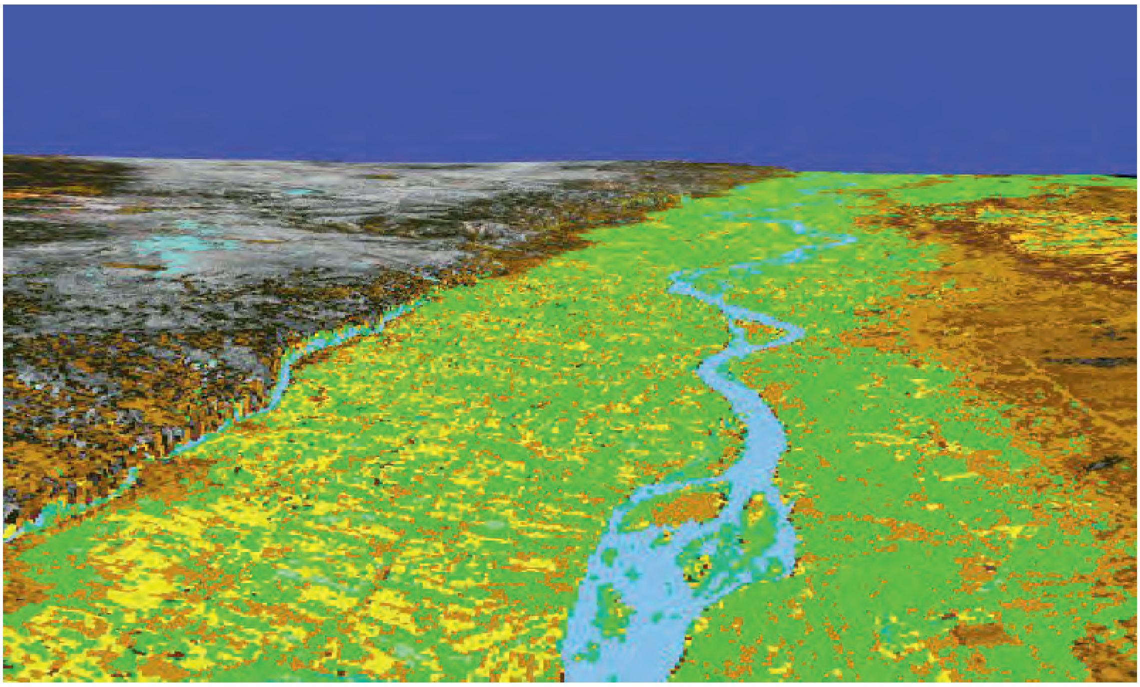

Fig. 6 Landscape modelling of the Euphrates valley following Jebel Bishri from west to east. Modelling carried out by fusing Landsat image data with SRTM mission radar data (modelling: Markus Törmä)

groups worked in different parts of the mountain in the field. The differences in the areas were also environmental: in the central area it was desert steppe, and on the Euphrates side it consisted of desert steppe and river terraces with alluvial plateaus.

The chosen areas differed culturally and economically between mobile and sedentary ways of life, the mountain being the hunter-gatherers' area, where they lived in rock shelters or huts, looking for pray; pastoralists grazed from tents or huts and reared animals, while villages associated with agricultural fields served as bases on the Euphrates side. There was a spatial difference in environments and landscapes that affected the choice of economy.[60] In this relationship of highland and lowland interaction, the two types of areas were the focus of our research. The possibility of a landscape model was created by fusing Landsat-7 data with XSAR-mission radar data (Fig. 6). With the landscape models, fly-over animations over the Euphrates and Jebel Bishri were presented at the British Museum conference *The Levant in Transition* in spring 2004.[61]

The sites on the mountain were largely of the types belonging to mobile people that had been identified in previous studies from 2000 and 2003. There were plenty of Palaeolithic and Epipalaeolithic finds. The sites, including previously discovered *abris* and hut bases reflected the mobility of the people. But both the corrals and the cairns/*tumuli* associated with pastoral economics became the most numerous of all the structures.[62] A presentation on the differences in archaeological remains on the mountain compared to the Euphrates Valley was given in ICAANE in Madrid in 2006: the mountain was littered with flint implements, while pottery was meagre in this desert-steppe region in contrast to the Euphrates terraces and valleys, which provided plenty of pottery. The mountain was clearly an arena of mobile people.

A number of Roman and Byzantine sites and roads were recorded and documented in 2004–2005, both in the central areas, the edges and the piedmonts. They became an important new

60 Lönnqvist – Törmä 2004b.

61 Lönnqvist 2009.

62 Lönnqvist et al. 2006a.


Fig. 7 GORS Satellite Atlas of Syria (courtesy: GORS)

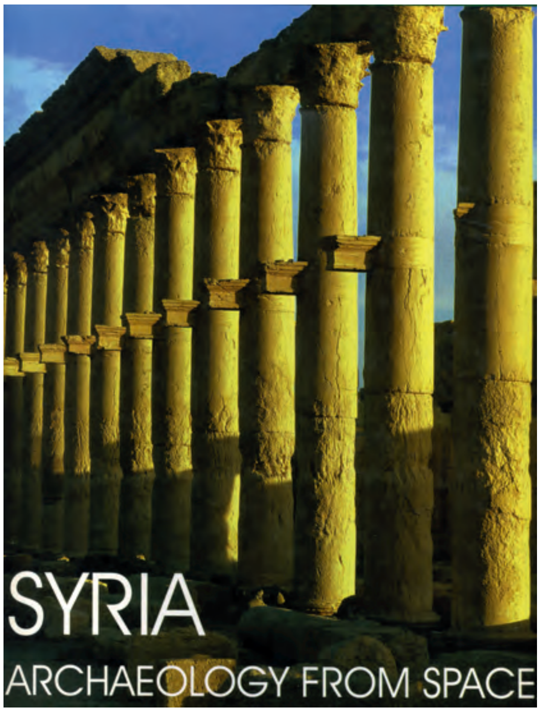


Fig. 8 GORS Archaeological Satellite Atlas of Syria (courtesy: GORS)

avenue of inquiry, diverging from the project's main theme. In the central area of the mountain, QuickBird images with high spatial resolution (0.6m) provided clues to the existence of a Roman military camp of the playing-card type with a *via principalis* running through the camp on the mountain. It seemed that there were lacuna in our knowledge on the Roman presence in the region of Jebel Bishri, and new evidence indicated the active presence of the Romans on the mountain, even if known historical atlases and maps depicted it as void of any Roman remains.

Roman roads and networking became important aspects in the area between Palmyra and the Euphrates. Small sites dating from the Roman period were traced on the mountain.[63] The impact of the Roman military presence in the border zone between Parthians, Sasanians and, later, Persians during the Roman and Byzantine era, and trade near the branches of the Silk Road, became clearer. The Late Roman-Byzantine fort of Tabus on the edge of the Euphrates was documented and studied.[64] Special viewshed analyses were carried out between Roman military sites using satellite imagery. The purpose was to study the possibilities of observation and signalling between the forts.[65] The preliminary report of the 2000 field season was published with the work from 2003 and 2004 in *KASKAL* in 2006, and the final report appeared in 2011.[66]

In 2004 the General Organisation of Remote Sensing (GORS) in Damascus invited SYGIS to present work on saving cultural heritage by using remote sensing in the conference *Remote Sensing and Development*.[67] Beside a satellite atlas of Syria, GORS had published an archaeological satellite atlas of the country (Figs. 7–8). Colleagues from Iraq, which had been at war since 2003, were able to participate in the conference.

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63 Lönnqvist et al. 2006a; see also Lönnqvist et al. 2011.
64 Lönnqvist 2005; Lönnqvist et al. 2005a.
65 Lönnqvist et al. 2005b.
66 Lönnqvist et al. 2006a; Lönnqvist et al. 2011; see also Silver et al. 2020.
67 Lönnqvist – Törmä 2004a.

### The Fieldwork in 2005 and 2006

In the spring of 2005 the principal investigator was invited to the universities of Halle-Wittenberg and Leipzig to present aspects of the archaeology of nomads and the results of previous fieldwork by the Finnish project on Jebel Bishri. During the visit, Prof. Felix Blocher expressed interest on the part of his students in participating in the fieldwork in 2005, which was agreed, and Dr. Michael Herles and Marcus Königsdörfer, MA, joined the project.

During the years 2005 and 2006 SYGIS concentrated on surveying on the Euphrates side of the mountain, although some defined sites were recorded and documented on the mountain with the aid of remote sensing and field visits. Palaeolithic sites were encountered in numbers on the Euphrates side. However, that area included major sedentary sites such as tells, some of which had not been studied earlier. More attention was paid to environmental impacts on mobility from a long-term perspective and the impact on Bedouin life following desertification by using satellite imagery. An invitation to participate in organising a conference in environmental management in Hyderabad in India was received in 2005. A paper dealing with the impact of desertification and Bedouin life in the region of Jebel Bishri from an environmental point of view was submitted for the conference,[68] and the subject was also discussed in the Geohazards symposium in the Geological Congress in Oslo in 2008. But the lives of the Bedouin and *fellahin* sites were also studied in relation to Jebel Bishri.[69] The shift in the mode of mobile life from a hunter-gatherer economy to pastoral nomadism became one of the avenues for seeing a long-term continuity of mobility, especially in the development of transhumance.[70]

The occupations of the tells on the Euphrates side dated from the beginning of the Neolithic/Chalcolithic occupation to the Bronze Age, some with Iron Age and Roman remains. A visible rise in sedentary sites, or sedentarisation, took place in the Early Bronze Age. Also Bronze Age *tumuli* were especially numerous on the Euphrates-side piedmont; some showed a cultural connection to the Middle Bronze Age kingdom of Mari. In the studies of 2003 and the surveys of 2005 and 2006 Tell Tibne, in combination with the peninsula of Halabiya, provided important signs of Chalcolithic, Bronze Age and Roman/Byzantine occupation (Fig. 9). Its association with the Sumerian world, trade along the Euphrates and the cultural ties to the kingdom of Ebla were traced.[71] A previously unknown site of Tell Kharita was identified, also recorded and documented at the foot of the mountain. This interesting site had an integral relationship with the mountain, being on its piedmont. It seems to have been occupied by nomadic groups, apparently West Semites such as Amorites and Arameans, as indicated by pottery and an inscription discovered at the site. The position of the new tell in relation to the changes in the Euphrates channel was approached from the satellite images, like CORONA photographs and Landsat images.[72] Amorite and Aramean connections were studied in texts in relation to new findings.[73] The finds at tells discovered by SYGIS on the Euphrates side, along with the studies by the Syrian-Japanese project led by Katsuhiko Ohnuma,[74] provided new data on the impact of the Early Bronze Age sedentarisation in the area. The contact between these sites on the right bank of the river can be characterised as a symbiotic relationship with the mountain and its grazing grounds, like today.

As already mentioned, several sites on the Euphrates side and the mountain also consisted of Roman-Byzantine military remains: roads, camps, a post and houses were mapped and photographed. The preliminary report from 2005–2006 was published in *KASKAL* 6,[75] and the final

68 Lönnqvist – Törmä 2006.
69 Lönnqvist et al. 2009b.
70 Lönnqvist 2014.
71 Lönnqvist et al. 2011.
72 Lönnqvist et al. 2007.
73 Lönnqvist 2010; see also Patriarchal narratives in Lönnqvist – Lönnqvist 2012; Silver 2016c; Silver 2019.
74 Ohnuma 2010.
75 Lönnqvist et al. 2009b.

results came out in 2011.[76] A special ‘Bishri corridor’ of Roman military supply was traced.[77] It has been observed in the Levant that there is a peak in site finds in the Chalcolithic and Bronze Age as well as Roman/Byzantine times in steppe areas.

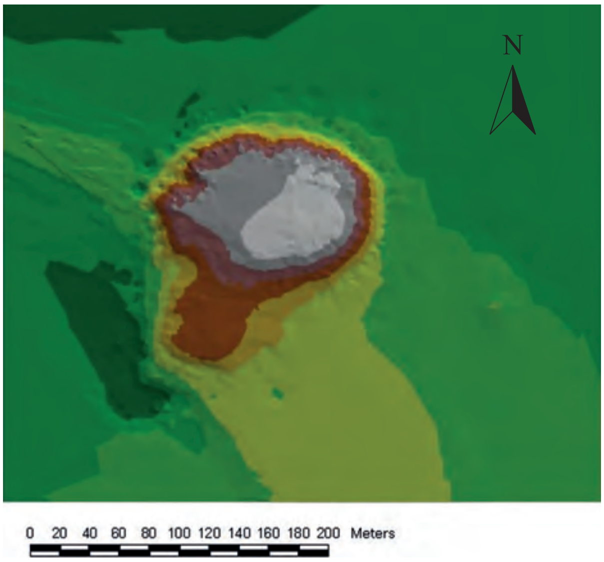


Fig. 9 Model of Tell Tibne below Jebel Bishri (constructed by Jari Okkonen)

### Studies in 2007–2010

Several archaeological study visits were made by SYGIS to Syria and Jebel Bishri during the period 2007–2009. At that time, two archaeological projects that based their research strategy on SYGIS after being involved with the Finns were established in the region of Jebel Bishri and the Palmyrena: a Syrian-Japanese and a Syrian-Norwegian project. They were joint projects, and in the Norwegian team the members were partly the same as in SYGIS. The Norwegians had initially learned about the region, remote sensing with satellite imagery and the GIS methodology used in the Finnish SYGIS project.

In 2007–2009 additional studies of corrals, animal pens, were carried out by SYGIS for a site catchment analysis based on QuickBird image data from the central areas of the mountain. Corrals and a possible kite site were checked and studied on the mountain. The studies were first published at the CIPA-Kyoto conference.[78] More attention was also paid to environmental impacts on Bedouin life by using satellite imagery and studying the local life of the Bedouin tribes. A paper on the subject of desertification was included in the International Conference on Environmental Management in Hyderabad in India.[79]

Syrians invited SYGIS to participate in the Geological Congress in Oslo to present studies on environmental hazards by using remote sensing in archaeological studies in 2008.[80] Furthermore, the approach and studies were developed and presented at the ICAANE conference in Rome in 2008.[81] In 2007–2008 SYGIS also presented studies on the environmental impacts of changes to the Euphrates’ river channels on the sites along Jebel Bishri. Historical accounts on Arameans were added, as there was information on Assyrian campaigns against them in the neighbourhood associated with the river channel and sites along it.[82] In 2009 the project was invited to a Tokyo conference dealing with tribal groups in the area of the Middle Euphrates organised by a Syro-Japanese project that has been working in the footsteps of the Finnish project on Jebel Bishri. A presentation was given about the possible appearance of tribal variation and the chiefdom system in tomb types of Jebel Bishri.[83]

Full efforts were invested in the prompt publication process. The Finnish project had a valid research license until 2009, and the project ended in 2010. In autumn 2010 the principal investigator was invited to participate in the seminar of the German project *Focus Fortification* at the Danish

76 Lönnqvist et al. 2011.
77 Lönnqvist et al. 2011, 269–296; see also Silver et al. 2020.
78 Lönnqvist et al. 2009a; see also Lönnqvist et al. 2011, 167–178.
79 Lönnqvist – Törmä 2006.
80 Lönnqvist et al. 2008.
81 Lönnqivst et al. 2010a.
82 Lönnqvist et al. 2007; Lönnqvist 2010; Silver 2019.
83 Lönnqvist et al. 2010b.

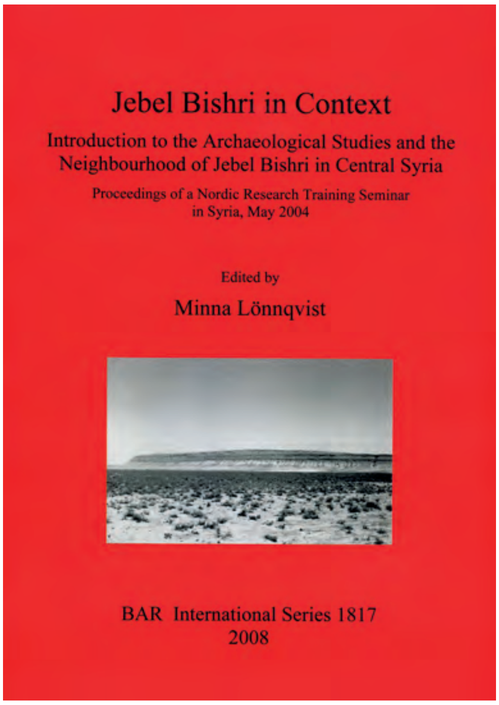


Fig. 10 Introduction to the studies of Jebel Bishri published in 2008

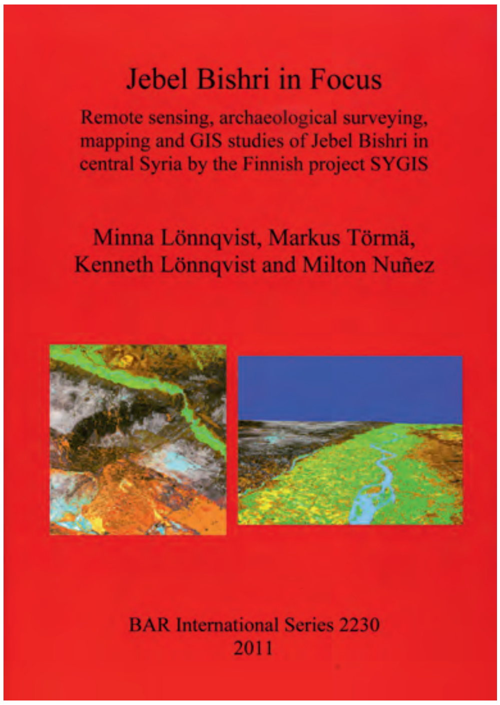


Fig. 11 The final SYGIS report published in 2011

Institute of Damascus in Syria by the German Archaeological Institute (DAI), the University of Berlin and the Danish Institute of Damascus. That was the last visit by the principal investigator to Syria before the Arab Spring of 2011. The final report of the Finnish project *Jebel Bishri in Focus* (Fig. 11),[84] including archaeological prospection, field surveying, ethnoarchaeology and mapping with satellite imagery by applying GIS, came out in the summer of 2011 in the BAR International Series. After the uprising had turned into the civil war, ISIS/ISIL captured all the areas studied by SYGIS, and Raqqa became the capital of the short-lived caliphate of the jihadists. The future will show to what extent the area of Jebel Bishri suffered destruction and looting.

## Aftermath of SYGIS

After the SYGIS project, further archaeological studies pertaining to the neighbourhood of Jebel Bishri were carried out based on the captured data. Therefore, articles emerging from the project results followed. Leads for new studies on the earliest state of the Amorites known as Mar.du-ki mentioned in the Ebla texts were traced with the new data. From the SYGIS surveys, Assyriological sources related to Jebel Bishri, and archaeological studies of Tell Bia/Tuttul,[85] Abu Hamed[86] and Ghanem Ali[87] at the foot of Jebel Bishri by Syrian-German and Syrian-Japanese missions, a new picture of the Amorite existence and development to statehood was emerging. The results were presented in the Amorite conference at the Oxford ARAM Society in 2011, a conference that

84 Lönnqvist et al. 2011.
85 E.g. Strommenger – Kohlmeyer 2000.
86 Falb et al. 2005.
87 Ohnuma 2010.

the principal investigator had organised with the society.[88] Climate change and its impact on the Amorites and their sedentarisation process were further studied.[89]

In addition, areas in Jebel Bishri were targeted for landscape modelling to visualise the terrain of Jebel Bishri by remote sensing. Satellite imagery can be used in studying archaeological landscapes, and topographic features attained by radar data.[90] The QuickBird image data was fused with ASTER-DEM data, resulting in very natural-type landscape models of the steppic areas. This was due to the high spatial resolution of QuickBird, allowing photo-realistic texture for the steppe areas in modelling.[91] Invisibility of the mobile cultures, such as those of hunter-gatherers and pastoralists, in archaeology were challenged also by further remote sensing studies of the region.[92]

Studies of road alignments appearing in satellite imagery, deviating from Palmyra and connecting areas on the Euphrates and the Palmyrides had been presented in the London ICAANE 2010 but were published in the CIPA heritage proceedings of the Taiwan symposium in 2015.[93] Furthermore, viewshed analyses of tower tombs appearing in the Palmyra district and Syro-Mesopotamia were carried out and also presented in Taiwan, and these appeared in the proceedings of CIPA in 2015.[94] Incidentally, the presentation took place on the eve before ISIS destroyed the tower tombs in Palmyra – tombs that had stood for two thousand years. When the news reached the Taiwan conference, nobody could believe that such actions were real.

Comparisons of the findings in the region of the two major rivers, the Middle Euphrates including Jebel Bishri, and the Jordan, dating to the Intermediate (Early) Bronze Age (or also known EBIV, EBIV/MBI and MBI) were presented in an ARAM conference dealing with the River Jordan that took place in Oxford in 2015. The cultural connections are visible in shaft tomb types, pottery and metal objects. The article was published in ARAM in 2017.[95] Furthermore, an article dealing with the Aramean impact in the region of Jebel Bishri was submitted to ARAM in 2019.[96]

The SYGIS studies on the Roman eastern frontier zone and Palmyra had become part of the remains recorded and documented during the project, when all the periods had been taken into account equally in the survey. The principal investigator joined in the Finnish-Swedish project to study further the Roman frontier in Mesopotamia on the Turkish side.[97] A larger picture of some unstudied remains and alignment of the frontier started to emerge through remote sensing and fieldwork. The Roman frontier, including surveys in Syria and Turkey, was therefore chosen as the subject of an article submitted for publication in a book studying the use of remote sensing in saving cultural heritage.[98]

Palmyra was sacked and its monuments and museum finds were destroyed by ISIS/ISIL in 2015–2017. Together with professors Gabriele Fangi and Ahmet Denker, the principal investigator published the monograph *Reviving Palmyra in Multiple Dimensions: Images, Ruins and Cultural Memory*[99] dealing with Palmyra and its digital revival with 3D modelling and virtual worlds in the context of Jebel Bishri and the Palmyrides.

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88 Silver 2014.
89 Lönnqvist 2010; Silver 2016a.
90 See Comer – Harrower 2013; Silver 2016b; Silver et al. 2019; Hadjimitsis et al. 2020.
91 Lönnqvist et al. 2012.
92 Silver et al. 2019. The subject was also earlier dealt with as an invited presentation by the author in World Heritage Strategy Forum at Harvard University in 2016. See <http://digitalarchaeology.org.uk/world-heritage-strategy-forum-2016> (last accessed 13 Oct. 2020).
93 Silver et al. 2015a.
94 Silver et al. 2015b.
95 Silver 2017.
96 Silver 2019.
97 Silver et al. 2017.
98 Silver et al. 2020.
99 Silver et al. 2018.

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# Documenting Syrian Built Heritage to Increase Awareness in the Public Conscience

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**Abstract:** The Laboratory of Geomatics for the Environment and Conservation of the Cultural Heritage (GeCo Lab) has been involved in two projects in the past that led us to work in Syria. Both of them were funded by the European Union: 'Coupoles et habitats. Une tradition constructive entre Orient et Occident', in 2007 and 'Mare Nostrum. A heritage trail along the Phoenician maritime routes and historic port-cities of the Mediterranean Sea', in 2009. As geomatics experts, we contributed by collecting spatial data and preparing graphical output aimed, through a multi-scale approach, at documenting construction details, buildings and parts of cities that today are probably severely damaged, if they still exist at all. Different approaches were followed in the projects: in the first one, a top-down approach, the core goal of the project being to analyse the construction system of earthen buildings in villages in the north of the Syria, which was carried out by an interdisciplinary and international team of experts; in the second one, a bottom-up approach, the Mare Nostrum project aiming to provide a sustainable mechanism for the protection and management of cultural heritage resources, leading to an awareness of cultural heritage in the public conscience. The project involved experts from universities, local public authorities, guides and tour operators, teachers and students, with the aim of boosting public interest and pride in the Syrian people's cultural identity.

**Keywords:** 3D metric survey; digital heritage; cultural mapping; laser scanning; geomatics; Syrian heritage; European projects

## Introduction

Between 2007 and 2011, with the Geomatics for the Environment and Conservation of the Cultural Heritage Laboratory, we had the chance to work in Syria, participating in two projects funded by the European Union. We travelled there several times before the onset of the troubles that have overturned the Syrian people's lives. At the time, we did not think that we were appointing ourselves to a bigger challenge: war means the sudden destruction of people, buildings, traditions, social identity and so on. The projects we are presenting here became more important than they were expected to be: they are not only an interesting opportunity to increase knowledge and become more conscious of the tangible and intangible heritage of a fascinating country, but we can now consider them as the opportunity to rebuild villages and a way of life, to save and transmit knowledge and proficiencies to the next generation.

The first project ('Coupoles et habitats'[3]) was about earthen domes and habitats in the northern region of Syria and it started in 2007. Since earth is the world's most accessible building material, earthen buildings vary in form, style and technology, and they contain an intangible tradition that has, in many cases, been continued through the generations. But earth is fragile and requires

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proper and regular maintenance. Recording traditional and local typologies and their decorations was intended as the first step in saving important know-how, still common in the small villages we visited but increasingly at risk. The aim of the project was to respond to the urgency to record and document this information, their 'language' as John Hurd, then president of the ICOMOS Committee for Earthen Architecture said.[4]

'Mare Nostrum. A heritage trail along the Phoenician routes and historic port-cities of the Mediterranean Sea' is the second project, and it started in 2009. As geomatics experts, we contributed by collecting spatial data and preparing graphical output aimed, through a multi-scale approach, at documenting construction details, buildings and parts of cities that today are probably severely damaged, if they still exist at all.

## Project Approaches

Different approaches were followed in the projects: in the first one, a top-down approach, as the core goal of the project was to analyse the constructional system of earthen buildings in villages in northern Syria, carried out by a multidisciplinary and international team of experts; in the second one, a bottom-up approach, as the Mare Nostrum project aimed to provide a sustainable mechanism for the protection and management of cultural heritage resources, leading to an awareness of cultural heritage in the public conscience. Beside the team of technical experts, local public authorities, guides and tour operators, teachers and students were also involved, with the aim of boosting public interest and pride in their own cultural identity.

## Coupoles et Habitats

This project responds to an increasingly important need: the growing necessity to learn from vernacular architecture, the techniques and materials, not only to register this information as historical knowledge and archival documentation, and to protect this patrimony, but also to design and construct new sustainable buildings using what is natural and local. The project was based on interdisciplinary scientific research linking an in-depth study of local architecture, the representation of architectural knowledge, and theoretical and experimental scientific analysis and interpretation.

### Who

The project was developed through a close cooperation and partnership between the Syrian authorities in charge of culture and heritage and a group of specialised European institutions with complementary profiles and competencies (universities, research, promotion and training centres in the field of cultural heritage). The profiles of the researchers and technical experts complemented each other in terms of archaeology, architecture, building technology, geomatics and mechanics.

The project leader was the University of Florence (Italy), and Prof. Saverio Mecca was the head and coordinator of the project. The other partners were:

- Directorate General of Antiquities and Museums, Syria;
- Hellenic Society, Greece;
- University of Liège, Belgium;
- Polytechnic University of Valencia, Spain;
- École d'Avignon, France;
- CNR – ICVBC, Italy;
- Culture Lab, Belgium.

[4] Hurd 2009.

### What

The core goals of the project were:

- to document this unique landscape, the expression of the complex relationship between the environment, people and architecture over thousands of years;
- to examine the common roots between East and West demonstrated by the astonishing diffusion of corbelled architecture all over Europe and the Mediterranean;
- to experiment with and test an interdisciplinary approach to the analysis and valorisation of knowledge systems known as Vernacular Architectural Heritage.

The final goal of the project was, therefore, to increase the perception and consciousness of the value of this local earthen architectural heritage in an effort directed towards the sustainable development of this region.

### Where

The interdisciplinary research started with the in-depth study of local architecture during an on-site mission in May – June 2008, where all the experts worked on different aspects of the architectural heritage.

The fieldwork focused on the analysis of three geographic areas of northern Syria:

- the west region of Lake Jabboul,
- the west region of Lake Al Assad,
- and the east region of Hama.

### How

The tools used in this first approach were:

- technical sheets for the identification, documentation and analysis of the urban and architectural morphology of villages, architectural morphology of houses, building technologies, building elements, building pathologies and causes, lifestyles;
- metric survey: manual methods, topographic methods, laser scanning, photogrammetry;
- mechanical testing;
- sampling of materials;
- interviews with builders and inhabitants.

The fieldwork produced a large set of data and qualitative and quantitative information, which provided the basis for more traditional scientific analysis and interpretation through the collaboration and integration of different scientific approaches to the urban, architectural, technical, archaeometrical, structural, geographical and environmental dimensions. The different scientific activities were organised so that all of the partners collaborated in a multi-directional way, by sharing data, information and knowledge, all converging at the project goal: to analyse and model the vernacular architecture knowledge system.

## The Role of Geomatics

The geomatics teams were required both to collect primary data, complying with the requirements of other experts, and to define the data recording and management tools.

In multi-disciplinary teams, geomatic techniques can be used, first of all, to construct a reference base that enables all members to meaningfully participate in both investigative procedures and project development and application.

Fig. 1 The adopted solution for closing the top of the vault (inner view), the arrangement of the brick can be read easily in the 3D model (© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

The regions were studied at several scales of investigation in order to obtain a complete analysis. The need to provide documentation at different scales highlights the usefulness of integrating various levels of detail in the same project.[5]

## Metric Documentation

Metric documentation of the cultural heritage requires a thorough understanding and careful observation of the site, and suitable graphic output using the data collected, as well as dimensional quantification with appropriate instruments.

In the belief that complexity is an inspiring challenge and that contingent difficulties constitute an effective stimulus to finding better solutions, here is a list of some of the factors that we had to take into account:

- preliminary knowledge of the investigated villages was limited, so a certain flexibility was required when setting up the on-site survey operations;
- instrument use was constrained by environmental and climatic conditions;
- the presence of experts from diverse fields highlighted the existence of different requirements for spatial data collection.

The need to provide documentation at different scales highlights the usefulness of integrating various levels of detail in the same project.

The most basic form of documentation is inventories. They require a low level of detailed analysis and produce 'identification': in our case every village first had to be identified, then geo-referenced and stored. By contrast, a high level of detailed analysis provides highly detailed 3D models, where the resolution is such that even the texture of the constituent materials is described (Fig. 1). The level of detail of the various investigations performed in the Syrian villages was often in the middle range, consisting of:

5 Tucci et al. 2009.


Fig. 2 Record of the structure of the buildings that make up the village. The buildings can be considered modular. This approach highlights only the most relevant dimensional differences of the cells (graphics elaborated on the basis of aerial images by Vegas et al. 2009)


Fig. 3 Considering the laser scanning survey of a single dwelling, it is instead possible to distinguish larger and smaller modules (the first are generally used for dwellings or as stores, the second as kitchens, ovens or secondary rooms), to identify the open areas associated with the modules, ascertain the position of the mastaba and indicate the presence of external dividing walls (plan and elevation of the dwelling studied in Joub Maadi village, graphics elaborated on the basis of a laser scanning survey) (© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

- positioning the various villages in the territory;
- documenting the arrangement of the settlements, i.e. the spatial relations between the residential units which, despite being quite autonomous, share 'pseudo-urban' spaces (Figs. 2–3);
- surveying single dwellings, including the rooms used for living, the central court and the accessory structures (oven, stores, animal shelters) (Fig. 4);
- documenting the technological and structural characteristics of a typical cell (Fig. 5–6).

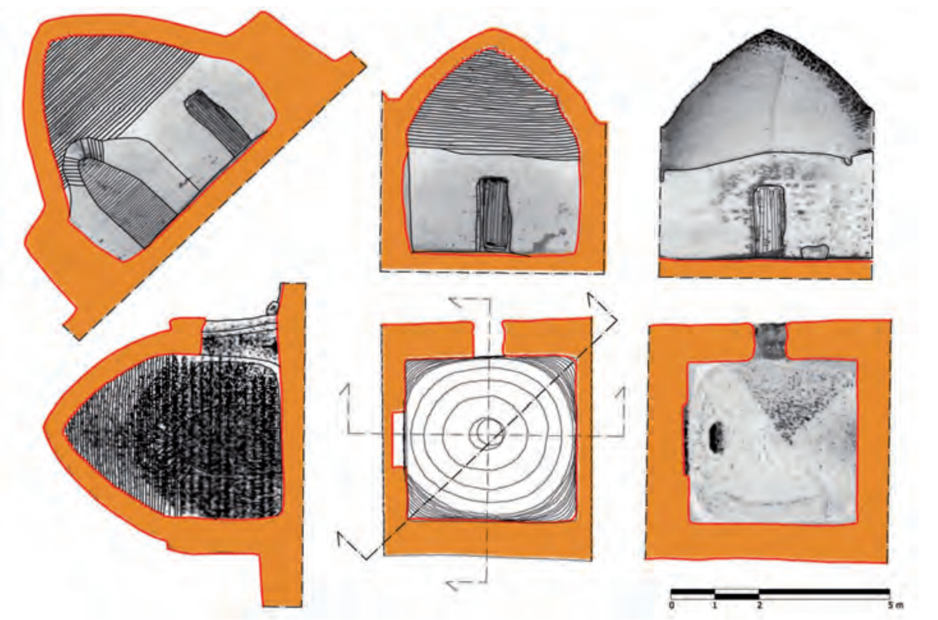

Fig. 4 Large-scale drawings of a single residential unit in the Oum Aamoud Seghir village. The horizontally laying bed dome is made of superimposed, progressively jutting rings of sun-dried bricks and raw earth mortar, making the construction process self-supporting (Paglini et al. 2009a)

Fig. 5 Views of 3D laser scanning models: the interiors of the residences have no fixed furniture and objects are usually placed in niches. There are some very small cavities, arranged in a sequence (left), some the size of a window, or niches that rise from the floor to the height of 1–1.50m (© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

Fig. 6 Different 3D solid models were realised for different purposes: on the left, an earthen scale model building used for analytical and numeric assessment of the static performance of the devices based on specific hypotheses (Paglini et al. 2009b); on the right a small-scale 3D model printed using a coloured filament, made for communication purposes (didactic, exhibitions, support for disabled people, etc.) (© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

## Mare Nostrum

The ‘Mare Nostrum. A heritage trail along the Phoenician maritime routes and through the historic port-cities’ project was a large European Union project on cultural heritage and urban regeneration, which aimed to bolster the sites involved by promoting and supporting sustainable tourism.

Site-specific sets of actions were developed in order to make both the tangible and intangible heritage more meaningful to the local communities and to make places more accessible for locals and tourists.

### Who

Six Mediterranean countries participated in the Mare Nostrum project: Greece, Italy, Lebanon, Syria, Malta and Tunisia. The cities in the Mare Nostrum network have a common Phoenician origin that can still be seen nowadays in their historical heritage, and all of them have a strong relationship with the Mediterranean Sea (Figs. 7–8).

### What

The goal of this project was to valorise the cultural heritage of the sites involved by promoting and supporting sustainable tourism. The multi-disciplinary team approached the issue from different

Fig. 7 An international meeting during the ‘Mare Nostrum’ project
(© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

Fig. 8 Training the local team during a participatory photographic workshop
(© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

points of view, but with common aims: to contribute to raising public awareness of the preservation and promotion of the Mediterranean port city and archaeological sites along the Phoenician ring-thread routes in a past-present continuum; to promote initiatives for community participation in decision-making to design culturally, physically and visually accessible Mediterranean port city sites by re-interpreting the spaces as new places of life; to promote the rediscovery and, in a historical past-into-present overview, the re-shaping of the local tangible and intangible heritage through different means of awareness-raising, in view of connecting Mediterranean port city sites along the Phoenician ring-thread routes; to trace specific educational paths along the historical role of the cities involved in the project in Mediterranean culture; to strengthen and address the actions of the local authorities/governments to preserve and regenerate the tangible and intangible heritage of their areas, through shared and integrated sustainable tourism plans for new tourist itineraries; to suggest new port city site designs – that show their past-present continuum – integrated with the urban fabric and archaeological sites; to promote Mediterranean handicrafts and safeguard their design and production.

## Where

One case study was chosen for each country and some activities were carried out only on selected sites. The project was divided into different 'work packages'. The fourth, which was the responsibility of the University of Florence, aimed to design and analyse the port-city site 'heritage trail' at the local and Mediterranean levels, with regard to socio-physical elements in particular. Information and material were selected with regard to safeguarding and regenerating archaeological sites. The geomatics team's work in Syria concentrated on the port city of Tartous (including the nearby Arwad Island, which is already on the World Heritage Tentative List) as a pilot site. Tartous is the second most important city on the Syrian coast and before the conflict it was the main centre of a network of important points of interest for culture and tourism. Tartous and nearby Arwad Island have the distinction of being the last Crusader strongholds in the Middle East; however, not much remains of the Phoenician Antaradus (Anti-Aradus – the town facing Arwad), the mainland settlement that was linked to the more important and larger town on Syria's only offshore island, Arwad. The few Phoenician ruins that remain on the mainland are at the nearby site of Amrit. Today, within the citadel, the urban structure is constituted by the vertical overlay of various stone structures – remains of galleries, fortifications, the hall and the chapel of the crusader fort, and new housing built on the ruins of the medieval city.

## How

The project goals were achieved by:

- development of a methodology for the definition of a tourism integration plan based on two pilot projects implemented in Rhodes, Greece and Tyre, Lebanon;
- publication of a Vademecum of Participatory Planning in the Mediterranean Sea Areas;
- design and realisation of an awareness-raising campaign and an appropriation process – various competitions with school children and students of architecture and graphic design, exhibition of the results;
- development of cultural trails in the six partner cities – including signage, maps, brochures – and training of guides and promotion of trails with the tourism sector;
- development of an online virtual tour for each city;
- identification and establishment of a network of artisans and craftsmen in the port cities;
- organisation of regional traditional markets and creation of the Melkart label for branding the project's products;
- conservation guidelines, specifically related to the activities of work package 4.

## The Role of Geomatics

The contribution of geomatics not only consisted in the application of the latest information technology procedures but also created a new methodological approach within the data acquisition and management process. Graphic, cartographic, iconographic and bibliographic material was gathered for the pilot sites and so, after an inspection, it was possible to define the area in which to concentrate the on-site research: on the one hand, a survey campaign was set up to acquire metric and qualitative data on the structures chosen as samples. This provided the necessary information for the systematic analysis (chronological phases, construction techniques, state of preservation) required for preparing conservation guidelines. On the other hand, an enormous amount of photographic and video documentation was collected: digital images, panoramic images for virtual tours and stereoscopic images (Figs. 9 and 10).

Fig. 9 Spherical panorama of the galleries in Tartous
(© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

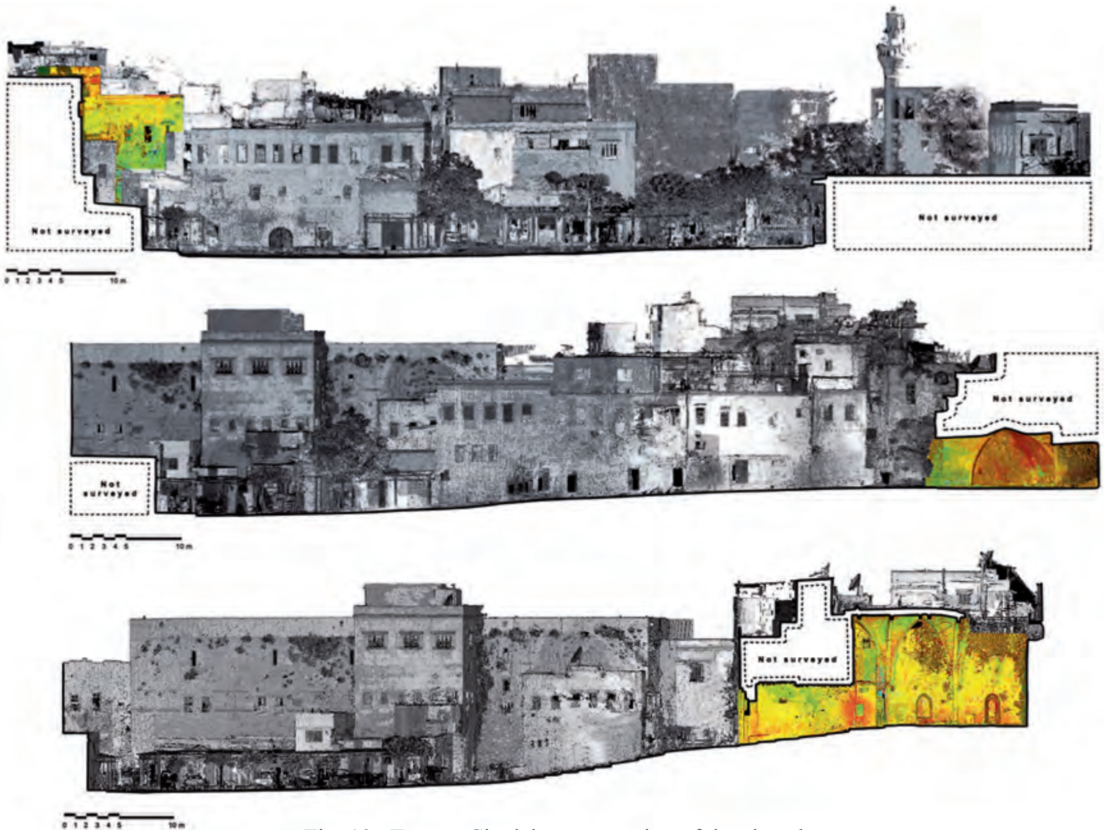


Fig. 10 Tartous Citadel, cross-section of the chapel
(© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

## Metric Documentation

The metric surveys and studies of the materials and construction techniques were mainly carried out in the old city of Tartous. The urban fabric has a complex structure because of its pronounced vertical stratification. The Knights' Chapel and the cross-vaulted galleries, both situated in the inner circle of the city walls, and a part of the wall circle were chosen because at that time they had the best preserved Crusader architecture. Three-dimensional metric surveys were carried out to document that part of the city as well as to detail wall textures (Figs. 11–13).

## Non-metric Documentation

The most interesting parts of Tartous, and the surrounding areas (Arwad Island and the archaeological site at Amrit) were photographed. About 60 panoramas were stitched and then

Fig. 11 3D model of the galleries in Tartous
(© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

Fig. 12 Scanner setting in Tartous
(© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

Fig. 13 Tartous Citadel, with the main monuments in colour and the urban fabric in grayscale (© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

linked together in a virtual tour published on the internet. At the same time, stereoscopic images were collected on the main building and some decorative elements (Fig. 14). Digital image recording has a high communication potential, enabling the preparation of virtual tours, integrated video and multimedia products, valuable material for improving the communication capabilities of websites, etc.

Fig. 14 An example of non-metric documentation: a stereoscopic image of a capital (© Geomatics for Environment and Conservation of Cultural Heritage Laboratory)

## Shared Cultural Mapping

There has always been a direct relationship between tourism and cartography: maps of travel routes and general information about the areas to visit are used to select the destination and plan travel and stays. Cultural mapping is a process of collecting, analysing and summarising information in order to describe the cultural resources, networks, links and usage patterns in a community.

A cultural mapping project was set up in Tartous, although it was interrupted shortly afterwards due to the conflict. The first stage of the project was to build a mapped catalogue of the most relevant tangible and intangible cultural features of the city. This process aimed more to build knowledge for planning activities than to produce an effect on the population’s identity. The knowledge produced by this mapping was mainly built by looking at Tartous’s past. This did not mean that the mapping activities would focus exclusively on the historical heritage: contemporary cultural activities and features were also to be mapped, and they would comprise part of the basis for planning the future development of the city. Overall, the main objective was to provide new value to those cultural features maintaining a connection with the past. Finally, this cultural mapping tactic could be viewed as a way to promote exogenous attention to Tartous's heritage. The city of Tartous today needs to undergo a new and far-reaching regeneration process, and participatory experiences such as those started with the Mare Nostrum project should be helpful.

## Conclusions

The goal of the projects presented here was to investigate the sites from a technical point of view and to boost the cultural heritage of the places involved by promoting and supporting sustainable tourism.

At the time the projects were developed, we focused our attention on conservation management planning and on the model for sustainable valorisation. These could be integrated to develop a new model wherein heritage serves as the core of the development process.

Nowadays, with the country at war, new needs arise and the spatial data collected in the past bears witness to parts of cities, villages and monuments, but also construction techniques, ancient materials and lifestyles, that have been destroyed. As a result, they can be considered their digital memories.

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# European and American Collective Initiatives

# s h i r ī n: What Place for Archaeology and Archaeologists during Wartime?

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**Abstract:** s h i r ī n is an initiative by the global community of scholars active in the fields of archaeology, art and history of the Ancient Near East. It brings together a significant proportion of the international research groups that were working in Syria prior to 2011, with the purpose of making their expertise available to heritage protection efforts. It seeks to represent the broad sweep of archaeological and historical research in Syria. s h r ī n collects information on damage resulting from the current conflict and identifies those cases in which emergency repairs or protective action may be required. s h r ī n also collaborates on the creation of comprehensive databases of elements of Syrian heritage (for example, sites and museum catalogues). By involving the international research community now, s h r ī n intends that this capability will be fully formed and thus ready to support the local authorities and communities when the emphasis shifts from safeguarding and the documentation of damage towards restoration and reconstruction.

**Keywords:** Syrian heritage; damage assessment; sites database; digitalised inventories of museums

## Introduction

The community of archaeologists has been one of the most influential and numerous of all the scientific communities collaborating in Syria during the last 50 years. In 2011, there were 109 field projects at over 107 sites, 51 joint projects, six Syrian national projects with foreign partners, plus dozens of surveys and joint projects and at least 20 museum artefact studies; that is, there were about 1000 foreign researchers working in collaboration with approximately 100 Syrian researchers. This international collaboration made Syria an essential and major 'knowledge zone' for human history and oriental civilisations from the Lower Palaeolithic to the 19$^{th}$ century.

This international scientific cooperation has a long history. After a period of continuation of the Mandate's model after Syrian independence in 1946, the sixties opened a new era. In the area of the Tabqa dam, archaeological survey since 1963 and five new excavations since 1965 have allowed a new generation of foreign researchers to be part of the international community working in the field in Syria. The 9$^{th}$ International Congress of Classical Studies, held in Damascus in 1969, was the occasion of a second large-scale call to international collaboration, launched by the Directorate-General of Antiquities and Museums of Syria (DGAMS). Next, rescue excavations at the Tabqa dam site, with the support of UNESCO since 1971, initiated 25 new projects.

These scientific policy choices by Syrian authorities have been followed with great consistency by successive officials of DGAMS up until today. The policy can be characterised as follows:

- opening up to international cooperation, with the objective of building joint research teams (field projects and the study of museum collections),
- new development of doctoral training of young Syrians abroad – already initiated in the 1950s – by establishing an increasing number of scholarships (c. 10 each year over the last decade) associated with pre-recruitment in universities and DGAMS services.

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Obviously, the increase in collaborations initiated in recent decades comes with obligations and responsibilities that need to be defined. The scientific record and archives of Syrian Heritage are, for a large part, abroad. They must be managed and protected, as well as made accessible and available to Syrian authorities and researchers. Many Syrian colleagues and students live abroad because of the war. The international partners must facilitate by any means their lives and safety in our countries. DGAMS has continued to work without interruption since 2011; we must also carry on with the cooperation and the development of new ways to conduct future projects.

shirīn can play a crucial part in facilitating present and future projects. shirīn – Syrian Heritage in Danger: An International Research Initiative & Network – is an initiative of the global community of scholars active in the fields of archaeology, art and history of the Ancient Near East. It brings together a significant proportion of the international research groups that were working in Syria prior to 2011, with the purpose of making their expertise available to heritage protection efforts. Its international committee includes the directors of a number of long-term international research programmes and others who share their strong commitment to the effective protection of the heritage of Syria.

The shirīn committee was created in response to a request by the participants in a special workshop at the 9th International Congress on the Archaeology of the Ancient Near East (ICAANE) in Basel, Switzerland, on 10 June 2014. It seeks to represent the broad sweep of archaeological and historical research in Syria and is also supported by the directors of research programmes active in neighbouring countries. shirīn national committees now exist in seven countries: Australia, Belgium, France, Germany, Switzerland, the United Kingdom, and Poland. These committees make possible enlarging shirīn audiences locally. The main aims they have in common are:

1) facilitating national initiatives for welcoming and training visiting Syrian colleagues;
2) collecting, maintaining and making available scientific archives of Syrian heritage in each country;
3) providing scientific expertise on Syrian artefacts and illicit trafficking; and 4) maintaining research projects on Syrian history and archaeology.

Representing major institutions, universities and research centres in Europe, North America, Oceania, and eastern and western Asia, the main purpose of shirīn is to support both government and non-government organisations in their efforts to preserve and safeguard the heritage of Syria (sites, monuments and museums). It takes account of, and responds to, the needs of Syrian colleagues and authorities, regardless of their political, religious or ethnic affiliation, in particular, with respect to emergency steps and measures. shirīn also includes members with long and profound experience of architectural and artefactual restoration, and specialists in all periods of the history and prehistory of Syria.

We must now acknowledge the constant and remarkable action of DGAMS since the conflict in Syria began. Continuing to pursue its fundamental mission of public service to the State, the management team of DGAMS was not only able to keep the institution in operation, using its own means, but also ensured the preservation of a large number of objects in museums and the protection of some sites and monuments. Their success was aided by DGAMS's own development of new methods to manage and analyse heritage through the computerisation of inventories and GIS mapping. DGAMS also ensured communication continued with the Syrian public and international audiences, both in 'mainstream' media and through the scientific community. It is also noted that in recent years DGAMS officers have continued their field research wherever possible. The directorate has always kept its communication channels with foreign teams open in order to share information, and this should be commended. We must, at the same time, emphasise the presence and strong involvement of Syrian colleagues in many initiatives outside Syria – an involvement maintained in constant cooperation with research stakeholders. These collaborations are essential to the continued participation of the Syrian team in global discussions.

By involving the international research community now in the ongoing efforts of Syrian colleagues, we intend that this capability will be fully formed and thus ready to support local authorities and communities when the emphasis shifts away from safeguarding and the documentation of damage towards restoration and reconstruction. Composed of scholars who, individually, have a profound knowledge of the field and, collectively, cover all regions of Syria, shirīn will activate local networks in order to collect information on damage (primarily to excavated sites) resulting from the current conflict and identify those cases in which emergency repairs or protective action may be required.

shirīn collaborates on the creation of comprehensive databases of elements of Syrian heritage: the archaeological sites database Historic Environment Record (HER) and the Digital Inventories of Museums of Syria (DIMS). The databases will provide a basic core of knowledge to which evidence of damage can be added on a case-by-case basis. They will also allow the evaluation of the overall pattern and scale of damage resulting from the conflict as it presents across different regions of Syria and the various classes of monument. They will thus be a key source of information that can be made available to those involved in heritage protection at a local level so that they have the knowledge necessary to prioritise heritage protection efforts in a systematic manner. shirīn is preparing for the post-war period by building cooperative tools which will facilitate archaeological heritage management in the future.

## Damage Assessment on Excavated Sites

shirīn was aware of long-term damage assessment work conducted by DGAMS and a number of NGOs, including APSA and Heritage for Peace, and damage assessment projects funded by organisations in the USA (ASOR SHI) and Germany (SyrHer). We complemented these initiatives with a specific survey on excavated sites, because we are convinced that the best experts on such sites are the project directors. A confidential questionnaire was sent to 120 directors. A first campaign for collecting information (September–November 2014) received 56 answers, reporting various types of damage to 20 sites and 14 dig houses. A second campaign launched in April–August 2016 received 31 answers.

To complement this information, a shirīn volunteer made a systematic study of damage to sites by analysing satellite imagery. The review of 103 images provided under a cooperation agreement with UNOSAT and of online imagery (Google Earth and Bing) allowed a long-term (2010–2016) assessment of the situation of the sites, describing the history of major damage to 32 among them.

A global assessment document is now in preparation. The information has already been communicated to DGAMS, and ways in which it might also be shared with emerging international damage assessment databases (for example, SyrHer in Germany) are currently being explored.

## Historic Environment Record (HER) of National Sites and Monuments for Syria

This project aims to record basic information on each known site – the name(s), nature of the remains, different components of the site, periods present, history of work and publications, location (coordinates) and extent – outlined in a GIS layer over maps or satellite imagery. A HER will be of real value in tracking damage to Syrian heritage during the current conflict. It is conceived as a fundamental tool for providing up-to-date information on known heritage sites, to be used in rescue excavations once proposed developments become known through the planning system post-conflict. It must be ready as soon as possible. When the conflict ends, a single central record will make it easier to review the situation and undertake the protection efforts that will be essential in the reconstruction period. Without such a resource, efforts to manage, protect and prioritise Syria’s heritage and to deal effectively with threats (development, looting and neglect) will be held back. No existing database will work as a HER, because all were designed as research projects rather than heritage management tools. DGAMS is developing a sites inventory and cooperation is needed to enable information sharing to maximise efforts in this area.

Existing datasets provide information on ± 5000 sites; this is the main dataset used by DGAMS and other databases.

A HER would provide:

- a list of known heritage sites that should be monitored for damage assessment purposes;
- a valuable tool to assist with heritage management during post-war redevelopment – it would make instantly clear 'what' was 'where';
- the ability to identify areas where no sites have been recorded because they have not yet been surveyed – it tells you where you still need to look.

A HER will also help meet the expectations of international donor organisations that suitable mechanisms of heritage protection are in place when they assess possible developments.

A good part of the information required to create a HER for Syria already exists. An international initiative to use the archaeological survey data collected by research projects working in Syria in recent decades forms the basis of a sites and monuments record. A Franco-British initiative, in place since December 2012, became associated with shirīn in 2014. It seeks to create a database containing, in a first phase, around 15,000–20,000 sites across Syria. This project is based on a fusion of the data from 1) the 'Fragile Crescent Project' (FCP) (2008–2013 – UK Arts & Humanities Research Council), Tony J. Wilkinson, Graham Philip and Danny Donoghue, Durham University, UK; 2) 'Projet PaléoSYR / PaléoLIB' (2010–2014 Agence Nationale de la Recherche (ANR) France), Frank Braemer (CNRS, Nice) and Bernard Geyer (CNRS MOM Lyon); and 3) additional data provided by colleagues from surveys in other regions, such as the Euphrates and Balikh Valleys, and western Jazirah.

The HER today contains approximately 12,000 sites. A pilot version was made in 2014 by extracting data under Oracle. It integrates within a single interpretative GIS/database framework field data, imagery data and cartographic data. The data is recorded in eight fields: site name(s); original data source and id; location; features; size; period; certainty; and co-ordinates. Conventions have been agreed upon for site names (more than one per entry is possible), date-periods, and site-certainty.

It is well known that combining data from different sources can have its own problems. With this in mind, the HER project is undertaking a rigorous data checking/cleansing process to remove inconsistencies and possible duplications, and to ensure that agreed conventions have been followed. This is where the real work begins – with data checking and verification.

After trialling a range of software, we decided upon ARCHES V.3.[5] A working example of this software in action is MEGA-Jordan,[6] which runs under an earlier and more basic version of ARCHES but gives a general idea of what will be possible. Nevertheless, all MEGA-Jordan users know that the question of data control is crucial; in its case, input of survey data took place without adequate preparation to eliminate duplicates and control the exact locations.

The HER pilot project is managed by the Durham University team. The aim is now to build a general site database and gazetteer for Syria. It will be open to the international scientific community and independent of the DGAMS database, but sharing information with it. The Durham team is now co-investigator for phase 2 of Oxford's Endangered Archaeology in the Middle East and North Africa (EAMENA) project,[7] responsible for the data from Syria and Iraq.

[5] <http://archesproject.org> (last accessed 18 Feb. 2020).
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## Digital Inventories of Museums of Syria (DIMS)

DIMS is an initiative for creating a central inventory of artefacts in the museums of Syria. In a world of conflict, war, looting and total destruction, inventories of immovable, movable and intangible cultural heritage are indispensable. Over the centuries, inventories of this kind were written by hand on perishable materials; they were often destroyed, even if they were deposited away from the objects they listed. The relative advantages of digital inventories are clear: they do not perish so easily as their analogue equivalents; they can be disseminated quickly to involved authorities and institutions; they can be made accessible to a large audience under controlled conditions; they are useful in identifying and tracing looted or stolen items; and they are a useful tool for restoration and reconstruction after the end of any given conflict. Without such resources, efforts to manage, protect and prioritise Syria's heritage, and to deal effectively with threats (loss, looting, neglect), are held back.

During the past 60 years, Syria has created an impressively decentralised landscape of museums: 36 in total, and the National Museums of Damascus, Aleppo, and Palmyra are known worldwide. During the past five years of conflict these museums have been, and still are, threatened by destruction and/or looting, and some have been destroyed and/or looted already.

By evacuating thousands of objects from threatened museums and starting a database of inventories of all Syrian museums, DGAMS has done an outstanding job of preserving and protecting the country's cultural heritage. Since 2015, s h i r ī n, in cooperation with UNESCO and DGAMS, has encouraged joint ventures to digitise the official registers of the Museums of Syria. These registers list all objects which have received a Museum Inventory Number [ID]. DGAMS and the Free University of Berlin have agreed to conduct a pilot project digitising the inventory of the National Museum of Deir ez-Zor. This joint venture is sponsored by the Foreign Ministry of Germany and operates in cooperation with the 'UNESCO-Emergency Safeguarding of the Syrian Heritage Project', the 'Syrian Heritage Archive Project' (SHA) of the German Archaeological Institute (DAI), and the ICOM-Comité International pour la Documentation (CIDOC).

The National Museum of Deir ez-Zor was founded in 1974. A new building was completed in 1990–1991. In a joint venture between Syrian/DGAMS and German/FU Berlin, the permanent exhibition was installed and the museum was inaugurated in April 1996. The official register lists 21,867 objects with Museum ID numbers; beyond that, it contains an unquantified number of items without a Museum ID that come from Syrian and international excavations in the districts of Deir ez-Zor and Hassaka (the new museum in Hassaka was not completed until 2010). Since 2013, the Deir ez-Zor museum has been threatened by IS conquest. DGAMS rescued 25,000 objects in 2014 and 2015.

In a first step, the record of the 21,867 officially registered objects will be transferred into a database. The denomination of the data fields follows the Object ID standard. The aim is to produce an illustrated list with diagnostic data of each item in English and Arabic, to be made accessible to international organisations such as UNESCO and Interpol. In the end, the system will be based at DGAMS. In a second step, the excavation inventories will be screened for those objects which have been delivered officially to the Museum of Deir ez-Zor but not registered. The DIMS project began in July 2015. In August and November 2015, two workshops on IT procedures, workflow and improved cooperation were conducted. By the end of 2015, the database contained some 3000 entries and the same number of scanned photographs from file cards.

The major part of the collections of Syrian Museums comes from national and international excavation missions. According to Syrian law, all excavated objects must stay in the country. Usually the office responsible is the regional museum. The procedure of allocation of Museum IDs in Syria is as follows: under the responsibility of the excavation director, the discovered object receives an Excavation Inventory Number (= Excavation ID). The Syrian representative on site decides which objects are to be delivered to the museum. They are registered in the mission's find listings, delivered together with the objects to the museum. The current number of this list becomes the Museum Entry Number; the museum director then selects objects for official museum registration and gives each of these a Museum Inventory Number; that is, a Museum ID. The unregistered delivered objects are stored in official repositories. Taking the example of a find listings page of the German Mission of Tell Sheikh Hamad, it may be noted that out of the 32 delivered objects only four received a Museum ID.

This explains why full knowledge of the museum collections requires close cooperation between mission directors and DGAMS for each museum in Syria. Next to the Deir ez-Zor Museum project, a Raqqa Museum inventory project has been initiated; however, the point of departure for this project differs completely, because the Raqqa Museum complex was plundered and destroyed by ISIS.

shirīn actions bear two features which are not fully shared by other NGOs:

1) In its origins, shirīn is the outcome of the concern of former excavation directors about their sites. These colleagues usually have premium information at their disposal, of a kind which is not only crucial for analysing the present situation, but will be even more important for reconstruction efforts in close cooperation with Syrian authorities once peace has returned to Syria.

2) shirīn aims to build tools facilitating the integration of data dispersed across many countries and teams. These data will be crucial for future preventive or rescue archaeology in Syria and for a full verification report of museum collections.

Syrian archaeology was built over 50 years on the basis of close international collaboration with Syrian research: the same mutual recognition will be a powerful way of initiating and fostering the future.

# Endangered Archaeology in Syria and Beyond: An International Perspective

*Emma Cunliffe*[1] – *Robert Bewley*[2]

**Abstract:** There are a number of ways in which the international community can help to protect the cultural heritage of countries affected by conflict. The aim of this paper is to highlight some of these approaches, primarily focusing on Syria, as that is where the most information is available, and to introduce the work of the Endangered Archaeology in the Middle East and North Africa project (EAMENA),[3] which was established in 2015, covering over 20 countries from Mauritania to Iran. The broader approaches addressed in this paper fall into three main areas: awareness-raising; legislative changes; and actions, and then an introduction to the EAMENA project follows these approaches. Much of the information comes from a series of reports compiled by the Non-Governmental Organisation (NGO) Heritage for Peace.[4] The reports provide information on national and international actions undertaken to protect Syrian heritage since 2011, and they are intended to promote collaboration between the different agencies acting in Syria, and reduce duplication of effort. The reports were collated from numerous websites, five mailing lists, 78 social media feeds, and regular news searches conducted via Google. Almost all information reviewed was in English or Arabic, with occasional mentions of German, Dutch and Spanish events, all of which are locations where other members of Heritage for Peace are located. They have been widely circulated, with key links shared by UNESCO.[5] This has been a 'one-way' communication, and we welcome a dialogue so we can better understand the efficacy and usefulness of the reports for the international community.

**Keywords:** archaeology; Syria; endangered sites; organisations; international actions; dialogue

## Problems Faced by Syria's Heritage Workers

It is perhaps important to start by highlighting the problems facing Syria's heritage workers, as they are significant, and contextualise all other issues noted in this paper. They also extend beyond the areas that the Syrian Directorate-General of Antiquities and Museums (DGAM) can reach. Without addressing these problems (where it is possible), the international community – and, of course, the Syrians themselves – face many problems in heritage protection. Nor are these issues unique to Syria, but unfortunately they are representative of countries in conflict in general (and in some cases may have existed prior to the conflict). In addition to speaking to government heritage workers, Heritage for Peace spoke with a number of people in northern and central Idlib – areas outside of government control – identifying the following problems:

- Limited resources and money available;
- Limited access to transport (of all types) to visit sites;

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[3] See the project's website <https://eamena.org/> (last accessed 18 Feb. 2020); Bewley et al. 2016a; Bewley et al. 2016b.

[4] Cf. the Heritage for Peace website <http://www.heritageforpeace.org> (last accessed 18 Feb. 2020); see Perini – Cunliffe 2014a; Perini – Cunliffe 2014b; Perini – Cunliffe 2015; Leckie et al. 2017.

[5] UNESCO, Observatory of Syrian Heritage, Reports. Online <https://en.unesco.org/syrian-observatory/damage-assesment-reports?> (last accessed 18 May 2020).

- Issues in obtaining looted items from local people (many of whom are resident in the same areas as the heritage workers);
- Language barriers that limit access to foreign aid;
- International systems that prevent NGOs from sending support;
- Lack of official documentation (e.g. passports, visas), whilst passports are more of an issue in areas without government facilities, visas are an ongoing problem;
- Lack of organisational affiliation, leading to a lack of external support or even recognition, and
- Lack of a place to work (using homes).

The problems faced by heritage workers in conflict areas were also highlighted in the report of the Special Rapporteur in the field of cultural rights, which examined cultural heritage destruction.[6] The problem of getting aid to heritage workers in conflict zones, given safety concerns, political complexities, and international sanctions, remains an enduring challenge. This was one of the reasons the Special Rapporteur called them 'Heritage Heroes'.

## Raising Awareness

The most obvious activity conducted by the international community is awareness-raising about the importance of cultural heritage, as well as the damage and destruction occurring in conflict. Such opportunities are enormous; especially via social media, but also television and radio. However, other outlets include exhibitions, talks, lectures, conferences, appeals, petitions, statements and podcasts; as well as newspaper articles and opinion pieces, both printed and online.

The first detailed report listing the damage to Syria's heritage was released in May 2012[7] and sought to collate the work of activists and NGOs who were trying to highlight the increasing problems. This report revealed just how few people were aware of the scale and impact of the damage taking place in Syria. It would be four years before Robert Bevan issued a revised edition of his book *The Destruction of Memory,*[8] incorporating recent heritage destruction. In 2016, a film of the book was released, receiving multiple awards, and reaching public awareness.

Since those early beginnings, the reporting of damage to Syrian cultural property has been a regular, often headline, feature for many media. In response, between 15 September 2015 and 12 April 2016 the international archaeological/heritage community has held the following events:

- 3 workshops
- 27 conferences
- 10 symposia
- 21 talks
- 9 discussions / panels
- 6 forums
- 3 seminars
- 1 roundtable

These 80 events (of which only four were not advertised in English) aimed to raise awareness, find solutions to the problems, and improve collaboration between colleagues. Whilst this is an indication of the increased interest in the topic, few were subsequently made available online for those who could not attend, and even then, these represent a large investment of time to view

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6 Bennoune 2016.
7 Cunliffe 2012.
8 Bevan 2016.

podcasts. Whilst the ability to work with colleagues in person is invaluable, sharing of key information could be improved.

The Heritage for Peace reports also show that there have been many petitions calling for the protection of heritage in some form or another. The most successful was one of several to help save Palmyra;[9] it attracted 14,800 signatures – almost double that of any petition asking to save all of Syria's heritage, but still 200 short of its target. Although there may be some small impact for a short period of time, few petitions are ever delivered, and most express a sentiment, rather than a solution.

At this point, it is worth noting the biases that can occur in awareness-raising. The international community has issued multiple statements and petitions on the World Heritage site of Palmyra, many stating a desire for a more representative view of heritage, and not focusing overly on Palmyra. Yet there is an inherent contradiction in this, as much less attention is paid to the other sites. The Department of Antiquities of Bosra (a World Heritage site of somewhat comparable importance to Palmyra), for example, requested help:[10] few organisations responded initially. Shirin conducted a damage assessment in 2015,[11] and Heritage for Peace attempted to contact it and carry out a needs assessment. It was not until August 2016 that ASOR's Cultural Heritage Initiative (CHI) was reported to be assisting with restoration work.[12] Nonetheless, the Heritage for Peace 2017 report[13] demonstrates a continued focus on Palmyra. This presumably reflects the intense publicity in western media arising from the destructive actions of the Islamic State group at the site.

If raising awareness is to be successful, it must encourage an understanding of the wider context of the issues, and positive action must flow from it. For example, funding, especially grants, large enough to employ staff to tackle problems and obtain equipment or imagery, does not usually become available until the issues affecting the destruction of cultural property are better understood, and there is a greater and more general awareness of the scale of damage. The University of Oxford was extremely fortunate to be approached by the Arcadia Fund in 2014 to explore endangered archaeology; to a small extent, this must be considered a result of the awareness-raising regarding heritage destruction. Certainly, the development of the Cultural Protection Fund, also generously supporting the EAMENA project, is a direct response to the increased awareness of the problem.

## Legislation

The second type of approach involves legislative changes by nations that may be involved in activities in countries affected by conflict, or that are concerned that they may be unwittingly receiving looted objects.

### The Hague Convention 1954

Currently, many of the approaches, and even responsibilities for improving the protection of the cultural heritage are falling on, and being developed, by NGOs. 'The international organisation tasked with advising UNESCO regarding Cultural Property Protection is the Blue Shield.[14] A "Blue Shield" approach is being drafted that will provide a framework for 25 existing national committees, from

9 A petition from the campaign to #SavePalmyra <https://www.causes.com/actions/1778720-sign-the-petition-to-_-savepalmyra> (last accessed 18 Feb. 2020).
10 Letter published on their now removed Facebook page by Bosra Sham Antiquities Department on 3 April 2016. A copy of the letter is available from the authors.
11 Fournet et al. 2015.
12 Ancient Near East Today 2016.
13 Leckie et al. 2017.
14 See the organisation's website <https://theblueshield.org/> (last accessed 18 Feb. 2020).

Argentina to Austria, and others under construction.'[15] This framework will advise local Blue Shield Committees on ways in which they can work to protect heritage in conflict. It will be one of the first international overarching frameworks of its kind, and one of its key goals is promoting ratification and implementation of the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict and its First and Second Protocols (1954 and 1999).

Largely resulting from the work of Professor Peter Stone, Chair of Blue Shield UK and Vice-President of Blue Shield International, the UK ratified the 1954 Hague Convention in December 2017, becoming the second permanent member of the UN Security Council (after France earlier in the year) to ratify the Convention and both Protocols. As 2019 comes to a close, over 130 countries around the world have ratified the main Convention, more than 100 the First Protocol, and more than 80 the Second Protocol, with more every year.

So, what will change as a result? For countries that have ratified the 1954 Hague Convention, the production of 'no-strike lists' (i.e. lists of cultural property that should be safeguarded, in any country or region of a country) are legally mandated under Article 3 of the main convention, and more explicitly in Article 5 of the Second Protocol (our focus): Safeguarding of cultural property.

Article 3. The High Contracting Parties undertake to prepare in time of peace for the safeguarding of cultural property situated within their own territory against the foreseeable effects of an armed conflict.

Article 5. Preparatory measures taken in time of peace for the safeguarding of cultural property against the foreseeable effects of an armed conflict pursuant to Article 3 of the Convention shall include, as appropriate, the preparation of inventories, the planning of emergency measures for protection against fire or structural collapse, the preparation for the removal of movable cultural property or the provision for adequate in situ protection of such property, and the designation of competent authorities responsible for the safeguarding of cultural property.

It is simply not possible to safeguard heritage without knowing what there is and where it is: site registers are therefore essential.[16] Such lists form part of a body of legally mandated instructions for safeguarding measures to be undertaken by State Parties (usually Ministries of Culture, or their equivalents) in peacetime – seen, for example, in the creation of the UK's safeguarding list once they became a signatory state.[17] Preliminary guidance stipulates that if it has not been done, armed forces must endeavour to collect the information as best they can from any who will assist them,[18] resulting in value determinations that may not reflect the priorities of those whose heritage it is (a less than desirable situation). International guidelines are being drawn up by Blue Shield International[19] for the creation and management of such registers. The EAMENA project is also documenting sites to internationally agreed standards, as will be explained later. However, inventories are just one of a wide body of stipulated proactive preparatory measures to be undertaken by both cultural organisations and armed forces in peacetime. Other work in the UK, for example, includes the creation of a Cultural Protection Unit (as stipulated under Article 7.2 of the main convention) within the armed forces,[20] and the design of specialist cultural property protection training courses to meet the obligations of article 7.1.[21] Similar measures are underway elsewhere, e.g., in the US, Austrian, and Swiss Armed Forces.

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15 Stone 2017, 30.

16 Cunliffe et al. 2018.

17 See the policy paper on <https://www.gov.uk/government/publications/protection-of-cultural-property-in-the-event-of-armed-conflict> (last accessed 18 Oct. 2020).

18 O'Keefe et al. 2016.

19 Cf. the Blue Shield International website <https://theblueshield.org/> (last accessed 18 Oct. 2020).

20 Purbrick 2016–2017.

21 For example, the Cultural Property Protection in Armed Conflict course <https://militaryethics.uk/en/course> (last accessed 18 Feb. 2020); the UK Cultural Property Protection Special to Arms staff training course, running October 2019; or the training courses that Blue Shield International attends or runs <https://theblueshield.org/news-and-activities/> (last accessed 18 Feb. 2020).

### Other Recent Legislative Changes

Several countries are also working to tighten their laws regarding illicit trafficking. Germany is notably leading the way here with its Cultural Property Protection Law,[22] and the USA has now passed H.R.5703 and 1493 Protect and Preserve International Cultural Property Act[23] (passed 1 June 2015) and USA H.R.2285 – Prevent Trafficking in Cultural Property Act (passed House amended 22 September 2016).[24] These laws are – at least in part – a response to UN Security Council resolutions banning the illicit trafficking of cultural property from countries like Syria and Iraq, and which require states to refrain from supporting terrorist financing (e.g. UNSCR 2199, 2253, 2368).

## Actions

The third type of action works directly to protect heritage, through the documentation of the sites and the damage that has taken place. The following is a rough count of the types of actions taken:

According to the Heritage for Peace reports, between September 2014 and September 2015 there were 11 training events (four at national and seven at international level); there were ten international projects covering looting and trafficking, and an unknown number of national projects; nine projects examining inventories and digitisation; as well as nine events, groups and projects exploring the topic of restoration.

One of the most common activities is recording damage to sites. Twenty-three international organisations are reporting damage (with many more national groups), ranging from small organisations publishing updates on social media accounts to large organisations such as UNOSAT, who publish comprehensive damage reports,[25] or the ASOR Cultural Heritage Initiatives (ASOR CHI), who publish regular detailed reports online.[26] Whilst the majority of these use social media, at least six have databases or publish pdfs.

Despite the extensive amount of data collected, problems remain. There have been few analyses of the information (although notable exceptions include the special volume of Near Eastern Archaeology, sponsored by ASOR CHI[27]). Nor, despite the extensive discussions about the prosecution of cultural heritage crimes, is information always collected to the standards required for prosecution – although a number of institutions signed the Vienna Statement at ICAANE 10,[28] which stated that 'Criminal investigations into the illegal trade in antiquities must be facilitated, and supported by professional expertise'. Also see, for example, the United Nations and OHCHR's Guidance and Practice for Commissions of Inquiry and Fact-Finding Missions on International Human Rights and Humanitarian Law 2015,[29] which recommends chains of custody of documentation, amongst other key metadata. Similarly, photographic documentation is rarely of the standard needed to aid in reconstruction. At best, information of this nature can only aid a basic needs assessment.

Lastly, the data are rarely prioritised, providing an almost-overwhelming picture of damage to Syria's heritage, and hindering heritage aid work in the country. The EAMENA project, on the other hand, operates at an international level, using freely available satellite imagery to record sites and site damage at a scale that can elucidate regional damage trends, and is also developing

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22 Puhze – Henker 2015; Hickley 2016.

23 The White House 2016.

24 Congress 2016; Jarus 2016; Sputnik 2016.

25 UNOSAT 2014.

26 ASOR CHI Weekly Reports <http://www.asor.org/chi/reports/weekly-monthly> (last accessed 18 Feb. 2020).

27 The Cultural Heritage Crisis in the Middle East. Special Issue, Near Eastern Archaeology 78, 3, 2015.

28 Vienna Statement 2016, 10th ICAANE. Statement about the Threat to Cultural Heritage in the Near East and North Africa. Online <https://www.oeaw.ac.at/fileadmin/Institute/OREA/pdf/Publikationen/Vienna_Statement_Online.pdf> (last accessed 18 Oct. 2020).

29 United Nations OHCHR 2015.

the capacity to record sites down to the level of individual features such as walls or windows – the level needed for reconstruction. However, given the variable standards operating, work remains to be done in both the collection and the analysis of heritage damage information.

## An International Rescue Framework: A Way Forward?

One recent suggestion for how to approach the provision of aid and allocation of the limited resources was the creation of an International Rescue Framework, to aid organisations operating in conflict.[30]

The primary goals are assumed to be:

- Equitable direction of resources for reconstruction;
- Assessment of damage trends to prevent re-occurrence, and
- Identification of likely threats during reconstruction.

In order to fully realise such a proposal, the following questions need to be answered for data collection, and what, again, is rarely dealt with is current recording standards:

- What and where are the sites? This requires a definition of 'what is a site', encompassing not only the consideration of when something becomes 'heritage', but also the extent of the site – something that is frequently hard to define. This is necessary to understand the scale of work that may be required – for example,
- does the 'site' encompass multiple damaged buildings like at Apamea in Syria, or is it a single building, like Qalb Lozeh?
- How damaged is the site? For example, is 100% of the site is affected, or is damage restricted to a small area?
- How significant is the site? For example, is it a World Heritage site or a single cairn, and how many other sites of a similar nature are known?
- How significant is the damage? For example, has the site completely collapsed or is the damage just cosmetic shrapnel scarring?[31]
- To whom is it significant? Is this a parish church or the only church in the region?
- Does it have only archaeological value; wider scientific importance; or local, national or international significance? For example, is it a single site in an archaeological survey, an important human evolution site, a local shrine, a historic palace?

Recording in this level of detail has additional benefits for heritage management outside or after conflict. In addition to direct conflict-based damage, significant damage has also been, and will continue to be, caused by increasing agriculture, and the development of villages, towns and cities, which becomes even more urgent in the post-conflict period, hence the EAMENA project work (see below). Development like this is noticeable not only at small, surveyed sites, but also at some Tentative and World Heritage sites, like Bosra and Raqqa. Archaeologists stand ready not only to provide significant support to the DGAM in securing sites and paying site guards,[32] but also to consider a wider outreach programme, working with those who will be supplying materials for rebuilding, for example, to raise awareness of the damage being done.

A new framework could have multiple dimensions. Cultural heritage is used in state building, peace building, military ethics and doctrine, law, political science, and countless other spheres. If we want to facilitate prosecutions, we need to record the data needed by law. To facilitate peace

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30 Shirin 2016.

31 Although see Mol et al. 2017, who argue that even apparently cosmetic damage can have major implicatons for site stability.

32 Ali 2013.

building, we need to understand the ethnic dimensions of heritage, and focus on local community heritage, rather than state-level projects.[33] To facilitate reconstruction, we will need to find a way to prioritise. For example, a lot of attention has been given to the World Heritage Site of Crac des Chevaliers, but significantly less to the historic al-Saraya Mosque in the surrounding town, which was still in use, but which has been shelled in the fighting. Archaeologists may need to develop better ways of understanding the communities amongst whom they have worked for so long. But this task is not easy: 'With the halt of archaeological fieldwork in Syria and the difficulty of finding new archaeological projects in the Middle East generally, heritage studies has presented itself as a novel area of research and field work for many international archaeologists. As a result, archaeologists have been forced to grapple with the specialised theoretical literature and research methodologies of the robust field of heritage studies for the first time.'[34]

## The Endangered Archaeology in the Middle East and North Africa Project

The second part of this paper details the work of the EAMENA project, the aims of which are to provide information on archaeological sites that will be useful for all countries affected by conflict, and especially after the conflict is over.[35]

Funded by the Arcadia Fund, the EAMENA project records and documents archaeological sites across twenty countries from Mauritania to Iran by interpreting satellite imagery and creating records in a bespoke ARCHES database, so that the basic forms of the site are recorded as well as an assessment of threats to it. Noting the issues identified in the first half of this paper, the EAMENA project has been pragmatic in ensuring it does not duplicate the work of others, for example the ASOR (American Schools of Oriental Research) Cultural Heritage Initiatives[36] or others who have worked in the same field[37] or in the same region.[38] Through our partnership between the Universities of Oxford, Leicester, and Durham, we are able to collaborate with many of the fieldwork projects (past and current) that have taken place in the region over the past decades. The stated aims of the project are to:

- Identify, understand and monitor the endangered archaeology of the MENA region;
- Create a record of sites and monuments for each country in the MENA region that includes an assessment of the threats to sites (similar to the Historic Environment Records in the UK and parts of Europe);
- Help to protect and conserve MENA's archaeological heritage;
- Raise awareness and encourage informed debate about heritage in the region;
- Assist customs and law enforcement agencies in tackling looting and the illegal trade in antiquities, and
- Train heritage professionals in our methods and techniques to monitor the condition of archaeological sites in as many countries as possible.

The EAMENA project is the only one working at the scale of the whole MENA region. By collating and interpreting information from satellite imagery, we assess levels and types of threats to sites in a standardised manner. Our project combines primary satellite imagery analysis with collation of existing data and sources. Although we utilise a variety of cartographic sources (e.g. 1:25,000 maps), aerial photographs (e.g. Hunting Aerosurveys) and satellite data (e.g. declassified

33 Lostal – Cunliffe 2016.
34 Quntar – Daniels 2016, 382.
35 Bewley et al. 2016a; Vafadari et al. 2017.
36 Casana – Panahipour 2014; Casana 2015.
37 Contreras – Brodie 2010; Brodie – Contreras 2012.
38 Parcak 2015.

CORONA photographs), the majority of initial data collection is carried out using imagery available in Google Earth. This approach has a number of distinct advantages: although the imagery is of variable resolutions, it is freely available; and large parts of the MENA region are also covered by more than one set of imagery, meaning that it is possible to look at change over time.

Ground survey and excavation data, however, are also vital. In this respect, the experience, contacts, and connections developed by individual EAMENA team members has allowed us to integrate both published and unpublished datasets into our analyses and data collection. Whether entering data from existing surveys or from satellite imagery, each potential or confirmed archaeological feature is recorded in our project database[39] using a set of standardised, controlled vocabularies. The database uses ARCHES, an open source platform implemented by the Getty Conservation Institute and World Monuments Fund, and is designed to conform to CIDOC CRM standards.

The project also makes its information freely accessible, via an online database, and through professional networks. Not all the information is made available to everyone; by giving too much access to sensitive data that might end up in the wrong hands we could be at risk of making the situation worse.

The EAMENA database aims to facilitate research and heritage management on both a local as well as a broad scale. The database currently contains over 150,000 records, including information about the archaeological sites themselves and the data sources (e.g. satellite imagery, articles, books and photographs) used to create these records. As we further enhance existing records and add new sites to the database it will be possible to explore the main disturbances and threats affecting sites across the whole MENA region, as well as how patterns of disturbance may vary from area to area and between different types of sites. However, based on preliminary data, we estimate that circa 20,000 sites are at risk from one or more of the agents of destruction we are recording – be it looting, agriculture, conflict, urban expansion, construction activities, or natural erosion.

Avoiding duplication, the project's approach towards data collection in Syria has aimed at filling in existing gaps in knowledge, given the extent of previous surveys.[40] Two main areas have so far been targeted by the EAMENA project: the Halabiya Plateau and the coastal strip, from the Turkish border in the north to the Lebanese border in the south.

The Halabiya region (c. 2,500km$^2$), prior to the ongoing conflict in Syria, was marked for a dam project that was intended to affect more than 2,000km$^2$. This region is particularly rich in archaeological sites, particularly cairn fields and enclosures: in addition to the known sites, the EAMENA team identified more than 3,000 potential sites in the zone expected to be submerged or destroyed during construction using Google Earth imagery. Rescue excavations and surveys had been planned by the Syrian authorities for nine sites (some of which were already recorded), in addition to a study of the plateau area, but neither these investigations nor the dam project itself could be conducted once the conflict started, making surveys such as EAMENA's essential.

The coastal strip, c. 9,000km$^2$, in contrast, has been heavily developed since the mid-20th century. Our mapping here has focused on using a variety of different imagery and map sources, e.g. CORONA and Google Earth, to explore the changes and threats to archaeological sites along this coastline since the 1950s. Detailed records currently exist for over 1,600 potential archaeological sites from this region.

Other sites in Syria have remained untouched, remarkably, and we are also investigating these further, so that a better record can be made of them, just in case they do become targets for looters. In Syria 6,094 sites have been recorded, in an area of c. 11,200km$^2$.

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39 EAMENA Database v3.0 <https://eamena.org/database> (last accessed 18 Oct. 2020).

40 E.g. Poidebard 1934; Geyer 2001; Lönnqvist – Törmä 2003; Wilkinson 2003; Casana – Wilkinson 2005; Castel 2007; Ur – Wilkinson 2008; Braemer et al. 2009; Lönnqvist et al. 2011; Wilkinson et al. 2012; Matthiae – Marchetti 2013; Meyer 2013; Wilkinson et al. 2014.

Utilising these records, we have been working with a small number of countries to assist in the development of their national historic environment records, especially for Yemen (through the Oxford team) as a test case, and we hope this will be developed for Syria (through the Durham team[41]). If these initiatives are successful we will expand their scope though the training activities (already planned to take place in Tunis, Beirut and Amman over the next three years), to other interested countries through training courses funded by the UK government's Cultural Protection Fund. In many ways the EAMENA project is just at the beginning; further grant applications and fund-raising are planned for the next five years and it is hoped that the project will continue to expand and develop. Key to this is building up new collaborations. We are already working with several existing field projects or initiatives within the region (e.g. the Kūbbā Coastal Survey in Lebanon, in Morocco with the Wadi Draa project at Leicester University), and hope to develop more initiatives and collaborations for fieldwork and monitoring in the future.

Although the project is still in its data collection phase, it is already starting to develop a training component, building on initial success in Iraq.[42] Therefore it was very fortunate that the Cultural Protection Fund was launched in June 2016 by the British Council in partnership with the Department for Culture, Media and Sport.[43] This £30m fund was set up to protect cultural heritage at risk due to conflict in nine countries, mainly in the MENA region. We applied for a project to train up to 120 heritage professionals in the EAMENA methodology; interpreting satellite imagery, creating records and monitoring the condition of sites. The focus was on six countries (Jordan, Lebanon, Libya, Palestinian territories, Tunisia, and Syria) and funding for this was approved in late 2016. The 'Training in Endangered Archaeology Methodology with Middle East and North African Heritage Stakeholders' project is now well underway and the first training course is expected to take place in Tunis in late 2017 with subsequent ones in Beirut and Amman in early 2018.

The last facet of EAMENA's work involves the trade in illicit antiquities. There is no question that the archaeological sites of Syria, many of them World Heritage sites,[44] are under the greatest threat because of the five-year long conflict there. At the time of writing, very important sites and individual temples and structures in Palmyra have been destroyed as part of the so-called Islamic State's publicity programme. In addition we have also seen many large, important sites, and other smaller sites, subject to systematic looting for artefacts.[45] EAMENA is conducting essential research on the timing and stimuli for the illicit trade in artefacts, but there can be no doubt that as state control diminishes, or is totally absent, looting of archaeological sites increases.[46] We have seen significant changes to sites in connection with looting activities in Egypt, Iraq, and Yemen. In Syria, the most often quoted example has been the illegal excavations at the Roman city of Apamea, although Dura Europos has also received significant attention.[47]

## Conclusions

As professional archaeologists we strive to minimise the amount of damage done to fragile archaeological remains. We know we cannot save everything, but we can aim to document and study as many sites as possible. As more and more sites are threatened by conflict, natural disasters and the development pressures of an increasing population, archaeologists must grapple with

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41 See Vafadari et al. 2017.

42 Bewley et al. 2016b.

43 Cf. <https://www.britishcouncil.org/arts/culture-development/cultural-protection-fund> (last accessed 18 Feb. 2020).

44 Burns 1999.

45 Stone 2015.

46 See the website of Trafficking Culture for more information <https://traffickingculture.org> (last accessed 18 Feb. 2020).

47 See UNOSAT 2014; Casana 2015.

the complexities of heritage management to develop the tools to understand the threats and tackle them. The approaches showcased here demonstrate the potential to utilise new technologies in ways that were inconceivable a decade ago. Now the challenge becomes how best to utilise them rather than suffering from information overload. To this end we have also made it a significant aim to allow the EAMENA database to be used as a basis for national heritage inventories. These national records (see MEGA-J, for example[48]) can provide the necessary information for planners, those rebuilding the countries after conflict and those responsible for the cultural heritage in their countries to better protect their cultural heritage. Through our training programmes we are hoping to develop the necessary expertise across the whole region so that these digital inventories can be used and maintained by staff working in each country, placing the responsibility for their heritage in their own hands.

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# The ASOR Cultural Heritage Initiatives: The Cultural Heritage Crises in Syria and Northern Iraq

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**Abstract:** Years of civil war in Syria and the seizure of much of northern Iraq and Syria by extremists have precipitated what is currently the world's largest humanitarian crisis. While the international community must focus first and foremost on ending the conflict and meeting basic human needs, protecting the region's irreplaceable cultural heritage forms an integral and inextricable part of humanitarian efforts. Looting, deliberate destruction of heritage places by extremists, combat damage, and illegal development occur daily in Syria and northern Iraq and are obliterating the cultural patrimony of millennia. Extremists are systematically disassembling the heritage sector in the conflict zone and seek to stamp out cultural diversity in what is nothing short of a war on culture. These crimes threaten to proliferate and spread the conflict, complicate peace efforts, and erode future stability and prosperity. Cultural identities and the futures of countless vibrant communities hang in the balance. To help to address these challenges, the U.S. Department of State and the American Schools of Oriental Research completed a cooperative agreement in August 2014 forming the ASOR Cultural Heritage Initiatives.

**Keywords:** heritage; looting; conflict; destruction; Syria; Iraq

The American Schools of Oriental Research Cultural Heritage Initiatives (ASOR CHI) was formed in August 2014 through a cooperative agreement between the United States Department of State and the American Schools of Oriental Research.[3] ASOR CHI strives to help Syrians and Iraqis in preserving and protecting cultural rights, particularly rights linked to access to tangible and intangible cultural heritage, which have come under increasing assault over the last five years across the Middle East and North Africa. To achieve these ends, ASOR CHI implements cultural property protection in Syria and Iraq by: (1) monitoring, reporting, and fact-finding; (2) promoting global awareness; and (3) conducting emergency response projects and developing post-conflict rehabilitation plans. While the international community must focus first and foremost on ending the conflict and meeting basic human needs, protecting the region's irreplaceable cultural heritage forms an integral and inextricable part of humanitarian efforts. Looting, deliberate destruction of heritage places by extremists, combat damage, and illegal development occur daily in Syria and northern Iraq and are obliterating the cultural patrimony of millennia. Extremists are systematically disassembling the heritage sector in the conflict zone and seek to stamp out cultural diversity in what is nothing short of a war on cultural diversity, memory, and identity.

Due to the high level of instability caused by the conflicts in Syria and in areas of northern Iraq controlled by the Islamic State of Iraq and the Levant (ISIL), much of our work over the past 27 months has focused on documenting damage and destruction rather than the hopeful work of rehabilitation. Between August 2014 and November 2016, ASOR CHI published 120 Weekly Reports, which are available online.[4] These reports detail the ongoing thefts and looting of cultural property and damage to cultural heritage sites, including archaeological and religious sites,

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[4] Weekly Reports are available at <http://www.asor.org/chi/reports/weekly-monthly> (last accessed 18 Feb. 2020).

due to military activity, looting, deliberate destruction, and illegal development. Our incident reports are compiled using a variety of sources, including conventional media and social media outlets, photographic and videographic evidence, other ground-based information, and high resolution satellite imagery. In ASOR CHI's second year, between September 2015 and August 2016, we reported on 850 cultural heritage incidents primarily affecting religious and archaeological sites (Fig. 1). The majority of the reported damage was due to military activity such as airstrikes and the use of explosives, deliberate destruction, as well as illegal excavations or looting taking place at archaeological sites within these regions (Fig. 2). High frequencies and magnitudes of reported damage occurred in northwestern Syria, Palmyra (modern Tadmor), Deir ez-Zor, Damascus, Mosul, and Fallujah. Due to the large number of reported incidents, we focus here on case studies of the damage sustained at the archaeological sites of Ebla in Syria and Nineveh in Iraq, analysing the known damage to these locations during the ongoing conflicts. We also outline ASOR CHI's collaboration with the Bosra al Sham Antiquities Department in Syria on mitigation and restoration projects.

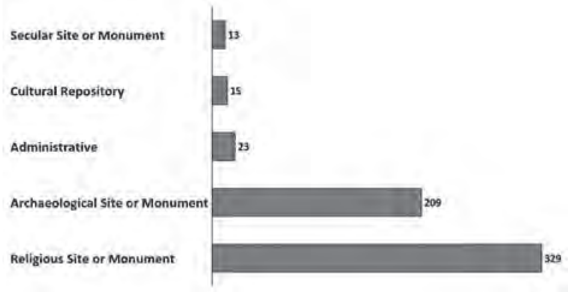


Fig. 1 Breakdown of reported heritage incidents by site type from September 2015 through August 2016 (M. Danti)

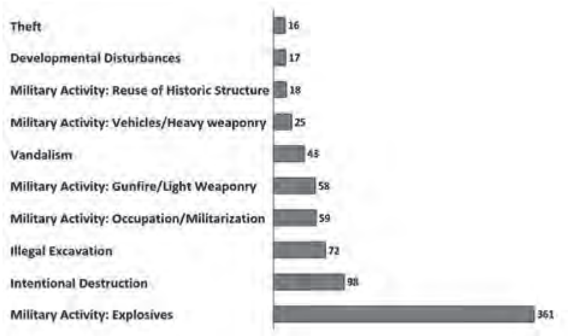


Fig 2 Breakdown of reported heritage incidents by pattern of damage from September 2015 through August 2016 (M. Danti)

## Case Study: Ebla

Ebla (Tell Mardikh) is located 60km southwest of Aleppo in Idlib Governorate. Occupied from at least the late Chalcolithic (c. 3,500 BC) until the 7th century CE, the site consists of a central high mound (the 'Acropolis') surrounded by a lower mound comprising the Bronze Age lower town, which in turn was encircled by the remains of a large Middle Bronze Age earth and stone fortification wall and rampart with four gates.[5] Ebla is best known for the discovery of a large Early Bronze Age palace, Palace G, that was destroyed by fire in Antiquity. This destruction has been variously attributed to the Akkadian king Sargon, his grandson King Naram-Sin, or the rival city-state of Mari located on the Euphrates River. Excavations in the palace area recovered an important archive of more than 5,000 complete and fragmentary administrative documents known as the 'Ebla Tablets'.[6] The Bronze Age city was destroyed and rebuilt several times, until its final destruction c. 1,600 BC by the Hittites. Ebla never recovered, although modest settlements were located at the site until its final abandonment in the 7th century CE. The Italian Archaeological Expedition of the University 'La Sapienza' under the direction of Paolo Matthiae began excavating the site in 1964 and continued until 2011.[7]

[5] Gordon et al. 2002, 76–78.
[6] Matthiae 2013, 37.
[7] Matthiae 2013, 36.

Since the beginning of the Syrian conflict, control of Idlib Governorate, which contains the site of Ebla, has been hotly contested by opposition groups, such as the Free Syrian Army, and the Al Qaeda affiliate Al Nusra Front. By June 2015, Al Nusra Front had reportedly gained control of over 90% of Idlib Governorate. Since late September 2015, the area has been the focus of an intense air campaign. Thus Ebla is located within an active conflict zone, which precipitated the site's occupation by military forces, sporadic looting, and reported airstrikes.

Fig. 3 Evidence of looting and heavy machinery on the Acropolis of Ebla (DGAM; 14 June 2014)

Illegal excavations began at Ebla as early as April 2012[8] and have continued within multiple phases over the last four years. Looting is first visible in DigitalGlobe satellite images from 31 May 2012 within previously excavated areas on the Acropolis. On 10 December 2012 the Directorate-General of Antiquities and Museums in Syria (DGAM) reported that digging at the site had declined due in part to unpredictable finds and local protection cooperation;[9] however, this decline was short lived. The DGAM later reported that illegal excavations had restarted sometime in December 2012, including at the Early Bronze Age Royal Palace and Archives, the Middle Bronze Age Royal Palace on the Acropolis, and areas south and southeast of the Acropolis.[10] In July 2013, the DGAM reported the use of heavy machinery.[11] These reports of looting were confirmed through analysis of DigitalGlobe satellite imagery from 18 August 2013, which highlighted the increased illegal excavations on the Acropolis and within 'Area A', as well as through site photographs published by DGAM on 12 November 2013.[12]

Representatives from the DGAM visited the site again in June 2014 and noted numerous looting pits, including some that were 'down to the foundations of the walls', as well as evidence of the use of heavy machinery (Fig. 3).[13] A 4 August 2014 DigitalGlobe satellite image confirmed this intensification in looting and also revealed an increased number of earthen berms built up around the site. Illegal excavations continued through 2014, with large trenches dug south of 'Area Z' and the expansion of previously excavated areas east of the 'Palace of the Crown Prince'. New looting pits were also visible east of the Ceremonial Northern Palace. In 2014, UNITAR published a report comparing satellite imagery of Ebla from 14 August 2014 with pre-war imagery from 2008. The report presented evidence of looting resulting in severe damage and destruction, including in 'Area CC', 'Area F', the Great Temple of Ishtar, the Dead Kings' Sanctuary, the Southeastern Gate, the Temple of Resheph, the Southeastern Fort, and the site museum, as well as moderate or possible damage elsewhere.[14]

8 UNITAR 2014.
9 DGAM 2012.
10 DGAM 2013a.
11 DGAM 2013b.
12 DGAM 2013c.
13 DGAM 2014.
14 UNITAR 2014.

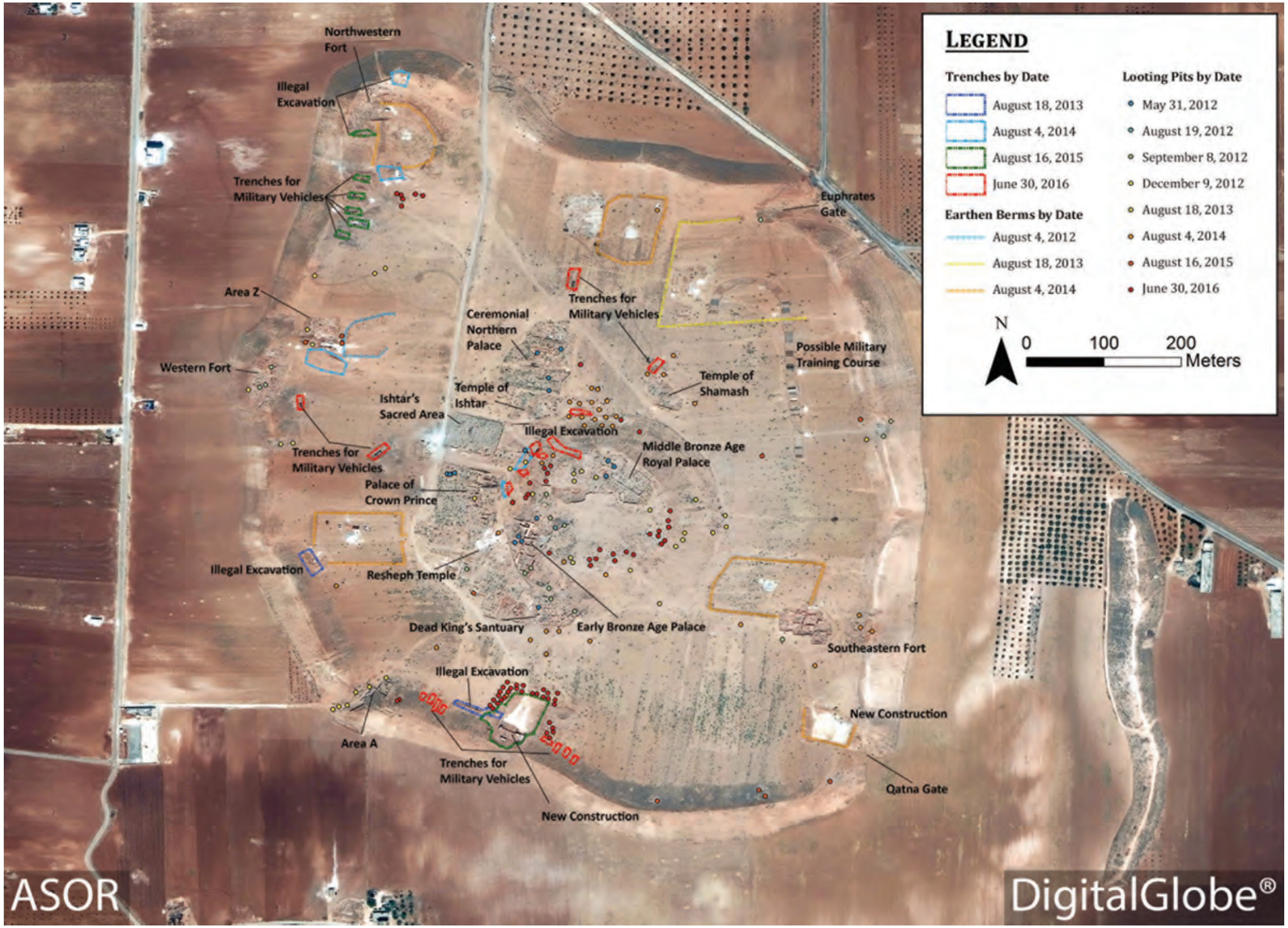


Fig. 4 Annotated satellite image of damage to Ebla, separated by date first visible. Not all the looting pits are noted as they were not clear in available images (ASOR CHI/DigitalGlobe; 30 June 2016)

By 16 August 2015 Ebla was occupied by an opposition force and new constructions (including trenching into the mound to fortify positions) were built in the northwest corner and the southern edge of the site. In addition, new looting pits and expansions of previous illegal trenching were visible in DigitalGlobe satellite imagery, primarily around the Northwestern Fort. Many of the previously excavated areas looked to have degraded, with vegetation and soil infilling over time. DigitalGlobe satellite imagery dating between 16 August 2015 and 30 June 2016 shows additional looting and militarisation at Ebla (Fig. 4). The occupying military force dug trenches into the mound to create fortified positions for armoured vehicles, some of which are visible on satellite imagery. One of these vehicles was located within the stone paved courtyard of Ishtar's Sacred Place. A military training ground also appears on the western side of the site, as well as new looting pits, primarily on the Acropolis and the southern edge of the mound. The slope to the west of the Middle Bronze Age Palace has badly eroded due to the continued illegal excavations along the base and on the slope. In addition to the illegal excavations, multiple impact craters from airstrikes or artillery strikes are also visible.

In November 2015, an ASOR CHI in-country assessor was able to visit Ebla and report on the state of the archaeological site. The mound was used as a military headquarters for the armed opposition group Faylaq al-Sham, though by that time they were no longer actively using the site but had left an armed presence to prevent others from entering. This military presence caused the site to become a military target and multiple airstrikes hit the site in October and November 2015. The reported damage was noted as not structurally significant, with an ammunitions repository next to the site being destroyed. Yet the report also notes that the bombing and shelling of surrounding areas was shaking the ground at Ebla and cracking the mud-brick walls of the archaeological site. In addition to military damage, there is also ongoing damage due to neglect, such as plant growth, graffiti on the walls of the site, and fire residues from areas that were reused as residences.

Over the past four years, Ebla has been subjected to militarisation by occupying forces, the excavation of multiple defensive trenches and earthworks, reuse of archaeological spaces for defensive purposes, ongoing illegal excavations, and military airstrikes.[15] Based on all the available information, ASOR CHI has assessed the site as over 60% damaged. The site remains under urgent threat as the conflict continues in this disputed territory.

## Case Study: Nineveh

Nineveh, ancient Ninua, is located on the eastern bank of the Tigris River, at its confluence with the Khors River within the bounds of modern-day eastern Mosul.[16] The impressive archaeological mound complex consists of a lower town dominated by two high-citadel mounds, Kuyunjik and Nebi Yunus. Kuyunjik rises about 20m above the surrounding plain and covers an area measuring 800 × 500m. The upper layers have been extensively excavated revealing several Neo-Assyrian palaces, temples, and other buildings.[17] These include King Sennacherib's 'Palace without Rival', known as the Southwest Palace, which was roofed over in the 1960s by the Iraq Department of Antiquities and Heritage to create the Sennacherib Palace Site Museum.[18] Nebi Yunus, located one kilometre south of Kuyunjik, has not been extensively explored since a modern mosque to the prophet Jonah occupied the summit. The mounds and lower town are surrounded by the remains of a massive fortification wall of c. 12km in length. Most of the wall consists of a stone footing (h. 6m), capped by a mud-brick superstructure 10m high and 15m thick defended by stone towers

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15 Danti – Ali 2014, 8; Danti et al. 2015d, 35–38; Danti et al. 2015f, 16–18.

16 Bryce 2009, 510.

17 Stronach – Lumsden 1992.

18 El-Wailly 1965, 2–8; El-Wailly 1966, a–j.


Fig. 5 Left: Nebi Yunus prior to destruction (DigitalGlobe; 15 November 2013); Right: Nebi Yunus post destruction and subsequent demolition of courtyard wall (DigitalGlobe; 12 February 2016)

placed at every 18m.[19] Multiple city gates have been preserved within the ancient wall, including the Mashki Gate, Nergal Gate, Adad Gate, and Shamash Gate. These were reconstructed by the Iraqi Board of Antiquities in the 1950s.[20]

Nineveh was settled by at least 6,000 BC, and by 3,000 BC the settlement had become an important religious centre for the worship of Ishtar, goddess of love and war. During the Neo-Assyrian period (c. 900–600 BC), Nineveh served as a capital of the vast Assyrian Empire (as were Nimrud and Khorsabad), until the city was sacked by a coalition of Babylonians, Medes, Persians, Chaldeans, Scythians, and Cimmerians in 612 BC. The site was temporarily abandoned, but parts of the site were fairly continuously occupied into the modern era, although the location of these settlements shifted over time. In the mid- to late 19th century, the site was the focus of early European expeditions that resulted in the discovery of large numbers of carved bas reliefs, monumental sculptures, and large numbers of cuneiform inscriptions that were taken back to Europe and North America by early archaeologists such as Sir Austen Henry Layard and later explorers, missionaries, and travellers, contributing to avid public interest in the ancient Near East. The site has seen many subsequent expeditions carried out by foreign and Iraqi teams.[21]

Nineveh's location within modern Mosul has put it at the centre of armed conflict since the city fell to ISIL on 10 June 2014. ISIL continued to expand further into Iraq, capturing the majority of Ninawa Governorate and pushing to within 60 miles of Baghdad. The militants quickly began a campaign of destruction, targeting cultural heritage sites in and around Mosul, as well as in newly captured areas. Reports of looting at these sites and antiquities trafficking by ISIL for financial benefit soon surfaced. The first operations to recapture Mosul were officially launched on 24 March 2016 when Iraqi security forces, backed by Peshmerga and US forces, liberated several villages south of Mosul.

The Nebi Yunus Mosque Complex was the first monument damaged within the site of Nineveh by ISIL. The mosque, which contains a shrine/tomb, was targeted for an ISIL performative deliberate destruction using explosives on 24 July 2014.[22] A portion of the southern exterior courtyard

19 Stronach – Lumsden 1992.
20 Madhloom – Mahdi 1976.
21 For a list of excavations, see Reade 2001, 392–394.
22 Danti et al. 2015b, 48–54.


Fig. 6 Destruction of the Mashki Gate at Nineveh (Just Paste It; 15 May 2016)

Fig. 7 Video still of an earthmover and dump truck at the Nergal Gate of Nineveh (Amaq News Agency; downloaded 7 June 2016)

wall was further dismantled using heavy machinery between 29 August 2015 and 12 February 2016 as documented in DigitalGlobe satellite imagery (Fig. 5).[23] Such attacks on more modern religious heritage typify the initial stages of ISIL campaigns of cultural cleansing, as documented in the areas of Palmyra/Tadmor and Raqqa in Syria.

The northern portion of Nineveh has been damaged on multiple occasions, primarily by ISIL deliberate and performative deliberate destructions. On 26 February 2015, ISIL released a video showing multiple episodes of intentional destruction of antiquities at the Mosul Museum and

23 Danti et al. 2016a, 85–87.

at the archaeological site of Nineveh. In the Mosul Museum, ISIL militants and 'plain-clothed' unidentified assailants destroyed a large number of sculptures and some replicas/casts from the site of Hatra, as well as Neo-Assyrian sculptures, partial reconstructions, and replicas/casts from sites in the Mosul area. The video also included images of the intentional destruction of colossi at Nineveh's Nergal Gate.[24] Following this initial incident, Nineveh was temporarily spared from ISIL looting and acts of deliberate destruction as the organisation again focused its cultural cleansing efforts on more modern religious heritage in the Mosul area and the archaeological sites of Hatra and Nimrud. In April 2016, ISIL destroyed the Mashki and Adad Gates, as well as portions of the ancient wall, using earth movers (Fig. 6).[25] This destruction was corroborated in DigitalGlobe satellite imagery from 2 May 2016 that showed that both gates had been bulldozed to their foundations. DigitalGlobe satellite imagery from 25 May 2016 revealed that the Nergal Gate had been partially destroyed. The southern side of the gate was visibly damaged and bulldozer tracks were present around the gate. This image captured the gate in the process of being intentionally destroyed. DigitalGlobe satellite imagery from 16 June 2016 confirmed that the entire Nergal Gate had been demolished and the ground where it stood had been levelled. The debris from the destruction was removed. ISIL released a propaganda video of this destruction on 7 June 2016 (Fig. 7).[26]

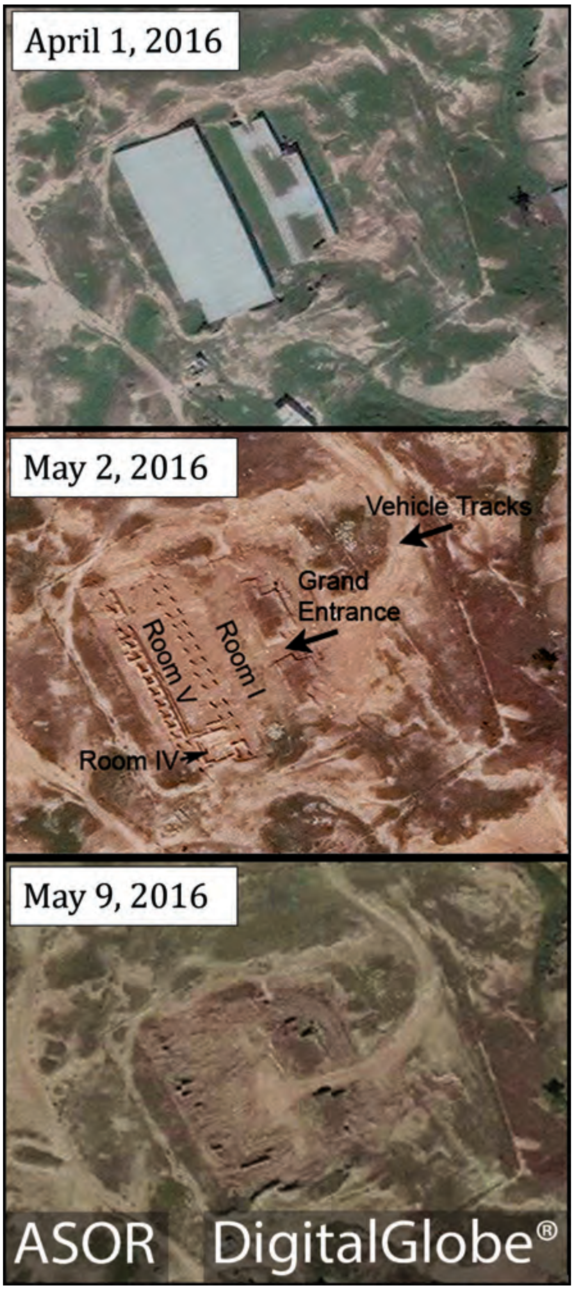


Fig. 8 Satellite imagery of the Southwest Palace of Nineveh illustrating the deliberate destruction and removal of debris from the site (DigitalGlobe)

In addition to the deliberate destruction of these three city gates, ISIL also dismantled the Southwest Palace in April and May 2016 (Fig. 8).[27] This building had been reconstructed atop its original foundations to display ancient sculptures found there, and a metal roof had been added in 2004 to protect the stone reliefs lining the walls. The building was destroyed slowly using heavy machinery, with the best-preserved stone reliefs likely removed for sale. DigitalGlobe satellite imagery from 2 May 2016 showed the mud-brick towers flanking the Grand Entrance were intact, but the brick walls dividing the Throne Room (Room I) from Room

[24] Danti et al. 2015a, 108–132.
[25] Danti et al. 2016b, 60–66; Danti et al. 2016c, 80–92.
[26] Danti et al. 2016d, 107–122; Danti et al. 2016e, 52–56.
[27] Danti et al. 2016c, 93–104; Danti et al. 2016e, 57–61.


Fig. 9 ISIL-affiliated photograph of an Assyrian lamassu located at the western entrance of Room V at the Southwest Palace of Sennacherib at Nineveh. The metal beams from the reconstructed roof can be seen on the ground and around the lamassu (Just Paste It; 15 May 2016)

V were mostly removed. Only the metal support pillars, surrounded by brick, remained, with the stone reliefs removed. The southwestern corner of Room V was still intact, possibly with the ancient bas reliefs still in place along the western wall. Room IV appeared untouched with all walls still intact. Vehicle tracks leading up to the Grand Entrance of the Palace were visible.

By 9 May 2016, the Southwest Palace was further dismantled with the remaining metal pillars between Rooms I and V removed and the remaining portions of the brick walls of Rooms I, IV, and V almost completely dismantled, with the stone reliefs taken away. Only small sections of the southern and western walls of Room V and the south wall of Room IV remained. Vehicle tracks could be seen going inside the palace rooms, probably to remove the debris from the interior walls, and also running directly through the Grand Entrance, which still appeared to be relatively intact. ISIL released photos of the palace partially destroyed, showing an Assyrian lamassu still standing in the western entrance of Room V with metal roof beams laying on top of it (Fig. 9).

Other damage incidents occurring at Nineveh include the construction of a new four-lane road across the southern mound and a drainage ditch cutting the ancient wall, created between 29 August 2015 and 18 July 2016,[28] and new houses and commercial buildings constructed around and within the ancient site (Fig. 10).[29]

In early 2016, local sources began reporting tunnels at the site, which first appear in DigitalGlobe satellite imagery from 9 May 2016.[30] These tunnels are visible due to the debris pattern around the tunnel entrances. Tunnels have been excavated into the city walls, the mound of Kuyunjik, and the Nebi Yunus mound in order to search for antiquities as well as for military purposes (Fig. 11). Since the liberation of eastern Mosul, local sources have reported to ASOR CHI and on social media sites that ISIL forces tunnelled the mound of Nebi Yunus, probably for both defensive and looting purposes. These tunnels within the Nebi Yunus mound have caused significant damage to Neo-Assyrian monumental architecture and have almost certainly undermined a large part of the overlying mound, threatening extensive areas of well-preserved archaeological deposits.

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28 Danti et al. 2015e, 25–28.
29 Danti et al. 2015c, 46–54.
30 Danti et al. 2016c, 80–92; Danti et al. 2016f.


Fig. 10 Completed paved road and new irrigation channel within the southern portion of Nineveh (DigitalGlobe; 18 July 2016)


Fig. 11 Example of tunnel looting located within the site of Nineveh (DigitalGlobe; 2 May 2016)

Overall, the archaeological site of Nineveh has been badly damaged by the ongoing conflict. ISIL's deliberate destruction directly affected much of the reconstructed and previously standing architecture, including the Nebi Yunus Mosque Complex; the Mashki, Adad, and Nergal Gates and the Southwest Palace. It is hoped that the recent liberation of the site from ISIL will lead to conservation and preservation efforts to repair this important archaeological site.

## Mitigation and Restoration Work at Bosra al Sham

Beginning in November 2015, ASOR CHI partnered with local Syrians on mitigation and restoration projects to address conflict-related risks and damage at the UNESCO World Heritage Site of Bosra al Sham and other heritage sites in the area of Apamea and Ma'arat al Numan. We focus

Fig. 12 BSAD team members assess damage within the museum
(BSAD; 16 April 2016)

here on the outcomes of the Bosra al Sham project. The capture of Bosra al Sham in March 2015 by Syrian Opposition forces ended support to the employees of the Bosra al Sham Antiquities Department (BSAD). The ancient city, the site museum, and the antiquities collections were severely impacted by combat and looting, thus local heritage professionals sought international assistance to protect and preserve Bosra al Sham and neighbouring sites. At that point, Humanitarian Research Services (HRS), a non-profit organisation conducting relief work in the region, alerted ASOR CHI to the possibility of implementing heritage projects with BSAD.

The ancient city of Bosra (modern Bosra al Sham) is located in southern Syria and is home to a well-preserved Roman theatre, dated from the 2nd century CE, and a number of structures of the Nabataean, Byzantine, and Islamic periods. In addition to the theatre, the city is home to the Al-Omari Mosque and many other Islamic-era buildings. The settlement was fortified from 481 to 1251 CE, and extensive ruins of those fortifications still remain. Unfortunately, the ancient city has experienced significant damage during the Syrian conflict at the hands of both the Syrian Arab Republic Government (SARG) and opposition forces.[31] While the damage and destruction has been extensive over the last five years, there have been some encouraging signs of hope.

The war in Syria left the local antiquities department without basic equipment or supplies, and they were often forced to work without electricity. ASOR CHI provided funds to purchase a generator, office equipment, computers, and digital cameras. The BSAD team performed emergency collections assessments and site assessments and began rehousing the remaining museum and archaeological storehouse collections (Fig. 12). The projects have provided support for BSAD staff and local carpenters, masons, and other craftspeople. Because the project takes place in a complex and dangerous war-zone environment, ASOR CHI can only remotely monitor progress. Thus HRS undertook steps to ensure safety and adherence to best practices through joint planning, monitoring, and evaluation with BSAD.

The BSAD staff continued to carry out emergency response projects beyond the period supported by the initial collaborative project. ASOR CHI received a separate grant from a private foundation to support an additional three months of work. This additional funding provided support to catalogue and safely store the museum's remaining collections, which were severely

[31] See this link for 'Bosra' in the index of the ASOR CHI Weekly Reports <http://www.asor.org/chi> (last accessed 12 Oct. 2020).

Fig. 13 Museum storerooms are assessed and inventoried; the collections are then photographed and packed for relocation in secure storage (BSAD; 16 April 2016)

Fig. 14 The Roman theatre of Bosra al Sham during and after cleaning (BSAD; 16 April 2016)

damaged and looted during clashes between SARG and Opposition forces, and to complete more thorough site condition assessments (Fig. 13). Finally, the team oversaw the removal of military explosives from the site by demolition experts and clean-up efforts drawing on local labour. Through this and other cooperative efforts, the citizens of Bosra al Sham have been involved in the preservation of Syria's rich cultural heritage and ensuring the fundamental human right of access to cultural heritage. Locals volunteered to assist in the cleaning and reparation of the Roman theatre as well (Fig. 14). ASOR CHI will continue to assist local heritage professionals in their work towards conservation and preservation of cultural heritage resources.

## Conclusion

Since August 2014, ASOR CHI has recorded and reported on damage to cultural heritage within Syria and northern Iraq and conducted an emergency response effort. Our Weekly Reports have been posted to the ASOR CHI webpage in order to raise awareness of what is the most severe cultural heritage crisis since World War II. While ASOR CHI has documented and analysed thousands of cultural heritage incidents, there are thousands of other sites that have not been impacted. Even for those heritage locations that have been damaged, there is hope for restoration and preservation through collaborations with local heritage groups within affected communities. The international community will have to play an expanded role in assisting where needed once these conflicts have been resolved. ASOR CHI believes that our documentation of looting, theft, damage, and destruction of cultural heritage will continue to facilitate ongoing emergency responses and facilitate post-conflict rehabilitation, restitution, and repatriation efforts.

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# Technical Examples and Solutions

# Terrestrial LiDAR Survey as a Heritage Management Tool: The Example of Tell eṣ-Ṣâfi/Gath

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**Abstract:** In recent years, LiDAR technology has been systematically applied to the study of archaeological sites and/or monuments largely as part of the study of landscape topography (including view sheds, architectural relationships, etc.). Rarely is it used as an analytical tool to record dimensions and stratigraphic relationships while terrestrially-based. This can yield extremely accurate and detailed information about archaeological sites, especially those that are topographically and stratigraphically complex. LiDAR technology can capture millions of data points in a brief span of time, allowing for more subtle imagery and analysis than in more popular data collection techniques. LiDAR technology also allows for disparate excavation areas to be integrated into a single analytical unit and for more accurate estimation of excavation and site dimensions. As a heritage recording, conservation, display and analytical tool, it is excellent choice of technology. Data from the archaeological site of Tell eṣ-Ṣâfi/Gath, Israel will be used to demonstrate some of the advantages of this kind of approach to data collection and analysis.

**Keywords:** heritage; conservation; survey; remote sensing; terrestrial LiDAR; complex urban sites; Early Bronze Age; Israel; archaeology

## Introduction

Remote sensing has become a widely used method for archaeological prospection over the last century.[4] As part of the management of heritage resources, particularly in the recent Syrian, Iraqi and other Near Eastern conflicts, it has also become an ever more important part of the suite of techniques used to collect data on endangered archaeological resources. Two types of remote sensing are commonly used to collect data about the shape and nature of the archaeological record – those that are ground based, such as with GPR, resistivity/conductivity, magnetometers,[5] and those that are more truly remote forms of sensing since they involve satellites and various forms of aerial remote sensing.[6] Each has its utility for collecting data about archaeological sites, but none provide a complete replacement of the other.

Another technique, LiDAR (Light Detection and Ranging), can provide an additional level of data resolution that is unobtainable through other means. It is not widely used at present, partly because of its newness and expense, but is slowly growing in usage and understanding.[7] Most practitioners of this technique use it in an aerial mode, usually from airplanes or drones, to collect broad swaths of data across regions and sites. This technique is particularly useful for creating highly accurate three-dimensional maps of topographically complex sites.

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4 Kvamme 2005; VanDerwarker – Peres 2010.

5 Creekmore – Fisher 2014.

6 Ur 2010; Ur 2013; Casana 2015.

7 Romero – Bray 2014.

In this paper, we will discuss the utility of terrestrial LiDAR for generating highly accurate digital models of topographically complex archaeological sites and their role in heritage management. We advocate the use of such technologies as a regular part of archaeological excavations, which are by definition destructive, since the physical shape of the site and layers can eventually be reconstructed by such data. As part of this paper, we will introduce recently collected data from the archaeological tell site of Tell eṣ-Ṣâfi/Gath in Israel as an example of the potential of this technique and technology for management and preservation of heritage resources.

## Method: LiDAR Scanning

Light Detection and Ranging, or LiDAR, is a remote sensing technique that was developed based on the principles of RADAR.[8] It uses light pulses to detect the distance to objects being scanned. In order to measure distance, it records the time and in some cases the intensity of the reflected light pulse as it returns to the instrument. It records the individual points scanned at a specified resolution (X, Y, and Z) and generates a point cloud based on those calculations. Since the speed of light is a known constant, this measured time calculates a distance to the object from the instrument. Then, using the known location of the instrument or a set of predefined control points (absolute or relative), the point cloud is registered to a known datum point that can be georeferenced. In some cases as well, the instrument can acquire photographic images of the object or landscape under study and colour the individual points based on those photographs, almost like draping the photographs over the 3-dimensional point cloud.

Most techniques used to generate topographic maps or images of sites can be time consuming and expensive, are often inaccurate or too generalised (by too few data points), and are often poorly georeferenced when traditional surveying equipment is used on such archaeological sites.[9] Other techniques (such as photogrammetry, Structure from Motion, or satellite imagery) may be more accurately georeferenced, but often do not produce the desired data resolution or complete coverage.[10] In contrast, terrestrial laser scanning represents a significant step forward for creating highly detailed and accurate topographic maps of complex archaeological sites that can integrate with other georeferenced datasets from the same and other sites.[11]

Contrary to techniques such as photogrammetry, LiDAR technology collects integrated data at various levels of areal coverage that allow the researcher to move seamlessly from discrete excavation units to the larger landscape. The level of resolution and extent of coverage is defined by the researcher in a much more integrated and comprehensive manner. It integrates photography and point cloud data that can be fully manipulated so they do not merely represent 'pretty pictures'. In this way, LiDAR becomes part of the suite of analytical tools that enhance our understanding of the archaeological landscape.[12]

There are two methods for collecting LiDAR data. The first is the aerial method that scans areas from the air via airplanes or drones/UAVs. The second form of LiDAR scanning is terrestrially-based that scans areas from a ground-based unit. The equipment for terrestrial LiDAR scanning is built primarily for construction purposes for engineers and planners. It has been adopted by other industries, such as geography and forestry, but has only recently been adopted into archaeology.[13] Terrestrial LiDAR scanning is probably the least commonly used LiDAR scanning method at this time, but we predict that it will become increasingly common in archaeological excavation and surveys as the cost decreases and the technology becomes easier to employ.

8 Kvamme 2005.
9 Olson et al. 2013.
10 Ur 2003; Olson et al. 2013.
11 Richter et al. 2012.
12 Hesse 2010.
13 Campana et al. 2012; Schindling – Gibbes 2014.

Currently, terrestrial scanning is conducted with the use of a relatively small portable scanner that is set up on a tripod, much like a total surveying station (Fig. 6). From this vantage, it can scan a much more discreet area at higher resolutions than aerial LiDAR. The scanning can be conducted directly from the unit or it can be linked directly to a laptop computer for enhanced software control.

LiDAR terrestrial scanners have a number of advantages in their own right. First, the machines are small, portable and versatile. They can be carried into relatively inaccessible locations (caves, under tarpaulins, etc.) that are not accessible with aerial technology. It can provide images that are integrated between the more visible and invisible parts of the landscape.[14] LiDAR scans can be stopped, and the scanner set up and taken down relatively quickly to allow people, animals, and goods to pass through the area being scanned. The scanner can be moved close for more detailed scans or farther away for broader images. This allows discrete swaths of land or individual features to be scanned and integrated into a single point cloud for analysis.

Terrestrial LiDAR scanning yields point clouds and images that are significantly higher in resolution than can be easily obtained in aerial LiDAR scanning. This adds a level of detail to the spatial database that is unobtainable with other technologies.[15] Also, scans can be done at various levels of resolution, from very coarse down to very fine point clouds (ranging from a point every 1mm to one every 1m). This allows scans of different surface areas, excavations, and even objects to be seamlessly integrated into a single image for analysis at comparable levels of resolution. For example, scans of individual artefacts or features scanned by the terrestrial method can be reintegrated back into trenches or broad surfaces scanned by either method. There can be a significant resolution differential between aerial and terrestrial scanning. However, the data from the different techniques can still be integrated into a single LiDAR data set and image for analysis. That being said, this process is not as seamless as it sounds and requires substantial software manipulation of point cloud data sets.[16]

Terrestrial scanners can deal with topographically very uneven surfaces at close range. Most sites include various natural or man-made features, such as rocky overhangs, houses, caves, etc.[17] By being able to move the scanner around and within features, it is possible to obtain images of the complexities of features that are not possible in aerial scans. It avoids the black spots often seen in aerial scans that fall into the shadows (e.g. far side or inside of walls and other structures).[18] As a result, it allows a more complete scan of a landscape to be made without spatial gaps.

The terrestrial LiDAR scanner that we employ can collect data over a relatively large area at comparable levels of resolution. For example, the Leica C10 HDS will scan up to 300m (maximum) away from the station's origin, although the dpi will decrease with distance. However, this can be compensated for by adjusting the range and resolution to collect comparable data resolutions. The resolution (points per $m^2$) can be easily adjusted per individual scan that will allow point clouds with different levels of resolution to be integrated. In contrast, aerial LiDAR is usually conducted with a single predefined resolution for the entire surface.

Ground-based scanning also allows for repeat scanning of even small areas at different times at a reasonable cost. If one area is either inaccessible or covered in seasonal vegetation that does not allow for accurate scans, it can be scanned at a different time of year or rescanned. Multiple-return LiDAR technology sends multiple light pulses to the same location and each individual point is recorded.[19] While first return points usually only reflect off of the first object it encounters, such as the canopy of a forest, multiple return scans can eventually penetrate down to the surface level in such a situation. However, this is not the case for solidly built structures, or natural structures such as overhangs which a light-pulse cannot penetrate. In these cases, and such is the

[14] Richter et al. 2012.
[15] Young et al. 2010.
[16] Young et al. 2010.
[17] Richter et al. 2012.
[18] Arav et al. 2014.
[19] Wehr – Lohr 1999; Doneus et al. 2008.

nature of the terrain at Tell eṣ-Ṣâfi/Gath, terrestrial laser scanning provides a significant benefit over a one-time aerial scan.

Terrestrial scanning can be done incrementally. Various parts of an area (both large and small) can be scanned over one or multiple seasons.[20] Each of the scans can be stitched so that the point cloud will be seamless. As a result, areas covered by seasonal vegetation or other temporary covers (shade cloth for excavation) becomes less of an issue.

Ground-based laser-scanning also does not have to interfere with other activities taking place on the site. This is an advantage to us as we have multiple survey and excavation teams moving around the site at any given time. The freedom to move and scan areas not currently being worked on, and the ability to return to those being excavated during a season when the staff is not present is an advantage over the aerial method as well. Under the aerial method, we would want the entire site vacant during the scan, which is not possible in our case, as the site is a national park and visited daily by tour groups, hikers, cyclists, or the local Bedouin grazing their herds.

Finally, terrestrial LiDAR can be used much more cost effective (financial, labour, time) for small and/or complex surfaces since it can be completed incrementally. As a result, it does not interfere with other activities and is not a huge expense, especially when cost for its use over the length of a long-term project is factored into consideration. For example, two aerial scans by a private contractor over our site would have taken up our entire budget for purchasing the Leica C10 scanner.

## Integration of Photography and LiDAR Data

Two types of data are collected in terrestrial LiDAR scanning: point cloud and photographic images. The point cloud is the more analytical form of LiDAR data. The point cloud consists of hundreds to millions of points taken on an area at a resolution specified by the technician. As with the photo image, a point cloud can be taken up to 360 degrees horizontally, and 270 degrees vertically or any subset of that. Each individual point has the possibility to exist as a stand-alone point and contains its own X, Y, and Z data. Any subset of the larger point cloud can be exported and manipulated for analytical purposes or simply as a 3-dimensional image. The point cloud is a consistent grouping of empirical points, highly accurate, and based on direct data collection. Terrestrial LiDAR has the added benefit that it collects the point cloud at the point of origin and is not derived separately as in photogrammetry.

While the advantage of the point cloud is readily apparent for measurement, it is in reality only a series of points (with x, y, and z coordinates) that independently lacking any interpretive significance. For humans, it is difficult to interpret the dots behind the image without the colouring, lines, and other visual cues that enable us to interpret the meaning of images in photographic pictures. This can be provided by photography. Point clouds provide the real spatial coordinates for the information in the photographs. It is the combination of the two that makes LiDAR, in particular terrestrial LiDAR, a strong data collection and analytical technology.

The photographic image is taken by an internal camera as a series of raw images that overlap in a hexagonal style. These are stitched together by the software (in our case, Cyclone) into a photographic mosaic that is used to colour or shade the point cloud. The extent of the photograph is up to the user and can be as complete as a 360 degree by 270 degree panoramic style or any subset of that. As with traditional photography, the camera has the ability to adjust exposure time in order to lighten or darken the photo. This is particularly important in the field with the weather conditions and time of day constantly changing the lighting. The mosaicked image can then be used to colour the point cloud with realistic colours. Images taken through the terrestrial LiDAR technique have the advantage of being directly tied to a completely ‘true’ point cloud. It differs from photogrammetry in that the point cloud is not artificially generated through a series of algo-

[20] Arav et al. 2014.

rithms that is based on only a few known points. Every point in the cloud is separately measured and linked to the photograph.

The quality of the photographic image is limited to the specifications of the internal camera. The internal camera generally captures a lower resolution image in comparison to stand-alone cameras. In the case of the Leica C10 internal camera that we use, it generates images with a 4 megapixel resolution. An external camera that can collect a much higher quality image can be mounted specifically for this purpose. However, a photographic image is not the ultimate goal and significance of LiDAR scanning.

When digital cameras are embedded within the LiDAR scanner, the digital pictures can be seamlessly draped over the point cloud. The point cloud is coloured to represent the landscape in very much the same way as a digital image would be, which is important for human recognition of the meaning of the data. The images can be taken at the same or different times as the scan, if lighting conditions are not optimal. In this way, they can be used to colourise the point cloud data. This is particularly useful when the time of day and lighting conditions are not optimal for photography, which is a major issue for other remote sensing techniques (such as photogrammetry). Bad lighting conditions do not inhibit the use of terrestrial LiDAR scanning. The underlying point cloud data are not affected by shadows or lighting conditions. Point cloud data can be collected under any kind of light conditions, even at night in the total dark.

The quality of the photographic image that accompanies the point cloud is not as precise as the point cloud, nor is it a seamless image. The software stitches together a series of hexagonal im-ages that may have different light exposures. At this point, the software does not compensate for this and any editing must be conducted in specialised photographic editing programs that do not allow the images to be reimported back into the software to be integrated with the point cloud. Often it is not possible to scan the entire area of interest at one time which can generate the need for new photographic images each time. In contrast, a new point cloud scan does not need to be collected again. New photographic images can be taken repeatedly at different times of day or even seasons to enable the photographic image to look as if it were taken all at once at the same time of day.

Terrestrial LiDAR collects both a photographic image as well as a point cloud during the initial data collection phase. This has the significant advantage of reducing the time for field data collection and post-field processing of the data. It allows the analyst to georeference the data and confirms the accuracy of the data at the time of collection, instead of only being able to do quality control after the data has been processed, and to interpret the data both spatially and culturally.

## Background to the Research: The Site

Aren Maeir has directed a long-term research project at the site of Tell eṣ-Ṣâfi/Gath since 1996. While the excavations have largely focused on the Middle Bronze, Late Bronze and Iron Age occupations,[21] in more recent years it has also included a systematic investigation of the extensive Early Bronze Age occupation of the site.[22] As we realised that the nature of the surface of the site changed significantly over time, it was decided that digital landscape models of the site were necessary. Given its size and topographic complexity, it was deemed that traditional topographic data collection techniques were neither sufficiently sensitive nor efficient to collect the necessary data. As part of the joint venture between Maeir and Haskel Greenfield to investigate the Early Bronze Age city that underlies the later occupations, it was decided that a terrestrial LiDAR survey of the site would be conducted under the direction of Greenfield.

21 Maeir 2012b.
22 Greenfield et al. 2017.

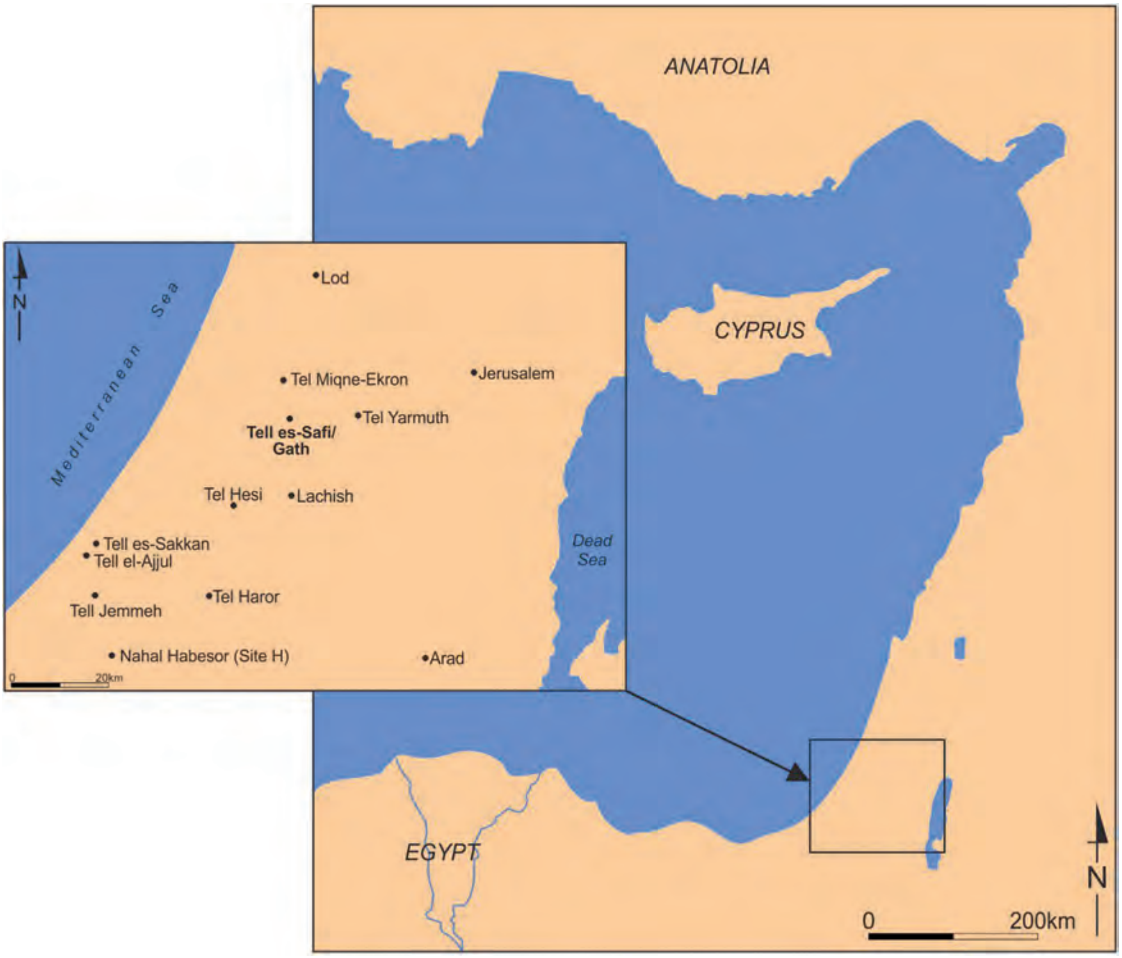


Fig. 1 Location of Tell eṣ-Ṣâfi/Gath and other Early Bronze Age sites in the region (© The Tell eṣ-Ṣâfi/Gath Archaeological Project)

Fig. 2 Aerial view of Tell eṣ-Ṣâfi/Gath, looking northwest (© The Tell eṣ-Ṣâfi/Gath Archaeological Project)

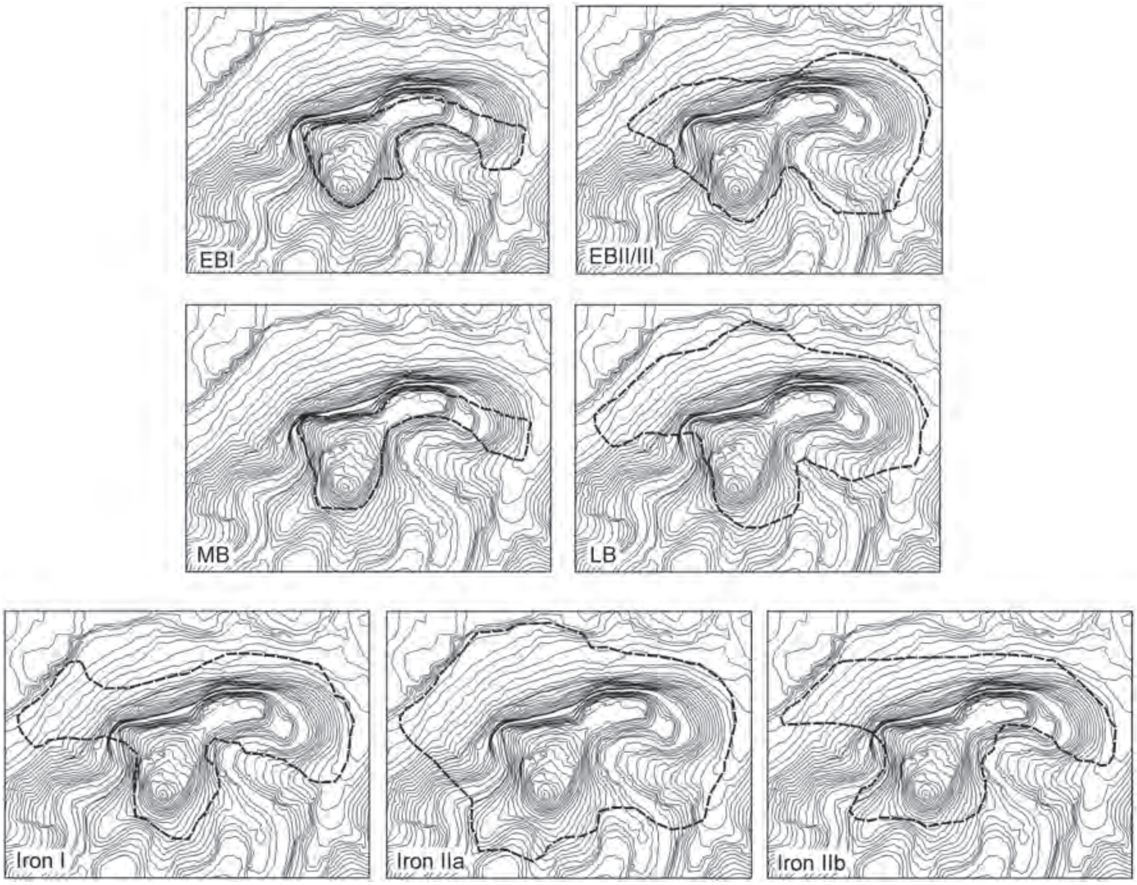


Fig. 3 Topographic map of Tell eṣ-Ṣâfi/Gath showing spatial extent of occupation during different time periods based on the analysis of the surface distribution of ceramic objects (© The Tell eṣ-Ṣâfi/Gath Archaeological Project)

The Tell eṣ-Ṣâfi/Gath site is located in central Israel on the edge between the flat southern coastal plain ('Philistia') and the rolling foothills of Judea (*Shephelah*). From its summit, Tell eṣ-Ṣâfi/Gath has a commanding view from the coast to the mountains of Judea (Figs. 1–2). The site is most famously known as 'Gath of the Philistines' that according to the biblical narrative was the hometown of Goliath during the Iron Age.[23] This is where Goliath would have set out from on his way up the Elah Valley to his battle with the young David. The site has various toponyms that relate to its occupation in different periods (e.g.: Gath in Canaanite and Judean texts from the Late Bronze and Iron Age and during the Iron Age occupation by the Philistines, *Blanche Garde* in the Crusader period, and Tell eṣ-Ṣâfi in the medieval through modern periods). While there are over 14 major occupational horizons at the site from Chalcolithic to modern, there are a few gaps in occupation that coincide with its repeated destruction and abandonment.

Maeir began this long-term field project with a comprehensive topographic mapping and systematic surface collection of the site. The main objectives were to determine which periods were represented at the site, the size of the site in different periods, and which periods were closest to the surface for systematic investigation. Analysis of the remains from the surface collection suggested that the site was occupied (with intermittent breaks) from the Chalcolithic period until recent times. It also demonstrated that the Early Bronze, Middle Bronze, Late Bronze, and Iron Ages were significant periods of occupation (Fig. 3).[24]

[23] Levin 2012.
[24] Uziel – Maeir 2012.

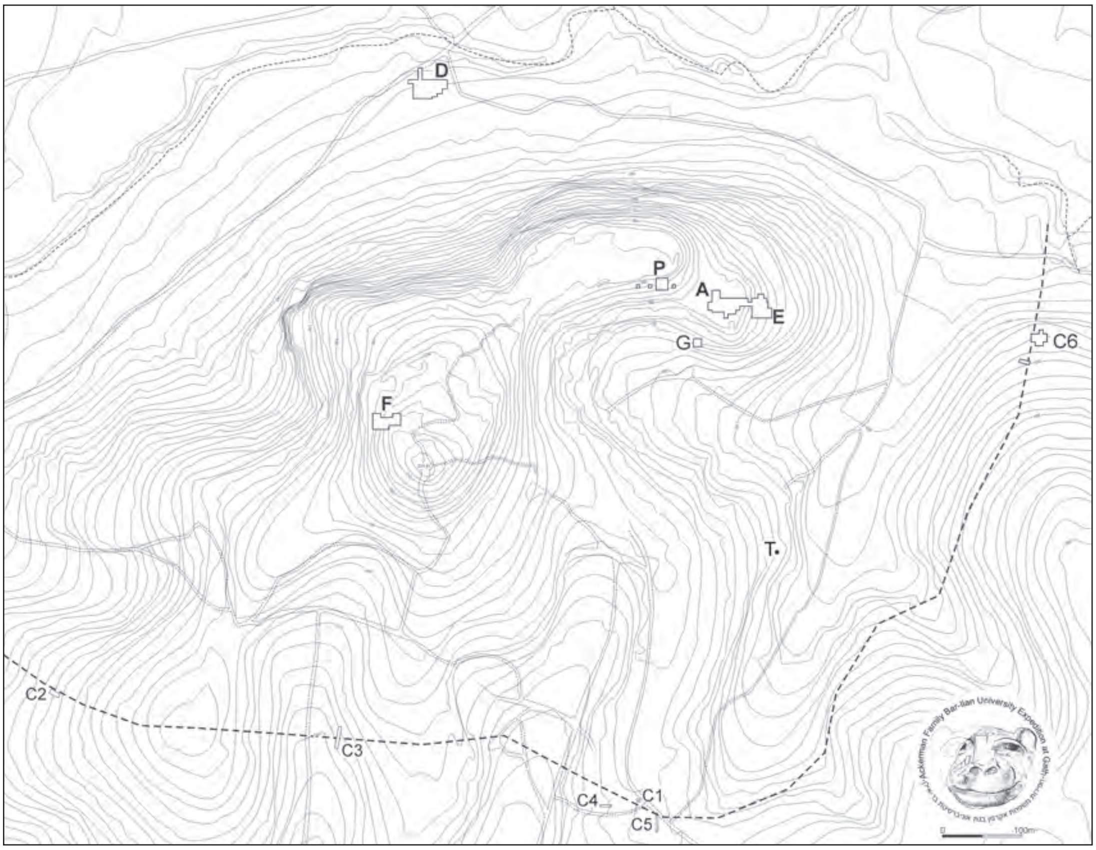


Fig. 4 Contour map of Tell eṣ-Ṣâfi/Gath with excavations areas labelled with letters. Aramaean siege trench is a dashed line with the C series of trenches. Contours are at 2m intervals (© The Tell eṣ-Ṣâfi/Gath Archaeological Project)

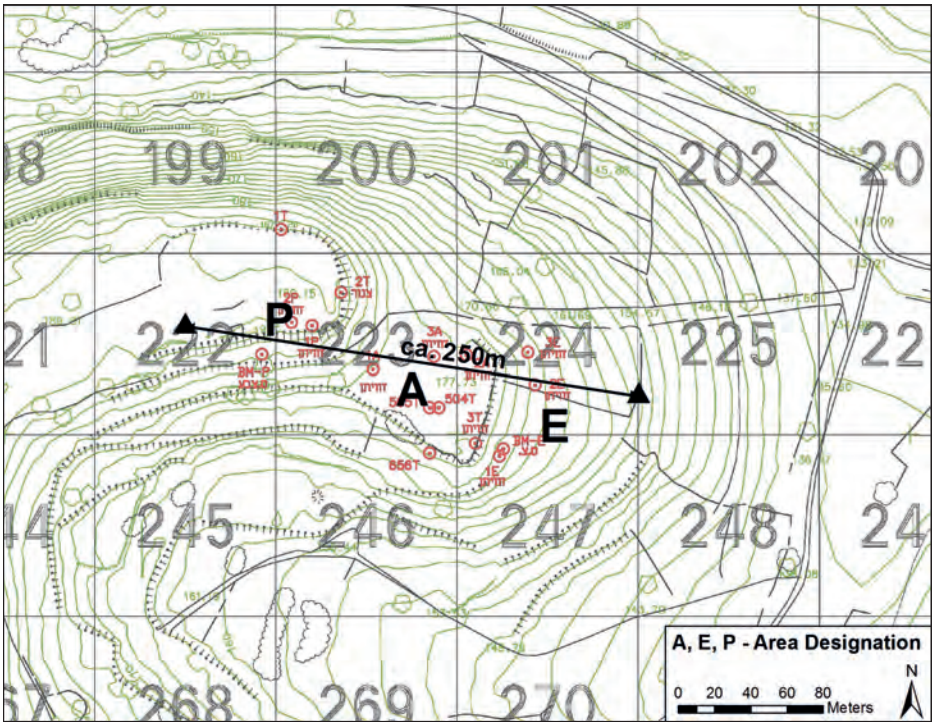


Fig. 5 Contour map of eastern half of Tell eṣ-Ṣâfi/Gath with topographic survey grid blocks labelled (100 × 100m) with Arabic numbers and excavations areas discussed in the text labelled with letters. Contours are at 2m intervals (© The Tell eṣ-Ṣâfi/Gath Archaeological Project)

The surface collection and aerial photographic survey also demonstrated that the site is composed of three spatially distinct areas. Two of these represent what would traditionally be described as off-tell areas of occupation: the lower city area (Excavation Area D) and the surrounding siege trench (labelled with the dotted line around the site) (Fig. 4). The lower city is found below the northern face of the upper tell. It is on a broad terrace overlooking the Elah River valley. The siege trench is a semicircle dug into the hills that surrounds the sides of the site. The latter is probably the remains of the siege trench that hastened the conquest of Philistine Gath by the Aramaeans (see II Kings 12:17/18).[25]

The tell or upper city corresponds to the visible mound that rises above the surrounding landscape (Figs. 2 and 4). It is on the top of a limestone-based rocky outcrop. The upper surface of the tell is approximately 25ha in area based on traditional topographic survey. The tell is shaped like a kidney bean, the centre of which encloses a pronounced interior valley that may at times have been part of the site. The topography of the tell is very uneven from end to end, with a high 'acropolis'-like summit at the western end and broad relatively flat and sloping plateaus toward the east.[26]

No systematic micro-contour topographic map of the site was ever made. The topographic map is based on a photogrammetric map which was prepared at the beginning of the project.[27] However, these topographic maps were made on such a gross level that the data cannot be easily synchronised with the LiDAR survey or excavation area results (Fig. 5).

## Instrumentation at Tell eṣ-Ṣâfi/Gath

LiDAR scanning began at Tell eṣ-Ṣâfi/Gath under the direction of Greenfield during the 2012 field season. Some of the results of the initial three seasons of scanning are reported here. We conducted two different types of scans – detailed scans within the excavation area and broader scans of the site's topography around the excavation area. Our goals are to model the pre-excavation surface of the tell for heritage purposes, as well as to ascertain the actual site dimensions for various periods of occupation based on highly accurate scans.

We employed a Leica C10 high definition scanner (HDS) and associated LiDAR software (Leica Cyclone) to collect and process the LiDAR data (Fig. 6). This scanner is construction grade, with ½-centimetre or better accuracy and is capable of measuring up to 50,000 points/second at sub-millimetre resolution or greater.[28] The scanner incorporates an internal camera allowing the acquisition of a photographic image of the area being scanned that is integrated with the point cloud data. This photographic image is very useful in the registering of benchmark targets (set in place with a total surveying station) in order to georeference the scan, as well as to colourise the point cloud with natural, instead of neutral colours (Fig. 7). Through the Cyclone

Fig. 6 Leica C10 HDS scanner in use at Tell eṣ-Ṣâfi/Gath (© The Tell eṣ-Ṣâfi/Gath Archaeological Project)

25 Maier – Gur-Arieh 2011.

26 Maier 2012a.

27 Maier 2012b, fig. 1.1.

28 Leica Geosystems 2014.

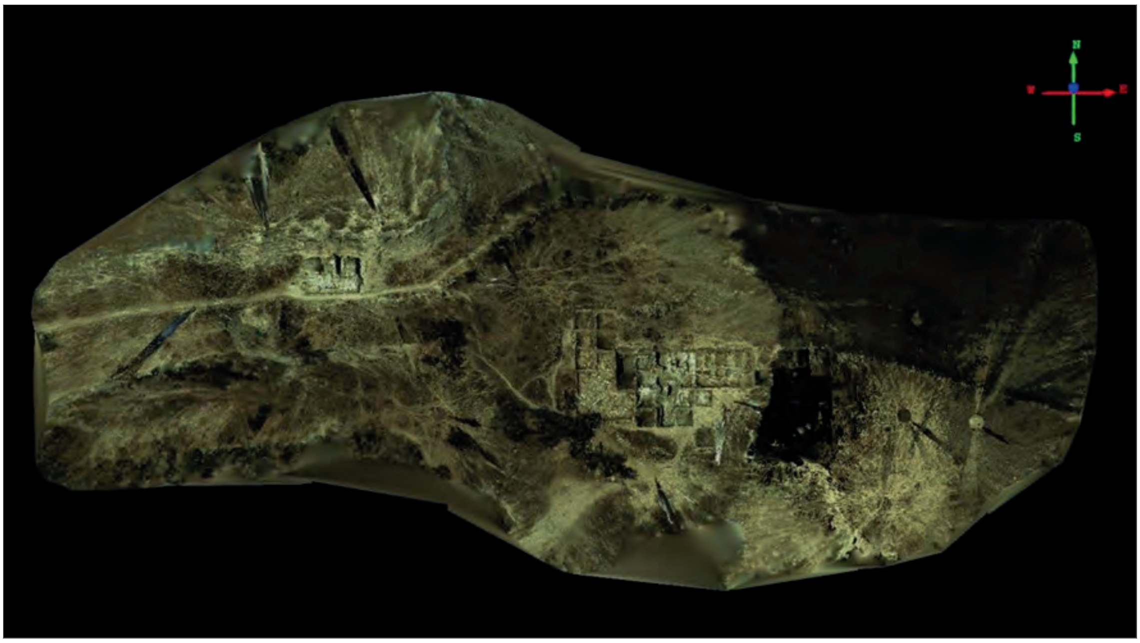

Fig. 7 Measurement of distance across survey area as if taken from the analogue contour map. LiDAR DEM image (as if from 90 degrees overhead) of the east end of Tell eṣ-Ṣâfi/Gath including excavation areas E, A, and P through the end of the 2013 season (© The Tell eṣ-Ṣâfi/Gath Archaeological Project, background image: courtesy of Jack Landy)

software, the point cloud and photographic image can be viewed as they are collected in real time even in the field. Cyclone provides the necessary tools for editing the point cloud, selecting sub-sets, as well as exporting the data into other formats (i.e. .txt or CAD format) for incorporation into other software programs (e.g. computer-aided design, CAD, or Geographic Information Systems, GIS).

## Results

The results of the 2013 field season are presented here. They consist of broad scans of excavation areas A, E, and P (Fig. 5). Approximately 20 scans were undertaken in and around these three excavation areas in order to fully integrate each into a single image file for analysis. Care was taken to ensure that the areas were fully scanned, with sufficient overlap, to account for any shadows due to vegetation or other objects such as stones. This increased the number of scans needed in each area due to the complexity of the surface. Furthermore, since the terrain is not uniform, completely scanning the individual terraces required more scans than if the surface was flat and homogenous. Scans were completed at a predefined resolution in order to maintain consistency throughout the project. Five-centimetre resolution was used at a range of 80 metres. That is to say, that although the scanner will scan well beyond 80m, at 80m, the resolution will be 5 × 5cm, with higher resolution being higher based on proximity to the scanner, and lower resolution beyond the 80m threshold.

Once completed, individual scans are registered together in Leica's proprietary Cyclone software program that allows for the viewing and editing of individual scans or multiple scans registered together and to the Israeli Trans Mercator (ITM) Grid. Once properly cleaned of obtrusive 'noise', such as vegetation or rogue points, the data were exported as an ASCII (text) file for importation into Geographic Information Systems (GIS) programs, such as ArcGIS, or a LiDAR-specific modelling software program, such as Quick Terrain (QT) Modeler. The data are converted into an open-source LAS format for viewing in 2 or 3 dimensions. The imported data can then be viewed as individual points (ArcGIS), or a continuous surface (ArcGIS and QT Modeler). These surfaces are more commonly referred to as digital elevation models (DEMs). With these DEMs and previously created contour map, we were able to complete the analysis described

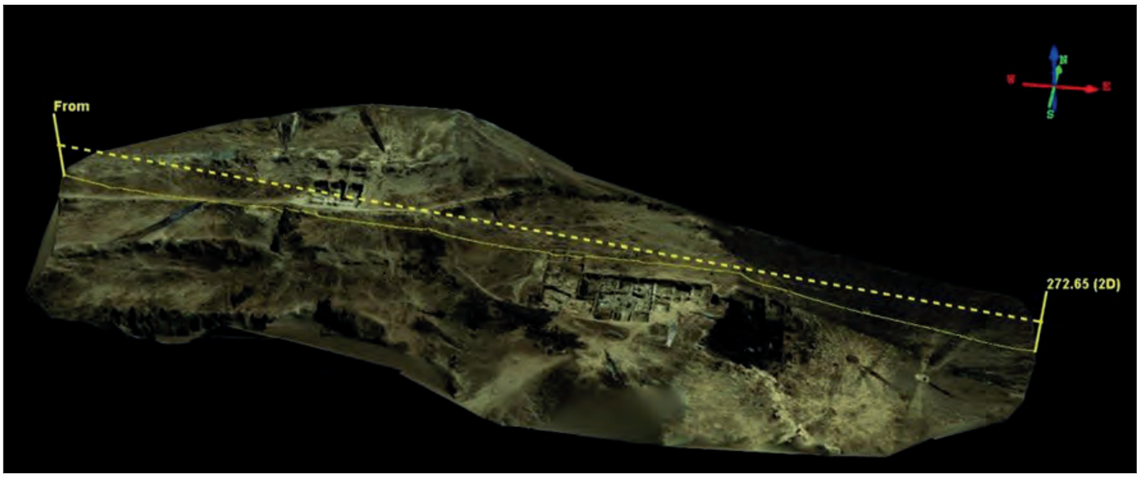


Fig. 8 Measurement of distance across survey area to account for changes that would occur with 2D imagery. LiDAR DEM image (tilted to c. 45 degrees) of the east end of Tell eṣ-Ṣâfi/Gath including excavation areas E, A, and P through the end of the 2013 season. Measurement extent is clearly delineated for the survey area with 2D measurement (© The Tell eṣ-Ṣâfi/Gath Archaeological Project, background image: courtesy of Jack Landy)

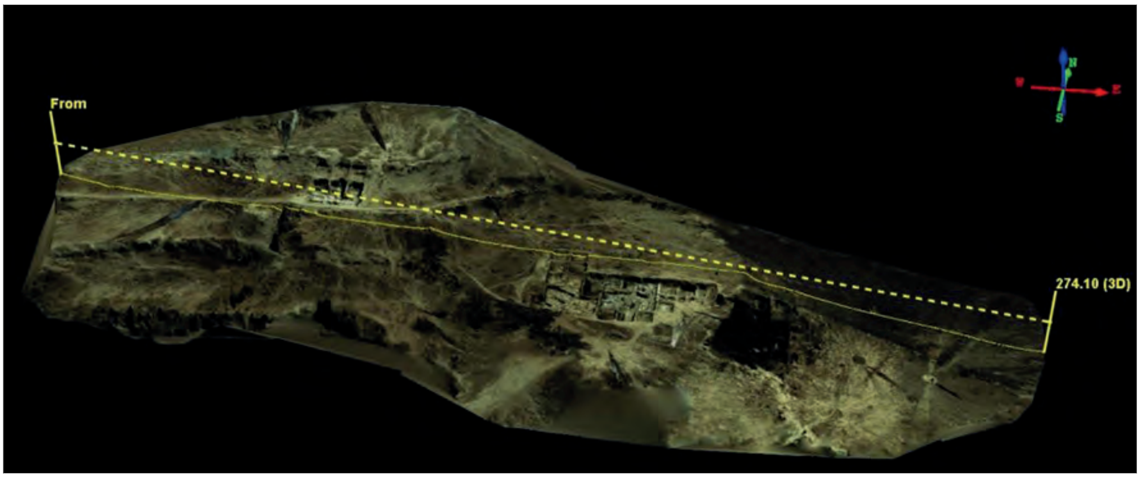


Fig. 9 Measurement of distance across the survey area to account for changes that would occur with 3D imagery. LiDAR DEM image (tilted to c. 45 degrees) of the east end of Tell eṣ-Ṣâfi/Gath including excavation areas E, A, and P through the end of the 2013 season. Measurement extent is clearly delineated for the survey area with 3D measurement (© The Tell eṣ-Ṣâfi/Gath Archaeological Project, background image: courtesy of Jack Landy)

below. Based on the 3D model created from the integrated LiDAR scans, differences between the LiDAR map and the traditional analogue topographic map become apparent.

### Site Dimensions

The first issue relates to estimates of dimensions of the area being investigated. This affects any eventual calculations of site size. The analogue topographic map used at Tell eṣ-Ṣâfi/Gath is on such a gross scale that any measurements from it are difficult to calculate accurately and are really nothing more than 'guestimates' (Fig. 5). When we treat the LiDAR point data and image as a flat 2D surface (similar to the analogue topographic map, the distance from Excavation Area P to the terrace edge below (east of) Area E is approximately 250m (Fig. 7). However, this does not take into account the changing slope of the terrain between the two points. It is simply measuring the area as if it were a flat and not sloping irregular terrain.

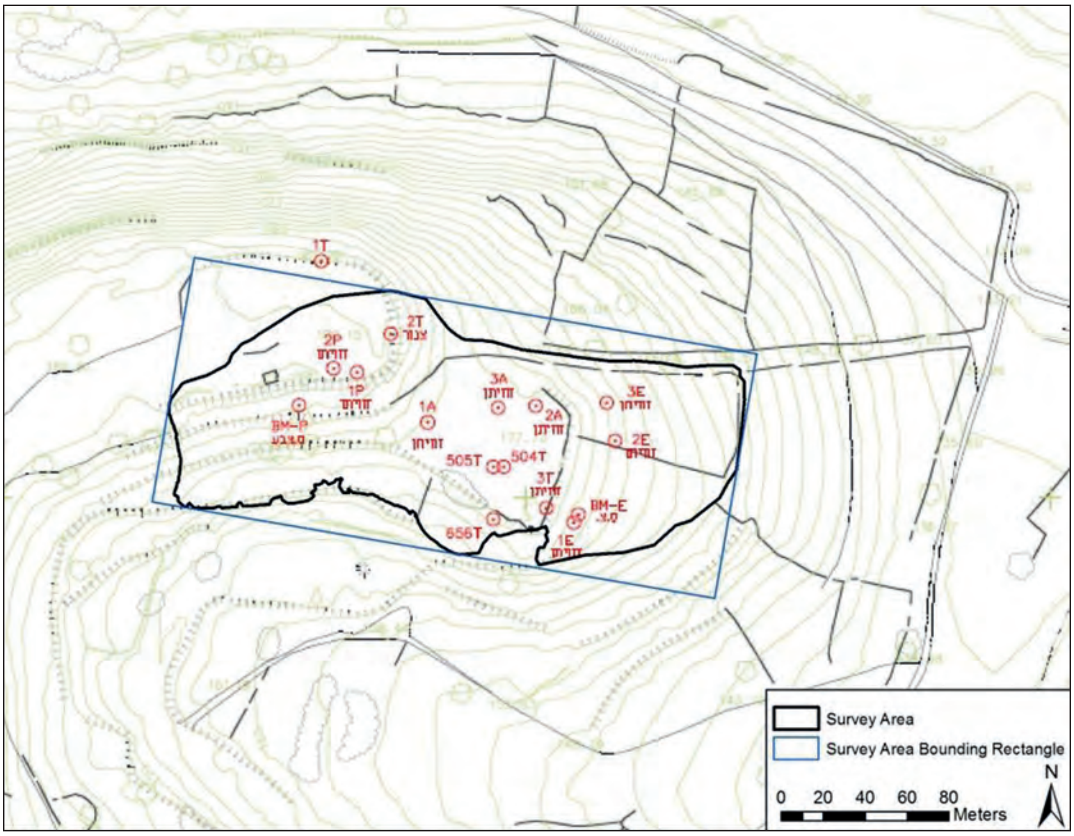


Fig. 10 Analogue topographic (2m contour intervals) map of Tell eṣ-Ṣâfi/Gath with LiDAR survey area and minimum binding rectangle overlaid (© The Tell eṣ-Ṣâfi/Gath Archaeological Project)

In order to compensate for this kind of potential error source in measurements and to measure the surveyed region more accurately, we imported the LiDAR point cloud data into two different programs. The first program was QT Modeler where the data were cleaned and the distances initially measured in two-dimensional space (2D). In this program, we were able to generate a distance of 272.65m between the two areas of excavation (Fig. 8). This is 22.65 m longer than what was visible in the traditional topographic 2D map that does not take into account the actual slope of the terrain since it is essentially a flat image. The difficulty with this program is finding the longest axis of a rectangle between the two points being measured at opposite ends of the survey area. This is where ArcGIS, the second modelling program, can yield superior results. When the LiDAR point cloud data are imported into ArcGIS, we are able to create a minimum binding rectangle that encompasses all of the individual points. An automatic calculation of the long axis of this rectangle in 2D space yields a measurement of 272.31m (Fig. 9), which is approximately the same distance that was generated with QT Modeler. However, when we measure the distance in 3D space through QT Modeler, which ArcGIS does not allow us to do, we obtain a measurement of 274.10m along the same axis (Fig. 10). This is nearly 1.5m longer than we see in the 2D measurements, and 25m longer than a manual/analogue measurement from a simple topographic map. Such inaccuracies would be compounded as the distances increase across the site and to the surrounding landscape.

## Site Size

Given the above, one would imagine that the size of this part of the site based on the LiDAR data would be larger than with traditional analogue mapping techniques. However, this is actually more complicated.

When we compare estimates of site size based on analogue topographic maps and LiDAR data, it becomes a matter of comparing apples and oranges. If we overlay a simple rectangle over the survey area, this generates an area based on the maximum length and width of the survey area (250 × 100 = 25,000m² or 2.5ha). However, the rectangle sticks out beyond the edges of the surveyed area.

When we measure the same area in a GIS framework that takes into account the irregularities of the area and the slope of the actual LiDAR survey area based on the boundary seen in Figure 10, we obtain a smaller area – 23,350.15m² or 2.34ha. The ability to use polygons (rather than simple rectangles) to calculate the area provides a more accurate dimension because we are measuring from the actual boundary of the area. One would assume that we would obtain a larger area in the LiDAR data even though our length dimensions change. However, this is not necessarily the case because of the irregularities in the surveyed area that are determined by the actual breaks in slope at the site.

However, if we really wish to compare the analogue and digital techniques for area size calculation, then it is best to both employ the minimum binding rectangle on both. When the area of the minimum binding rectangle (length × width) is calculated across the LiDAR data surface which takes into account irregularities in the landscape (including changes in slope), we get an area of 32,143.47m² or 3.2ha. The difference between the analogue and digital calculations for even this small area is quite profound – 2.5 vs 3.2ha.

If we extend the results of our research from the east end of the site to the entire summit of the tell, it is likely that the traditional analogue topographic survey techniques underestimate its true spatial extent. In consequence, instead of the total area of the site of being c. 25ha in extent, which measures simply the visible summit of the tell at this (modern) point in time, it is likely that the actual Early Bronze Age surface is actually much larger. The Early Bronze Age pokes out from beneath the overlying strata lower down the slope often up to 10 or more metres beyond the current summit toward the surrounding valley bottom, particularly along the southern face of the tell. If this area of the site is so much larger than estimated with traditional techniques, then the size of the overall Early Bronze Age settlement would change in proportion to the site as a whole. With the use of LiDAR technology, there can be significant improvements in our ability to estimate site size.

### Elevation

Similar measurements can be taken with regard to changes in elevation between points on the landscape. One can approximately determine changes in elevation based on contour intervals from traditional analogue contour maps. But, this can only be approximated when the area or points being measured fall between contour lines that are usually in and of themselves manual or digital interpolations between measured points. In the case of the Tell eṣ-Ṣâfi/Gath analogue topographic map, the elevation appears to decline from 190m to 154.57m asl between Area P and the east end of the site. This is a change of 35.43m (Figs. 5 and 10).

However, if we employ QT Modeler to measure the elevation change digitally represented in the LiDAR point cloud data, there is a smaller elevation change between the two points on the map – only 29.48m (Fig. 11). If this 6m difference in the two types of measurements is occurring over even a relatively short distance (270m) between two points, then measurement errors will likely compound and become much more dramatic as the distance increases.

## Discussion

3D modelling has significant advantages over traditional topographic maps, even in digital form. The results presented above show the improvements in accuracy that can be achieved through the use of digital, semi-automated survey and analysis over traditional survey methods, even digital equipment such as total stations. In the case of the long-axis length measurement, we see only a minor difference when compared to the two digital methods, but a much more significant change

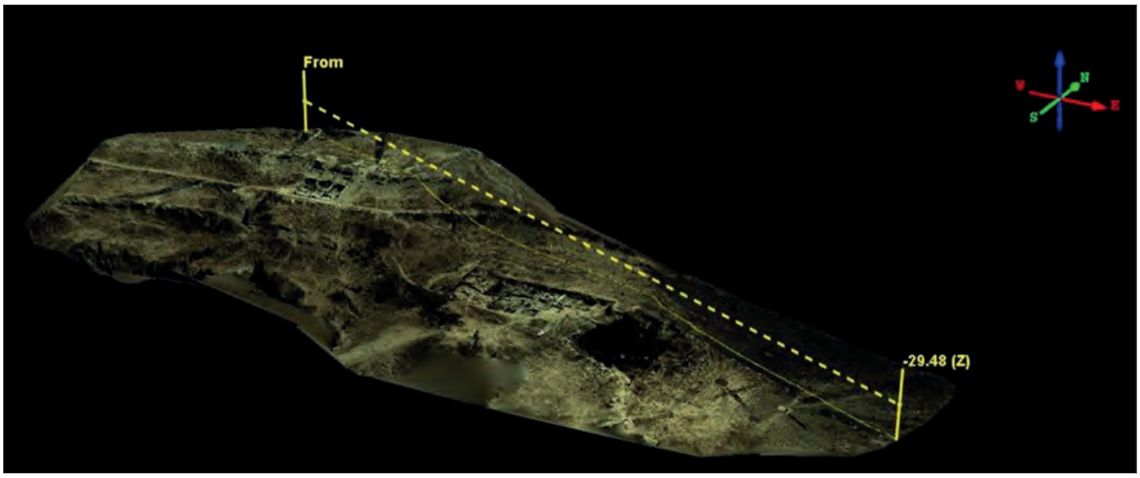


Fig. 11 Measurement of changes in elevation across survey area. LiDAR DEM image (tilted to c. 45 degrees) of the east end of Tell eṣ-Ṣâfi/Gath including excavation areas E, A, and P through the end of the 2013 season. Measurement extent is clearly delineated for the survey area with 3D measurement (© The Tell eṣ-Ṣâfi/Gath Archaeological Project, background image: courtesy of Jack Landy)

when compared to analogue measurements. As the survey region for this is only a tiny portion of the actual site, we can see how different estimates for the extent of the site's area of occupation would be created.

The same can be said for the elevation changes of a site. In the case of Tell eṣ-Ṣâfi/Gath, we see a drastic difference in estimates even over a small area of the site (i.e. the eastern end), which is the part of the site that has the least dramatic slope changes. Other parts of the site have much vaster changes in slope through its many terraces, cliffs, etc. These dramatic changes in slope make it difficult to create and accurately measure changes in elevation with analogue or total station survey data.

Furthermore, and most significantly, if one were to attempt volumetric calculations on a mounded site, such as Tell eṣ-Ṣâfi/Gath, the elevation changes become even more important. The initial estimate of the total areal extent of the tell as being c. 25ha in area based on analogue topographic maps may have to be dramatically revised. We have already demonstrated that there was an elevation difference of 6m and distance difference of 25m simply within the 2.5ha areal extent of the eastern plateau of the site with its relatively flat slopes. If we have such dramatic changes within the relatively short survey distance (270m) at the eastern end of the site used in this study, this will have a dramatic and compounding effect across the entire site.

Our DEMs (digital elevation models), produced through laser scanning, also have the advantage of creating a permanent record of the site for cultural heritage purposes. One of the main questions that archaeologists face today is whether we are excavating too much, and not leaving enough of a record for future generations to study with improved technology. Laser scanning as a highly accurate tool can model a landscape accurately to create a record for future generations to study and as a tool for cultural heritage management. Long-term excavation projects such as the one being undertaken at Tell eṣ-Ṣâfi/Gath may require a highly detailed record of the site as excavation areas are opened and closed over many years and the modern landscape of the site becomes significantly altered by excavation.

## Conclusions

In this study, we have demonstrated that measurements based on traditional analogue topographic maps are only rough estimates. In contrast, one can be much more precise in measurements with digital applications, such as LiDAR.

The above examples of issues that have arisen as we migrated from analogue to digital surveying techniques at Tell eṣ-Ṣâfi/Gath, though preliminary in nature, show the validity of terrestrial LiDAR scanning for archaeological research. While Terrestrial LiDAR scanning is quite recent in its use within archaeology, it represents the future for obtaining much more accurate measurements of the extent, topography, volume and other important indices for individual excavation units, sites, and the larger landscape. Each LiDAR scan can be integrated into a nested series of images that can be quantitatively analysed. LiDAR data can be imported and used within various Geographical Information Systems software programs that are designed for digital and statistical analyses. Site area and distance measurements can be calculated with relative ease and increased accuracy (and independently verified) when compared to traditional analogue measurement techniques.

In conclusion, the use of LiDAR can be used to create a highly accurate digital record of a scanned landscape. For archaeological research, this record can be used in real time, while one is still in the field, to test specific questions and reformulate research agendas, as well as to maintain a record for future generations and heritage management. At sites such as Tell eṣ-Ṣâfi/Gath, which double as national parks and areas where locals put their animals to pasture, significant damage can be done to the site over time by visitors and modern land use. Additionally, although the region is generally considered arid, the rainy season can see high amounts of water moving across the tell, leading to severe erosion across its surface. For all of these reasons, generation of a highly accurate 3D digital model of the site is the way of the future for archaeological research, conservation, and management.

## Endnote

The LiDAR instrument was operated and the data were collected by University of Manitoba graduate students Chris Neufeldt (2012), Jack Landy (2013) and Deland Wing (2014–15) for the Tell eṣ-Ṣâfi/Gath project.

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# On the Possibilities for Crowdsourcing and Automated Structure from Motion (SfM) Algorithms for Cultural Heritage Documentation

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**Abstract:** Cultural heritage all over the world is at high risk. Natural and human activities endanger the current state of monuments and sites, whereas many of them have already been destroyed, especially during the last years, or are situated in hazardous environments. Very often in situ preventive, protective or restoration actions are difficult or even impossible, as e.g. in cases of earthquakes, fires or war activity. Digital preservation of cultural heritage is a challenging task within photogrammetry and computer vision communities, as efforts are taken to collect digital data, especially of the monuments that are at high risk. Visits to the field and data acquisition are not always feasible. To overcome the missing data problem, crowdsourced imagery is often used to create a visual representation of lost cultural heritage objects. Crowdsourcing has become possible with the advancement of web technologies and the spread of social media. Initiatives to collect imagery data from the public and create visual representations of monuments, recently destroyed or not, are presented and discussed in this study. Such digital representations may be 2D or 3D and definitely help preserve the memory and history of the lost heritage, and sometimes they also assist studies for their reconstruction.

**Keywords:** cultural heritage; protection; crowdsourcing; digital images; Structure from Motion; 3D models

## Introduction

Cultural heritage is recognised by all civilised countries of the world as the most important carrier of historic memory for mankind. However, it is not respected and protected as it should be in all cases. Hence, the world's cultural heritage is in great danger as it may be destroyed, lost, altered or forgotten for a number of reasons. The main sources of danger are natural hazards, violent actions, such as wars, terrorism etc., looting, illicit trafficking, vandalism, modern construction activities, globalisation, our modern way of life and indifference, urban population growth and many more (Fig. 1).

Consequently, the protection of cultural heritage is an obligation for all generations both to future generations and to mankind in general for the preservation of historic memory. Several international organisations have been established for the protection of cultural heritage. The main global organisation with a mandate to protect monuments is, of course, UNESCO (United Nations Educational Scientific and Cultural Organization). UNESCO has also formed some other international bodies for specific protective actions, such as ICOMOS (International Council on Monuments and Sites), ICCROM, ICOM etc. ICOMOS has active national committees in almost all civilised countries and is the main body taking practical action for the preservation and protection of cultural heritage all over the world.

In addition, there are a lot of international agreements which dictate the means and the good practices for actually protecting cultural heritage. Such agreements are the Athens Convention (1931), the Hague Agreement (1954), the Charter of Venice (1964), the Granada Agreement (1985) and, lately, the Nara Document on Authenticity (1994) and the Seville Principles (2011), to name but a few. It was in article 16 of the Venice Charter that the geometric documentation of

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Fig. 1 Destruction of cultural heritage (natural hazards, looting and violent actions) (a: Creator: SYmela Pandzartzi, Credit: ΑΠΕ-ΜΠΕ © 2014, https://www.lifo.gr/now/greece/56933; b: A. Georgopoulos; c: https://unitar.org/about/news-stories/news/unosat-analysis-reveals-nepal-earthquake-damage; d: https://www.hindustantimes.com/world/palmyra-s-bel-temple-appears-intact-after-is-blast-officials/story-iugbcpSF6CydBcgOpGt4aI.html)

monuments was recognised for the first time as a sine qua non prerequisite before any intervention. As a consequence, in 1969 ICOMOS and ISPRS (International Society for Photogrammetry and Remote Sensing) established CIPA-Heritage Documentation (Commité Internationale de Photogrammétrie Architecturale), an international scientific committee to promote good practices for the implementation of contemporary technological advances for documenting cultural heritage.

## Geometric Documentation

The geometric documentation of a monument, which should be considered as an integral part of the greater action, the integrated documentation of cultural heritage may be defined as:

- The action of acquiring, processing, presenting and recording the necessary data for the determination of the position and the actual existing form, shape and size of a monument in the three-dimensional space at a particular given moment in time.
- The geometric documentation records the present state of the monuments, as this has been shaped in the course of time and is the necessary background for the studies of their past, as well as the care of their future.[2]

The geometric documentation of a monument consists of a series of necessary measurements, from which visual products such as vector drawings, raster images, 3D visualisations etc. may be produced on small or large scales. These products usually have metric properties, especially those in suitable orthographic projections. Hence one could expect from the geometric documentation a series of drawings which actually present the orthoprojections of the monument on suitably selected horizontal or vertical planes (Fig. 2). Very important properties of these products are their

[2] UNESCO 1973.

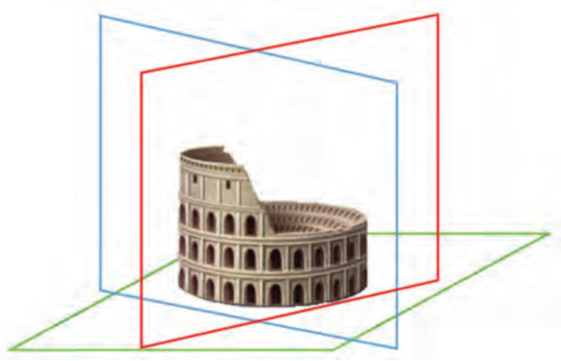

Fig. 2 The complete geometric documentation of a monument (designed by A. Georgopoulos)

scale and accuracy. These should be carefully defined at the outset, before any action on the monument is undertaken.

Another important issue is the level of detail which should be present in the final product. For a justified decision on that matter, the contribution of the expert who is going to be the user is indispensable. A survey product, a line drawing or an image implies generalisation to a certain degree, depending on the scale. Hence, the requirements or the limits of this generalisation should be set very carefully and always in co-operation with the architect or the relevant conservationist, who already has detailed knowledge of the monument.[3]

For the geometric recording, several surveying methods may be applied, ranging from the conventional simple topometric methods, for partially or totally uncontrolled surveys, to the elaborated contemporary surveying and photogrammetric ones, for completely controlled surveys. The simple topometric methods are applied only when the small dimensions and simplicity of the monument permit it, when an uncontrolled survey is adequate, or in cases when a minor completion of the fully controlled methods is required. Surveying and photogrammetric methods are based on direct measurements of lengths and angles, either on the monument or on images thereof. They determine three-dimensional point coordinates in a common reference system and ensure uniform and specified accuracy. Moreover they provide adaptability, flexibility, speed, security and efficiency. All in all, they present undisputed financial merits, in the sense that they are the only methods, which may surely meet any requirements with the least possible total cost and the biggest total profit. To this measurement group belong the terrestrial laser scanners (TLS). They manage to collect a huge number of points in 3D space, usually called a point cloud, in a very limited time frame.

It should, however, be stressed that, since there is to date no generally acceptable framework for specifying the level of detail and the accuracy requirements for the various kinds of geometric recording of monuments, every single monument is geometrically documented based on individual accuracy and cost specifications. Therefore, it is imperative that all disciplines involved should cooperate closely, exchange ideas and formulate the geometric documentation requirements in common, drawing on a profound understanding of the monument itself and on each other's needs. Hence, digital surveying and geometric documentation of cultural heritage requires the cooperation of several disciplines and experts in order to produce results that sufficiently satisfy the highly demanding environment of conservation, restoration, research and dissemination. It should not escape our attention that resources are frequently inadequate, while the infrastructure used (equipment, hardware and software) is expected to yield the maximum possible benefit.

Nowadays, there is a range of existing techniques used to perform digital surveying and produce 3D survey information. All these techniques can be categorised in different ways. Experience shows that the most useful method for doing so is to characterise them by the scale at which they can be used as well as by the number of measurements that can be used during data acquisition. Practically, this means that they are related to the object size as well as to the complexity of the object. Wolfgang Boehler and Guido Heinz[4] created and developed a diagram (Fig. 3) to summarise all existing techniques in terms of scale and object complexity.

[3] Georgopoulos – Ioannidis 2007.

[4] Boehler – Heinz 1999.

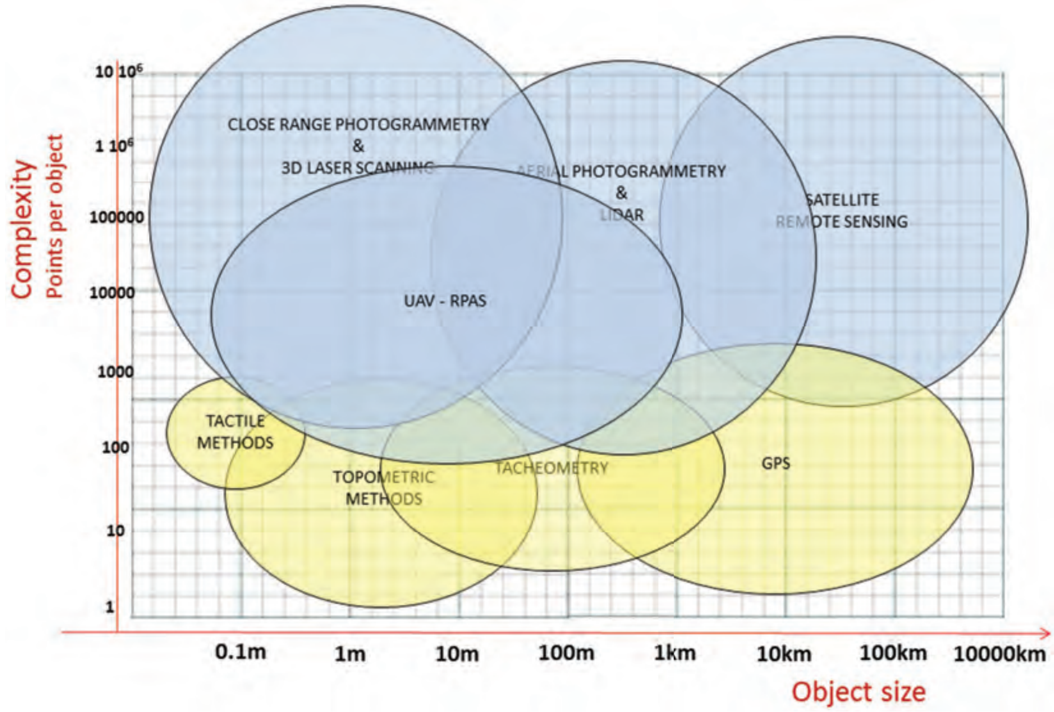


Fig. 3 Three-dimensional survey techniques characterised by scale and object size and complexity (adapted from Böehler – Heinz 1999)

According to this figure, the metric surveying techniques are organised according to the scale of the outcome, which is a function of the object size and the representation based on the required details. The complexity of the survey can be conveyed by the number of recorded points. In practice, this ranges from one single point, describing the geographic location of a single cultural heritage object, to some thousands of points (e.g. a single CAD drawing of a simple monument) or to a few million points (e.g. a point cloud) for the detailed representation of a cultural heritage site.

## Crowdsourcing

Crowdsourcing has become a very popular tool for acquiring image content, among other things.[5] A system is defined as a crowdsourcing one, 'if it enlists a crowd of humans to help solve a problem defined by the system owners'.[6] In this case study, crowdsourcing serves as a method for acquiring the large number of images (or videos) needed for the project as well as to guide the potential contributors according to the particular needs (e.g. specific viewpoints needed). The key aspects of the project concerning crowdsourcing information can be summarised as follows:

- The project has a time limit.
- The contribution from the users is of one type of content, i.e. images or video sequences.
- Special information (metadata) about the viewpoint of the images, the equipment used or the time taken could be useful.

Crowdsourcing has found its niche in cultural heritage documentation and other applications in general. Such examples include, among others, the Digital Archivist Crowdsourcing Cultural

5 Goodchild 2007; Sylaiou et al. 2013.
6 Doan et al. 2011.

Fig. 4 The virtual reconstruction of the Bamiyan Buddha
(https://www.buddhistdoor.net/news/bamiyan-buddhas-return-as-holographic-projections)

Heritage;[7] the 'Threadless' creative community that makes, supports, and buys great art; iStockphoto, which collects royalty free photos, vector art illustrations, stock footage and audio for print and use on websites and presentations;[8] 'Innocentive', which is a web-based community matching scientists to research and development challenges presented by companies worldwide,[9] and the Micropasts project.[10]

Notable efforts to exploit crowdsourcing for the benefit of cultural heritage in the past include the reconstruction of the Bamiyan Buddhas (Fig. 4) after their destruction by the Taliban rebels in Afghanistan,[11] which was largely based on images provided by scientists who responded to a pertinent appeal for previously existing data.

Another such case of resorting to the public's help for cultural heritage is the plan to equip visiting archaeologists with 3D cameras close to Roman and other ancient ruins in Syria, so that the recorded data can later be used to recreate those ruins precisely. The academics from Oxford University in the UK and Harvard in the US intend to install 5,000 cameras in 2015 and to have captured a million images by the end of 2016.[12]

Finally, Rekrei, formally known as Project Mosul, is an initiative started by Matthew Vincent and Chance Coughenour. By integrating their knowledge in archaeology, web development, and photogrammetry, their objective is to promote the digital preservation of lost cultural heritage using crowdsourced data in a cooperative, open-source project (Fig. 5).[13]

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7 Zastrow 2014.

8 See the provider's website <https://www.istockphoto.com/> (last accessed 18 Feb. 2020).

9 See the InnoCentive website <https://www.innocentive.com/> (last accessed 18 Feb. 2020).

10 See the project's website <https://crowdsourced.micropasts.org/> (last accessed 18 Feb. 2020).

11 Gruen et al. 2004.

12 GIM 2015.

13 See the project's website <https://projectmosul.org/> (last accessed 18 Feb. 2020).

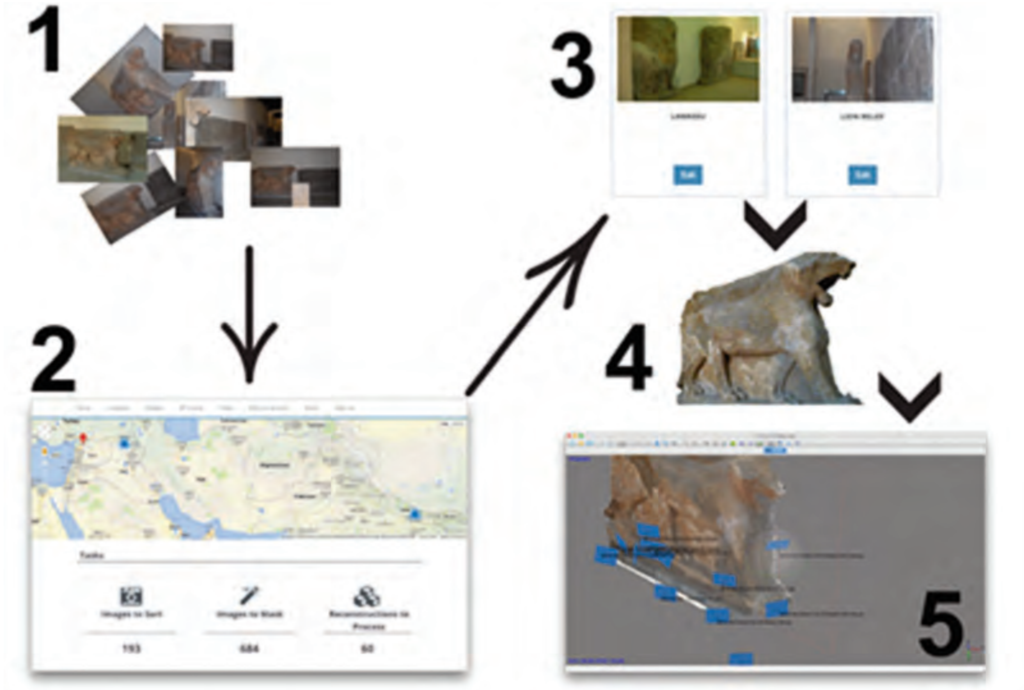

Fig. 5 The workflow of the Rekrei project (https://rekrei.org/)

## The Case of Plaka Bridge

A variety of arched stone bridges exist in the Balkan area, built mainly in the 18th and 19th centuries or even earlier. Just in the Epirus region in northwestern Greece there are more than 250 magnificent examples of such historic structures spanning over rivers and streams and bridging them with one to four arches. Such structures were built for pedestrian and animal passage, as the rivers did not allow easy crossing, especially during winter.[14] In the pre-industrial era, the main structural material in the Balkan region was the local stone. In Epirus, limestone and wood were commonly used by specialised technicians for such purposes. Stone bridges constituted a wide trail network for communication and transportation in the whole Balkan area.

The stone bridge of Plaka over the river Arachthos (Fig. 6) was a representative example of the aforementioned monuments. It was built in 1866 by local Greek stonemasons in order to facilitate transportation and trade needs.[15] It was the widest stone bridge in the area of Epirus with a 40-metre span and the biggest single-arch bridge in the Balkans with a height of 20 metres (Fig. 6). Next to the main arch, there were two smaller ones of 6 metres in width, the so-called relief arches.

Apart from its significant size and age, the stone bridge of Plaka was a renowned stone bridge in Greece because of its emblematic historic meaning. Firstly, it was the border between free Greece and the part of Greece occupied by the Ottoman Empire between 1881 and 1912. During World War II the bridge was bombed by the German army causing partial damage. During the same period, representatives of the various armed groups of Greek Resistance signed the Treaty of Plaka on this very bridge.

On the 1st of February 2015, the central section of the bridge's unique arch collapsed due to extreme weather conditions, namely massive flash floods caused by prolonged heavy rainfall. Most of the collapsed parts, especially some of the massive ones, lie in the river area near the abut-

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[14] Leftheris et al. 2006.

[15] See the synoptic table on <http://www.petrinagefiria.uoi.gr/gefiri.php?id=143> (last accessed 18 Feb. 2020).

ments that remain intact (Fig. 7). NTUA immediately initiated voluntary actions to aid in the eventual reconstruction of the stone bridge. An interdisciplinary group of scientists and engineers, such as architects, civil engineers, surveyors, photogrammetry engineers, computer scientists, material engineers, etc., will contribute to this project.

Fig. 6 The Plaka stone bridge (Stathopoulou et al. 2015)

Fig. 7 The remains of the bridge after destruction (http://epirusgate.blogspot.gr/2015/02/blog-post_32.html)

The type of eventual reconstruction in the current study is under discussion. Before the implementation of any actions, a thorough geometric documentation is necessary, as clearly dictated by the Venice Charter (1964). For that purpose the Laboratory of Photogrammetry undertook two tasks: (a) to produce digital three-dimensional drawings from a documentation study conducted in 1984 using traditional surveying techniques[16] and (b) to produce a textured three-dimensional model of the Plaka stone bridge in order to geometrically document its shape and size before its collapse. This 3D model would be produced using the contemporary Structure from Motion (SfM) technique, by which a series of densely overlapping images are processed in order to establish a large number of point correspondences and from this to determine their position in space and produce a dense point cloud of the object imaged. Due to the fact that such images did not exist for the Plaka bridge, it was decided to resort to crowdsourcing in order to collect existing images taken by visitors to the bridge over the years. These documentation products will form the basis for any eventual reconstruction study. Unfortunately, no earlier photogrammetric documentation is known to exist so far.

Although the stone bridge of Plaka is a significant monument within the area of Epirus, it lacks recognition in the rest of Greece compared to other cultural heritage sites. Therefore, fewer visitors have explored the area and photographed the monument, especially in the digital-imaging era. Thus, searching by keywords and other location-based queries in the web search engines returns few results and most of them are uploaded in low resolution. Wrong or inaccurate labelling is also a challenge. Radiometric low-quality or post-processed imagery (compression, filters etc.) often results in such queries, prohibiting their use for reliable 3D modelling.

To provide a suitable framework for the above, a website has been developed using the Drupal CMS (Fig. 8). Drupal is a content management system (CMS) with proper functions for community websites and has been used for educational and research crowdsourcing purposes.[17] More specifically, the website developed includes five sections: (a) a news and announcements page, (b) a general info page, (c) a submit content (images) page, (d) a submit page for volunteers and (e) a blog page.

To collect the images, the 'submit images' page is the only section utilised, since it also provides the required information to the contributors. The technical specifications of the webpage are:

[16] Karakosta et al. 1984.
[17] Munoz-Torres et al. 2011; Kaliampakos et al. 2015.


Fig. 8 Home page of the crowdsourcing webpage (Stathopoulou et al. 2015)

- It is available only in the Greek language. This addresses the fact that the bridge is a highly localised symbol and so it is expected that persons with connections to the surrounding area or Greek visitors would be more able to contribute.
- Since the time frame was short, promotion of the website could not be supported only by web search machines. Therefore, various social media as well as local blogs and news websites, have been used to make the website known to the public, a fact that adds to the previous comment about the localisation of the event.
- The user submission form is fairly simple. It only requires a short description of the images, the actual image files to be uploaded and an optional extended description.

Furthermore, the submit form is available to anonymous users, since there is no need for any sort of authentication. Anonymous contribution, without any form of evaluation, could be a serious issue in crowdsourcing; however, it does not pose an obstacle for the purposes of this project. The content (images) analysis can only be performed by the experts with the right tools available. A primitive sorting of the images related to their type, size, date taken, etc. could be done by software with no intervention from the user or the analyst. Since video files are relatively large in size, alternate methods were also selected to acquire them (after contact with the contributor), in order to avoid complications or user discomfort with the upload procedure. Moreover, the short time frame means a smaller amount of spamming attacks from internet bots. Hence, authentication or a more systematic form was avoided to limit the burden on users and increase their willingness to contribute, without resulting in additional effort for the researchers.

Within the first month of its operation, the website has been visited around 2,800 times. More than 470 images were uploaded to the platform during these sessions by more than 130 contributors. Apart from the uploaded content, approximately 200 images and 15 videos were collected through other means, mainly by ordinary mail delivery, by contacting the contributors.

The majority of the collected images were of high resolution, correctly focused and without significant perspective or optical distortions.[18] Nevertheless, in crowdsourcing applications the

[18] Stathopoulou et al. 2015.

Fig. 9 The dense point cloud produced using the SfM software (Stathopoulou et al. 2015)

Fig. 10 Example of masking the object on the images available (Stathopoulou et al. 2015)

Fig. 11 The orthophoto of the south side of the Plaka bridge (Stathopoulou et al. 2015)

data may not meet the requirements of the scope for which they were collected. In this case study the authors have had to cope with some special challenges. A high percentage of the images were acquired from a viewpoint very close to the object and cannot, thus, be registered to the rest using the available algorithms. Large illumination variations due to natural light (bright sunshine, clouds, shadows, twilight etc.) appear in several photos. Apart from that, the images that are suitable for the specific purpose of the project show significant variations on the bridge's surface due to seasonal effects. During summer months the stones are dry; in winter they appear darker and wet, with a black/grey crust and growing grass, thus complicating the location of point correspondences. Trees and other natural or human obstacles hinder important information. The geometry of the bridge, which is almost symmetrical, makes it difficult to distinguish between the north and the south façade. The majority of the collected photos were taken facing upstream and mainly from the east riverside due to landscape inaccessibility. This causes gaps and difficulties for the algorithm in converging to a stable geometry. After a thorough and careful sorting, it was established that fewer than 60 images fulfil the needs of the project in terms of the viewpoint, image resolution, lighting conditions, occlusions etc., which corresponds to 10% of the total contributions.

The selected data have been processed using commercial as well as freeware software, i.e. the VisualSfM, which is a free GUI application for 3D reconstruction that implements SfM and PMVS along with other tools,[19] and Agisoft Photoscan, a commercially available SfM software. A final dense point cloud was created (Fig. 9). In order to assist the algorithm to determine the correspondences faster and more reliably, masking was required (Fig. 10).

Based on the methodology described briefly above, it was possible to produce a 3D model at least of the south side of the bridge (Fig. 11). From that, a large scale orthophoto was produced, which proved to be a valuable tool for the restoration study. As for the north side, there were not enough images available; the corresponding orthophoto was produced using the survey points from 1984 in order to generate a suitable image.

## Concluding Remarks

In the above, the contribution of crowdsourcing to the production of 3D textured models and orthophotos of the stone bridge of Plaka, which was lost suddenly and unexpectedly, was presented. The crowdsourced images are the only way to preserve its memory and help towards its eventual reconstruction. A crowdsourcing platform has been designed and commercial as well as free 3D reconstruction software has been used to this end. Preliminary results demonstrate the robustness of the state-of-the-art algorithms that are able to register together images with a high level of diversity and create usable 3D models. These preliminary models may not be complete yet, but constitute an adequate basis for future work, visualisation and educational purposes. It is also estimated that further exploitation of more images uploaded will result in a usable geometric documentation record for the eventual reconstruction.

A serious issue which arises when lost cultural heritage is concerned is the lack of systematic documentation. We should all perhaps contemplate seriously embarking on such systematic documentation, at least at the metric data acquisition stage. In this way a valuable world archive of metric data, i.e. survey measurements, digital images, camera calibration data, laser scans etc., could be acquired for all monuments of mankind, especially for the endangered ones.

It should be stressed that the wide promotion of the '3 × 3 Rules' proposed by CIPA[20] and revised in 2013[21] would ensure the existence of more useful images and related metadata for the Plaka stone bridge, as the public would be more aware of the eventual future significance of their souvenir images. This may be useful in the future for other monuments in similar situations.

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19 Wu 2007; Furukawa – Ponce 2010; Furukawa et al. 2010; Wu et al. 2011; Wu 2013.

20 Waldhäusl – Ogleby 1994.

21 Waldhäusl et al. 2013. Both versions are available at the relevant website <https://www.cipaheritagedocumentation.org/activities/publications/> (last accessed 18 Feb. 2020).

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# Virtual Revival of the Great Temple of Bel in Palmyra

*Ahmet Denker*[1]

**Abstract:** During international dissents and conflicts, history is of no concern and heritage is not important. Wars leave devastating marks on monuments and ancient cities and cause irreplaceable loss to global cultural treasures. The Great Temple of Bel in Palmyra was one of the latest (but not last) and most painful of such losses. Before being blown up by the jihadists of ISIS, the Temple of Bel was arguably the most renowned building in Syria. It was the relic with which Palmyra was associated. It is to be hoped that its virtual reconstruction and preservation as a legacy in digital cultural heritage may provide some healing for the lost temple in memories. The Great Temple of Bel can be virtually restored to its former condition in Roman times. By using information from ancient texts, lithographs, architectural drawings and photographs as well as digital images, virtual models of the temple are created with the objective of restoring the past sense of the architecture and the place.

**Keywords:** Temple of Bel; Palmyra; virtual reality; digital cultural heritage

## Introduction

The Great Temple of Bel, Palmyra, one of the most impressive and renowned edifices which had survived from Antiquity to the modern age, can no longer be seen. We can neither enjoy the play of light on its patinated stones, nor admire the aesthetics of the architecture and beauty of the place anymore. It was one of the latest victims of terrorist vandalism, when the jihadists of ISIS targeted and bombed it, in 2015, on the last day of August. The history and art lovers of the civilised world were shocked by the news of its destruction. Recursive images of this intolerable crime against civilisation were spread in the media sphere and incised into our minds. One of the best-preserved monuments of Antiquity has been lost to posterity.

The Great Temple of Bel was a remarkable example of the monumental architecture which blended Graeco-Roman architecture with Oriental aesthetics. The hybrid elements of this temple demonstrated the numerous cultures that frequently overlapped and intermixed in Palmyra. The defining feature of the devastation of this temple was the intentional targeting of the material evidence of Palmyra's multi-cultural identity. Satellite pictures showed that the entire structure had collapsed in a heap of rubble. After Palmyra was recaptured, it was obvious that the temple was lost forever. The only part of the temple which remained was the western doorway into the sanctuary building. With its destruction and disappearance, another irreplaceable treasure of the world's cultural heritage had vanished.[2]

The Temple of Bel was not only historically and culturally significant, but it was also beautiful. Hundreds of thousands of tourists who visited Palmyra every year used to be captivated by what they saw: the ruins of the temple were remarkably well preserved and rose in splendour in the surrounding Syrian Desert. Regrettably, since the end of the summer 2015, that view of the Temple of Bel that visitors used to savour no longer exists. The *cella* of the temple has crumbled into its courtyard and obscurity in the surrounding desert.

The objective of the work presented here is to virtually revive in our memory this most imposing monument of the pillaged ancient city of Palmyra. The Great Temple of Bel is here restored

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[2] See Silver et al. 2018.


Fig. 1 City plan of ancient Palmyra (A. Denker after Wiegand 1932 and Borra 1753)

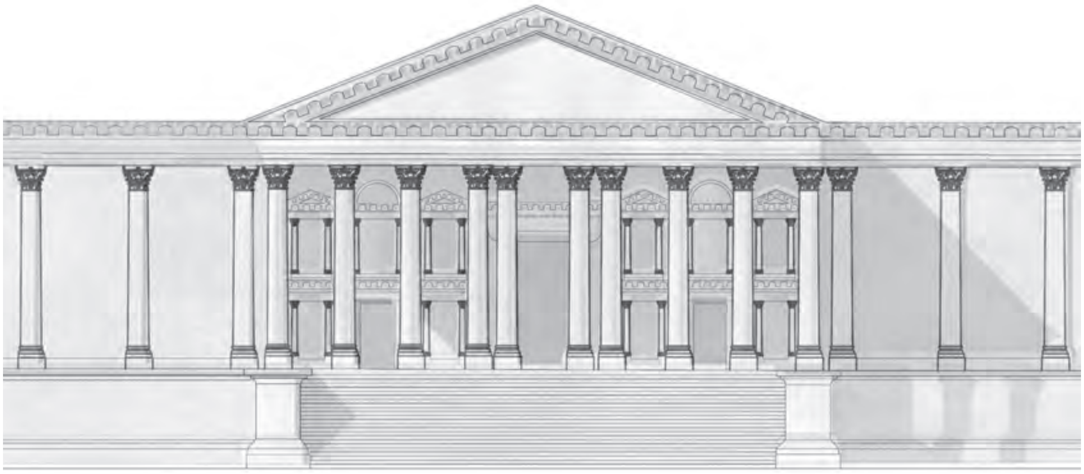

Fig. 2 Reconstructed Propylaeum (after Cassas 1799)

virtually to the proposed condition it formerly enjoyed in Roman times. By using information from ancient texts, lithographs, architectural drawings, photographs and digital images, virtual models of the temple are created, showing what it may have originally looked like.

The aim of this digital reconstruction endeavour is to provide some healing for the lost temple in memories. Its virtual rediscovery and visual recovery can never replace or totally remedy the loss of the temple, but it can visually awaken memories, provide some experience of the temple as in the past and restore a sense of the architecture and the place.[3]

[3] See Silver et al. 2018.

## Bel: Setting and First Impression of the Temple

The *temenos*, the ritual precinct of the Temple of Bel, stands as a gigantic, quadrangular architectural complex in the southeastern part of Palmyra. It was enclosed by the ancient city walls and surrounded by a grove of palm trees in Antiquity. It rises at the eastern end of the colonnaded road (Fig. 1). The ancient beholder was captivated by a stupendous *propylaeum* and enticed into the court (Fig. 2). At first sight, the architecture seemed familiar to the beholder since it resembled all

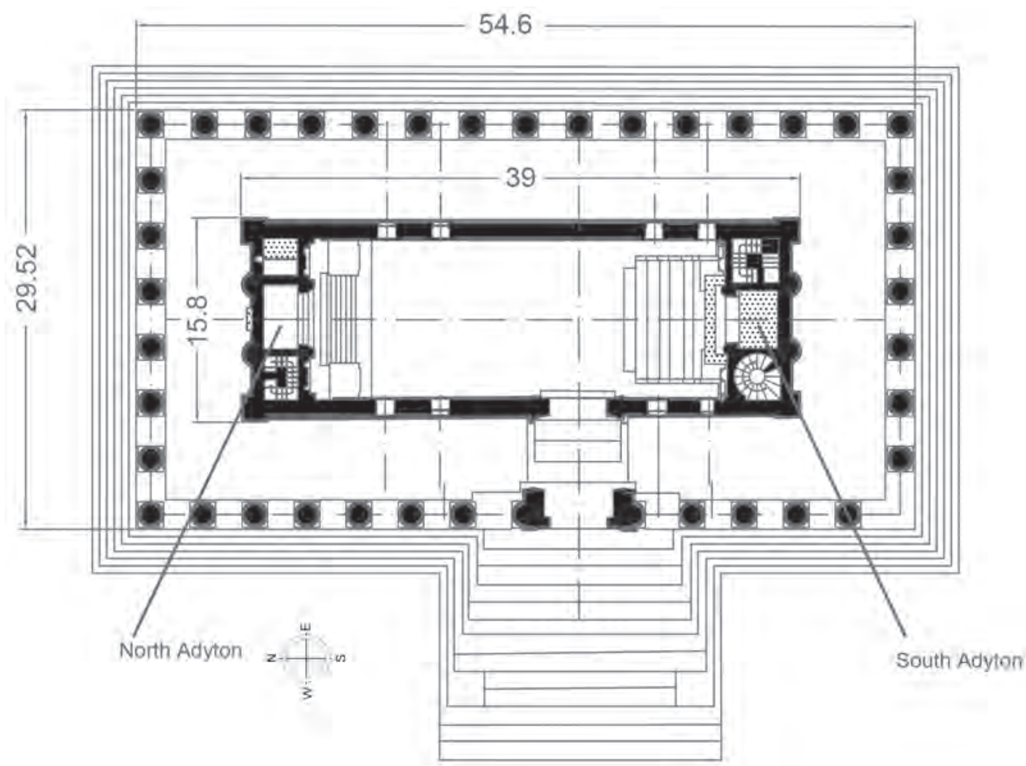


Fig. 3 Plan of the sanctuary of Bel (after Seyrig et al. 1975)

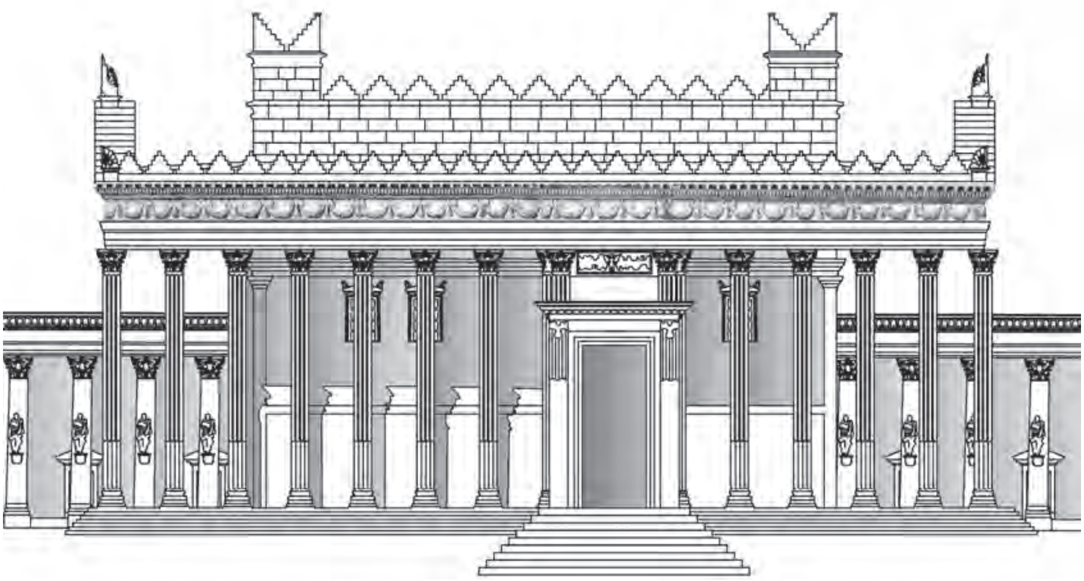

Fig. 4 Flank of the reconstructed sanctuary of Bel (after Seyrig et al. 1975)

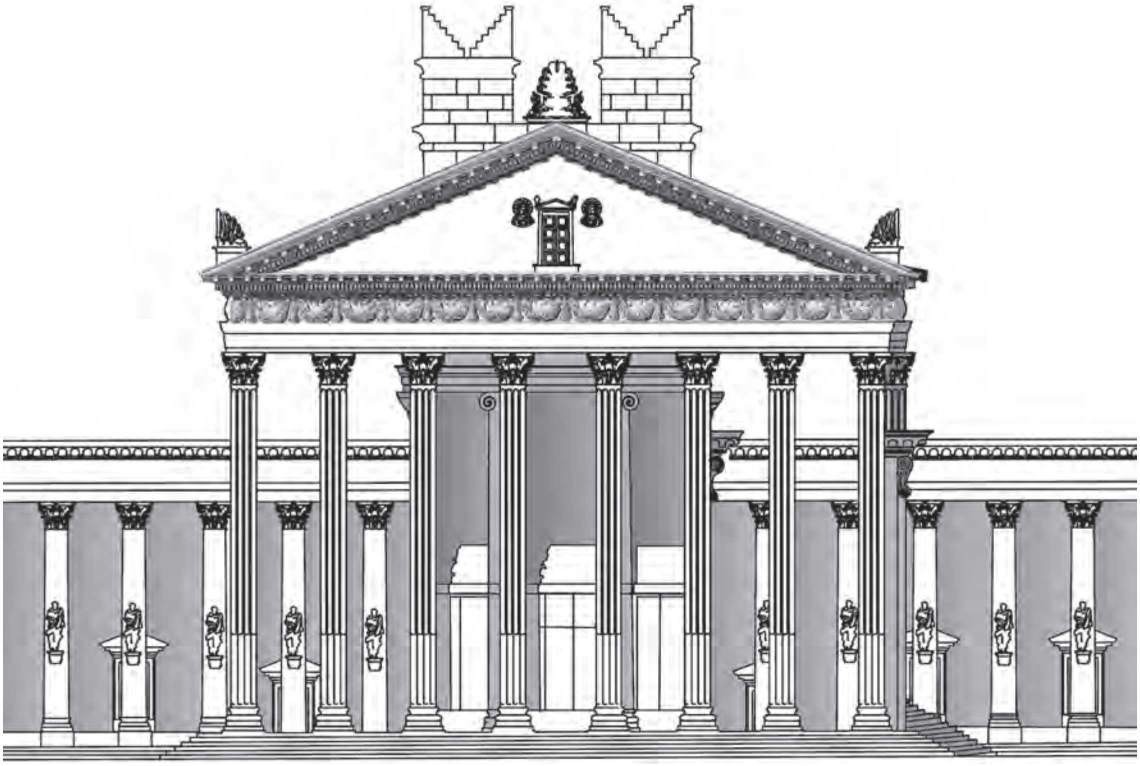

Fig. 5 Façade of the reconstructed sanctuary of Bel (after Seyrig et al. 1975)

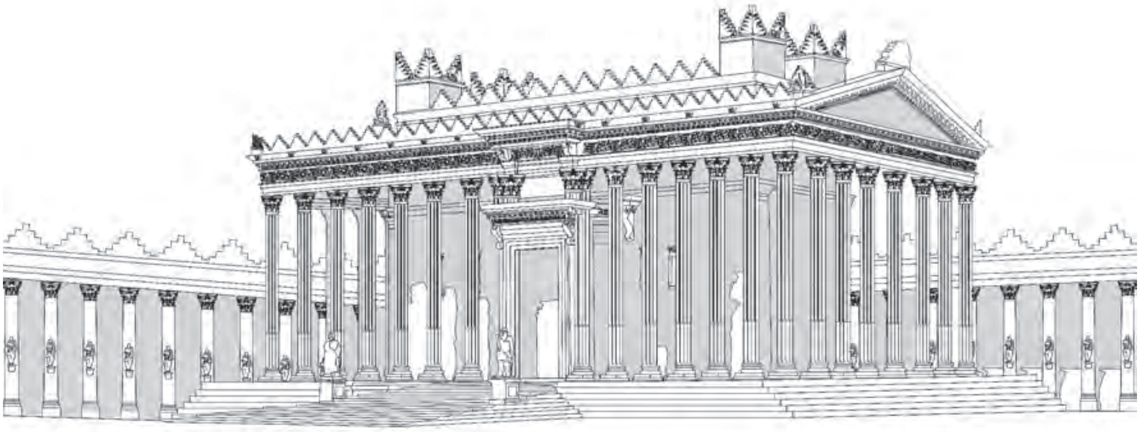

Fig. 6 Isometric view of the reconstructed sanctuary of Bel by Jane Elisabeth Digby (after Seyrig et al. 1975)

the other sanctuaries in the Graeco-Roman world. Through its Corinthian style columns created a silhouette which corresponded to the fashion of the 1st century AD.[4]

But at the second glance, the building complex, including the *cella*, seemed to be different, if not weird. It was, indeed, an eccentric combination of a pseudo-dipteros of Ionic tradition with a peristyle of Corinthian columns. The entrance door to the *cella*, the central sanctuary, was located not on one of the short sides, as one would have expected, but surprisingly on the western one of

4 Seyrig et al. 1975; Veyne 2016.

the two long sides (Fig. 2). This led to a modification on the west side of the podium, in order to provide access to a large portal through an asymmetrically placed ramp (Fig. 3). In addition, the *cella* had windows; a temple with windows had never been seen in the Graeco-Roman architectural canon. Instead of a gabled roof, as one saw in almost every other temple, the building had a terrace with merlons along the edges. The roof was decorated with two pediments which were enriched by towers at the four corners (Fig. 4). The most striking feature, however, was that in the Great Temple there were columns bearing capitals of gilded bronze.[5]

Thanks to its abundant decors, the polychromatic beams of the peristyle, and sculptured figures, this edifice created an astonishing impression on the first encounter. It was one of the highest and the most original expressions of the combination of Semitic and Hellenistic cultures which coexisted without melting in the desert city. It was a Semitic sanctuary with a Hellenistic clothing (Figs. 5–6).[6]

## The Triad of Deities

When and for what divinity or deities was the temple building built? It is more convenient to answer these questions before discussing the detailed virtual reconstruction of the temple itself.

This temple was the habitation of Bel, the most holy of the deities of Palmyra. Bel became the omnipotent God, the creator of the astronomical heaven, like the Greek Zeus, the king of the gods, whose symbol was the planet Jupiter. Bel is not a sun god but a cosmic god. He had originated from the great god of Babylon, Bel-Marduk. Linguistically the word has an Akkadian origin; it means ‘Lord’.[7]

He was not the only god who was worshiped in his temple; two other gods were with him as subordinates: the Sun god, Yarhibol and the Moon god Aglibol, meaning the three divinities formed a triad. The adjoining gods are portrayed on a slab in the Louvre Museum as standing to the right and the left of Bel. Around Aglibol’s head is the moon squall, and Yarhibol bears the sun-disc. This relief clearly supports the ‘Triad of Deities’, a theory which was postulated by H. Seyrig[8] in his classical paper on this subject. The gods in this relief are portrayed as warriors, rather than heavenly bodies. Seyrig provided an answer to the question of why they were depicted in military attire in his 1970 paper. He argued that armed gods were the embodiments of saviours.[9]

This temple is one of the rare monuments for which epigraphy provides a precise date of dedication. Thanks to a dedicatory inscription found during excavation of the temple, we learned that the *cella* building was erected in the Augustan period (27 BC–AD 14), and the sanctuary was consecrated in AD 32, but the complex was not completed until the early 2nd century AD. The inscription was engraved on a statue base which dated to October AD 45. According to this inscription, the temple was dedicated by the influential Komare tribe to the ‘Triad of Deities’, Bel, Yarhibol and Aglibol, on the sixth day of April (Nisan) AD 32.[10]

The sixth day of April (Nisan) marked the beginning of the New Year in Palmyra, like in Babylon. Palmyrenes, like Babylonians, celebrated a festival, the beginning of the New Year, on that day. The choice of this precise day for the inauguration establishes without any contestation a direct link between Bel and Bel-Marduk, as well as between Palmyra and Babylon.[11]

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5 Seyrig et al. 1975; Veyne 2016.
6 Denker 2017a.
7 Butcher 2003; Ball 2016.
8 Seyrig 1950.
9 Seyrig 1970.
10 Gawlowski 2015.
11 Seyrig 1950; Schmidt-Colinet 1995.

### A Journey to the Past of the Temple

Otto Puchstein[12] had assumed that the Bel sanctuary was the oldest building in Palmyra, stating that '[r]emains of older periods of culture are nowhere to be observed'. When he visited Palmyra (in 1902), the *cella* of Bel was indeed the oldest building visible above the ground, but the archaeological research in the following years showed that this conjecture was only partially correct, as the remains of older and, indeed, purely Hellenistic buildings were detected buried under the sands of the desert not to mention Bronze Age remains.[13]

From the fragmentary slabs of inscriptions, reliefs, and architectural pieces which were found in the *temenos* of the temple, it was deduced that there was an earlier sanctuary dedicated to Bel at the same place and it could be dated to first century BC.[14]

The Temple of Bel was the most magnificent monument of Palmyra, conceived as such in the very epoch when the city was erected. It was mentioned as the *Templum Solis* in the *Life of Aurelian* (*Historia Augusta Aurelianus*). The temple retained its splendour and functioned so until it was gravely decimated in 273 by Roman soldiers during the war waged between Queen Zenobia of Palmyra and Emperor Aurelian of Rome. As previously pointed out by Minna Silver,[15] we learn from the *Historia Augusta, the Life of Aurelian* that Aurelian himself was concerned about the pillage and destruction of the Temple of Bel, which he called the Temple of Sun, and demanded its restoration in his letter, to be funded using the treasure of Zenobia and Palmyrenes: '[…] three hundred pounds of gold from Zenobia's coffers, […] eighteen hundred pounds of silver from the property of the Palmyrenes, and […] the royal jewels. Use all these to embellish the temple; thus both to me and to the immortal gods you will do a most pleasing service.'[16]

The temple's misfortunes did not end there: the partial destruction of the temple by the armies of Aurelian was followed by the systematic hammering of anthropomorphic figures by the Byzantine iconoclasts. The temple suffered from the continuation of these hammerings in the following years. Earthquakes and metal looters contributed to the work of destruction.[17] As a dismal result, much of the information we could have used in our work had already been erased. Moreover, no detailed architectural description exists which would be contemporary with the temple, or even close to the time of its glory and splendour.

As already indicated, the Temple of Bel had remained partly visible and partly buried under the sands of the Syrian Desert like the rest of Palmyra, waiting to be rediscovered. James Dawkins and Robert Wood, as early as 1753, were the first to resuscitate the monument before the eyes of an audience devoted to orientalism and antiquities. After Wood published *The Ruins of Palmyra, otherwise Tedmor, in the Desart*,[18] interest for the antiquities of Palmyra was at its acme. Wood had stimulated a special interest for the Great Temple. With Giovanni Battista Borra's drawings, Wood's book was the main repository of information as regards to graphical data.[19] These drawings, a little devoid of fancy, but relatively exact, were succeeded by others, more extravagant, from the pencil and brush of Louis François Cassas (1799), and we may add to them a plate by Count Leon of Laborde from 1837. Photos taken between 1867 and 1876 by Felix Bonfils, which provide the most complete visual record of Palmyra from the 19th century, have been another indispensable source of information which enabled the realisation of this project.[20]

12 Puchstein 1932.
13 Seyrig et al. 1975.
14 Seyrig et al. 1975.
15 Silver et al. 2018.
16 Historia Augusta Aurelianus, section 31, 7–10.
17 Veyne 2016.
18 Wood 1753.
19 Silver et al. 2018.
20 See Silver et al. 2018.

During this period the first truly scientific surveys were carried out by two German expeditions, one directed in 1902 by Otto Puchstein, the other in 1917 by Theodor Wiegand; the architectural drawings of the temple were rendered by architect Bruno Schulz.[21]

The 1972 publication by Henri Seyrig, Robert Amy and Ernest Will displayed the well-illustrated and not yet outdated research of the temple; it compiled and presented almost everything we need to know for the restitution of the Temple of Bel, which would enable the monument to be revived and justify the present reconstruction work.[22] Finally, a small watercolour by Jane Elisabeth Digby, which Seyrig managed to find in the summer of 1972 and included in the book by the co-authors (after Seyrig's unexpected death), showed the building in its unruined state. This has been one of the main inspirations for our 3D model.

With stimulus derived from these sources, and encouragement from the advances in computer graphics technology, modelling and reconstruction of the ruins of Palmyra has been the subject of a recent book: *Reviving Palmyra in Multiple Dimensions: Images, Ruins and Cultural Memory.* This book, which was co-authored by Minna Silver and Gabriele Fangi together with the present writer, provides a virtual reconstruction of Palmyra with the aim of raising it from its ruins.[23] The project New Palmyra and some earlier works by the present author presented the first virtual models of the temple together with the other landmarks of Palmyra.[24] In the following works, an improved model of the temple was presented.[25] In sequel, the present work is dedicated to the Great Temple of Bel and aims at reviving it with a new generation model, more detailed and comprehensive reconstruction.

## Architectural Description and Reconstruction of the Temple

The great sanctuary dominated Palmyra which stretched at its feet, with its monuments and colonnaded streets and with its houses, olive trees and vineyards further to the west and to the northwest. The Temple of Bel complex was crowned by the grove of palm trees behind it, and a pleasant stream skirted it. The existence of this stream was mentioned in Pliny as follows: 'Situated in a vast expanse of sand and renowned for its fertile soil and pleasant streams, the ancient city of Palmyra was a stopping point for caravans traversing the Syrian Desert.'[26] Through satellite imaging and remote sensing the existence of this river was also confirmed.

The following is to be noted concerning the imposing position of the temple: when one stood at the centre of the city where the crossroads of the *Cardo* (central section of the colonnaded street) and the *Decumanus* (eastern section of the colonnaded street) was marked by a large *Tetrapylon* (Fig. 1), and walked along the latter towards the southeast, one reached the Triumphal Arch. After the Triumphal Arch, a colonnaded street made a turn of 30 degrees southwards (this part was never finished) with respect to this main road, and there was the *Propylaeum* of the Great Temple (Fig. 2). In response to the question why the bend was arranged in this particular direction, and why the Triumphal Arch was erected at precisely this point, it is unlikely to be a mistake to respond that this was so the bend after the Triumphal Arch would direct the view precisely to the *propylaeum* of the temple; an attempt has been made to recreate this impression (Fig. 7).

The Temple of Bel complex was built of sandstone; its appearance and colour were, as previously noted by Silver, described by Gertrude Bell in a letter: '[...] looks like marble and weathers

21 Schulz 1932.
22 Seyrig et al. 1975.
23 Silver et al. 2018.
24 Denker 2016; Silver et al. 2018.
25 Denker 2017b; Silver et al. 2018.
26 Pliny the Elder, 5.88, 1.

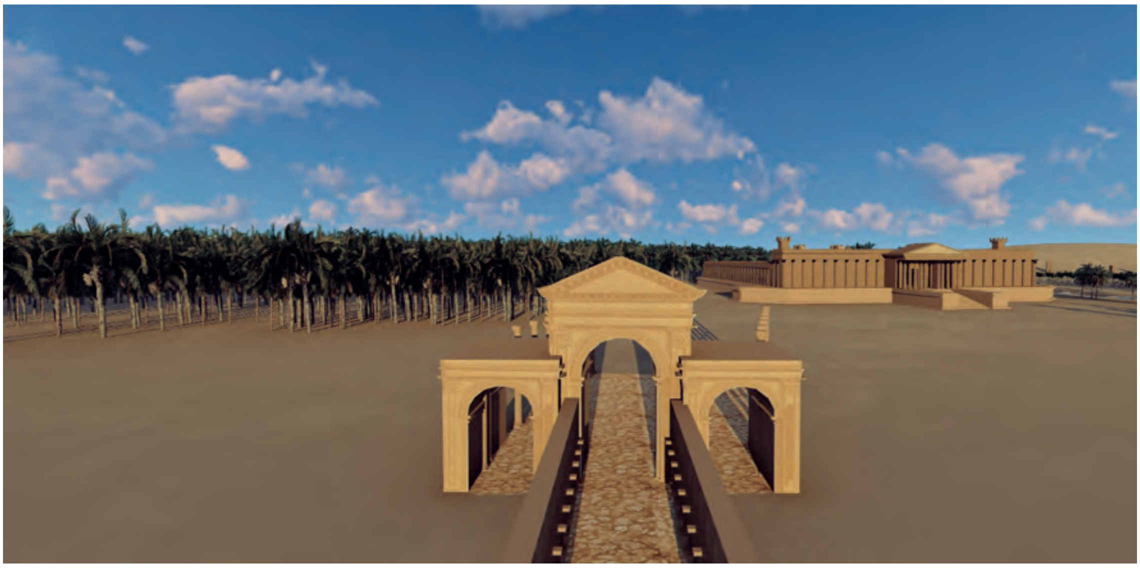

Fig. 7 View of the temple from the Triumphal Arch (reconstruction A. Denker)

Fig. 8 Propylaeum (reconstruction A. Denker)

a golden yellow [...]'.[27] The golden yellow of the building together with the dark green of the palm grove and light blue of the nearby stream formed a spectacular composition. Palmyrenes reached the courtyard, on the western side, via the *Propylaeum*, which was preceded by a monumental staircase. The *Propylaeum* occupied about a sixth of the length of the western peribolos wall; it had an open-plan portico colonnaded with eight Corinthian style columns (Fig. 8).[28] Both the propylaeum and the staircase vanished a long time ago.

The *cella* of the Temple of Bel stood in the asymmetric centre of the large *temenos* lined with porticos. The west side was the entrance side and it was marked by a high one-aisled *stoa* along

[27] Silver et al. 2018.
[28] Wiegand 1932; Seyrig et al. 1975.

the whole length. Against it ran a much lower but two-aisled *stoa* along three other sides of the court.

The *cella* was on a podium in the middle of an almost square open court (175 by 180 metres). The portico which surrounded the courtyard had a depth of 30m, which meant that the outer dimensions of the *temenos* were extended to 205 by 210m. The *cella* stood in the court asymmetrically, facing the north. Its main axis was tilted only by 5 degrees from the north-south axis. The main axis of the *cella* divided the open court into two portions with a ratio of 3:2. The western and eastern portions were approximately 105m and 70m deep, respectively. The edifice was a pseudo-dipteral Corinthian-style building. There were 41 columns, altogether: eight columns on the façades, 12 on the west flank and 13 on the east flank. The height of the building was 33.14m. The column height was 15.81m, and the base diameter was 1.33m. These measurements indicate very slender columns since the column height (H) : diameter (D) ratio is = 11.8. Compared with the Vitruvian recipes based on ideal column heights of 8D to 9.5D, this is a quite unique composition. These slender columns were topped with bronze Corinthian capitals. Considering the dazzling lustre of the temple, there is a conviction that they were gilded with gold![29]

There is no doubt that this significant detail added to the edification of the temple, and to its cost greatly. Such capitals were rarely seen, and it should be kept in mind that the Great Temple of Baalbek, had never possessed more than stone capitals, like the vast majority of the ancient temples. The Temple of Bel, on the contrary, possessed 41 bronze capitals that meant tonnes of bronze (Figs. 9–10)! This detail alone suffices to indicate that constructing the Temple of Bel had been a Herculean endeavour that needed enormous funds. It was the unique product of an epoch of prosperity in the Roman East. In contrast with this lavish and extravagant choice in the capitals, the architraves were devoid of any kind of ornamentation, they were characterised by one window in the middle which was flanked by two medallions (Fig. 10).

One discerns that this arrangement could be one of the traces of the supposed influence of the Hellenistic architect Hermogenes upon the architect of the Temple of Bel. This subject will be addressed in more detail below in the section devoted to the architect.

Fig. 9 West flank of the temple with the great portal (reconstruction A. Denker)

[29] Seyrig et al. 1975; Veyne 2016.

Fig. 10 Façade of the cella of the temple (reconstruction A. Denker)

A monumental portal occupying the place of two inter-columnar openings was opened in the long west side of the peristyle. It was not placed symmetrically. The portal was followed by an asymmetrically placed door. Sheltered behind the portal, the door was pierced in the west long wall of the *cella*. A different impression was felt on entering to the *cella*: it diverged from the Greek and Roman temples and was more in line with ancient oriental arrangements. The *cella* was a building stretched lengthwise, the depth of which corresponded to more than twice the width (15.8m by 39m). The asymmetrically placed door also created an asymmetrical interior space. The area located to the north of the door was larger than the area located to the south. Inside the *cella* was illuminated by sunshine coming from eight large windows which were cut through two long walls. The two narrow ends of the main hall were occupied by two monumental ensembles, each of which framed an *adyton* or *thalamos*, accessible via a porch. To designate these *adyta*, we shall use the names north *adyton* and south *adyton* (Fig. 3).

The ceilings of both *adyta* had elaborate decorations. The decoration which embellished the ceiling of the north *adyton* portrayed at its centre a series of deities. The primary deity Bel was in the centre and he was surrounded by six other deities. The seven deities were placed inside a vault so that they also symbolised the five known planets plus the moon and the sun. The decoration of the south *adyton* was more ornamental than religious. Europe learned about these decorations thanks to the drawings of Borra. After they were published in the book by Wood, they became the source of inspiration for many mansion ceilings.

## The Architect

The architect of the temple is not known; however, there is a conviction that he was an adept of the Ionic traditions, and particularly of the principles of Hermogenes.[30] The main thrust of this conviction stems from the planimetric data which are related to the *cella* and the peripheral colonnade. They carry the essential features of the 'Hermogenian' archetype which was embodied by the Temple of Artemis Leukophryene at Magnesia on the River Meander. It was the first Hellenistic pseudo-dipteral temple with Ionic capitals. All of our information about

[30] Seyrig et al. 1975, 170.

Hermogenes comes from Vitruvius's ancient book *De Architectura* which was written in the 30s BC. Hermogenes is believed to have built the temple at the end of the 3rd or the beginning of the 2nd century BC.[31]

Vitruvius states in *De Architectura*: 'The pseudo-dipteros is so planned that there are eight columns both in front and at the back, and fifteen at each side including the corner columns'[32] and further: 'The proportions were devised by Hermogenes and he was the first to use the exostyle or pseudodipteral arrangement'.[33]

The rules that Vitruvius narrated were written by Hermogenes in his book. Hermogenes' book, which unfortunately has not survived, must have been known to the architect of the Bel Temple. This belief relies heavily on the fact that he designed the temple exactly in accordance with the rules of Hermogenes i.e. with eight columns on the short sides and fifteen columns on the long sides. What is more, from the use of local limestone, his origin was clear for many: the master of the Temple of Bel must have been local, maybe from Syrian Antioch. Having traced the Greek influences back to the Hellenistic architect Hermogenes, it has also been suggested that the architect could have been Greek, but with a Syrian origin.

In addition, one discerns that the arrangement of architraves which we mentioned above could be one of the traces of the supposed influence of the Hellenistic architect Hermogenes upon the architect of the Temple of Bel. Hermogenes had also implemented a similar arrangement in the architrave of the Temple of Artemis Leukophryene at Magnesia on the River Meander. In Hermogenes' Artemision the architrave (which is still extant) had a primary window or opening in the middle and it was flanked by two smaller windows on both sides. The main window was kept in the Temple of Bel, whereas the smaller windows were replaced by two medallions (Fig. 10).

This great master of the Temple of Bel had, on the one hand, followed the tradition, and on the other hand, prepared the way for the unifying architecture of Greece, Rome and the Orient by opening the hinterland to influences from the West.

## Reconstruction Results of the Great Temple of Bel

As for digitally reviving the Great Temple of Bel, an attempt at virtual restitution is presented here through six plates (Figs. 7–12) which aim at reflecting its splendour as it was conceived in the very epoch when the city was erected. An exhaustive analysis and reconstruction effort was undertaken so that details could be inserted into restitution models, as far as the capabilities of computer technology allows. The precision of the models of this extraordinary building is extremely important for the understanding of a decisive phase in the history of the East Mediterranean. This reconstruction effort will have successfully fulfilled its mission if the Temple of Bel, which is lost forever, assumes a second life, to the solace and pride of those who believe that blowing it into pieces does not mean the building will be deleted from memories. Render outputs aim at displaying the particulars of the temple with rigour and elegance, including as many details as possible and reflecting the most complex modalities with fidelity.

The initial stages of the reconstruction are shown as drawings in the first six figures which comprise a number of details from the plan of the sanctuary building (Fig. 1) to the isometric view of the temple (Fig. 6). Figure 7 provides a visual explanation of why the Triumphal Arch was erected at its chosen place, by depicting how the view is directed from the Triumphal Arch to the Great Temple. The splendour of the *Propylaeum*, which used to charm visitors, is reflected in Figure 8. Figures 9 and 10 display the slender columns of the sanctuary; the gilded bronze

[31] Bingöl 2007.
[32] Vitruvius, III, 2, 6.
[33] Vitruvius, III, 3, 8–9.

Fig. 11 Perspective view of the temple towards the cella (reconstruction A. Denker)

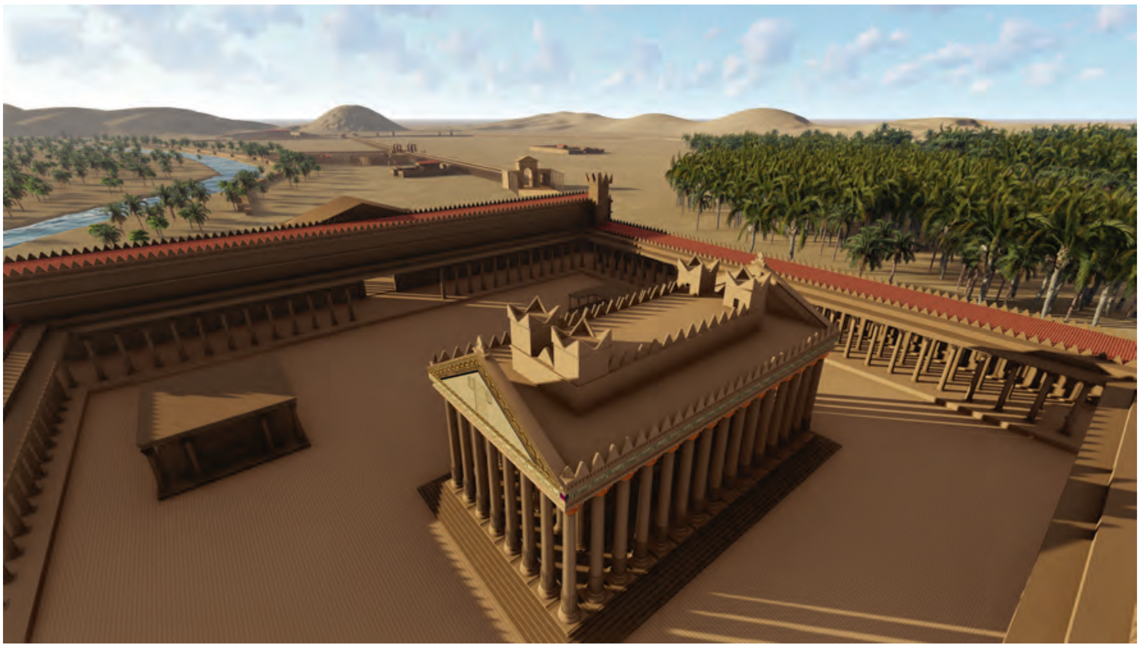

Fig. 12 The Great Temple of Bel in Palmyra (reconstruction A. Denker)

capitals are vividly shown. The great portal, which was located asymmetrically in the west flank of the peristyle, is displayed with its lavish decoration in Figure 9. It is seen as occupying two inter-columnar openings. The perspective view of the sanctuary building covered by porticos which delimit the *temenos* is given in Figure 11. Finally, Figure 12 shows the Great Temple of Bel in its dominant location. Palmyra is stretched at its feet with its colonnaded road, monuments and western necropolis.

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# New Documentation Possibilities for the Great Umayyad Mosque in Aleppo, Syria, Based on Historical Images

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**Abstract:** The care of monuments, like government planning, needs precise documentation for the architectural analysis, proposed reconstruction and preservation of historical objects. In the recent past, there have been significant changes in object documentation technologies. Current practice uses laser scanning or virtually fully automatic photogrammetric processes, which are used for powerful computing and software. In the last century, classical stereophotogrammetry was used as an exact and precise method completed by single photo photogrammetry for planar objects; however, it is very time consuming in its classical form. By the end of the twentieth century, digital technology slowly pushed out classic analogue methods. Digital technology entails using new instruments, technology, data storage and manipulation, and offers new possibilities in automated data processing and for the presentation of the results. In 1999, the documentation of the Great Umayyad Mosque in Aleppo, Syria, was conducted. After an international tender, all documentation was carried out by the Czech firm Geodezie CS in cooperation with the laboratory of photogrammetry of the Czech Technical University (CTU) in Prague. CTU was responsible for the photogrammetrical work and data processing, while classical geodesy was undertaken by specialists from Geodézie CS. At the end of the last century, analogue cameras were still being used and digital cameras were just beginning to be used. In the Umayyad Mosque documentation project, mainly analogue metric cameras were used. Captured images were digitised and processed on the first digital workstations. The original results from 2000 are good, but some of the outputs are now quite obsolete. The content of existing historical materials (measurements, CAD outputs, photographs) therefore provides a unique opportunity for future reconstruction. This paper refers to existing materials, their evaluation and new processing possibilities with modern technologies.

**Keywords:** Great Umayyad Mosque; photogrammetry; Syria; Aleppo; historical object documentation

## Introduction: Short History

Syria is enormously rich in historical sites, monuments and objects related to many cultures. Syrian history is incredibly varied; many civilisations and influences have been encountered there. Some of the most important ones are the following: the Kingdom of Ebla (3500–2000 BC); the influence of the Akkadian, Assyrian and Babylonian empires as well as the Amorite and Aramean kingdoms (2000–539 BC), followed by the Persian Empire (539–330 BC). In 330 BC, Syria was conquered by the Greek Macedonian Empire (Alexander the Great). Consequently, Syria became a province of the Greek Seleucid Empire (323–64 BC). After the end of Seleucid Empire, the Armenians retained control of Syria for a short time (83–64 BC), before being driven out of the western part of Syria by the Roman Empire; the eastern part was controlled by the Palmyrene Empire till AD 273, when it became a part of the Roman Empire. After the breakup of the Roman Empire, the area was controlled by the Byzantines.[3] The Arabs conquered Syria in AD 640. In the mid-7th century, the Umayyad dynasty was prevalent. Sections of Syria were held by the Crusaders (AD 1098–1189) and the Seljuks (11th century AD). After the Seljuks' time, Syria was then

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3 Alafandi – Rahim 2014.

Fig. 1 The citadel and the nearby neighbourhood with the Great Umayyad Mosque in Aleppo after military operations, large block destruction (Pleiades satellite, 2016; processing: CTU in Prague)

controlled shortly by Saladin.[4] Then came the Mongols (AD 1250–1281), who were later expelled by the Mamluks.[5] The Mongols went to Syria in 1400; Timur Lenk invaded Syria, sacked Aleppo and Damascus and massacred the inhabitants. In 1516, the Ottoman Empire conquered Syria, and incorporated it into its empire. After its disintegration at the end of World War I, it fell under the French mandate. Syria has been an independent state since 1945.[6]

Unfortunately, peaceful demonstrations in 2011 were suppressed by the military, and a year later the war in Syria began. The conflict escalated into a civil war and to the actual fragmentation of the country into many factions fighting for various goals in a very confusing conflict.

In Syria, historical cities like Damascus, Aleppo, Palmyra, Latakia, Tartous, Hama and others should be mentioned. In the following text, valuable historical monuments in Aleppo will be cited.

The most well-known monuments in Aleppo are the citadel on an ancient tell in the city centre and the Great Umayyad Mosque, not far from the citadel. Near this mosque, the entrance to the Al-Madina market (souk) can be found. The Umayyad Mosque is one of the oldest mosques in Aleppo, located in the district of al-Jalloum in the local Old Town, which was declared a World Heritage Site and included in the UNESCO list of world monuments in 1986.[7]

The place where the mosque was built was originally an agora from the Hellenistic period; the garden of the Cathedral of St. Helena was also previously there. The mosque was founded by the Umayyad caliph Suleyman at the beginning of the 8th century AD. Inside the mosque, St. Zacharias, the father of John the Baptist, was allegedly buried. The original historical minaret dates from AD 1090, the reign of the Seljuk Dynasty. However, with the exception of the minaret, the present building, which dates from the period of the Mamluks, was built in the 13th century AD.[8]

4 Ring et al. 1996.
5 Bacharach 1996.
6 Beck 2010.
7 Diab 1999, 45.
8 Mitchel 1978.

## Present State

As in many others conflicts, several historical sites, monuments and objects have been damaged or destroyed during military operations. A large number of historical monuments have been damaged during the Syrian Civil War and a number of monuments were unfortunately also destroyed by the so-called Islamic State. Miraculously preserved for thousands of years, Palmyra was severely damaged in just a few days in 2015 and 2017, when Syrian and Russian troops left it unprotected. This is a world-class tragedy and a toll taken by wars.

Aleppo's historical city centre has also been heavily damaged in the Syrian Civil War, mainly in 2012–2016. It is hard to find out who was responsible for the destruction of entire historic city blocks; it can be assumed that a large part of the blame falls to air raids. The citadel was damaged, the historical souk destroyed, and the Umayyad Mosque was partially destroyed (Fig. 1). The mosque was damaged during the fighting between the Free Syrian Army and government troops in 2012, and consequently on 24th April 2013 the historical minaret (the upper part of which was already in poor condition and was renovated as an inner court in 2003) was destroyed (Fig. 2).[9] Both parties blame each other for its destruction. Unfortunately, other parts of the historical mosque like the historical downtown were also damaged.

Today with the end of the war possibly in sight, we are already looking for information about destroyed or damaged monuments. Contemporary technologies are capable of processing recent and historical image records that can be used for restoration and reconstruction. The following text speaks of these possibilities.[10]

Over twenty years ago, in 1998, the decision on the contemporary complex documentation of the Great Umayyad Mosque in Aleppo was made by the Syrian government. After a tender, the documentation of the mosque was carried out by the Geodezie CS firm in cooperation with the Faculty of Civil Engineering's laboratory of photogrammetry of the Czech Technical University (CTU) in Prague; the work took place in 1999. Geodezie CS ensured geodetic measurement and data processing in CAD, while CTU was responsible for the photogrammetrical part. The reason was that the laboratory of photogrammetry at the Czech Technical University in Prague was the largest university photogrammetric centre in the Czech Republic at the end of the last century and the major work of its laboratory was, and still is, the 3D measurement and documentation of historic buildings and monuments.

The photogrammetric equipment was typical for the end of last century and consisted of a set of precise analogue photogrammetric cameras: UMK, SMK and RolleiMetric for terrestrial photogrammetry. Digital cameras were in development and were not used as a primary photogrammetric instrument. For processing, precision stereo comparators and PC-connected analogue instruments such as digital stereo equipment (digital photogrammetric workstations) were used. The technology has changed dramatically since the beginning of the new century – only digital technology remained in use, while direct 3D object point measurement using laser and triangulation scanners was on the rise, due to the fact that high-performance computer IBMR (image based modelling and rendering) started to develop.

The project in the Umayyad Mosque in Aleppo came right at the time of major changes in technology documentation. During that time the Czech team used the Sokkia total station for classical geodesy and for photogrammetry, the classical old analogue large format UMK 10/1318 camera (Carl Zeiss Jena, b/w sheet film, 13 × 18cm), the middle-format RolleiMetric réseau 6006 camera (colour or b/w roll film, 6cm) and, for basic hand-held documentation, the Olympus digital camera with a 2Mpix resolution. All measurements (control points, object points etc.) were measured with the Sokkia total station.[11]

9 Spencer 2013; Alafandi – Rahim 2014.
10 Pavelka et al. 2018.
11 Třasák-Štroner 2016.

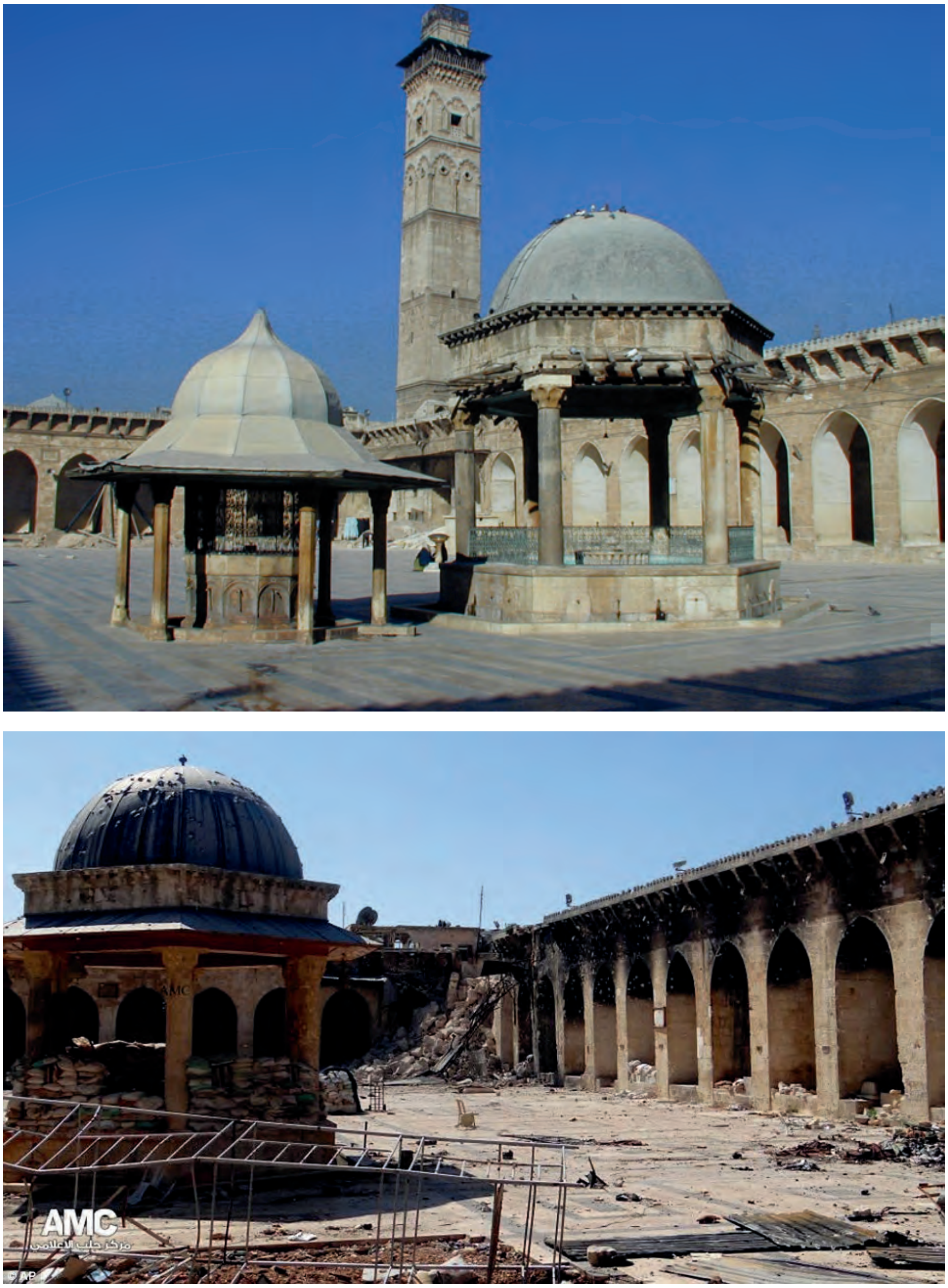


Fig. 2 Photo from the Great Umayyad Mosque with minaret in 1999 and destroyed minaret in 2013 (photo above: K. Pavelka; below: Watson 2013)

### Documentation

The Great Umayyad Mosque is a rectangular structure with one dominant minaret and several entrances. The basic rectangular structure consists of buildings with arcades and interior spaces; in the largest space there is a big decorated cupola. Two historic ritual fountains are dominant in the mosque inner court, which is decorated with a mosaic of tiles of different colours. With an age of about 1,000 years and a dimension of about 100 × 60m it is a very valuable object.

But the outward appearance of the mosque has changed over time, with only the minaret having been stable until 2013. For a basic 3D documentation, the combination of classical geodetic mea-

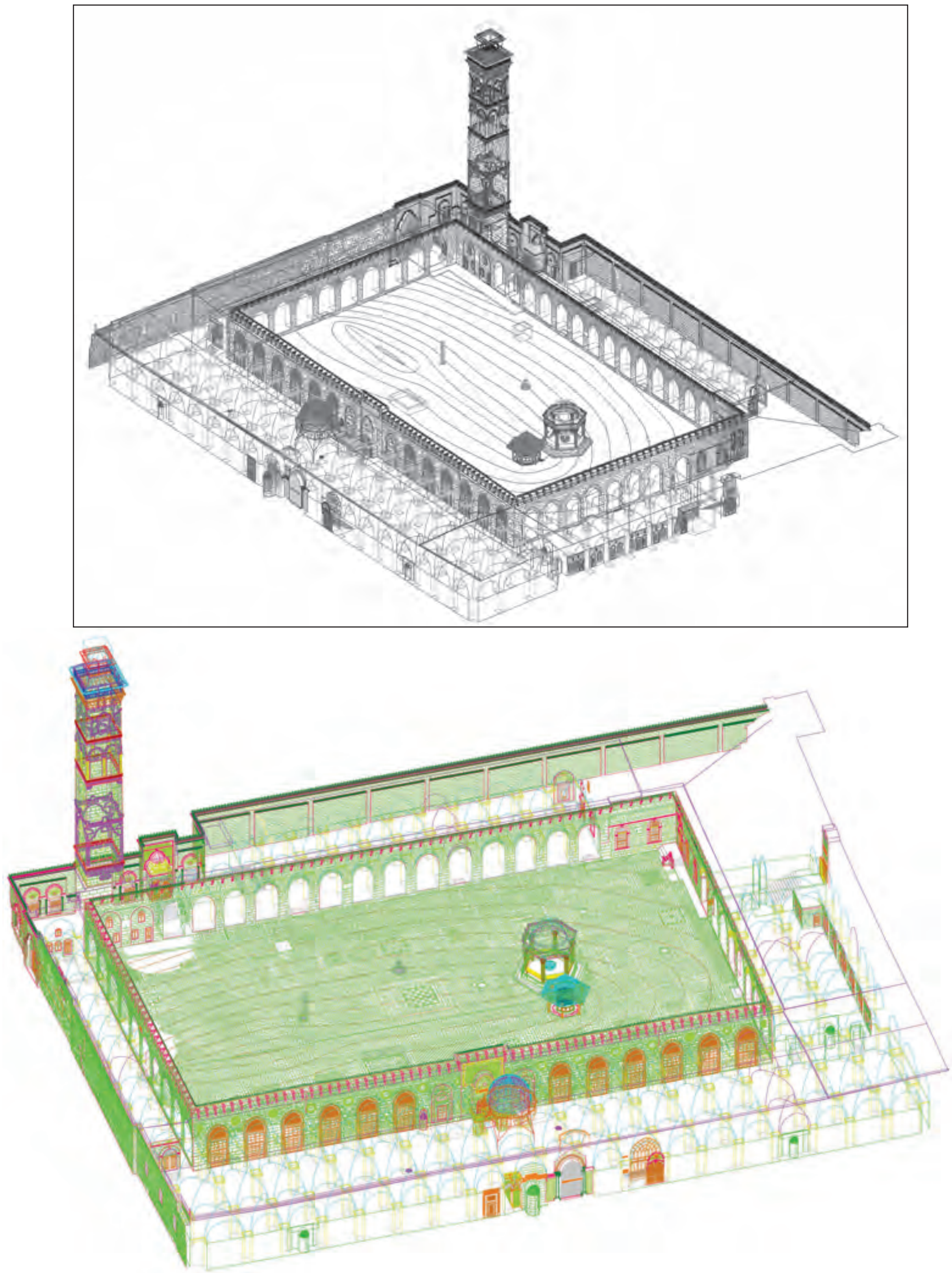

Fig. 3 Vector visualisation of the inner court with fountains, vector visualisation of the 3D model (K. Pavelka et al., CTU in Prague)

surement and terrestrial photogrammetry was used. About 600 signalised control points and about 3,000 object points with accuracy of less than 1cm were measured from a local geodetic network. From a photogrammetrical point of view, about 300 photos were taken for single image technology, intersection photogrammetry and for stereo processing. Digital photogrammetry was used for image data processing; GIS (Geographic Information Systems) technology and CAD (computer-aided design) were also used. The complex data set with processing is about 20GB in size.[12] B/w sheet

[12] Pavelka 2000.

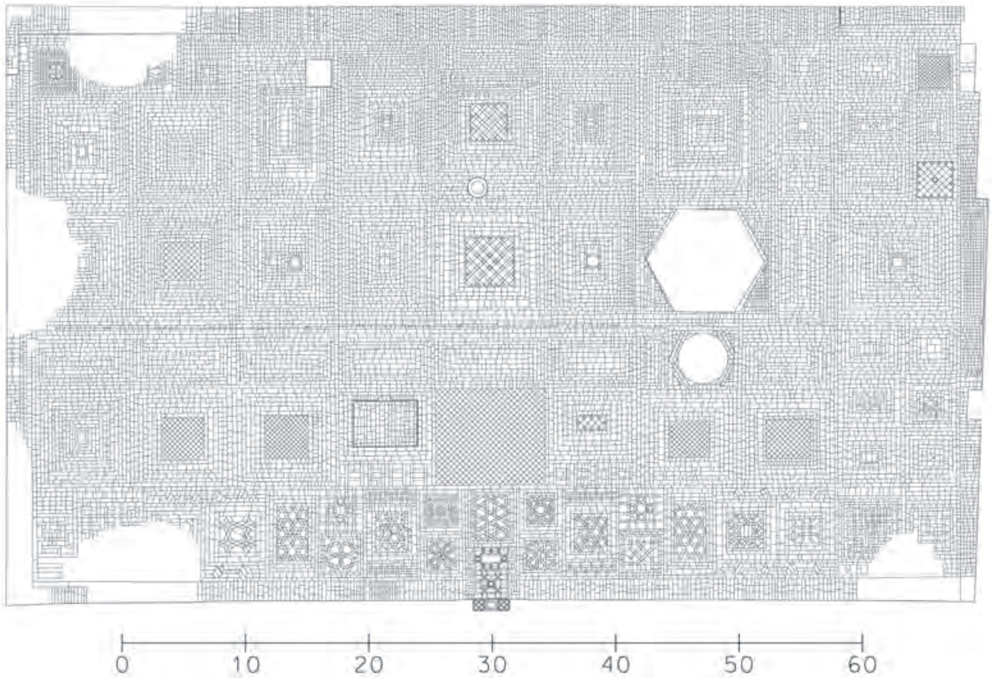

Fig. 4 Inner court of the Great Umayyad Mosque, results from 2000, vector plan (K. Pavelka, CTU in Prague)

films and roll films were developed directly in provisional spaces in a hotel that accommodated the documentation team. The hotel bathroom was used as a darkroom; it was necessary to have photogrammetric material before the end of the relatively short measurement mission (10 days) in Aleppo due to a low budget.

As was said earlier, the original images were analogue; they were later scanned in the Czech Republic on professional scanners such as the Nikon CoolPix (roll film) and Zeiss Intergraph (sheet films). Data processing carried out by CTU was divided into a photogrammetric part (photoplans of four façades with arcades of inner court, photoplan of inner court with mosaic and part of outside walls) and a part of image processing to vector plans (façades, minaret and both fountains in 3D, inner court vector plan). The Bentley Microstation was used as a primary CAD system for the creation of the vector plans and a 3D model. All work was performed in three months and was completed in 2000 (Figs. 3–4).

During our measurement operation in 1999, archaeological research was ongoing; at the mosque (mainly in the inner court), some extensive archaeological probing was conducted. The area showed many cultural layers that were destroyed over time, including burning and pre-Islamic remnants.

## New Processing of Photogrammetric Data

After many years, photogrammetric data processing changed dramatically, just like the situation in Syria. In 2017, we searched for archive data from 1999 and attempted a new, modern processing using the digital technology IBMR (image based modelling and rendering).[13] From the initial point of view, it seemed to be a simple task. After reviewing the data, it was noted that the data varied in quality and was primarily obtained for single-image photogrammetry with minimal overlap between photographs. Initially this meant that it was not possible to use IBMR technology,

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[13] Pavelka – Řezníček 2011.

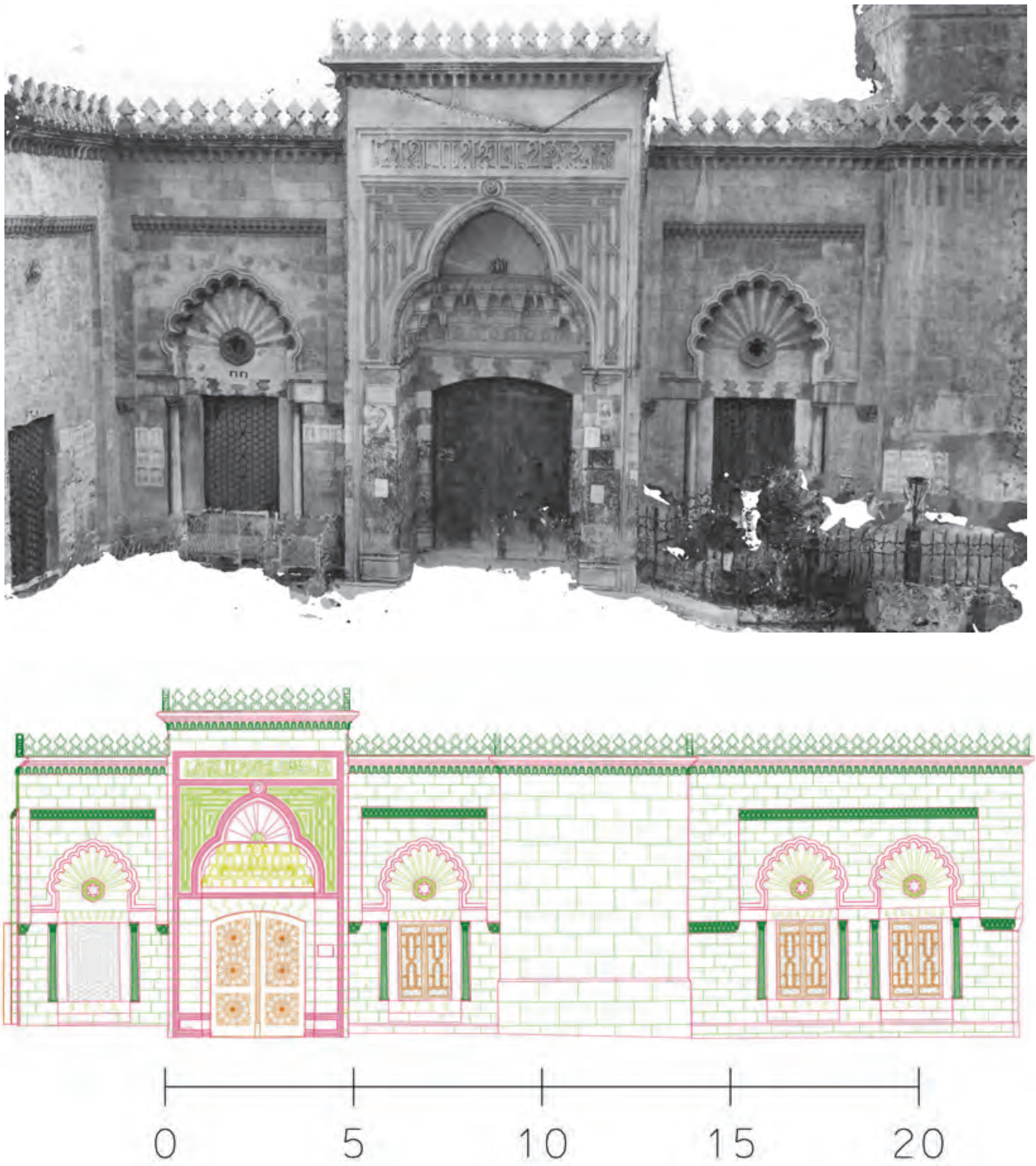


Fig. 5 North entrance, textured model from 2017, and vector model from 1999 (K. Pavelka, CTU in Prague)

which needed a big overlap between images, for this historical data. Fortunately, the individual parts of the façades were photographed by different cameras (UMK 1818, RolleiMetric 80mm and Olympus digital camera) from different positions. Thus, in the case of building façades, a good database of overlapped photographs was collected, which it was possible to process in Agisoft Photoscan.[14]

## Façades and the Northern Main Entrance

After many attempts, all the images from the internal façades and the northern main entrance to the mosque were processed (Fig. 5). There was a set of overlapped photos from three camera types (Tab. 1); of course, the best results were achieved by using photos from the precise

[14] Falýnová et al. 2016.

| | UMK (b/w) | Rollei | Olympus |
|---|---|---|---|
| South façade | 10 | 8 | 6 |
| North façade | 9 | 9 | 27 |
| East façade | 6 | – | 10 |
| West façade | 5 | 5 | 17 |
| North entrance | 4 | – | 8 |
| Inner court | – | 22 (b/w) | 26 |

Tab. 1 Number of photos used

| | max [cm] | min [cm] | average [cm] | max [pix] | min [pix] |
|---|---|---|---|---|---|
| South façade | 5.9 | 1.1 | 3.6 | 0.35 | 0.12 |
| North façade | 3.8 | 0.4 | 2.3 | 1.64 | 0.30 |
| East façade | 3.0 | 0.5 | 1.7 | 0.50 | 0.01 |
| West façade | 1.9 | 0.4 | 1.2 | 0.74 | 0.24 |
| North gate | 14.1 | 1.4 | 8.9 | 0.72 | 0.59 |

Tab. 2 Final precision, which seems to be good for the future restoration

| | No. of control points |
|---|---|
| South façade | 11 |
| North façade | 19 |
| East façade | 11 |
| West façade | 13 |
| North entrance | 7 |
| Inner court | 267 |

Tab. 3 Number of control points used

| | Tie points | Dense point cloud | No. of triangles in mesh | Orthophoto resolution [mm/pix] |
|---|---|---|---|---|
| South façade | 25 942 | 8 598 665 (medium) | 1 693 786 | 2.57 |
| North façade | 25 279 | 3 086 110 (medium) | 601 049 | 3.11 |
| East façade | 10 262 | 4 946 760 (high) | 978 480 | 4.31 |
| West façade | 23 952 | 3 972 193 (high) | 778 380 | 4.66 |
| North entrance | 18 009 | 1 845 712 (high) | 369 139 | 3.91 |
| Inner court | 24 718 | 2 808 773 (high) | 561,752 | 9.05 |

Tab. 4 Processing information and final orthophoto resolution

universal Zeiss UMK photogrammetric camera, but these images were only b/w. After the processing of a sparse point cloud, it was necessary to erase a lot of incorrect points. After this, a good result was created for the façades such as the mesh model. After the masking of unwanted parts (people, things and shadows) a true orthophoto and textured models were computed. As a result, a true orthophoto of the entire internal arcade – façades with a pixel size of approximately 3–5mm and a textured point cloud such as a 3D meshed model – were produced (Tabs. 2–4). For the orthophoto, control points were used (Tab. 3), which helped to create a real model and improved computation of image orientations. Some original sketches of control points were found, while others were derived from the vector model. Based on stereophotogrammetrical processing and stereo-pairs, some details were modelled in Agisoft Photoscan, such as the north gate.[15]

## Inner Court

Both the inner court and the minaret of the Great Umayyad Mosque are dominant elements of the structure. The minaret was documented in 1999 by geodetic methods and single image photogrammetry by CTU Prague and later by subsequent photogrammetrical projects.[16] There is no information about other documentation and mapping of the inner court based on geodetical and photogrammetrical measurements carried out by CTU Prague since 1999–2000. Old orthophoto plans created using single image photogrammetry with the help of hundreds of geodetically measured control points is unique. From this output, a vector plan and small GIS has been derived, which is very detailed (all stone tiles). The creation of this orthophotoplan was very laborious and lengthy. After many years, the quality of the original orthophotoplan is not sufficient for contemporary technology. Today, the RPAS (drone) would be very suitable for this work, and the high quality orthophoto would be made with excellent resolution in a few hours, including a quality DSM (digital surface model), but about twenty years ago, this technology was not possible and it was necessary to use only the available historical photos. By processing old photographs based on IBMR technology, a problem occurred with the preserved images. Only 25 photographs were found from the RolleiMetric camera, taken on black/white film; the quality of these photos was very bad – the radiometrical quality was not sufficient, and in the inner court there were many people and very dark shadows. Images taken with the RolleiMetric camera were scanned on a precise NikonCoolScan scanner. Original camera calibration protocols still exist, but it was necessary to manually perform a transformation on all 121 crosses and scanned images of different sizes to crop to the same size (using outer crosses). Additionally, approximately twenty colour images taken with the Olympus camera have been found. However, these images have only a 2MPix geometric resolution and every image has a different internal orientation (there was no calibration when zoom was used; originally, these images were taken for documentation only). All these photos were taken from the roof and from the minaret; they were taken with a very oblique direction, with a low overlap, and in many cases against each other, which is not good enough for IBMR technology. All existing images were processed together in Agisoft Photoscan. In this case, the IBMR application gave very poor results or was terminated. What does it mean? Not everything was processed well enough with the IBMR technology (Agisoft Photoscan); this technology is not a panacea.[17]

As a next possible attempt, the photogrammetrical software called Photomodeler was chosen. The idea was simple; it was necessary to create an original photogrammetrical model based on intersection photogrammetry and finally get a precise internal and external orientation for all photos. Photomodeler was used for processing and for reverse calibration computing. Hundreds of control points were used without appropriate results. Apparently it is because images with poor geometry, no quality calibration, and significantly different cameras were used. In this case, the system is very free and contains too many unknowns. After many attempts, we were still not able to get any good results. Intermediate results were distorted or failed to create a complex model. Results from reverse calibration were often meaningless. In future research it is necessary to try to get more photos or include other images from the UMK camera (Fig. 6).

15 Bílá et al. 2015.
16 Dlesk et al. 2018.
17 Housarová et al. 2017.

Fig. 6 Complex textured model of Great Umayyad Mosque without minaret (K. Pavelka, J. Šedina, J. Zachariáš, CTU in Prague)

## Minaret

There is a basic vector plan from the geodetic measurement completed with photogrammetric measurements. The minaret was not processed to a model or point cloud due to a lack of overlapped images and other projects with better results. Fortunately, it was very well modelled by other authors.[18]

## Cupola and Other Details

When viewing the data, indoor photography photos were also found taken with the Olympus digital camera. We managed to get about 20 pictures from the big cupola inside the mosque. From this set a very good result was derived with decorational details; it was possible to process the 3D model using Agisoft Photoscan software (Fig. 7). Other spatially distributed details and structural parts, such as side entrances, decorated elements or windows, can already be modelled from several images. Photos of the details of the exterior and interior of the building (interior decoration, decorated doors, quotations from the Qur'an, etc.) have also been found that may be valuable in the future possible reconstruction of the building.

## Conclusion

This contribution shows that it is possible to process historical old photographic data using modern technology, which does not require detailed information about cameras, camera positions, interior or external orientations. This was not possible in the recent past. Of course, it depends on the image quality, image overlapping and other parameters. In this case, analogue photos and his-

18 Fangi – Wahbeh 2013.

Fig. 7 Cupola of Great Umayyad Mosque (K. Pavelka, CTU in Prague)

torical low-resolution digital data of the Great Umayyad Mosque in Aleppo, Syria, partially damaged during the civil war in 2012–2016, were used. Analogue data was digitised and preserved in digital form, but the radiometrical resolution was not sufficient and the original image frame was not known and stable (if possible, fiducial marks can be used for image size reconstruction).

A precise vector model and historical photographs were collected from archived measurements in Aleppo in 1999. Unfortunately, all photos were taken for single image photogrammetry, which was typical in the care of monuments using planar objects. We tried to process historical photos using today’s innovative technologies; in this case IBMR was chosen. The results were quite good for data that was originally created for a totally different image processing technology. All four inner façades of the mosque such as entrances or decorated parts, the cupola and other details were processed to the textured 3D model and true orthophotos. We believe that other photos of the mosque were found and the object can be reconstructed more effectively for future restoration work; the modern form is now crowdsourcing and a lot of people have photos from holiday trips or from visiting other valuable and unfortunately destroyed historical objects.

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# Documentation, Databases and Reaching People

# The CIPA Database for Saving the Heritage of Syria: Challenges and Coordinating Efforts[1]

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**Abstract:** CIPA, a joint committee of ICOMOS and ISPRS, is contributing with its data and technical knowledge to saving the heritage of Syria by constructing an open-access database. It is largely based on the data that the CIPA members have collected during various projects in Syria over the years before the civil war in the country broke out in 2011. In this way we wish to support the protection and preservation of the environment, sites, monuments, artefacts and the memory of the region that has been crucial for the human past and the emergence of civilisations. Apart from countless human atrocities and loss, the damage, destruction and looting of the cultural heritage have taken place on a large scale. CIPA's initiative is one of the various international projects that have been set up since the conflict started. The Directorate-General of the Antiquities and Museums (DGAM) of Syria, as well as UNESCO with its various sub-organisations, have been central in facing the challenges during the war. Digital data capture, storage and dissemination are at the heart of CIPA's strategies in recording and documenting cultural heritage, including in Syria. It goes without saying that for the conservation and restoration work high-quality metric information is of the utmost importance.

**Keywords:** cultural heritage; documentation; database; data standards; GIS

## Introduction

CIPA, the joint scientific committee of ICOMOS (International Council on Monuments and Sites) and ISPRS (International Society of Photogrammetry and Remote Sensing) has specialised in the recording and documentation of tangible cultural heritage including cultural landscapes, archaeological, architectural and artistic data. It is the former International Committee of Architectural Photogrammetry. It develops and uses the best technical equipment, methods and practices for saving heritage. CIPA's aim since 2014 has been to set up a platform for archiving and information sharing focused on sites and monuments to protect and preserve the cultural heritage of Syria. CIPA's asset is expertise in high-tech data capture, storage, use and dissemination. The data used by CIPA is divided into metric data, image-based and range-based data capture, analysis and visualisation. The purpose is to provide data that can be used and shared digitally. The data can serve institutions, organisations, cultural management stakeholders, individual researchers and private enthusiasts.

Syria is one of the cradles of human civilisation in the Near East covering parts of the Levant and Mesopotamia, located, as it is, at the continental crossroads of Africa, Asia and Europe. It was a bridge for early human movement in the Palaeolithic era. For example, the tools from

[1] This article is an updated version of an ISRPS e-paper published on the web in 2016. The paper largely dealt with the subjects that were presented in the CIPA workshop in Vienna. However, it is important that this paper will be published in print to document and preserve the situation of various efforts to save the heritage of Syria.

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the El Kowm basin belonging to the so-called Pebble Culture are 1.8 million years old.[7] Additionally, archaeological projects as part of the Tabqa Dam rescue work conducted in the 1960s and 1970s, produced significant results including new information about the earliest cultures of Syria in the Lake Assad region on the Euphrates. Unfortunately, because of the dam some sites have since been submerged. At Abu Hureyra in the Lake Assad area, evidence of the earliest agricultural initiatives from c. 9,000 BC was discovered.[8] As far as the Syro-Mesopotamian civilisation is concerned, countless clay tablets bearing cuneiform writing have been recovered in Syria, including ones from such large ancient kingdoms as Mari, Ebla and Ugarit. In the coastal areas some of the first signs of the alphabetical writing system have been traced at the site of Ugarit-Ras Shamra.[9]

## The Situation in Syria

Since the Arab Spring of 2011 and the start of the Syrian civil war, apart from the immeasurable human suffering and loss, the cultural heritage of the region has been continuously and speedily damaged and destroyed (Fig. 1). Such sites as Aleppo and Palmyra, also belonging to the World Heritage Sites defined by UNESCO, have faced total destruction of monuments during the conflict. The intentional destruction was partly led by ISIS/ISIL (the Islamic State of Iraq and Syria) at Palmyra, which was captured by the Islamic militants in May 2015.[10] Atrocities followed with ISIS/ISIL, and several cultural sites in Syria were damaged and buildings totally erased. That has been case in Palmyra, like in Iraq before it. Minna Silver, along with Gabriele Fangi and Ahmet Denker,[11] has paid special attention to the case of Palmyra by providing data, such as old drawings, photographs and digital modelling, in the form of a handy book that can be used by cultural heritage professionals as well as laymen.

The trafficking of illicit antiquities out of Syria has also been growing and drying the artery reflecting past lives in the human-made artefacts and traditions that belong to the cultural patrimony of the people of the area as well as to the heritage of all, as Syro-Mesopotamia is the cradle of civilisation. There are valuable initiatives, and more coordinated efforts are taking place to plan how to collect data and share it for the purpose of heritage preservation. There are scientific requirements and standards for the use of the data and material from the conservation point of view that need to be assessed. CIPA's execu-

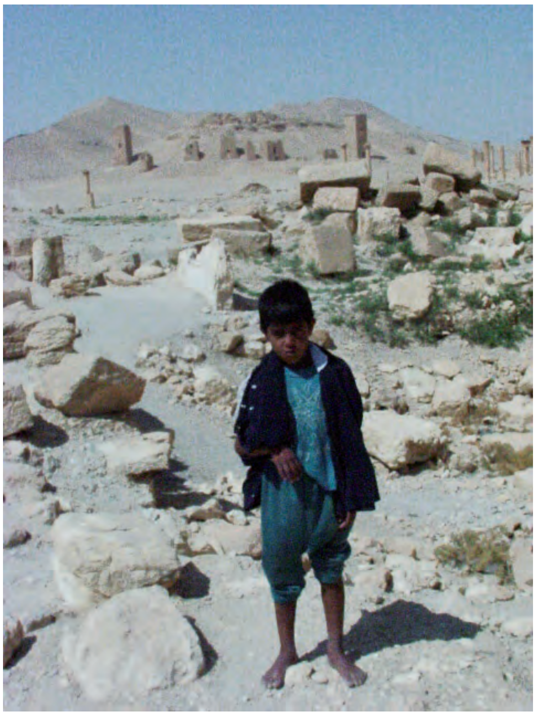

Fig. 1 A Syrian child photographed with the first generation digital camera in the midst of the Palmyra ruins in 2000 before the conflict. The famous tower tombs can be seen in the background (photo: SYGIS)

[7] Le Tensorer et al. 2015.
[8] Moore et al. 2000.
[9] Schniedewind – Hunt 2007.
[10] Lönnqvist 2015a; Lönnqvist 2015b.
[11] Silver et al. 2018.

tive board has produced a book on 3D recording, documentation and management of cultural heritage that provides tools for the documentation of sites and monuments in the digital era.[12]

## CIPA among the Cultural Heritage Initiatives for Syria

Some members of the CIPA executive board, who have personally worked on various projects in Syria, have plenty of interesting data regarding the recorded and documented tangible heritage of the region, especially from the Aleppo and Palmyra regions. This data is serving as a basis for our initiative that was decided upon in the CIPA executive board meeting in Riva del Garda, Italy, in 2014. In addition, there are archives that can be used to supplement the site information which provide old photographs, drawings and images in digital form without copyright restrictions.

However, as mentioned, CIPA is a joint organisation of ICOMOS and ISPRS, and our data mainly concerns location information, sites and monuments including satellite data and 3D modelling. The information provided by the data concerning movable artefacts associated with sites is limited. That data belongs to the field of expertise of ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property)[13] and ICOM (the International Council of Museums)[14] and may only be referred to, for example, through a weblink, or supplied when available and applicable. On the other hand, our data is important to any study of artefacts and their provenance. This is to be taken into account in the case of the increased trafficking of looted antiquities out of Syria during the conflict.

The database design with the CIPA project graphic interface was presented for the first time in this specific CIPA workshop on saving the cultural heritage of Syria arranged during the 10th International Conference on Archaeology of the Ancient Near East (ICAANE) in Vienna in April 2016.[15] The plan was published online in the ISPRS International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences in the ISPRS Congress in Prague in 2016[16] in order to get some feedback on its structure and develop it further. In the meantime, other databases have emerged, some paying specific attention to damage assessment based on the work of EAMENA and Shirin.[17] The latter initiative is near to the scope of ICORP, the scientific committee of ICOMOS on risk preparedness that has produced a specific management manual.[18] Some database projects have benefited from CIPA's ideas. A survey of the existing datasets and databases concerning the Syrian heritage built up by other organisations is acknowledged in the construction of the CIPA inventory. Already accessible data will not need to be duplicated. A link is provided to other datasets and databases offering existing material or information when such knowledge is available. It will be beneficial to co-operate and share data with various stakeholders.

The storage facilities, archives, museums, datasets and databases of the DGAM (Directorate-General of Antiquities & Museums of Syria) are central in saving the cultural heritage of Syria. Apart from the initiatives by UNESCO (the United Nation Organization for Education, Science and Culture): UNESCO Observatory of Syrian Cultural Heritage and the project Safeguarding Syrian Heritage,[19] the ICOMOS and ICORP (International Committee on Risk

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12 Stylianidis – Remondino 2016; see also Silver 2016.
13 See <https://www.iccrom.org> (last accessed 18 Feb. 2020).
14 See <https://icom.museum/en> (last accessed 18 Feb. 2020).
15 See Rinaudo – Silver 2016.
16 See Silver et al. 2016.
17 Vafadari et al. 2017.
18 International Council on Monuments and Sites, International Committee on Risk Preparedness (ICOMOS – ICORP) <http://icorp.icomos.org/index.php/documents/> (last accessed 18 Feb. 2020).
19 See <https://www.unesco.org> (last accessed 18 Feb. 2020).

Preparedness)[20] organisations under UNESCO specialise in safeguarding cultural sites, the latter especially in the case of catastrophes. ICCROM and ICOM under UNESCO are active in conservation and restoration as well as storing artefacts. With its UNOSAT programme, UNITAR[21] under the UN has collected satellite data on the damage at heritage sites in Syria. The International Committee of the Blue Shield (ICBS)[22] has taken special actions for protecting and preserving the heritage in conflict areas like Syria.

ASOR Cultural Heritage Initiatives (American Schools of Oriental Research)[23] is also active in the field. CyArk is documenting digitally at-risk heritage sites in Syria in co-operation with ICOMOS[24] and the Anqa project that is presented in these proceedings of the CIPA workshop. The World Monuments Fund is also supporting the cultural heritage preservation in Syria.[25] SHIRIN International (Syrian Heritage in Danger: an International Research Initiative and Network) and EAMENA (Endangered Archaeology in the Middle East and North Africa at Oxford University)[26] are also active in saving the heritage in Syria. In co-operation with UNESCO, 3D cameras have been provided by British funds and coordinated by the Institute for Digital Archaeology[27] for locals in Syria to document endangered sites. People on the ground in Syria have been involved in sharing information as images and videos during the armed conflict. Antiquities Coalition[28] has especially been fighting against the trafficking of the looted artefacts.

Manar al-Athar is a free online multi-media source with a photo archive at Oxford University[29] that includes data from Syria. SYRHER (Syrian Heritage Archive Project, Germany),[30] and the Aleppo Project at the Center for Conflict, Negotiation and Recovery at the Central European University, Hungary, are also contributing to the preservation work. Some databases use the ARCHES platform developed by the Getty Conservation Institute.[31]

In addition, APSA (the Association for the Protection of Syrian Archaeology) and the Heritage for Peace organisation[32] should be mentioned as having been actively participating in sharing information on the situation with the cultural heritage in Syria.

## The CIPA Project

### The Aims and Strategy

It is well known that in the protection and preservation of tangible cultural heritage each recording and documentation action needs to be planned and oriented by considering the specific use of the documentation. However, CIPA is not involved in targeted recording and documentation in Syria at the moment but will initially primarily be using the existing data held by the CIPA members (images, metric and historical records, like maps, drawings and textual descriptions, as well as reports of archaeological studies) to organise the data into a database structure useful to the conservators and restorers.

20 See <http://icorp.icomos.org> (last accessed 18 Feb. 2020).
21 See <https://unitar.org> (last accessed 18 Feb. 2020).
22 See <https://theblueshield.org/?s=syria> (last accessed 3 June 2020).
23 See <https://www.asor.org/chi> (last accessed 18 Feb. 2020).
24 See <https://www.cyark.org> (last accessed 18 Feb. 2020).
25 See <https://www.wmf.org/project/cultural-heritage-sites-syria> (last accessed 18 Feb. 2020).
26 See <https://eamena.org> (last accessed 18 Feb. 2020).
27 See <https://digitalarchaeology.org.uk> (last accessed 18 Feb. 2020).
28 See <https://theantiquitiescoalition.org> (last accessed 18 Feb. 2020).
29 See <http://www.manar-al-athar.ox.ac.uk> (last accessed 18 Feb. 2020).
30 See <https://syrian-heritage.org> (last accessed 18 Feb. 2020).
31 See <http://www.getty.edu> (last accessed 18 Feb. 2020).
32 See <http://www.heritageforpeace.org> (last accessed 18 Feb. 2020).

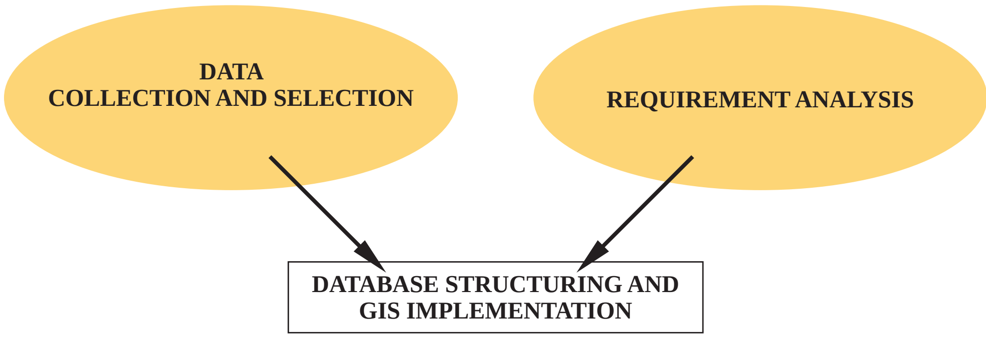


Fig. 2 The three steps of the CIPA project

The main aim of the CIPA project is concentrated on a specific goal: to provide the restorers and conservators with all the available data that CIPA has, which will allow the design of future actions. The second aim of the CIPA effort is to collect the existing data from other stakeholders to offer the possibility to transmit knowledge of this universal patrimony worldwide. In the following paragraph the first steps of the CIPA project will be described as it was conceived by a group in which archaeology, architecture, conservation and geomatics expertise were present. In the long run, the project aims to contribute to the safeguarding of the heritage by considering not only the collection of existing records but by inserting them into a more complete approach which is oriented to planning a strategy for the real preservation of the data.

The first step of the CIPA project is the data collection, and it is organised by following two different strategies. The first action is the description (by using the metadata structure to be described in the following paragraphs) of the data collected from the CIPA members, and, in future, the data collected from other providers. The second step is to attach the metadata to the data and to store the accepted data to allow downloading by interested parties. All the collected data will be described in a synthetic way. At the end, as the third step, it will be possible to design a database structure to be implemented inside a GIS platform (Fig. 2).[33]

## The Data Structure and Data Archiving

The data to be collected, saved and disseminated have been conceived as 1) primary data and 2) elaborated data. Primary data (Fig. 3) are essentially images and videos. Images are split into two different categories: descriptive images and metric images. Descriptive images basically come from photographic surveys made in the past by specialists but also tourist types of documentation at sites at different times. Metric images are classified by grouping the medium scales into terrestrial, aerial and/or satellite images.

Elaborated data (Fig. 4) relates to 2D maps, drawings, 3D models and reports. 2D maps will be subdivided into cartographic products, excavation plans, and architectural scale drawings. 3D models and reports will be organised by considering different scales: environment and/or landscape, urban scale or architectural objects.

## Setting Up a Graphic Interface for the Data

As CIPA's aim is to collect and share the data through an open access digital platform on the internet and to develop the database further, a website is conceived as an efficient tool.

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[33] See, e.g. Ardissone – Rinaudo 2005.

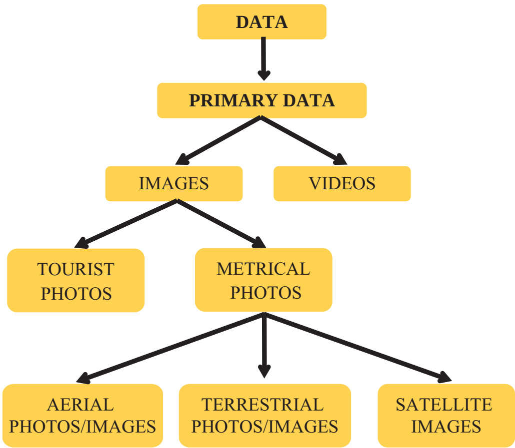


Fig. 3 Primary data classifications

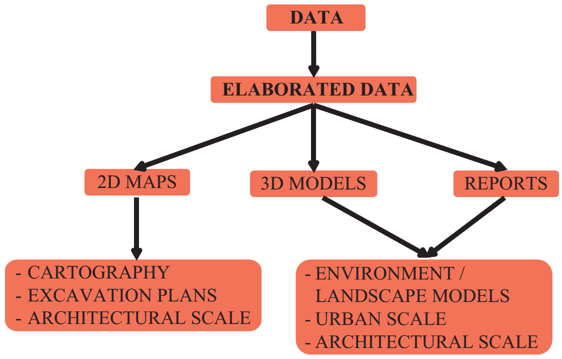


Fig. 4 Elaborated data classifications

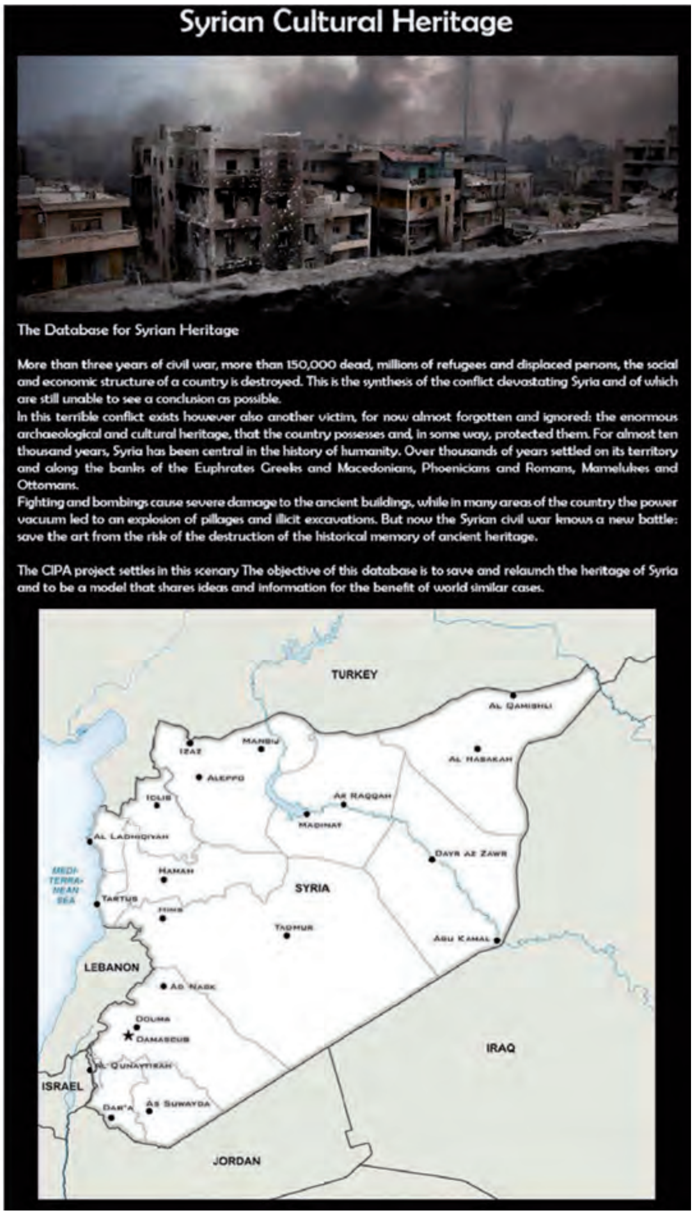


Fig. 5 The CIPA website interface

The website is designed in the simplest possible way to allow easy access to the stored and connected information and to facilitate the upload of new sets of data by all interested people. The main page offers the map of the territory of Syria (Fig. 5) as it existed before the civil war broke out and where all the locations with available data will be underlined. This basic map of Syria with its governorates and centres will in due course be linked to the Google Earth map that provides the interactive locations of places and sites. The question of the site names in the main languages and spellings is taken into account: beside English, transliterated Arabic, French, German and Italian can be applied.

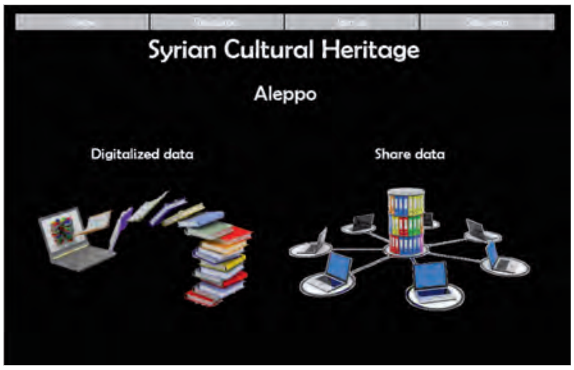


Fig. 6 Selection between the CIPA data and external data


Fig. 7 Collecting the elaborated data

By clicking on specific locations, the visitor can see the type of accessible data by following the conceived structure of the data (see Figs. 4–5). The first way to access the data is by searching the data according to the origin (the CIPA data or external data, Fig. 6). The second possibility is to access the data by considering the type of data (images, video, reports, Fig. 7). Both possibilities open access to the stored and shared material with the visualisation of the related metadata.

## The Data Collection and Core Metadata

As previously mentioned, the data to be archived in the CIPA server is based on the CIPA members' data acquisition and collection and later acquisition as a voluntary action is proposed by the website, where people are invited to submit data. They can follow a simple interface (Fig. 8) on which they are invited to describe the uploaded data by means of a short set of metadata. The data which can be collected by following the already presented scheme (Fig. 2) would not create a comprehensible dataset for the aims of the project without preliminary classification according to a simple set of metadata.

It is well known that in a rigorous database design the metadata structure is essential to understanding the real content of the data themselves. Our proposal is to start with a simple metadata structure in order to be able to clarify the real information content of the collected data and to postpone a more rigorous attribute and metadata structures to the third step of the project when a real database for a GIS platform will be realised.


Fig. 8 The data collection site

By considering the different kinds of data the CIPA project wants to manage,

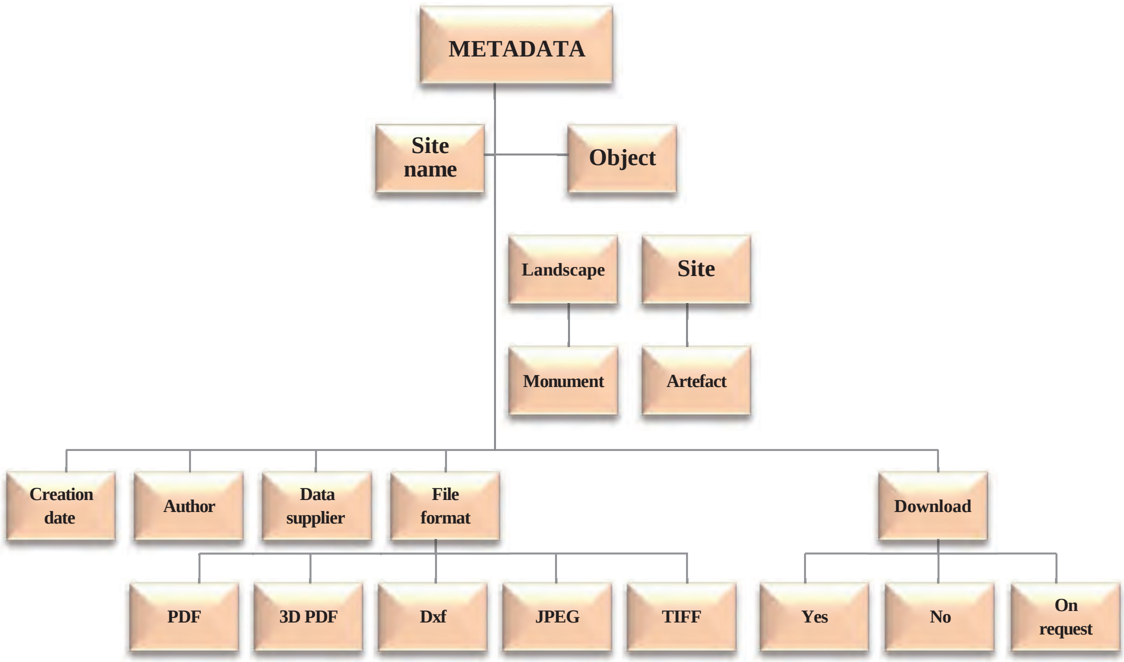


Fig. 9 Core metadata structure

the metadata has been conceived as a shell structure where, beside a set of common metadata for all the possible achievable data, specific metadata has been selected for each kind of interesting data. The following steps drive the visitor to select the different data by considering the year of data production, the author, the data provider and the specific object (Fig. 8).

Without considering the kind of data to be acquired, the following set of metadata has been established (Fig. 9):

- Site name: By considering the consistency of the cultural heritage in Syria, the name of the site is the first location key for all data. Several sites are specified by various experts (archaeologists, historians, conservators, etc.) in different ways (e.g. the site of Palmyra as Tadmor, Tadmur, Palmyre, Palmira, etc.). In order to avoid this problem, in the first step of classification the data provider is asked to indicate the exact place by using a Google Earth map interface. The decision to avoid use of the cartographic coordinates is due to the fact that it is difficult for non-specialists to deal with.
- Object: This information will be requested from the data provider to indicate in a general way if the data refers to a landscape, a site, a building or an artefact by also indicating whether the object still exists or not.
- Creation date: This field aims to define when the data was acquired, and can also be specified by indicating just the year if no more information is available.
- Author: This field requires the name and affiliation of the data producer, which can be different from that of the data provider. This information will be used to check possible copyright conflicts by publishing the data.
- Data supplier: This is the information about the person/people who is/are uploading the data and can be useful to obtain more detailed information if necessary.
- File format: The data have to be uploaded in one of the most diffused and open formats such as ‘pdf’ and ‘3D pdf’ for text and 3D models, ‘dxf’ for drawings and ‘JPEG’ or ‘TIFF’ for images.

- Download: This last information is required to understand whether the data can be uploaded into the CIPA server and then downloaded by interested people or can just be viewed on the website, or if the possibility of downloading the data is limited by payments and/or specific authorisation from the data owner.

During each upload a free text field will be provided to allow the data supplier to add any other information which can aid a better understanding of the information content.

## The Data Evaluation and Data Standards

Considering the importance of the first steps, the website has to be managed by a team of experts with skills in metric surveying, archaeology, and conservation. All the uploaded data has to be checked in terms of readability and completeness of the metadata information. The same team will also be responsible for checking similar initiatives and providing the necessary metadata structure for those data not inserted directly into the CIPA project.

The collection of the existing data inevitably involves specific problems about knowledge of the quality of the collectable data in terms of significance and accuracy (not only metric but also semantic), and therefore a preliminary action of collection, analysis and classification is needed (Fig. 2). Obviously, in the case of data offered by other initiatives (e.g. Shirin), the set of common metadata will be provided by the manager of the CIPA initiative by reading the data directly from the websites or by requesting the information from the persons responsible for single projects.

The preliminary scheme for the core metadata proposed above (Fig. 9) will allow initial identification of the really usable data. If some of the metadata is not defined, the data will be inspected directly by the manager of the CIPA project in order to allow introduction into the future GIS structure. The basic information following the core data standards, such as a site and its location as defined in the CIDOC data standard[34] and the CIPA RecorDIM data standard task group specifications are applied in evaluation of the data. However, as far as the CIDOC is concerned, some additions will be made in collecting environmental and landscape data associated with the site/s and monuments when available. Also, some specific glossaries may be left out.

The exact location of a site is a primary parameter in queries and the basic feature in data standards to be taken into account in any initiative to protect and preserve a site or a monument, also needed for its future conservation and eventual restoration. Without coordinate information, the exact locations of sites with their street addresses and monuments may be lost for ever. This is an issue in the areas that have been affected by conflict or faced natural disasters. Such transformations can change the landscape and site structures with streets and architectural features.

It therefore needs to be kept in mind that the street addresses are not eternal, and notes of directions without global references like coordinates, are data that can totally vanish. The map location on Google Earth with the coordinates used and local grid systems can provide an initial basis for the site assessment, but the UTM is the preferred coordinate system and will be used when such data is available associated with sites and monuments. The lack of coordinate information may also make a future archaeological assessment and study of the site after the conflict difficult. It also affects the extent of the site and its buffer zones.

But the reasons why the environment and landscape aspects are also applied is the modern approach in which the sites and monuments are to be understood in their context or setting.[35] The environmental and landscape data provide the means to understand the site's development and the effects of the environment. Apart from old drawings, old photographs can be used in studying the evolution of landscapes, sites and monuments.

The date of the data is essential in understanding the development of sites and structures, and the CIDOC standard is applied in associating the date information. This is also an aspect that

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34 See <https://cidoc-crm.org> (last accessed 18 Feb. 2020).

35 Cf. Vita-Finzi 1978.

needs to be taken into account in data evaluation. In addition, references to events like field work are provided when available.

For each category of data, specific metadata have been defined in order to have better knowledge about their informative content. For elaborated data such as 2D drawings and 3D models, a nominal scale has to be defined by the data supplier and whether the data are stored in a reduced scale or in 1:1 scale must be specified.

For tourist images, the specific information concerns the camera and focal length used, while for metric images, in addition to that data, the availability of a calibration certificate and of metric useful information is a scale, possibly resulting in a 3D model. An indication of overlaps in the images and the distance from which they were taken will be asked for, and for satellite images, the satellite system which provided the images is important data to know.

By considering the fact that in some cases not only images in the visible spectrum have been used, the data supplier should also indicate if the images are multispectral data. Information on the bands used during the recording of the images is also needed.

## Aleppo and Palmyra as CIPA Case Sites

As previously mentioned, the destruction of architectural and archaeological heritage in Syria has taken place on an especially large scale in Aleppo and Palmyra, both belonging to UNESCO's World Heritage Sites. The CIPA members who had acquired data especially in those cities before the civil war broke out, are providing data for the CIPA project. This data will be inserted into the CIPA server. In the following paragraphs we provide some initial examples.

### Aleppo: The Citadel and the Great Mosque

Aleppo is the second largest city in Syria, but the whole city has been heavily damaged during the civil war. The old covered market, the souq, was one of the first targets that became the target of destruction. The APSA organisation is paying special attention to the post-war reconstruction of Aleppo.[36] The medieval citadel of Aleppo (Figs. 10–11) is an area that encloses the early urban layers of the city, a tell that was an important Bronze Age site and the centre of the kingdom


Fig. 10 A sample site for Aleppo on the planned website

[36] Ali – Quenet 2016.

Fig. 11 Aleppo's citadel in an old photograph from the beginning of the 20th century (Library of Congress collections)

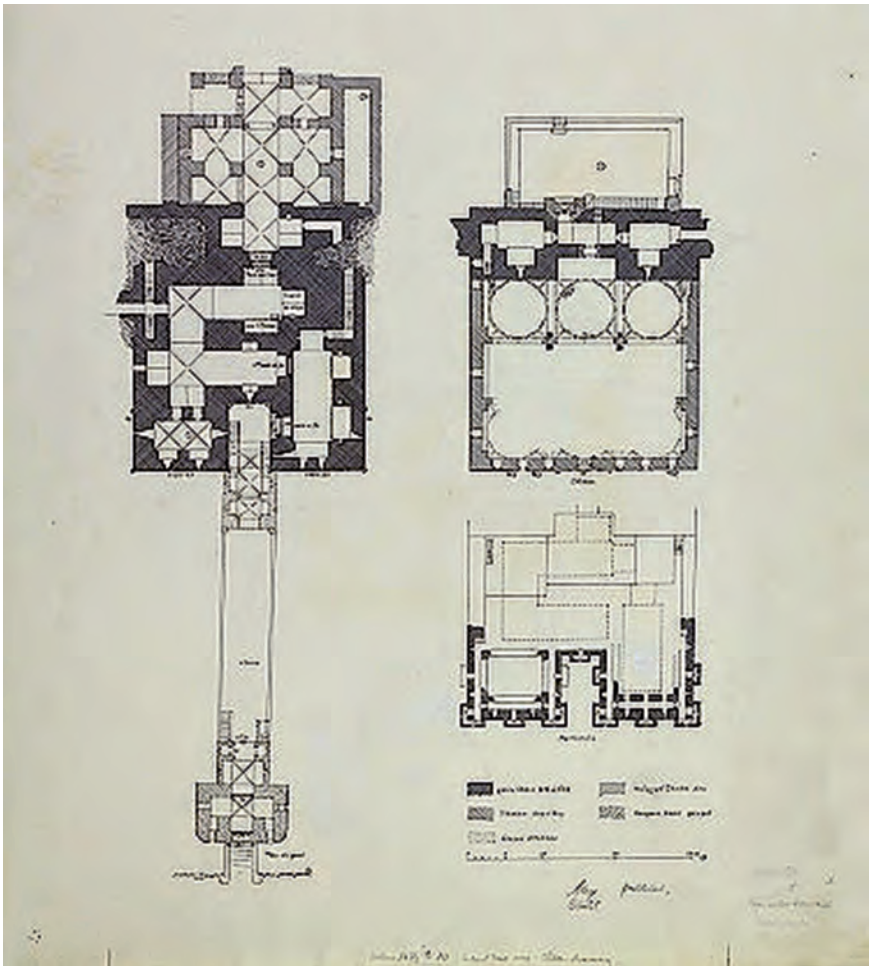

Fig. 12 Architectural drawings of the Ayyubid entrance block to the Aleppo citadel by E. Herzfeld (Ernst Herzfeld Papers. Freer Gallery of Art and Arthur M. Sackler Gallery Archives, Smithsonian Institution, Washington D.C., Item FSA A.06 05.0004)

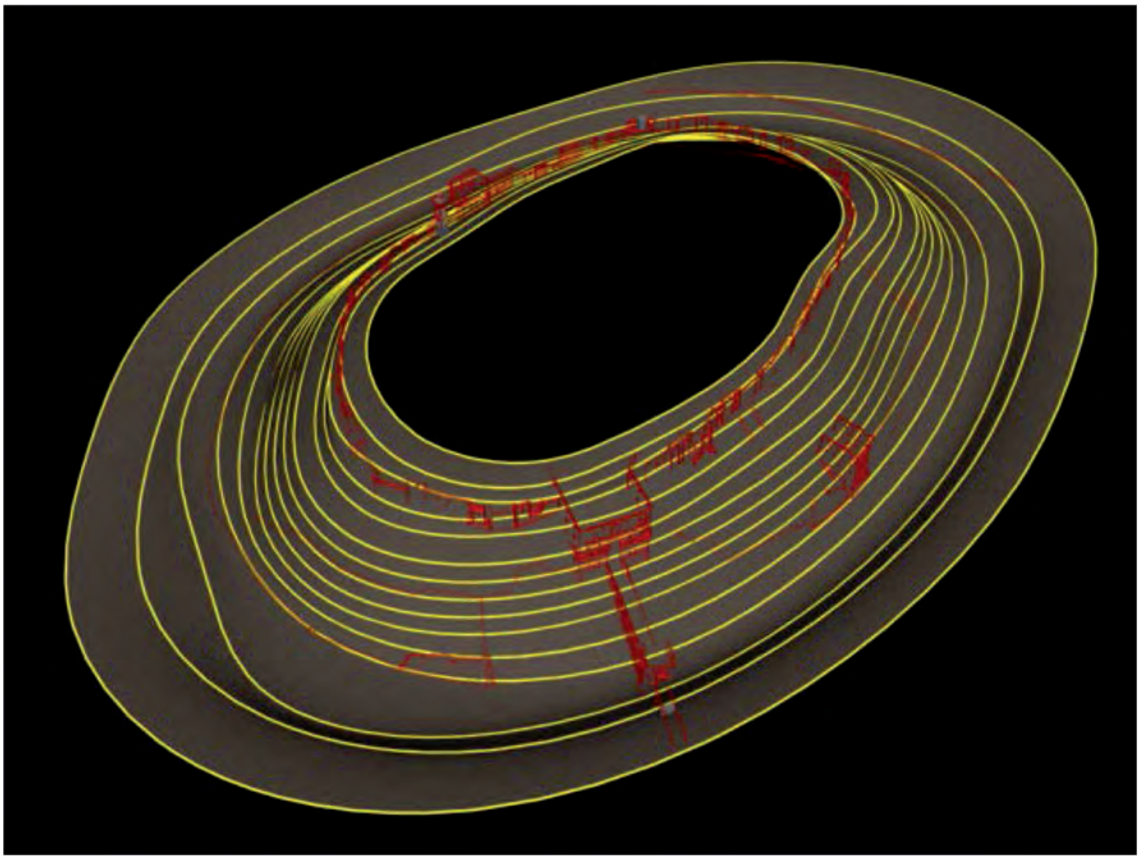

Fig. 13 Modelling the Aleppo citadel with its walls
(courtesy of G. Fangi)

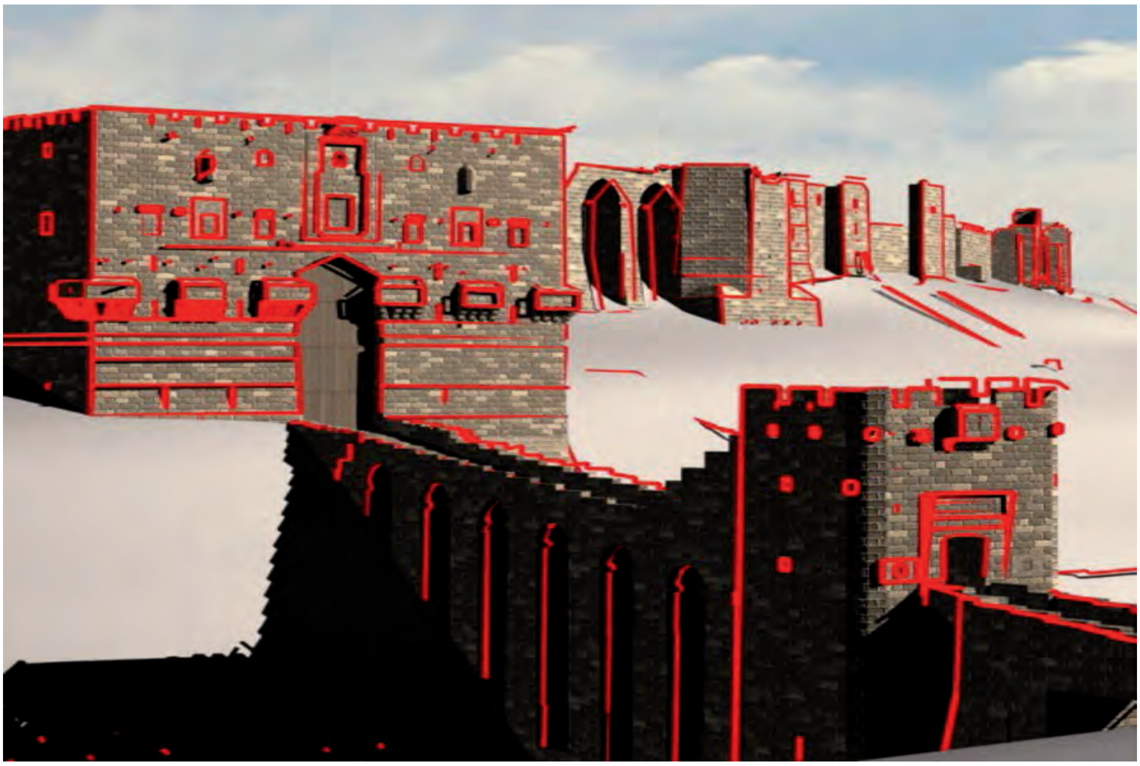

Fig. 14 Plotting the architectural entrance to the Aleppo citadel
(courtesy of W. Wahbeh and G. Fangi)

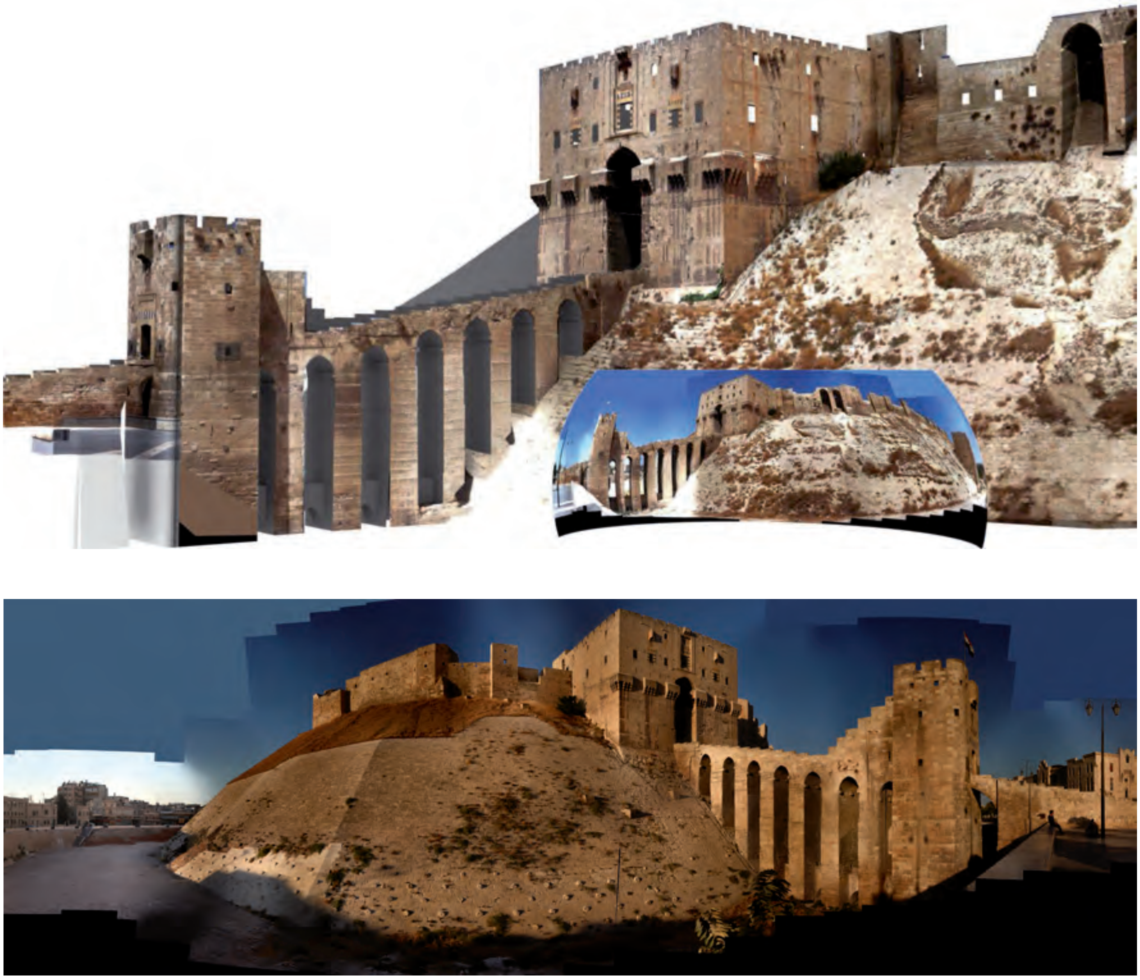

Fig. 15 The 3D modelled entrance to the Aleppo citadel
(courtesy of W. Wahbeh and G. Fangi)

of Yamhad in the Middle Bronze Age.[37] The World Monument Fund has been able to make 3D models of the reliefs from the Temple of the Weather/Storm God situated in the citadel and dating from the Bronze Age.[38]

The area has faced destruction including the walls and the main gate.

Apart from old photographs, old architectural documentation by drawing also exists of the citadel structures (see, e.g., Fig. 12), made by Ernst Herzfeld, who also took a panoramic photograph of the site in 1907.[39] He also modelled the citadel by drawing. The walls of the citadel have been elaborately photographed by Fangi from CIPA in 2010. He also carried out the 3D modelling of the site with Wissam Wahbeh (Figs. 13–15).[40]

37 Lönnqvist 2000.

38 Kohlmeyer 2000; see <https://www.wmf.org/project/temple-storm-god-citadel-aleppo> (last accessed 18 Feb. 2020); the models of the temple were seen in Bonnie Burnham's 2015 key-note presentation in the CIPA symposium in Taiwan.

39 See Guide to the Ernst Herzfeld Papers in the Department of Islamic Art, Metropolitan Museum of Art Islamic. Herzfeld 1. Online <https://libmma.contentdm.oclc.org/digital/collection/p16028coll11/id/4464/rec/1> (last accessed 4 June 2020).

40 Fangi 2015, figs. 11–12, 14–15.

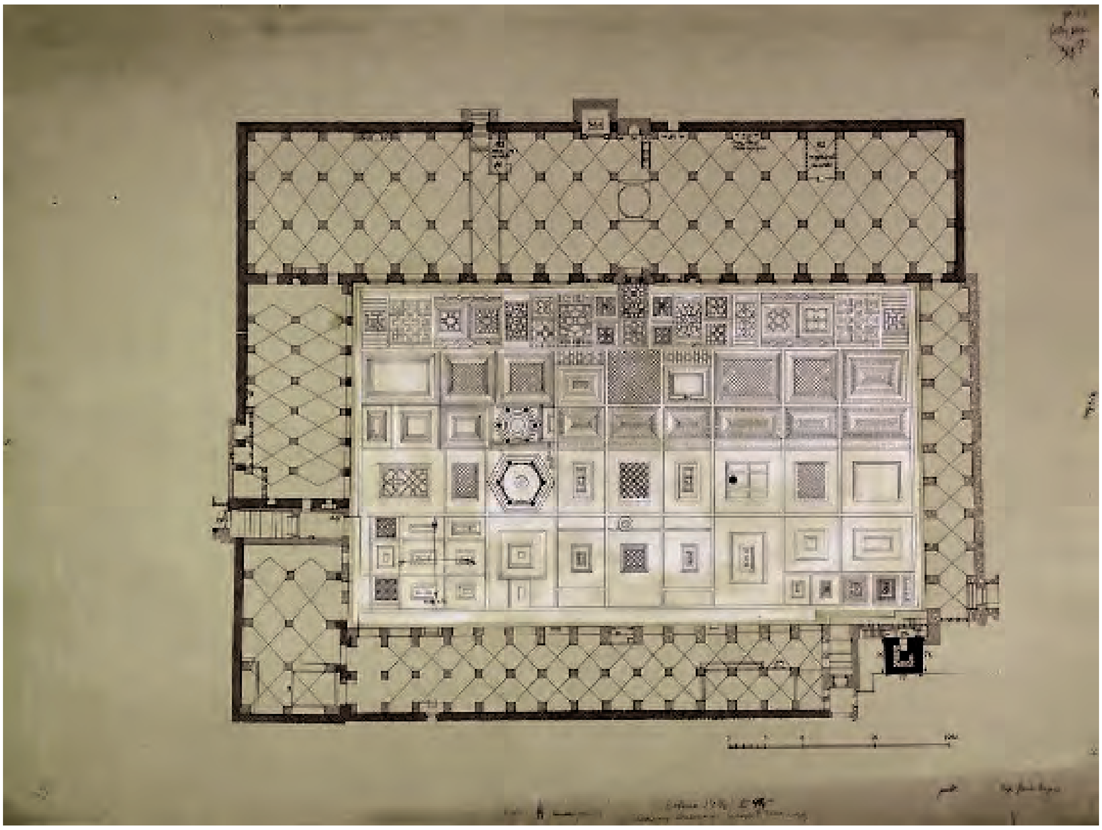

Fig. 16 The plan of the Great Mosque of Aleppo by E. Herzfeld (Ernst Herzfeld Papers. Freer Gallery of Art and Arthur M. Sackler Gallery Archives, Smithsonian Institution, Washington D.C., Item FSA A.06 05.0003)

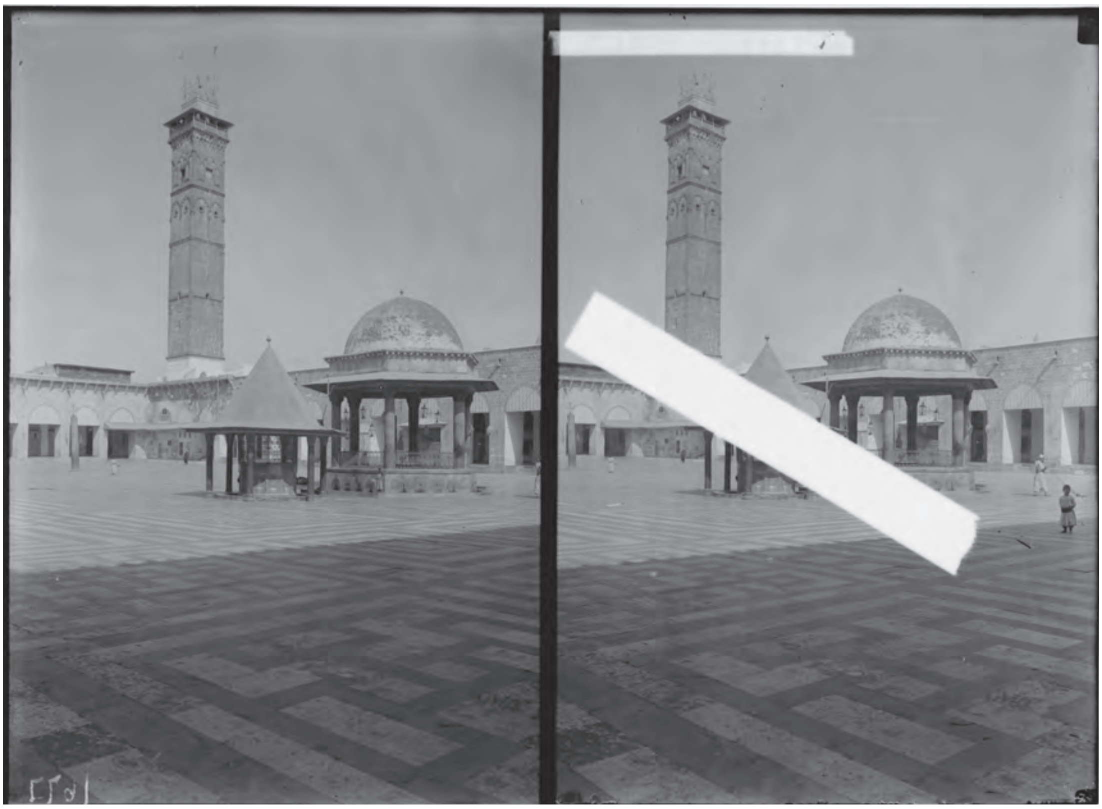

Fig. 17 The Great Mosque of Aleppo with its minaret photographed in 1900, the minaret was destroyed in 2013 (Library of Congress collections)

Fig. 18 3D modelling of the destroyed minaret of the Great Mosque of Aleppo: the wire frame, shaded and textured model (courtesy of W. Wahbeh and G. Fangi)

The Great Mosque of Aleppo has also faced destruction. Its plan was drawn by Herzfeld in 1908–1914 (Fig. 16), and the building was photographed early (Fig. 17), for example, by Gertrude Bell[41] at the beginning of the 20th century. Before the civil war, the CIPA members Gabriele Fangi,[42] Karel Pavelka (see in this volume) and Pierre Grüssenmeyer[43] captured valuable data by documenting structures of the Great Mosque. They have presented their work in this volume and/or in the workshop. During the first years of the conflict the minaret of the mosque was destroyed. Based on the captured data, the CIPA members, together with Wahbeh, have been able to reconstruct the minaret in 3D based on the metric data (Fig. 18).

## Palmyra: Temples, the Triumphal Arch, Tower Tombs

Palmyra, known as 'the Queen of the Desert' is an oasis city in the Syrian Desert and was a caravan post on the Silk Road during Antiquity (Fig. 19). The city even expanded to an empire under its queen Zenobia. The heyday of the site dates from the first to the third century AD.[44]

The city and its monuments have been documented by travellers and artists by drawing for hundreds of years. Photographs begin from the early photographing already in the 19th century

[41] Bell 1911.
[42] Fangi – Wahbeh 2013; Fangi 2015.
[43] Grussenmeyer 2016.
[44] Anadol 2008; Silver et al. 2018.

Fig. 19 The ruins of Palmyra photographed in 1929 (Matson collection, Library of Congress)

Fig. 20 Temple of Bel, aerial photograph by A. Poidebard 1932 (Poidebard 1934)

Fig. 21 The Tower Tomb of Elahbel modelled by an Italian team led by G. Fangi (courtesy of G. Fangi and M. Franca)

exemplified in the fine Bonfils collection. Bell also photographed the ruins at the beginning of the 20th century, and Father A. Poidebard[45] took aerial photographs of the area in the 1920s and 1930s (Fig. 20). Palmyra is also well known by CIPA and was the target of documentation by its members before the war. Silver led the SYGIS project under the Museum of Palmyra in 2000–2010 and stored the archaeological finds in the museum.[46] Fangi documented ruins with his students in 2010[47] and has digitally remodelled several structures with his students (Fig. 21).[48]

When ISIS took over the site in May 2015, the destruction of ancient monuments including the Temple of Bel and the remaining artefacts in the museum started, not to mention the human atrocities for which the monuments became a scene, including the fate of the retired museum director.[49] Beside the naos of the Temple of Bel, the Temple of Baal Shamin, the Triumphal Arch of the colonnaded street, some tower tombs, the Tetrapylon and the stage of the Roman theatre were destroyed by ISIS militants during their two periods of occupation in 2015–2017. The Arab citadel of Fakhr al-Minaret in Palmyra has also been damaged during the conflict.[50]

Based on the documentation by Fangi from CIPA and others such as the New Palmyra project, an open-source project to rebuild Palmyra,[51] 3D reconstructions of the destroyed structures of Palmyra have been produced by Fangi, Denker, ICONEM, Rekrei[52] and the Institute of Material

45 Poidebard 1934.
46 See Lönnqvist et al. 2011; Silver et al. 2018.
47 Fangi 2015.
48 Fangi et al. 2016; see passim Silver et al. 2018.
49 Lönnqvist 2015b.
50 See <https://www.reuters.com/news/picture/palmyra-before-and-after-isis-idUSRTSCQPG> (last accessed 4 June 2020).
51 See <https://newpalmyra.org> (last accessed 18 Feb. 2020).
52 Silver et al. 2018.

Culture of the Russian Academy of Sciences with experts from the Hermitage Museum in St Petersburg. Both ICONEM and the Russian Academy of Sciences projects have used drones in documentation. The Russians were able to take 20,000 drone images during their expedition in 2016.[53] The Institute for Digital Archaeology produced a replica of part of the Triumphal Arch in 2016, but it needs to be emphasised that this model printed with the 3D robotic technique in marble is just a symbolic statement and not a substitute.[54]

## Final Remarks: Conservation and Restoration Work

This important step concerning the collection of data testifies to all the efforts made by scholars to study and share the importance of the Syrian heritage. The CIPA project, moreover, creates a useful database with which it will be able to support the protection, preservation, restoration and reconstruction strategies.

The data availability and the international importance of CIPA will help all the experts to select the best way to operate with regard to the heritage of Syria. The project will allow operation at a material level, providing information for the treatment of original and historical surfaces, suggesting their protection, their structural consolidation and, when necessary, their partial reconstruction, highlighting the distinctive requirements.

In addition, in order to respect the architectural sites, most characterised culturally and socially, the CIPA project will allow us to propose a reconstruction that is not concerned with the substantial and structural aspect of the buildings, but founded on concepts related to virtual and 3D reconstruction. Evocative phenomena such as these may, through the use of the data collected, help heritage conservation while safeguarding the cultural value of the original context, avoiding a total reconstruction, hardly compatible with international Charters of Restoration.

As previously mentioned, the project described in this paper has its origins in a proposal made by some of the authors during the CIPA executive board meeting in 2014. The authors will present and elaborate the proposal at the 10th ICAANE in Vienna in April 2016 and at ISPRS 2016 in Prague for future meetings of CIPA. It is obvious that an enlarged project cannot be supported only by a volunteer action, therefore the project could be the basis for fundraising among CIPA's supporters and by joining international competition for research projects.

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[54] See Silver et al. 2018, 140–141.

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# Documentation of Syrian Lost Heritage: From 3D Reconstruction to Open Information System

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**Abstract:** All six of the Syrian World Heritage properties were inscribed on the List of World Heritage in Danger in the 37th session of the World Heritage Committee, held in Cambodia in June 2014: the ancient city of Aleppo; the ancient city of Bosra; the ancient city of Damascus; the ancient villages of northern Syria, Crac des Chevaliers and Qal'at Salah El-Din, and finally, the site of Palmyra. Apart from the ancient villages of northern Syria, Fangi has visited all the world heritage sites and partly documented them. In 2010, just before the war, Gabriele Fangi made a trip together with Crua (the Recreational Club of Ancona University). It was the occasion to ensure rapid documentation of some monuments belonging to the Syrian cultural heritage (CH). The images were mostly taken by Fangi. The purpose was not to make a survey but to obtain a photographic report, as fast and complete as possible. Nevertheless, Fangi carried out the three most important surveys – the Aleppo minaret, the Aleppo citadel walls and the Umayyad Mosque in Damascus – in a rigorous manner, following the 4 × 4 CIPA rules. Syria is a country of many civilisations: Amorite, Aramean, Phoenician, Greek, Roman, Byzantine, Islamic and Ottoman. Consequently, it is full of cultural heritage remains. Unfortunately, many of them have been destroyed by the war, as well as hundreds of thousands of civilian people having been killed. However, some of the photographs were originally taken in such a touristic way that our work required finding some usable plotting as 3D restitutions. That worked successfully most of the time. These surveys could be useful in the case of reconstruction and where there is a lack of suitable alternative forms of metric documentation. We built up a database of the available material to organise historic information, the localisation and the state of the buildings. It was the occasion to define a collection of data and store it in a dedicated database for every cultural heritage remain, to retrieve in an automatic way a single report to link a 3D model shared in a dedicated project on the internet.

**Keywords:** Syrian cultural heritage; war; emergency; spherical photogrammetry; 3D model; database

## Introduction

The current territory of the Republic of Syria is partially the same as 'historic Syria', which, in ancient times included the western region of the Fertile Crescent between the rivers Tigris and Euphrates and the Mediterranean Sea. The following populations are proved by the existing monuments and ruins, e.g. Phoenician temples, Greek and Roman theatres and old cities. Early Christians and Byzantines left remains of churches and monasteries; Crusades raised different defensive fortresses. Then Islamic civilisations built mosques and citadels and introduced architectural elements such as a minaret and a *madrasah*. In the end, the Ottomans allowed a modernisation of the country and promoted commercial trade with the construction of *souqs* and *khans*.

During the last five years of civil war, the fighting of various fronts reshaped Syria into different control areas. Beyond being a tragedy for the civil population, the conflict represented and

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Fig. 1 Examples of spherical panorama. a) Hall of the Knights, Crac des Chevaliers (F. Di Stefano); b) Roman theatre of Palmyra (E. Ministri)

even now represents a threat to the cultural heritage (CH) that has faced huge damage from military action, clandestine excavations, illegal civil constructions, and also acts of vandalism. During the civil war, almost 300[6] heritage places within Syria have been raided.

Our work consists of the documentation of Syrian lost heritage, thanks to the precious contribution made by Fangi who took so many photos (almost 17,000) of most of the Syrian CH monuments during his trip in 2010, before the civil war began. Our project selected 32 monuments, in various cities where they stand. The cities and the monuments are: Aleppo: the Al-Halawiye madrasah and its mihrab, the minaret of the Umayyad Mosque, Khan al-Wazir, the al-Madina souq, the citadel walls, Ayyubid Palace, Bab al-Faraj Clock Tower; the Church of St. Simeon Stylites; Apamea: the Roman Temple of Tyche; Bosra: the Nabatean Arch and the Roman theatre, Crac des Chavaliers and the Hall of Knights; Damascus: the Umayyad Mosque, Azm Palace, Darwish Pasha Mosque, al-Sibaiye Mosque-Madrasa, Tekkiye Mosque, the minaret of the al-Qali Mosque, the gateway of Qasr el-Heir al Gharbi, Hejaz Railway Station; Hama: the minaret of the al-Nuri Mosque; Palmyra: the Great Colonnade, the Triumphal Arch, the Temple of Bel, the Roman theatre, the tower tomb of Elahbel; the dead city of Serjilla; Shahba: Filippeion and the Roman theatre. Most of these monuments are included on the Syrian UNESCO heritage list and many of them were inscribed on the 'List of World Heritage in Danger' in 2014.

'With the loss of this heritage, as a historical and cultural treasure, the future generations were deprived of invaluable inheritance. A chain of humanity, culture and nature can't be violated in 21st century without intervening to save it.'[7]

The aim of this research has been to build a technological platform for the collected data and 3D models based on low-cost digital technologies and open-source tools, becoming a valid contribution to recovering the lost heritage for a cultural rebirth and to giving back the identity of the Syrian population.

Spherical photogrammetry (SP) solves the first step of acquisition; the relational database collects and organises all the information in a structural way, producing some reports.

6 UNITAR 2016.
7 Di Stefano 2016, xiii, Introduction.

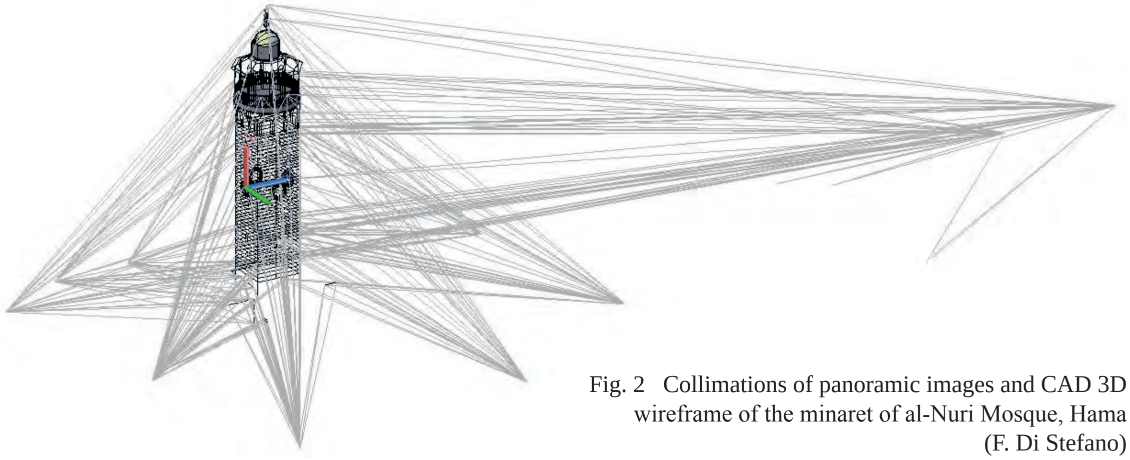


Fig. 2 Collimations of panoramic images and CAD 3D wireframe of the minaret of al-Nuri Mosque, Hama (F. Di Stefano)

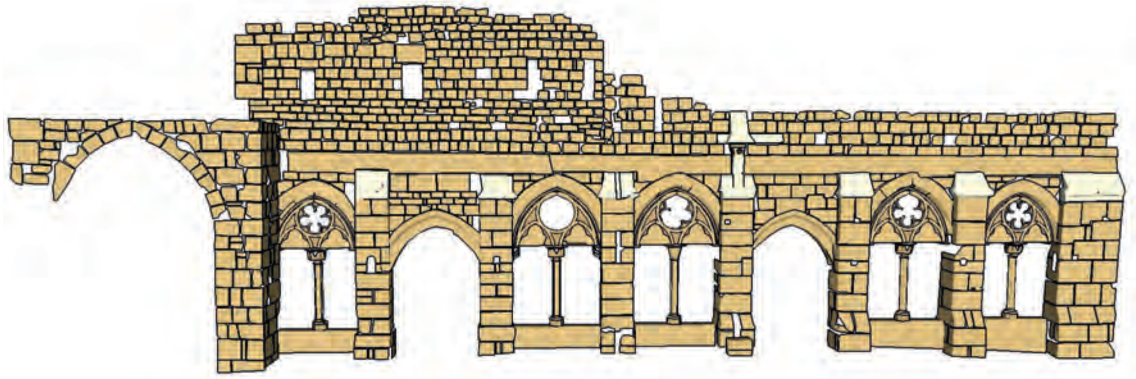


Fig. 3 The edited 3D model of outdoor façade of the Hall of Knights, Crac des Chevaliers (F. Di Stefano)

Another improvement is the export of the database in a desktop based on Geographic Information Systems (GIS), to localise sites and monuments on the world satellite map. The cultural heritage data is displayed with a related data sheet or multimedia data, activating a hyperlink. Finally, it is disseminated on the web using the Google Earth platform.

Our research will focus on the development of methods and technologies for the construction of libraries of 3D digital models representing architectural artefacts in order to have access to information in real time on offline or web-based systems. Analysing different scenarios, satisfying standard and quality requirements, developing procedures, we provide the integration of different types of data and the knowledge of selected artefacts.

The SP seems to satisfy many requirements for collecting a lot of CH in a fast and simple way. It is a new, very low-cost photogrammetric technique for architectural recording. It provides panoramic images with great resolution (much higher than any commercial camera), distortion-free, with a wide field of view (up to 360°), reducing drastically the amount of traditional photogrammetric models which are necessary to undertake a 3D survey.[8]

There are several advantages in using panoramic images. One of these is that a spherical panorama, even a partial one, normally having a larger field of view compared to that of a normal WA camera, enables better comprehension of the object and needs a smaller number of images. This is evident in indoor applications, but it is also present outdoors, where only a portion of the 360°

8 Fangi 2009; Fangi – Pierdicca 2012.

panorama is covered (Fig. 1). In addition, a wider field of view allows the operator to get closer to the object, resulting in a larger photo scale.

In general, as the panorama is an omnidirectional image, it facilitates the operator in the field by freeing him from the constraint of the fixed field of view inherent in the traditional camera. Therefore, it makes this acquisition method more affordable and cheaper than other surveying approaches for cultural and architectural metric documentation.

Panoramic images look impressive, but to be suitable for measurement they must fulfil some rigid geometric conditions.[9] The SP works by means of an analytical approach based on spherical images to realise 2D and 3D CAD modelling products (Figs. 2–3).

We have decided to organise the data acquired by means of a basic database in order to be able to retrieve quickly the information, which is of use for different purposes: historical analysis, architectural knowledge, promotional aspects and current states.

In keeping with the philosophy of using as soon as possible low-cost or well-known solutions, we have created the database core in Microsoft Access. This platform is useful and simple when managing many records; each of these is related to a single object characterised by many attributes/features.

The Access table is not the only product, but it is possible to produce a report in the form of a data sheet, which summarises, in an organised manner, some distinctive features, useful for knowledge of the object. Unfortunately, this tool does not have mapping support, so it needs to transfer the table, like a text, into an open-source GIS environment.

The final step of this research is related to the dissemination of all data archived by means of Google tools. Here we tried to use an experimental web sharing system to gather, visualise, and share data online using the Google Earth platform.

## State of the Art

### The Spherical Photogrammetry

Spherical photogrammetry (SP) uses the spherical panorama to support the image information. This is obtained by taking the photographs from the same station point, then, after being downloaded to the computer, they are stitched together and mapped into a plane with the so-called rectangular, azimuth-zenith, or latitude-longitude projection. The image coordinates of the spherical panorama are the two directions, vertical and horizontal, scaled by a factor, which is the radius of the projection sphere (Fig. 4). Therefore, one can regard the spherical panorama as the collection of any possible direction coming from the station point, the same that could be measured by a theodolite, with lower resolution, but a much greater completeness. Coplanarity links the adjacent panoramas forming the photogrammetric model. Triangulation with independent models ties the formed models into the same reference system. Finally, at the end, the bundle block adjustment will supply the final adjusted coordinates of the points, providing a minimum of control information.

The 3D reconstruction takes place after orientation via the intersection of projective rays coming from two or more oriented panoramas (Fig. 4).

## Methodology

The photogrammetric reconstructions in our research are based mainly on SP, even if there are many variables in the workflows due to the possibility of integrating various technologies. The advantages are the high resolution, the field of view (FOV) up to 360°, the low cost, the completeness of the

[9] Fangi 2007; Fangi 2010; Fangi – Nardinocchi 2013.

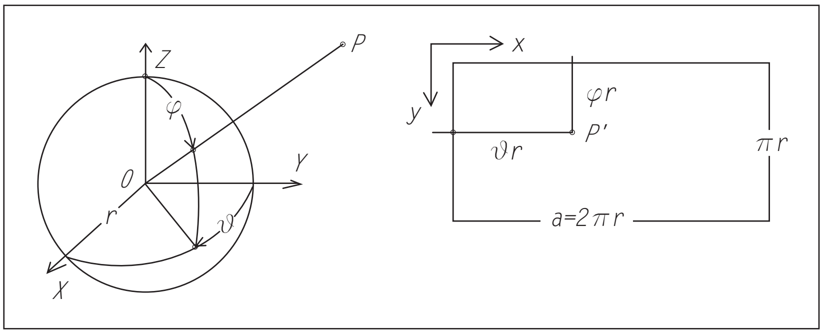



Fig. 4 The sphere and its mapping (G. Fangi)

information and the high speed of taking photos. By contrast, the plotting and the orientation are, to date, entirely manual. Nowadays more accurate and efficient tools and instruments are available for CH recording, such as laser scanning, and dense multi-view 3D reconstruction. The following examples are created with different workflows using SP and sometimes combining it with other photogrammetric-based technologies. It was mainly conceived and designed for cultural and architectural metric documentation. It was introduced by Fangi subsequent to the research carried out by Thomas Luhmann and Werner Tecklenburg[10] and by Danilo Schneider and Hans-Gerd Maas.[11] Since then it has been tested on several projects, performing the orientation of multiple panoramas and manual 3D object reconstruction. SP performs the bundle block adjustment.[12]

Many wireframe and then textured models were created using the aforementioned technique for Syrian monuments, as we have done in other places around the world. Among the Syrian monuments, we can mention the Ottoman railway station of Damascus (Fig. 5), the Roman theatre of Bosra (Fig. 6) and the Roman theatre of Palmyra (Fig. 7).

Starting from the SP orientation, there is the possibility to use the 3D modellers to create the 3D models based on the rules of projective geometry with a method called panoramic image-based interactive modelling, this technique is suitable for the architectural survey because it is not a ‘point by point’ survey of the type dense multi-view 3D reconstruction produces, and it exploits the geometrical constraints of the architecture’s geometry to simplify the 3D modelling process. Therefore, the surveyor in those techniques has to comprehend the geometry of the architecture before modelling it. In this approach the concept of this modelling methodology is based on the use of texture-mapping techniques in a generic modelling software as the virtual projector of an image, and thus to be used to model an architectural object. If the projection centre and the orientation are fixed in the 3D virtual space, objects could be created, moved and modified to match the projections. Objects therefore take the right shape and location in the virtual space of the surveyed elements. It is an interactive modelling technique because the interaction between the modelled objects and the projection of the images is visible in real time. Also, the quality of the model is verifiable in various interactive ways. Some of the Syrian monuments partially and completely use this methodology, such as the Al-Darwishya Mosque façade, the minaret of the Umayyad Mosque (Fig. 8) and the entrance to Aleppo’s citadel (Fig. 9).

In the case of the minaret of the Umayyad Mosque, for example, about 550 photos were used to create 25 panoramas with different focal lengths (50–200mm). The best panoramas were chosen for the orientation, then, using the orientation parameters, of which there are six for every image (three coordinates for the centre and three rotation angles), it was possible to create the main volume of the minaret. The depth was obtained by the spatial intersection of the projection rays

10 Luhmann – Tecklenburg 2004.
11 Schneider – Maas 2005.
12 Fangi – Nardinocchi 2013.

Fig. 5 The Ottoman railway station of Damascus (plotting carried out by C. Olimpio)

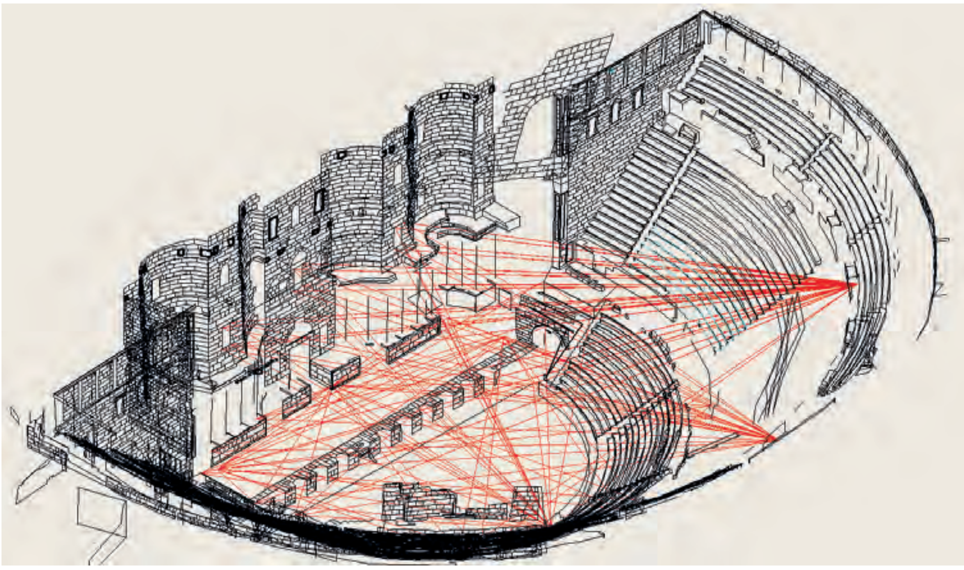


Fig. 6 The model of the Roman theatre at Bosra (constructed by S. Freddo)

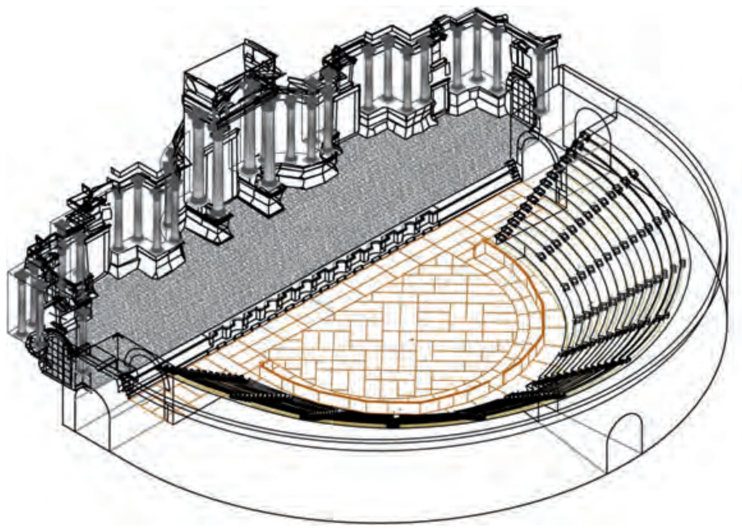


Fig. 7 Wire-frame model of the Roman theatre in Palmyra (constructed by E. Ministri)

Fig. 8 Modelling the minaret of the Umayyad Mosque of Aleppo (G. Fangi, W. Wahbeh)

using more than one panorama for every point. Then the main surfaces of the façades of the tower were created. The next step was projecting the photos onto the surfaces using spherical mapping to obtain textured façades.

Afterwards, details were modelled on the main minaret body corresponding with the image projections using mono-plotting. This exploits the geometrical constraints to simplify and speed the modelling. It is therefore based on recognition of the geometrical properties of the elements of the surveyed architecture.

This technique is ideal for architectural representation because it produces low-poly models with a rich, high-resolution map texture. Consequently, the resulting model makes this architecture easy to read and handle. The high-resolution images were useful for creating many details of the minaret, such as the relief writings. The high resolution of the panoramas is due to the focal length of the lens used, which was 200mm, but the use of such high focal length lenses involves many photos to create a single panorama.[13]

Another interesting application was using the dense multi-view 3D reconstruction. It was applied to the great Temple of Bel (Fig. 10), which is considered one of the most important religious buildings of the 1st century AD in the East with a unique design. The investigations and the reconstruction were carried out using two types of imagery. The first are freely available generic touristic photos collected from the web. The second are the panoramic images captured in 2010. In 2016 we presented a 3D reconstruction workflow for both types of imagery using state-of-the art dense image matching software, addressing the not trivial challenges of combining uncalibrated public domain imagery with panoramic images with very wide base-lines.[14] The panoramic images offered a great coverage of the monuments where open-domain images were limited. Moreover, in similar cases, the SP could support the reconstruction as a topographical survey where the partial dense matching point clouds could be registered and georeferenced.

[13] Fangi – Wahbeh 2013.
[14] Wahbeh et al. 2016.

Fig. 9 The entrance model of Aleppo Citadel (constructed by W. Wahbeh)

Fig. 10 Bel Temple (W. Wahbeh)

## Information System

This research, as already stated, has the objective of creating an architectural heritage catalogue by means of an information system (IS), to access, in a simple way, different types of multimedia content (images, drawings, 3D geometric models, animations, videos, descriptions, localisation, and so on) via a database.

The knowledge and the documentation are essential and very important to protect and promote the CH in general. The cataloguing in standard format of all available data allows decisions to be made regarding the priorities and the type of actions necessary for maintenance and restoration of the monument. We give an example of a dedicated IS, collecting and organising several kinds of documents.

Due to an efficient action of protection and enhancement of cultural and environmental heritage it is useful to create a basis of knowledge. In that way, the work continues with the creation of a digital data archive dedicated to the achieved heritage of Syria, facilitating management of the information and also updating over time all the data collected.


Fig. 11 The ‘Object Table’ items (fields)

We chose to implement a relational database, appropriate for recording and organising more features of each object analysed. This kind of database works according to the system entity relationship, first identifying the entities in which the digital information is recorded and arranged and then defining the relations among different entities on the same object.

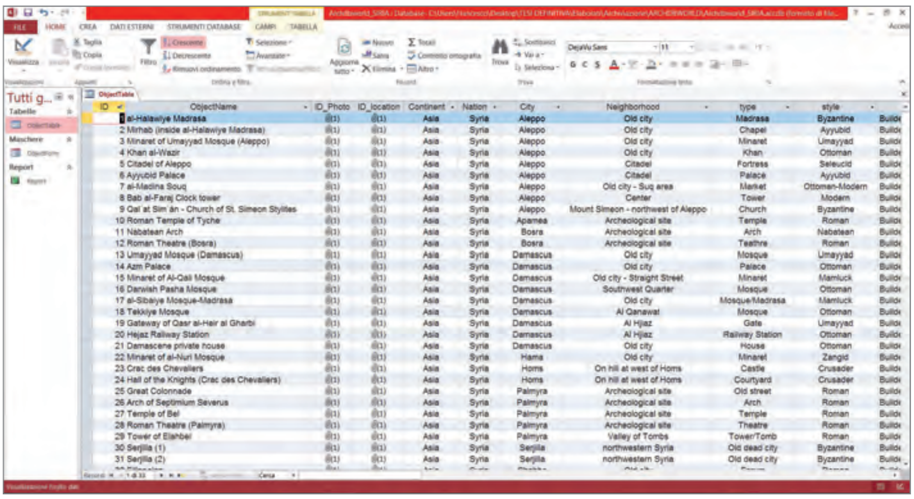
This is a kind of database characterised by good functionality, a fast system of information input, multimedia data management and, in particular, the dissemination and communicability of all the data entered.

The correct design of the database is essential to solving the required goals. The database design process consists of the following steps: determining the purpose of the database, finding and organising all the required types of information, dividing them into tables, identifying the list of each item characterising the subject (a potential field in each table), selecting a field as a primary key, and providing each subject with a unique identity (record in the table). Even if this list is not complete, it is a good starting point and can be continually refined to a better design.

Of the available database management system (DBMS) software, Microsoft Access allows one to organise a complex and basic database on a conceptual model and is easy to manage. The system can produce a final report in an automatic way too.

Once the aim, the subjects and the related items had been selected, we organised the information into a simple basic database via Microsoft Access, comprising only one table: a list of rows (records) and columns (fields). The ‘Object Table’ (Fig. 11) is built by these elements and stores all the collected data. The fields describe many characteristics of each object stored in each record, using different formats such as text, number, date, hyperlink and attached file.

For the purpose of our research we built a simple ‘Object Table’ whose fields track items such as: the ID; object name; description (type, style, builder, date of construction, architectural



| ID | ObjectName | ID_Photo | ID_location | Continent | Nation | City | Neighborhood | type | style | Builde |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | al-Halawiye Madrasa | (1) | (1) | Asia | Syria | Aleppo | Old city | Madrasa | Byzantine | Builde |
| 2 | Mirhab (inside al-Halawiye Madrasa) | (1) | (1) | Asia | Syria | Aleppo | Old city | Chapel | Ayyubid | Builde |
| 3 | Minaret of Umayyad Mosque (Aleppo) | (1) | (1) | Asia | Syria | Aleppo | Old city | Minaret | Umayyad | Builde |
| 4 | Khan al-Wazir | (1) | (1) | Asia | Syria | Aleppo | Old city | Khan | Ottoman | Builde |
| 5 | Citadel of Aleppo | (1) | (1) | Asia | Syria | Aleppo | Citadel | Fortress | Seleucid | Builde |
| 6 | Ayyubid Palace | (1) | (1) | Asia | Syria | Aleppo | Citadel | Palace | Ayyubid | Builde |
| 7 | al-Madina Souq | (1) | (1) | Asia | Syria | Aleppo | Old city - Suq area | Market | Ottoman-Modern | Builde |
| 8 | Bab al-Faraj Clock tower | (1) | (1) | Asia | Syria | Aleppo | Center | Tower | Modern | Builde |
| 9 | Qal`at Sim`ān - Church of St. Simeon Stylites | (1) | (1) | Asia | Syria | Aleppo | Mount Simeon - northwest of Aleppo | Church | Byzantine | Builde |
| 10 | Roman Temple of Tyche | (1) | (1) | Asia | Syria | Apamea | Archeological site | Temple | Roman | Builde |
| 11 | Nabatean Arch | (1) | (1) | Asia | Syria | Bosra | Archeological site | Arch | Nabatean | Builde |
| 12 | Roman Theatre (Bosra) | (1) | (1) | Asia | Syria | Bosra | Archeological site | Teathre | Roman | Builde |
| 13 | Umayyad Mosque (Damascus) | (1) | (1) | Asia | Syria | Damascus | Old city | Mosque | Umayyad | Builde |
| 14 | Azm Palace | (1) | (1) | Asia | Syria | Damascus | Old city | Palace | Ottoman | Builde |
| 15 | Minaret of Al-Qali Mosque | (1) | (1) | Asia | Syria | Damascus | Old city - Straight Street | Minaret | Mamluck | Builde |
| 16 | Darwish Pasha Mosque | (1) | (1) | Asia | Syria | Damascus | Southwest Quarter | Mosque | Ottoman | Builde |
| 17 | al-Sibaiye Mosque-Madrasa | (1) | (1) | Asia | Syria | Damascus | Old city | Mosque/Madrasa | Mamluck | Builde |
| 18 | Tekkiye Mosque | (1) | (1) | Asia | Syria | Damascus | Al Qanawat | Mosque | Ottoman | Builde |
| 19 | Gateway of Qasr al-Heir al Gharbi | (1) | (1) | Asia | Syria | Damascus | Al Hijaz | Gate | Umayyad | Builde |
| 20 | Hejaz Railway Station | (1) | (1) | Asia | Syria | Damascus | Al Hijaz | Railway Station | Ottoman | Builde |
| 21 | Damascene private house | (1) | (1) | Asia | Syria | Damascus | Old city | House | Ottoman | Builde |
| 22 | Minaret of al-Nuri Mosque | (1) | (1) | Asia | Syria | Hama | Old city | Minaret | Zangid | Builde |
| 23 | Crac des Chevaliers | (1) | (1) | Asia | Syria | Homs | On hill at west of Homs | Castle | Crusader | Builde |
| 24 | Hall of the Knights (Crac des Chevaliers) | (1) | (1) | Asia | Syria | Homs | On hill at west of Homs | Courtyard | Crusader | Builde |
| 25 | Great Colonnade | (1) | (1) | Asia | Syria | Palmyra | Archeological site | Old street | Roman | Builde |
| 26 | Arch of Septimium Severus | (1) | (1) | Asia | Syria | Palmyra | Archeological site | Arch | Roman | Builde |
| 27 | Temple of Bel | (1) | (1) | Asia | Syria | Palmyra | Archeological site | Temple | Roman | Builde |
| 28 | Roman Theatre (Palmyra) | (1) | (1) | Asia | Syria | Palmyra | Archeological site | Theatre | Roman | Builde |
| 29 | Tower of Elahbel | (1) | (1) | Asia | Syria | Palmyra | Valley of Tombs | Tower/Tomb | Roman | Builde |
| 30 | Serjilla (1) | (1) | (1) | Asia | Syria | Serjilla | northwestern Syria | Old dead city | Byzantine | Builde |
| 31 | Serjilla (2) | (1) | (1) | Asia | Syria | Serjilla | northwestern Syria | Old dead city | Byzantine | Builde |

Fig. 12 Some records from the ‘Object Table’

analysis, intended use); current state (type of damage); localisation (continent, nation, city, neighbourhood); different types of coordinates (latitude and longitude, WGS84 and East, North UTM – WGS84); link to the products (panoramic images, documents, orientation, restitution, CAD survey, multimedia content) stored into a relative file path; participants (authors) in the database project; customisation to export the table in QGIS and other features.

Every CH object investigated is stored in each record of a unique table and consequently the possible type of relationship is one-to-one, recording some special information applied to a specific product, so the table shares a common column or columns, enabling the information to be searched via a simple query.

Once the 'Object Table' was generated, the fields of each record were populated with the information, completing the set of items in each column as quickly as possible (Fig. 12). This then makes it possible to create queries, add new records, manage the information and so on.

The database keeps a list of customer information for the purpose of producing reports. In fact, another stage in Microsoft Access is to design the report in relation to the items that you want place on it, creating some captions to identify them. It is a good idea to construct a report or output listing because you have an overview of the database in descriptive form to share in different ways.

Once the database has been arranged, use of the 'Object Form' (Fig. 13) summarises and displays the data in the form of a report or data sheet. It is much easier to create meaningful reports if the database has a well-designed table structure and relationships.

A significant benefit is that the report is filled in automatically, retrieving the information from the Object Table fields and displaying them in an attractive and informative layout for printing or viewing on screen (Fig. 14). It can be updated immediately when you update the 'Object Table' fields. Grouping and presenting data in many different ways makes it a meaningful tool.

Reports provide a means to distribute or archive snapshots of your data, either by being printed out, converted to PDF or XPS files, or exported to other file formats suitable for sharing on the web, such as XML files.

## Dissemination of the Data via the Web

'Heritage information – the activity and products of recording, documenting, and managing the information of cultural heritage places – should be not only an integral part of every conservation project but also an activity that continues long after the intervention is completed. It is the basis

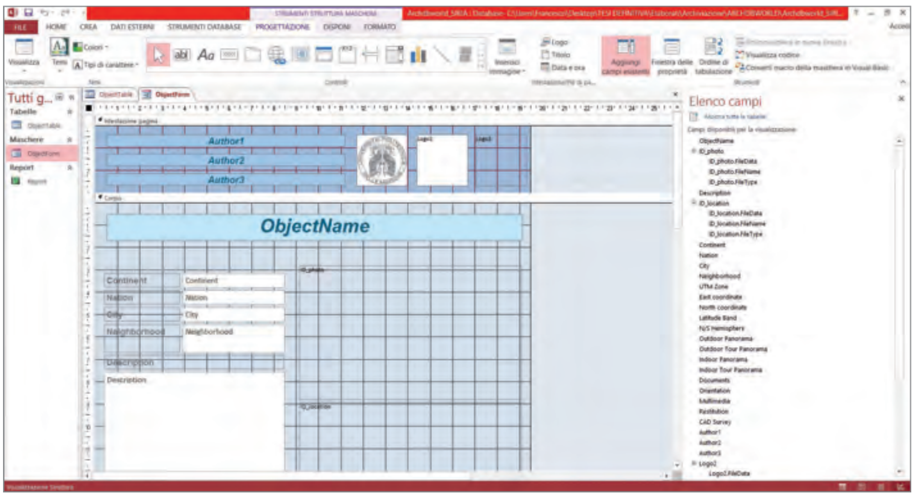



Fig. 13 The 'Object Form' structure

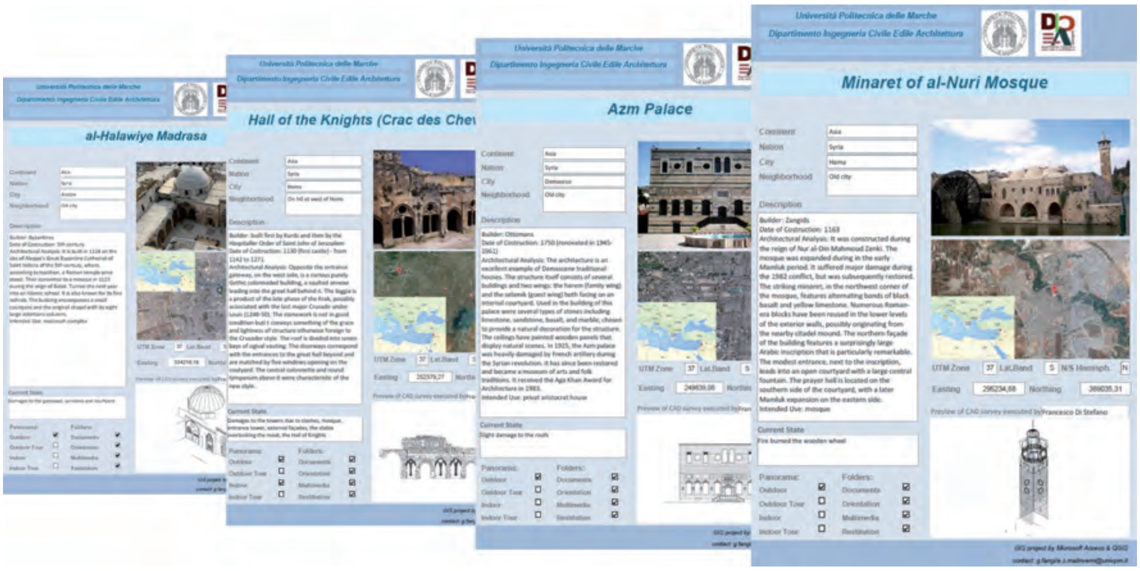



Fig. 14 Some reports in the form of data sheets summarising the information of an architectural heritage object stored in the database

for the monitoring, management, and routine maintenance of a site and provides a way to transmit knowledge about heritage places to future generations.'[15]

Maybe one of the most important factors for the protection and preservation of monuments is recognition of their value by the local people. In order for people to assign value to a monument, you need them to know it and know their history.

Nowadays, the best way to promote knowledge of CH is by using web applications. Therefore, the dissemination of information on the monuments is an essential part of this project, as this diffusion of the CH contributes widely to it being recognised and value being assigned to it.

Regardless of immediate applications that led to the execution of the survey, once data is produced, it needs to be indexed, stored and preserved for later use. To ensure that these data can be used effectively they must be disclosed, published and retrieved. That closes the cycle that encompasses planning, gathering, processing, indexing, storing, publication, dissemination, retrieval and use of data and information on buildings and architectural ensembles.

In this new approach, the result of this research is related to the dissemination of the CH database by means of the Google Earth platform. For the moment we have tried to use an experimental data visualisation web application to gather, visualise, and share data from bigger tables online: Spreadsheet Mapper (Google Docs template).

The first step was to identify all the monuments analysed with a placemark on the Google Earth map using the coordinates recorded in the Microsoft Access table.

We then uploaded the data table from a spreadsheet or comma-separated values (CSV) file and then filtered and displayed it on a satellite map; in the future we will customise the layout according to our needs.

All the data are stored in Google or it will be possible to use other web spaces. The updating of any new table is very easy by means of the merge function which generates a single visualisation including both sets of data and showing the latest value, too.

By exporting the Keyhole Markup Language (KML) file, you can view it in Google Earth or by providing a dynamic link to Spreadsheet Mapper; any changes to the data online are reflected in Google Earth and you can share it with the community. The data can be shared at different

[15] Whalen 2007, vii.


Fig. 15 Dissemination on the web by Google Earth

levels and discussed with others, or in order to find public data, combining it with yours to achieve better visualisation of all information in one place.

To achieve a more complete result, it is also possible to 'lay' the CAD survey realised by the SP, the modelled and edited 3D view, on the Google Earth map. Software SketchUp allows you to create a file format that makes the 3D object visible directly on the map.

You can share only what you want, keeping some of your dataset private and publishing a subset of rows or columns according to your own sharing permissions. This constitutes a powerful tool when you want to diffuse and promote knowledge of the building heritage and its current state in the world. It creates a big community that works together.

## Results

Our plan of work is appropriate to show the achieved results. From many simple photos, we managed to reproduce the lost heritage through 3D or 2D models for their documentation, using SP, a survey technique that offers a complete and flexible method and gives metric and scale levels of precision of the analysed objects that assist a possible future reconstruction of the damaged monuments.

We have collected all the data into specific folders to create order and, for a first archiving of information, we have designed a table. We got the best result by creating a relational database (Microsoft Access) thanks to a multidata management system, fast information input and efficient final reports ready to be consulted. Beyond representing a form of dissemination, the database can be updated, adding or modifying information, giving a dynamic and current state of the objects.

The web sharing system allows us to publish all the results through the Google Earth platform showing templates and edited CAD models directly on the online map, and so to facilitate data access and become a powerful tool for interdisciplinary communication. Moreover, it is possible to consult these results on ARCHDBWORLD, a Heritage Information System patented by members of the Università Politecnica delle Marche to share information, e.g. spherical panoramas, databases and reports of CH around the world documented by Fangi.

## Conclusions

As explained here, because of the number of variables involved and resources allocated, the documentation process for architectural and urban sites is a complex and multidisciplinary activity, involving traditional disciplines such as architecture, design, survey methods, history and art history and combining digital microelectronics, computer science and information science, involving significant technological, financial and human resources.

The documentation cannot protect the buildings physically, but it can provide information for their restoration in case of any accident. However, in the case of a building which has been completely wrecked, the multimedia database could serve to preserve its memory for future generations and educational purposes.

Finally, with this public divulgation of an architectural heritage database, we hope to contribute to the preservation of historical sites by promoting knowledge of them. The valorisation of these urban sites is an effective way to protect them and draw attention to the urgency of a heritage protection policy and the risk to which they are continuously subject. By the end of this project, it is expected that all this data and information will be available on the project website on the internet.

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# Partnership for Safeguarding Cultural Heritage in Syria: Project ANQA

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**Abstract:** The practice of recording and digitising cultural heritage sites on computers has wide acceptance among conservation professionals. Recently, the massive loss of sites in areas of conflict has highlighted the urgent need for both documenting heritage sites and training and building the capacity of local stakeholders. This process should not be limited to computerisation, but also includes a meaningful interpretation of sites with respect to their intangible values, which necessitates new tools. Our aim is to use new technologies to create accurate 3D recordings of at-risk heritage sites, to contribute to capacity building in the region, facilitate the transfer of knowledge and spur the creation of permanent architectural inventory units. A specific aim of the project is to develop a new sustainable activity by empowering local professionals with training and tools to continue the documentation work of cultural heritage beyond the life of our project. It is our hope that Project ANQA should serve as an example of 'people-centred' cultural heritage documentation in a digital age through an open-access, participatory web platform. Collected data should be accessible and useful for scholars, professionals, and the wider public with state-of-the-art tools. Project ANQA is supported by the Arcadia Fund (London, UK) and initially worked through a partnership of ICOMOS, CyArk and Yale University to train local professionals in documenting at-risk sites in 3D through an interdisciplinary process. It began successfully in Syria thanks to a fruitful local partnership with UNESCO and the DGAM. Training sessions were organised in Lebanon with exercises in photogrammetric and laser capturing 3D data. The project included the provision of equipment, as well as computer programs. A first batch of sites in the World Heritage historic city of Damascus was chosen as being representative of the typological variety of urban historic buildings in this city. The progress of the local team was monitored and remote technical support and guidance provided. Visual outputs have just been processed. Project ANQA represents a new challenge for a professional NGO like ICOMOS as it includes setting up a working, scientific, technical and financial partnership between half a dozen specialised institutions (Arcadia Fund, CyArk, DGAM, ICOMOS, UNESCO, Yale and then Carleton University) based in different countries while also responding to emergency needs in a war situation, with difficult material and logistical issues. The good results that have been achieved to date are due to the enthusiasm and dedication of all participants.

**Keywords:** Syria; 3D; capacity building; heritage at risk; open access; sustainability

## Aims

The human casualties and disruption of local communities as well as the intentional or collateral destruction of cultural heritage are catastrophic events for humanity. We are continuously losing important assets that are our common legacy.

Based on their previous knowledge of Middle Eastern countries and their ongoing activity, the ICOMOS Working Group on Safeguarding Cultural Heritage in Syria and Iraq is convinced of the key role played by local professionals and the importance of providing them with documentation as well as with risk preparedness and conservation skills.

New technologies in 3D reality capture such as 3D laser scanning make it possible to record monuments and sites in incredible detail and accuracy at a fraction of the time and cost of

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conventional surveying. The resulting engineering-grade data is used to create dimensional drawings and rich visualisations of the site that can be made available for international scholars to study. This is what we chose to provide.

Anqa means 'phoenix' in Arabic, and the purpose of Project ANQA, initiated by ICOMOS, is to support emergency documentation efforts for at-risk cultural heritage sites in the Middle East using new technology to create accurate 3D recordings of heritage sites in their current status. The resulting engineering-grade data should inform local conservation decisions about the sites and provide a database of open-access annotated data, which can be used by researchers around the world.

A specific concern of the project is to develop a new sustainable safeguarding activity in the region by empowering local professionals. With training and tools, participants will acquire the skills needed to continue data capture of sites beyond the project, guaranteeing capacity building and a sustainable documentation of sites in the country in question.

We therefore work together to train local professionals in documenting at-risk sites in 3D, to conduct scholarly research, and to create a web platform to educate the public on the importance of cultural heritage preservation. What sets ANQA apart from other related projects is our effort to build capacity on the ground in Syria through in-person and online technical and ethnographic training, as well as an emphasis on interpreting data for the dissemination of knowledge, raising awareness around sites located in conflict zones, and storytelling.

Bridging the digital and humanities gap in the practice of cultural heritage documentation is important as data move from the hands of computer technologists to domain experts, such as archaeologists or architects.[5] The web platform to be designed in shared ownership is geared towards scholarly inquiries, and will make RAW and academic data available to researchers on request.

The data that we analyse and process for Project ANQA comes through Yale's original partnership with CyArk. We work together to train architects, engineers, and computer scientists on the ground, who then collect information that includes RAW and ethnographic data, including field notes, drawings, and sketches of site plans, building structures, and the location of scanners. CyArk worked as an intermediary to collect and process RAW data and coordinate the on-site technical training, as well as to communicate regularly and directly with our documentation partners in Damascus and with the team at Yale.

The documentation includes what we call the 'subjective eye', which is based on a list of intangible categories in accordance with CIDOC-CRM and ICOMOS CIPA standards.[6] Photographs, videos, and interviews with building caretakers/users, on-site observations of rituals and processes, and the recording of the peculiarities of a building all help in the storytelling process and convey the importance of cultural heritage preservation.

Another important feature of ANQA is that it engages directly in capacity building in areas of high conflict through technical training and co-ownership of the resulting data. Close collaboration with the local team on recording, interpreting, and contextualising these sites is an invaluable contribution to the sustainability of the project.

## Partners

The original partners of the ANQA Project were

- ICOMOS, the International Council on Monuments and Sites, an international professional NGO (Directorate General and the Working Group on Safeguarding Cultural Heritage in Syria and Iraq),

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5 Alliez et al. 2017.
6 Silver et al. 2016.

- CyArk, a Bay Area-based international non-profit organisation that specialises in photogrammetric and laser-light scanning technologies and
- the Institute for the Preservation of Cultural Heritage (IPCH) at Yale University.
- After Yale's withdrawal at the end of 2017, the CIMS, Carleton Immersive Media Studio at Carleton University will continue the task of publishing the materials and data collected.
- Generous support is provided by Arcadia, a UK based grant-awarding fund.
- A UNESCO EU-funded programme in Beirut (The Emergency Safeguarding of the Syrian Cultural Heritage project) provided much-appreciated logistical collaboration.
- Our local in-field partner was the DGAM, the Syrian Directorate-General of Antiquities and Museums which, in spite of the war, has independently developed multiple activities across the country, including raising awareness, computerisation, museum inventories and a news website.
- ICOMOS provides an interface between the Arcadia fund and its partners and provides oversight regarding the grant awarded by Arcadia.

## Project History

From their previous experience of Middle Eastern countries and from their conflict-monitoring activity, the members of the ICOMOS Working Group on Safeguarding Cultural Heritage in Syria and Iraq were aware of the key role played by local professionals when few or no foreign experts could undertake perilous ground visits. Highly qualified national architects, archaeologists and computer specialists remained in spite of dangers, but they often lacked risk preparedness and advanced equipment.[7] It was therefore important to provide them with additional conservation skills. Some adequate technology transfers had to be organised and capacity building was needed in their institutions.

ICOMOS already had a relationship with CyArk, which had impressive worldwide experience, thanks to our president's participation on its board. A Memorandum of Understanding was passed between them in June 2015 and was soon presented during the Global Coalition launch at the World Heritage Committee meeting in Bonn, July 2015. The partnership with Yale was added shortly afterwards. The Director of its IPCH happened also to be the President of ICOMOS' International Scientific Stone Committee (ISCS). The Director General of the DGAM had a previous positive relationship with ICOMOS and immediately expressed his interest and a proposal was submitted to Arcadia the same month. Unfortunately, due to its annual decision-making calendar, the proposal was not examined by its board and accepted before April 2016.

After some discussions and refinement, a more detailed proposal including a cooperative research agreement between the three partners was sent by ICOMOS to the Arcadia Fund in September 2016. Self-supported by CyArk, early training sessions were held at the UNESCO regional office in Beirut in January and June of 2016 and a visit from the heads of ICOMOS WG and Yale IPCH was undertaken in Damascus in December 2016 to prepare the final training session that was given in January 2017.

On-site 3D surveys of six sites in Damascus began soon afterwards and were mostly achieved by the end of August 2017. Yale University however, withdrew from the project just a few weeks ago, fearing institutional complications. This is when Carleton University stepped in instead, with the agreement of the Arcadia Fund.

Half a dozen universities, public institutions and foreign organisations were meanwhile contacted in Iraq, but while training is quite easy to organise, an eventual sustainable activity in a permanent institution seems much more difficult to set up.

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7 Abdulac 2013; Abdulac 2014; Abdulac 2016; Abdulac 2017a; Abdulac 2017b; Abdulac 2017c; Abdulac 2017d; Abdulac et al. 2018.

Fig. 1 Training conducted at Beirut UNESCO office, January 2017 (Anqa partners)

Fig. 2 DGAM trainees at the end of their training in Beirut, January 2017 (Anqa partners)

## Training

For safety reasons, the training was not organised in Syria, but in nearby Lebanon. Thanks to an EU-funded programme, the UNESCO regional office in Beirut provided its logistical support, added to its practical experience in Syria and Lebanon. Following successful preliminary training sessions in 2016 on laser scanning and photogrammetric and panoramic image capture, full training was conducted in 2017 thanks to Arcadia funding. This training focused on refining data capture techniques and provided additional guidance to the DGAM on the site recording forms and pertinent information.

Two CyArk experts conducted the training from 16 to 26 January 2017 at the UNESCO offices in Beirut and on site at the Temple of Echmoun, a Phoenician archaeological site located approximately 40km south of Beirut. The training was used to review completed site recording forms and exchange any of the data collected in Damascus as a result of the preliminary training and borrowed equipment. The training was complemented by online sessions with interventions by the project team. Preliminary data was shared via summary electronic correspondence, but file size and connectivity challenges necessitated a subsequent exchange of physical hard drives and memory cards.

The DGAM selected trainees in architecture, archaeology, engineering and computer science. Most of them were young, but some mid-level staff also attended. A lot of them were from Damascus, but other provinces were also represented. Many women participated. All trainees showed an extraordinary interest, involvement and desire to learn. The project utilised a selection of LiDAR, structured light scanning and photogrammetric equipment, drones and dedicated methodologies. The participants excelled during the training and clearly demonstrated their proficiency in 3D site capture. About fifteen trainees finally received a certificate of participation (Figs. 1–2).

## Methodology

The training was also used to review completed site recording forms and exchange any of the data collected in Damascus. During the CyArk training, we agreed upon a method of collecting data by using forms that the DGAM team members print out and take with them into the field and also came up with a list of tangible and intangible categories that work in accordance with CIDOC-CRM[8] and ICOMOS CIPA standards.[9] A metadata form includes basic information about the site


Fig. 3 Trainees surveying Madrassa al-Jaqmaqia, February 2016 (Anqa partners)

8 CIDOC 2017.
9 ICOMOS 1996.

(site name, year built, architect/patron, location, etc.), along with the width and dimension of rooms and partitions, a description of the overall site condition, and a brief history. The additional categories work in tandem with the technical data collected through laser-light scanning and photogrammetric documentation. Some fall under a general category called the ‘subjective eye’. This includes general observations of the site, including sketches or notes about unusual markings or inscriptions, contemporary use, interviews with caretakers or visitors, short videos of the sites, or remarks about archival documents or plans that exist in nearby libraries or municipalities.

## Site Selection

Only Midan, a historical suburb of Damascus was subject to fighting between the government and rebels in July 2012. The World Heritage ancient city keeps being episodically shelled by random mortars. Some monuments were hit and one of the DGAM agents even lost his life. It was not initially predictable that Old Damascus would be a much safer place compared to Old Aleppo or Homs. Our trainees could, in any case, not be exposed to excessive risks.

Project ANQA successfully documented six historic architectural monuments, determined in coordination with the DGAM. They were chosen to illustrate the architectural variety of historic buildings in the walled old city. Their public status also allowed easier work conditions.

- Azem Palace (Museum of Popular Arts and Traditions):
  palace, built in 1749–52 by Asaad Pasha al Azem, the Ottoman governor of Damascus.
- Madrassa al-Jaqmaqia (Arabic Calligraphy Museum):
  school built in 1418–30 by Jaqmaq al-Argunsawi who was then the Mamlouk Governor of Damascus.
- Bimaristan Nur al-Din (Museum of Arabic Medical and Science History):
  building originally founded as a hospital and a medical teaching centre by Nur al-Din Zinki, ruler of northern Syria and Iraq, in 1154.
- Hammam Nur al-Din:
  public bath founded between 1154 and 1172 by Nur al-Din Zinki.
- Khan Asaad Pasha:
  caravanserai built in 1752 by Asaad Pasha al Azem, the Ottoman governor of Damascus.
- Ananias Chapel:
  the underground site reputedly includes a part of the house of St Anananias where St Paul took shelter (1st century AD), with later elements.

This choice was to provide a sort of ‘Noah’s Ark’ (one of each kind: housing, learning, health care, bath, commerce, religion), through a typological variety of small or medium-sized urban historical buildings. Their survey was initially THE objective; it gradually also became a means of providing a field exercise for the trained beginners (Fig. 3). Expert authorities may later on choose other cultural sites in urban or rural areas, inside or outside Damascus.

## Fieldwork

CyArk supported the DGAM remotely throughout the field capture. This included advising on technical issues as they arose, coordinating data transfer to CyArk offices and providing additional instruction to the DGAM via webinars, phone calls and extended written tutorials.

The data capture and transfer was slower than initially expected. To help further their work on the project, CyArk developed a detailed work plan for the remaining sites that were to be documented by the DGAM in the scope of Project ANQA. After top-level contacts with ICOMOS, the outstanding work for the six sites was completed by the DGAM on 22 August 2017.

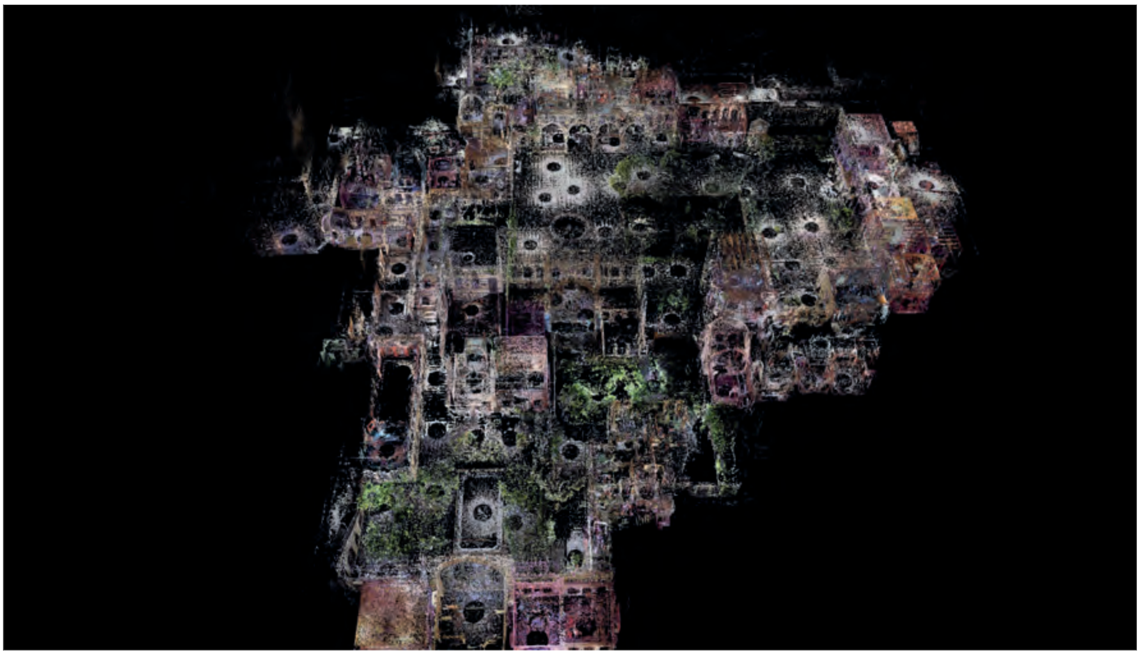

Fig. 4 Point Cloud Survey of Azem Palace (Anqa partners)

As soon as the DGAM completed a site, CyArk arranged for the data to be transferred from Damascus to the UNESCO offices in Beirut where they could be shipped via DHL to CyArk. A total of three hard drives were sent in August and the smaller files were uploaded to the shared Dropbox account. CyArk requested the accompanying metadata as well as recorded interviews with site managers. The interviews were completed by DGAM during the week of 27 August and were shared with Yale in September after review and assessment. Most site-specific metadata sheets had been compiled by the DGAM staff and already shared.

In fact, during the first half of 2017, beyond the designated six sites, surveys were also undertaken by the trainees on other additional sites. Panoramic images were completed for

Fig. 5 Photogrammetric view of Khan Asaad Pasha (Anqa partners)

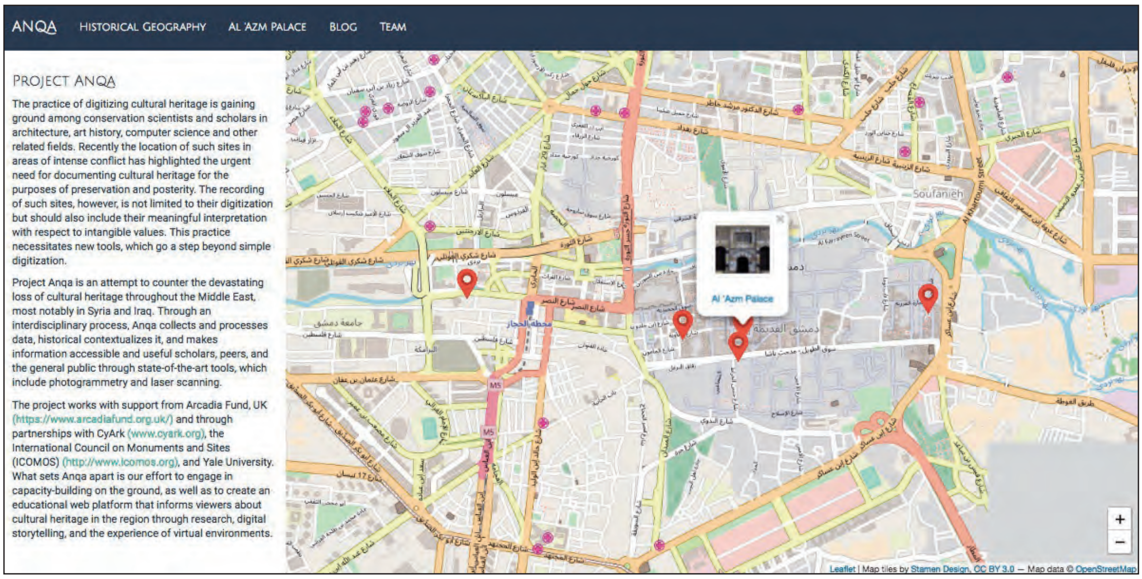


Fig. 6 Map of surveyed sites in the ancient city of Damascus (Anqa partners)

al-Tekiyeh al-Suleimaniyah Mosque. The DGAM has also partially completed LiDAR scanning of the Umayyad Mosque (complementary to the ICONEM external survey) and completed the LiDAR scanning of the Damascus Cultural House.

## Data Output, Review and Processing

In addition to performing basic data processing, CyArk has created the necessary 3D assets for display on the web so that they can be easily integrated into the Yale database. The RAW laser scan files for the sites were registered together to create six unified point clouds (Fig. 4). The point clouds are currently being uploaded to Sketchfab, a 3D viewer which can be embedded within a website. All photogrammetric documentation was aligned and six textured photogrammetric models (i.e. Fig. 5) have been uploaded to Sketchfab, which we share with Yale. The raw .obj textured models have also been shared directly with Yale via Dropbox. A data summary sheet for each site is being generated by CyArk, which describes the different technologies employed by the DGAM as well as a quantitative analysis of site coverage and scanning resolution. CyArk will continue working with the DGAM to obtain the final metadata sheets and will share the completed 3D models as they are completed.

## Results

Yale made significant progress on conceptualising and preparing a web platform for the dissemination of open-access data for Project ANQA, with support from the Yale Digital Humanities Laboratory. A homepage gives a general overview of the Project ANQA mission and locates the six sites on an interactive map (Fig. 6). There will also be a feature that gives an historical and geographic overview of the Middle East region with a special focus on the urban history of Damascus, which situates the sites in relation to one another.

A pilot, developed around the data from the al Azem Palace (Figs. 7, 8), is supposed to become the expandable base for a scholarly resource around the six sites, including general historical information and further metadata.

Based almost entirely on the panoramic photographs, a few of the RAW images that CyArk and Yale each used to derive photogrammetric models, but none of the LiDAR models, a pilot

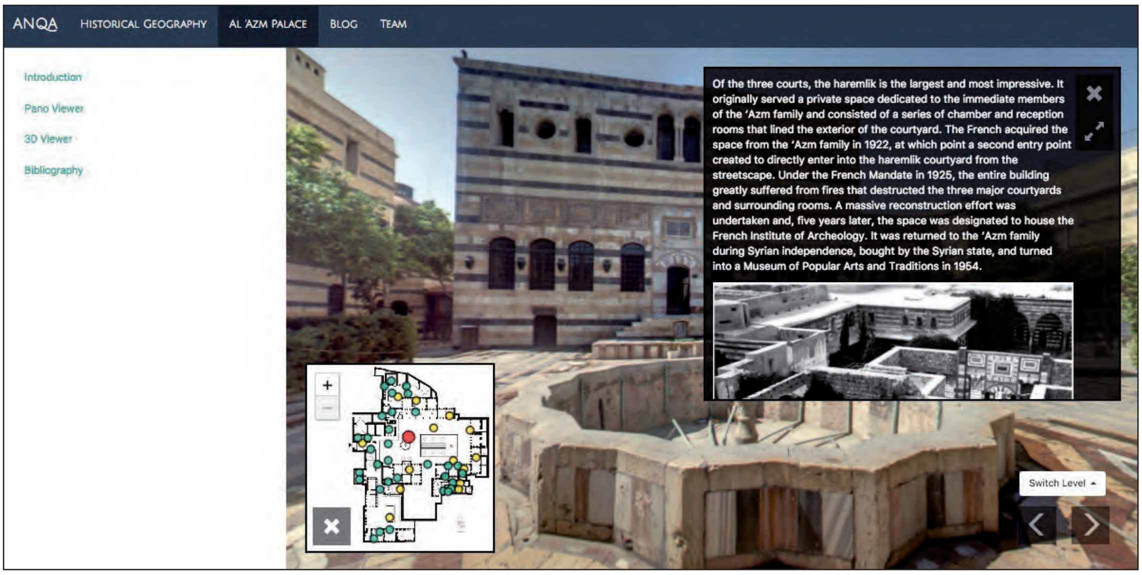


Fig. 7 Panoramic view of Azem Palace great Qaa (Anqa partners)

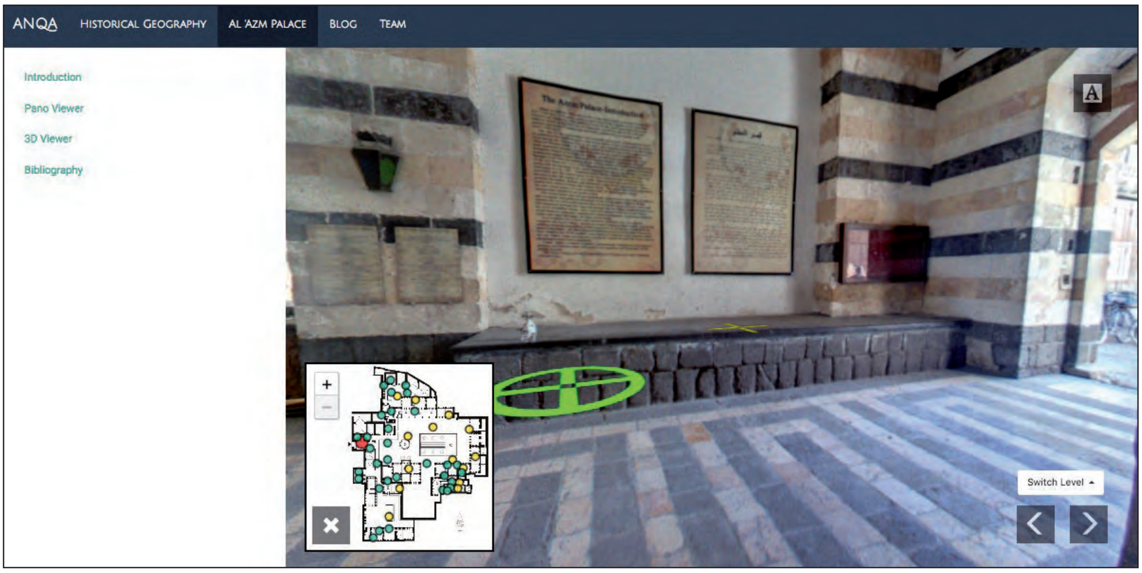


Fig. 8 Interactive virtual visit to Azem Palace, map, annotations and integration of historic photographs (Anqa partners and Yale University)

website for Azem Palace has been developed. Yale's Computer Graphics team developed a viewer that deploys familiar technology (cf. Google maps 'street view'), but which also demonstrates how three-dimensional 'pop-ups' can be incorporated into the viewer (Fig. 9). It furthermore allows for annotations and, for example, the integration of historic photographs for comparative purposes (Fig. 7).

The website incorporates state-of-the-art software designed by the Yale Computer Graphics team and IPCH called CHER-Ob,[10] an open-source platform for cultural heritage research, which provides annotations that appear on or beside 3D models and/or photographs. The CHER-Ob program will also feature a video component, which creates short animations of a site or object that highlight material or historical aspects of a site or object and provide annotated explanations.

[10] Shi et al. 2016; Kotoula et al. 2017.

Fig. 9 Photogrammetric view of Madrassa al-Jamaqia (Anqa partners)

Yale also envisioned a portal through which users can register and request RAW data files for more in-depth scholarly inquiries. The website will initially be published in English, and will hopefully be available in Arabic at a later stage. Our intended audience ranges from a general public, to educational institutes (including K-12 schools, colleges, and advanced graduate programmes), and scholars who can further their studies based on our data scans and research.

CHER-Ob analyses and annotates heterogeneous data files about cultural heritage entities, such as 2D images, 3D models, RTI and CT images in addition to their archival/textual data. The main features of the software are the Cultural Heritage Entity (CHE) – which is user defined sets of data – and the project – which is types of studies that are focused on answering specific research questions about a single or plural CHE. CHEs are the main source of data to be studied in CHER-Ob. They consist of a set of information uploaded into the software by the user, including image files and annotated data classified according to the Getty Classification of Works of Art, or GCWA.11 All of the images can be annotated, and point, surface, and polygonal annotations are available for 2D, RTI, CT images, including frustum (volumetric) for 3D models. Ultimately, the contribution of this platform is that it facilitates and enables the sharing of documents of a diverse nature for experts from different disciplines in their collaborative research.

During the development of a project, users can explore visualisations and their metadata and add bookmarks, annotations, and new files. They can also search, sort, and filter the data by making use of functions provided in CHER-Ob and generate new knowledge. The progress can be tracked by using the navigation tool. The program tracks users' names and timestamps, in addition to evidenced-based statements, which are important features that protect the intellectual rights of each contributor and preserve data provenance information. The content of projects and CHE(s) can be exported via the report generation function in .pdf and/or video formats, which encourages the distribution of information to non-CHER-Ob users for research, publication and archival purposes.

In the CHE named 'Al-Jaqmaqiyah Madrassa', for example, Yale has supplemented the models with general annotations, surface annotations and volumetric annotations. The general annotations contain historic information, stylistic analysis, and descriptions. The tabs on the right

[11] Baca – Harpring 2014.

side of the screen provide enhanced access options. Annotations can also be accessed through the ‘Navigation’ tab, metadata can be viewed and edited through the ‘Cultural Heritage Entity’ tab, and other functions such as adding general annotations, search, filter, and bookmarks can be found in the ‘Application’ tab.

## Project Recognition

Since beginning the project, there have been many opportunities to highlight the work and make future connections to additional support. Professor Stefan Simon of Yale’s IPCH was invited to present Project ANQA in front of a Congressional hearing in Washington, D.C. on 8 September 2016. This opportunity allowed for increased exposure for the project in front of the National Endowment for the Humanities as well as members of the United States Congress.

Additionally, the Chair of the ICOMOS Working Group was invited to present Project ANQA at the International Conference on the Protection of Cultural Heritage in Conflict Areas, Abu Dhabi, December 2016, and at a side event of the 41st World Heritage Committee Meeting in Krakow, July 2017, and multiple international meetings such as in Beirut, Leipzig, Lens, London, Oslo, Seoul, Rome, Tunis or Vienna in 2016 and 2017.

In August 2017, the team at Yale wrote and presented a paper on Project ANQA at the 26th International Symposium of CIPA on Digital Workflows for Heritage Conservation in Ottawa, Canada. Ms Elizabeth Lee, Managing Director of CyArk, was invited as a keynote speaker at the symposium.

Our hope is that, through this multi-partnered and interdisciplinary effort, Project ANQA may serve as a foundational platform for the study and documentation of tangible and intangible heritage sites, not only for conflict regions in the Middle East, but more generally around the world.

## Other Endeavours in Syria

A few other actions using 3D surveys before and during the armed conflict should also be mentioned, such as the Japanese and Russian ones in Palmyra, the French one in the antique northern villages, the Hungarian one in Marqab Castle, and a Czech, French and Italian one at Aleppo minaret.

The French ICONEM start-up with Yves Ubelmann has provided breath-taking drone and land views of Aleppo, Damascus, Palmyra and the Crac des Chevaliers. The French AGP has also undertaken surveys of the same spots. The Aga Khan Trust has lately presented a team taking views in Aleppo. Recent views taken during the conflict implied an on-the-ground personal intervention by foreign experts, sometimes with Syrian assistants. The image processing is, however. always undertaken abroad afterward.

Earlier 3D campaigns were just meant to provide quicker and more accurate surveys. Post-conflict ones aim at surveying the damage and sometimes at identifying fallen stones and debris, in view of later restoration or reconstruction works. Oxford IDA (The Institute for Digital Archaeology) tried to demonstrate how new technology may allow the 3D printing of destroyed monuments through crowdsourcing. However, the replicated Palmyra Arch presented in London, Florence, New York or Washington between 2016 and 2017 lacked the authenticity and aesthetics of the original stone carved one.

There is still a lot to do all across the country and we hope our trained and equipped team will survey and produce 3D imagery elsewhere in Damascus and Syria.

## Conclusions

The digital documentation of heritage sites, whether at risk of being destroyed or not, should go beyond simple digitisation to include social, historic, and ethnographic information so that these sites can be understood within the contexts in which they are situated. Virtual, or immersive, experiences of the sites are important, as this data gives users an experience of places that they may have limited or restricted access to. However, presenting heritage sites separately from the experiences or stories of local communities and neighbourhoods risks disconnecting them from the culture and traditions in which they were created. Our hope is that, through this multi-partnered and interdisciplinary effort, Project ANQA may serve as a foundational platform for the study and documentation of tangible and intangible heritage sites, not only for conflicted regions in the Middle East, but more generally around the world.

An initial criteria was that the grant was to be considered a success if the minimum number of sites (6) was recorded and made available via open access. As a publication should soon follow, we have already made good strides towards this. We also successfully added capacity building and the setting up of a national 3D survey sustainable activity.

Working with teams and sites located in a conflict zone comes with its own set of challenges and setbacks. First of all, the survey team should work in a safe and secure environment. Its working conditions should be as normal as possible given existing shortages (electricity, internet, etc.). A major challenge to Project ANQA was and has continued to be the transfer of large files out of Syria.

An international professional organisation has to remain neutral, particularly towards political pressure. However, we cannot expose our trainers to risks in conflict zones in the way smaller, more adventurous structures do.

External funding and administrative delays may also limit our flexibility and ability to react in emergency situations and generate misunderstandings.

In more comfortable situations, it seems better to choose between a priority for fieldwork or for capacity building, given the limited amount and duration of grants.

Many organisations have 3D data of cultural sites, but often the results are disparate, dispersed and not easily transferable.

Working directly with local state boards of antiquities, international cultural and technical experts, and scholars should allow for a more cohesive product to be shared with the wider cultural community.

New unified and comprehensive architectural and urban inventories, with common standards and languages as well as connected visual and geographical databases, have to be specifically developed for the region.

Stronger computer and storage equipment are needed. But the obsolescence of equipment and programs should also be considered.

Project ANQA illustrates how ICOMOS can respond to an emergency situation by setting up a multi-sectoral, international partnership with outside funding. A connection between the ICOMOS. ANQA and AMAL projects may also be explored in the future.

As an outcome, Project ANQA hopes to refine the methods and relationships necessary for the continued capture of high-risk sites throughout the Middle East and North Africa.

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