

English edition

Monuments of Mosul in Danger



The Czech Academy
of Sciences



Oriental
Institute
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Science 73

around us
Challenges
and questions

The Oriental Institute (www.orient.cas.cz) is a public non-university research institution. Formally established in 1922, just six years after SOAS in London, the Oriental Institute is one of the oldest institutions dedicated to the study of Oriental cultures in Central and Eastern Europe. Since 1993, it has fallen administratively under the auspices of the Czech Academy of Sciences (CAS), an umbrella research institution similar in function to its counterparts in continental Europe, such as the CNRS in France. Currently, the work of our researchers is mainly focused on the Middle East (Arab countries, Iran, Israel, Turkey), India, Central Asia, Southeast Asia, China, Japan, and the ancient Near East.

The project *Monuments of Mosul in Danger* – supported by the Oriental Institute and the research program *Strategy AV21* of the Czech Academy of Sciences – was launched in response to a serious threat to the Mosul architectural sites from ISIS (The Islamic State of Iraq and Syria; also known by its Arabic acronym Daesh), who seized the town in June 2014. Since then, dozens of historical sites have been razed to the ground or severely damaged. Monuments of diverse types, such as mosques, madrasas, mausoleums, graveyards, churches and monasteries have been subjected to destructive forces.

The project has five aims:

1. the monitoring of destructive activities in Mosul by means of satellite imagery;
2. the architectural and historical analysis of destroyed monuments by means of preserved visual (photographs, documentary films) and plan documentation as well as historical and recent descriptions published by Iraqi scholars;
3. the creation of 3D virtual models of destroyed monuments, where the available documentation enables this;
4. the mapping of all identifiable extant historical monuments in the town, which will be made accessible through a complex interactive map;
5. the analyzing of the ideological background of the destruction (religious edicts, rationale, historical precedence).

Web: www.monumentsofmosul.com

Youtube: Monuments of Mosul in Danger

Facebook: Monuments of Mosul in Danger

The Destruction of Mosul by ISIS and its documentation

Ideologically motivated attacks on monuments in Mosul did not just start in June 2014 when the town was seized by a Sunni radical group, which later declared itself to be the Islamic State (ISIS, ISIL, Daesh). Members and supporters of older rebel organizations, such as al-Qā'ida in Iraq or the Army of the Men of the Naqshbandi Order, had already been responsible for targeted bomb attacks a decade earlier, acts which had damaged some of Christian monuments in the town, such as the Syrian Orthodox church of the Virgin Mary (al-Tahra al-Fawqāniya).

However, the violence against cultural heritage perpetrated by ISIS in 2014–2017 had a far more serious impact. ISIS had both the time and the means to implement its iconoclastic objectives, and other than a few individual cases of unarmed resistance by Mosul inhabitants, there was no force capable of preventing these losses. The destruction of historical buildings was planned and systematic. It was ideologically motivated by selected extremist religious views, originating mainly from the Salafi milieu and massively disseminated by Saudi Arabian religious circles. These views forbid the erection of any constructions above graves so that they do not become objects of worship. The destruction of historical buildings and archaeological sites was extensively publicized and utilized to intimidate Mosul inhabitants, as well as the international community, and in order to eradicate the historical memory of the town.

On June 20, 2014, bulldozers razed to the ground the first monument in Mosul, the grave of the celebrated Mosul historian Ibn al-Athīr, who lived at the turn of the 12th and 13th centuries. The most extensive wave of destruction was unleashed in the third week of July 2014, when the world media reported on the blasting of eleven of the most precious monuments in the town, including the pilgrimage site of the prophet Jonah (Yūnus) in Nineveh, which had been venerated by both Muslims and Christians. Further waves of destruction in Mosul were carried out with little or almost no media attention being paid.

According to actual and verified databases, ISIS has destroyed 47 architectural sights in Mosul. With one exception, all of the buildings had a religious function. The vast majority of them (42) represented Islamic buildings (mosques, mausoleums, tombs and graves, and also a *madrasa* – school). Although they were, in the context of contemporary Mosul, Sunni constructions, many of them, for example the tombs of the Prophet's family members, are generally considered to be originally Shi'i. Only four destroyed monuments were Christian. However, all the remaining churches and monasteries were reportedly looted or set on fire.

The consequences of the destruction are catastrophic. Mosul has lost its most precious sites, which had once provided its panoramic skyline and distinctive appearance. Virtually the entire group of unique 12th–13th century buildings, defined by the German archaeologist Ernst Herzfeld (1879–1948) as the Mosul Architectural School, have been destroyed. Also destroyed or stolen were invaluable libraries, museum depositories and church treasures. The destruction also affected archaeological sites, mainly the remains of ancient Nineveh. The destruction of Old Mosul was completed during the liberation operation from



Destruction of the tomb of Ibn al-Athir by ISIS

(Source: The propaganda e-leaflet entitled "Taqrir 'an hadm al-adriha wa al-awthân fi wilāyat Ninawā" produced by ISIS)



Destruction of the Shrine of Yahyā ibn al-Qāsim (an image grab taken from an ISIS propaganda video)

October 2016 to July 2017 and is currently the subject of documentation. Other damage is likely to occur during the post-war rebuilding of the town.

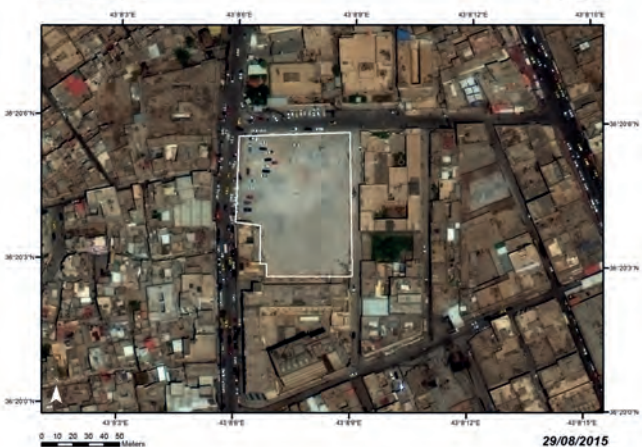
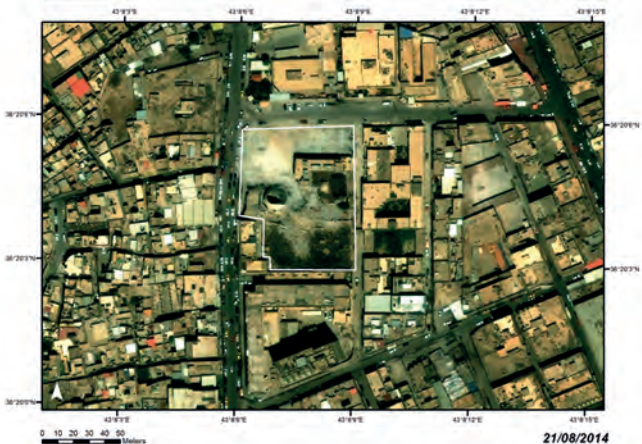
A team of Czech scholars started to collect and assess information on the intentional destruction of historical Mosul in the summer of 2014. This activity gradually transformed into a conceptual, interdisciplinary project entitled *Monuments of Mosul in Danger*, conducted in the Oriental Institute of the Czech Academy of Sciences. Its target is not only to document the cultural genocide in Mosul, but also to contribute to the scholarly knowledge of the neglected field of Mosul architecture, as well as to locate the deliberate destruction within respective historical, religious and ideological contexts. As part of the project, the obtained data are used to create 3D virtual models of destroyed monuments, wherever the quality of documentation makes this possible. All results of the project will be made available in support of the future restoration of Mosul monuments.

Mosul: the center of northern Mesopotamia and its European uncovering

The history of Mosul – a sprawling metropolis with close to two million inhabitants (until 2014) – stretches back to AD 641. It was founded by Muslim conquerors on the western bank of the Tigris River in northern Iraq, not far from an earlier fortress and a Christian monastery. Originally, only a garrison town, Mosul became, shortly thereafter, a regional center on an important route connecting Baghdad and Sāmarrā', two capitals of the Abbasid Empire, with the northern provinces and the Eastern Mediterranean.

Originally ruled directly by governors acting as representatives of the Umayyad and Abbasid caliphs, the town became subject to the regional dynasties of nomadic origin (Hamdanids and Uqaylids). The city reached the pinnacle of its influence and development under the rule of the Atabegs – originally the guardians of the underage descendants of the Seljuq sultans, who used the opportunity to establish their own ruling dynasties in the major centers of the caliphate. In Mosul, the Atabegs ruled for nearly 130 years. Their control was finally broken by the Mongol seizure and plundering of the town in 1261. Even in later periods, Mosul was able to regain its independence to a great extent, especially during the Ottoman period when it was ruled by the al-Jalili family for more than a century. Until the end of the 20th century, Mosul was distinguished by its extraordinarily multifarious mixture of inhabitants, composed of Muslims (both Sunnis and Shi'is), Christians, Jews, Assyrians, Kurds, Turkmens, Shabaks, Yezidis, Armenians and Mandaeans.

From an archaeological perspective, Mosul has always been overshadowed by its more famous ancestor, the Assyrian royal town of Nineveh, lying on the opposite, eastern bank of the Tigris. Nineveh used to be the main object of interest for all archaeologists conducting their research in the area. Mosul was only used as a temporary residence, a meeting place for archaeological expeditions and their logistical networks and bases. Many of the dozens of travelers who visited Mosul



Mosque of the Prophet Seth on satellite images before destruction, after implosion and after razing (source: WorldView-2 and WorldView-3 © 2015 DigitalGlobe, Inc., distributed by European Space Imaging GmbH/ARCDATA PRAHA, s. r. o.)

in the 16th to 19th centuries recorded short, though relatively detailed, descriptions of the town: the most valuable of them were compiled by, among others, Carsten Niebuhr, James S. Buckingham, and E. A. Wallis Budge. It was, however, Ernst Herzfeld who first realized the significance of the medieval architecture of the Mosul historical nucleus. During his expedition to Mesopotamia in the winter of 1907–1908, he spent 16 days there, intensively focusing on and systematically surveying the Islamic and Christian historical monuments. His one-hundred-page chapter in a travel report (published in 1920 in Berlin) represents, even today, the fundamental research on Mosul's architecture, exceeding all later archaeological work in terms of scope, the quality of acquired documentation, and the originality of interpretation.

After Herzfeld, the Mosul historical topography and history of architecture was researched predominantly by Iraqi scholars (e.g. S. al-Dīwahjī, A. al-Sūfī, A. Q. al-Jum'a); and in some cases, European specialists as well (e.g. E. Wirth, R. Parapetti). Italian engineers and architects participated in the statistical fixing and repairs made to the al-Hadbā' Minaret at the end of 1970s. Since the 1970s, the Mosul municipality has prepared several versions of the city's master plan and has initiated several general rescue projects of the largely neglected heritage architecture. After 2013, the security situation in the town declined to such an extent that all plans for the cultural and touristic development of the town had to be postponed indefinitely.

Mosul architecture: its development and forms

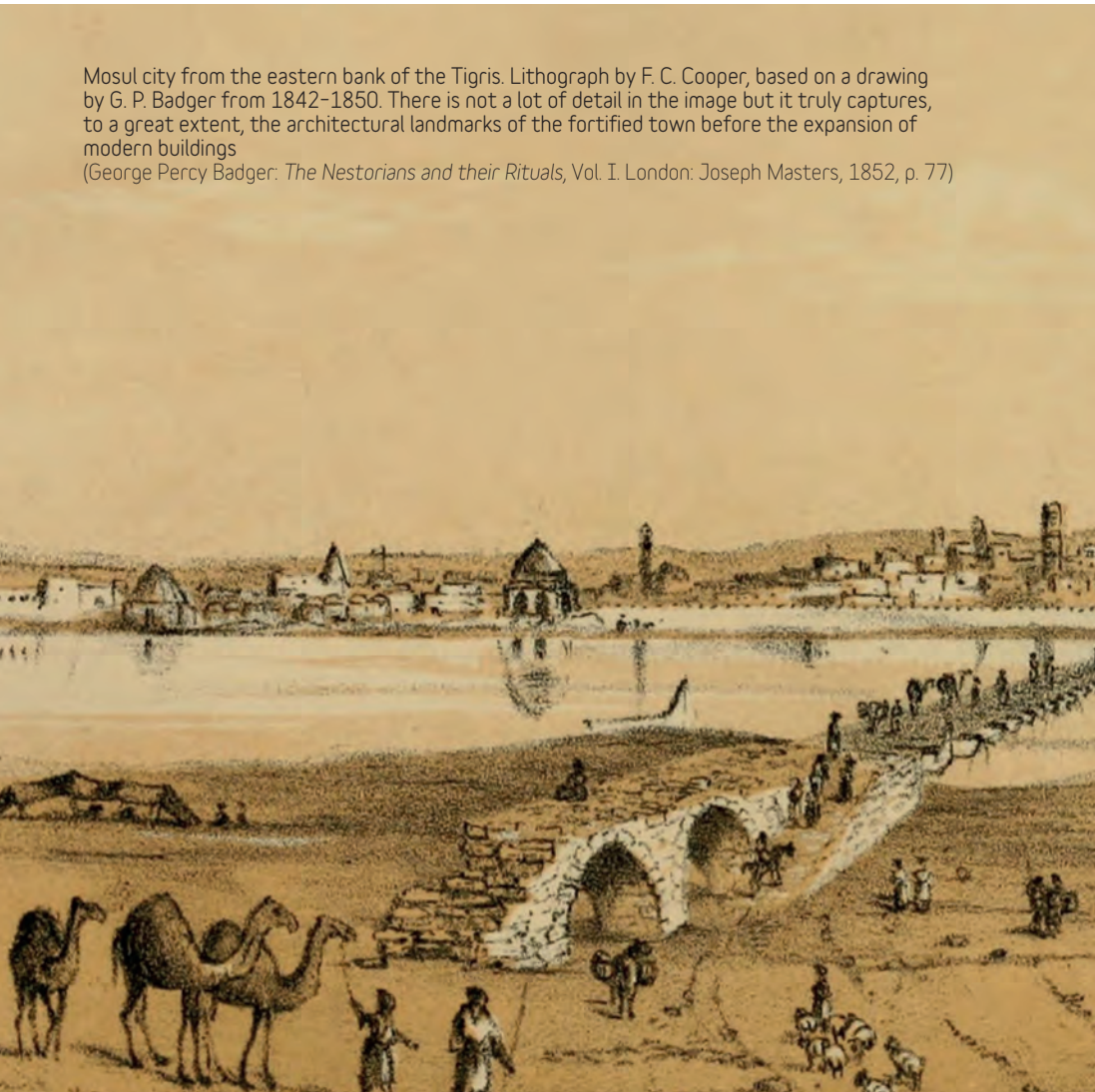
Mosul was founded on the same site as an earlier fortress of unknown date, location and appearance. Until the 12th century, the development of the town and its architecture is intermittently traceable only through written sources; no archaeological finds or reports are available. The one time garrison camp (*misr*) of the Muslim army was, from the end of the 7th century, forcefully and at great expense transformed into an urban center. On an elevation not far from the bank of the Tigris, near an earlier church, the main mosque and the governor's palace were built from dried-brick. The town was fortified, paved and provided with a bridge and two labor-intensive canals. Another, and even grander palace, al-Manqūša, was built outside the town's walls by the governor of Mosul in 725–726. This palace was decorated with teak wood, mosaics and marble. The position of both the palaces and the mosque cannot be determined, although siting the new palace outside the walled city indicates an expansion of the town's buildings beyond the original and smaller town area. In the middle of the 8th century, the town had roughly 50,000 inhabitants; it was twice as populous as contemporary Rome but ten times less populous than Baghdad.

The town wall, preserved intact until the 19th century, surrounded an approximately 300 ha town in an irregular semicircular shape, attached to the elevated bank of the Tigris. The wall included between eight and fourteen gates. Even today, five isolated sections of wall, as well as two small riverside gates, remain as part of the town's fortifications. The town's fortifications were reinforced by the creation of a citadel, occupying a small artificial island not far from the bridge.

The edge of the elevated terrace was flanked by a steep slope descending to the river and was used, from the initial phase of the town's development, for the construction of monumental buildings, which formed the unique panorama of Mosul; they were – from south to north – the mosques of al-Khidr, al-Aghawāt and Shaykh al-Shatt, the Atabeg palace Qara Sarāy, the mausoleum of Yahyā ibn al-Qāsim and the Ottoman fortress Bashtabiya. During the Ottoman era, the northern part of the town did not extend to the town walls, which means that either the earlier-period large cemeteries were included in the fortified area, or that the area of the town's neighborhoods had shrunk considerably. On the other side, the southern part of the town expanded outside the walls and became the

Mosul city from the eastern bank of the Tigris. Lithograph by F. C. Cooper, based on a drawing by G. P. Badger from 1842-1850. There is not a lot of detail in the image but it truly captures, to a great extent, the architectural landmarks of the fortified town before the expansion of modern buildings

(George Percy Badger: *The Nestorians and their Rituals*, Vol. I. London: Joseph Masters, 1852, p. 77)



administrative and commercial center of the town, with a considerable concentration of governmental and municipal buildings, caravanserais, bazaars, barracks, schools and cultural institutions (Mosul Museum).

The network of winding streets and alleyways were cut through by straight boulevards during the 20th century: first by the East-West Nīnawā Street (1914–1918) meeting and following the old pontoon bridge, and later by the orthogonal Fārūq Street. After WWII, other similar streets followed.

The labyrinth that constitutes the kernel of the historical town used to be a very well preserved heritage environment, which, in contrast to other Iraqi towns, had been little affected by modernization. In the 1980s, the heritage de-



A view of historical Mosul from the south-east. On the left, the conical roof of the Great Mosque (named al-Nūrī), on the right, the Minaret al-Hadbā' (photograph from 1932 by an unknown photographer)



Continuously preserved portion of the wall on the western perimeter of the town (photograph by T. J. Bradley, 1928-1929, © Edward Jones)



partment of Mosul Museum registered around one thousand historically significant buildings there. This number has since considerably decreased. The largest segment of the architectural monuments were – and still are – private houses and palaces from the late Ottoman period (18th–19th centuries). However, only a small number of this domestic architecture has been conserved; a great number of houses have been abandoned, are in ruins, or have been insufficiently maintained. Little consideration has been given in the past to a group of late Ottoman monumental buildings and the traditional central bazaar architecture on the southern edge of the historical town (*khāns* and *qaysariyas*). The religious buildings, both Islamic (mosques, mausoleums, *madrasas*, cemeteries) and Christian (monasteries, churches, cemeteries), represent a key segment of Mosul's architectural heritage. The oldest preserved monuments of this group come from the 12th century. We have not registered any Yezidi or Jewish monuments in Mosul. The synagogue, the dominant building of the Jewish neighborhood in the NW part of the town, disappeared after 1948 and its precise location is unknown.

Destroyed heritage: mosques and mausoleums of Mosul from the 12th–13th centuries

The oldest and most valuable layer of Mosul's architecture dates back to the 12th–13th centuries. Before the war, it comprised 25 diversely preserved buildings that can be divided – both chronologically and artistically – into two groups.

The first group is connected with the rule of the Zengids (1127–1219), the Atabeg dynasty, which is known for mounting an effective military resistance against the Crusaders. Written reports provide information on the founding of various buildings, only a small portion of which have since been preserved. The most significant building was no doubt the Great (Nūr al-Dīn's) Mosque, originally built between 1170–1172, which was rebuilt many times until it was finally demolished and replaced by a new building in 1942. The famous, 44 meter-high minaret named al-Hadbā' ('hunchbacked') represented a part of this architectural complex; it attained this popular nickname due to the extensive incurvation and deflection of its upper part. The endangered monument was eventually blasted by ISIS on June 21, 2017, at the very end of the battle for Mosul.

Regarding other 12th-century monuments, there were the rudimentarily researched mausoleum, mosque and *madrasa* of Shaykh Fathī (demolished during the night of June 26, 2014) and the spatially unique al-Mujāhidī (alias al-Khidr) Mosque (demolished on February 26, 2015). The only building of this period that has so far survived (albeit severely damaged) is the Mosque of Shaykh al-Shatt (also called *Madrasa al-Kamāliya*), founded in 1163. The building clearly represents only a part of the already decimated complex: inside, its simple prismatic outer form has an octagonal ground-plan, which passes into a low hexagonal dome. The decorations are very austere and geometric (there are sets of pointed-arched niches inside, while outside a simple brick frieze with *hazārbāf* decora-



A vast stucco panel, a highly prized work dated by some authors to the Atabeg period, was preserved in the mihrāb niche of the al-Mujāhidī (al-Khidr) Mosque. Unlike other valuable pieces of the Mosul's architectural sculpture, the panel was not transferred to a museum and was pulverized together with the mosque on February 26, 2015
(© Yasser Tabbaa)



The Mosque of al-Nūrī with the al-Habbā' Minaret, from the SE, in its original state, i.e. before its demolition in 1942. The prayer hall was topped with a ribbed conical roof. After the demolition of the mosque, the lavishly decorated mihrāb was transferred to Baghdad Museum
(Library of Congress Prints and Photographs Division, Washington, D.C.)



The Mosque of al-Bāshā, one of the busiest mosques in the southern, commercial zone of the town (photograph by T. J. Bradley, 1928-1929, © Edward Jones)

tion can be seen). The architecture of the mosque combines, in an interesting way, Syrian influences (plain geometric forms) with Persian traditions (brick-work decorations).

The medieval architectural development of the town culminated during the ambitious rule of Badr al-Dīn Lu'lu' (1219–1259), originally an Armenian slave and Muslim proselyte. Badr al-Dīn perhaps converted – for political reasons – to Shi'i Islam and launched the transformation of Mosul architecture in a way that fully represented his religious inclinations. Among other buildings, including the spectacular reconstruction of his own palace, whose ruins have been preserved until today, he built a group of c. 14 mausoleums consecrated to the descendants of the prophet Muhammad through his daughter Fātima and her husband 'Alī ibn Abī Tālib. Some of these mausoleums were created through the conversion of earlier Sunni buildings (Zengid *madrasas*). Badr al-Dīn's architectural program was also unique from an artistic point of view: his buildings were inspired by the contemporary Shi'i architecture of Fatimid Egypt, but also shared many shapes and decorative elements with the Christian architecture of northern Iraq, which suggests that they might have been built by local Christian architects. Typical features of this architecture (the so called Mosul school) are amply decorated brick facades: the geometric decoration being more delicate than earlier and complemented by blue glazed bricks, epigraphic friezes, arabesques and figural reliefs. The same is also reflected in the decoration of the interiors, where decorative elements were carved in local dark grey, spotted marble. The usual domes were replaced with conical brick roofs with a ribbed surface. The breathtaking view of the interiors was enhanced by the use of so-called *muqarnas* vaults.

Badr al-Dīn's architecture was absolutely original in its unique synthesis of trans-regional artistic identities and local traditions, mainly the architecture of Nestorian monasteries. Unfortunately, ISIS deliberately demolished all the buildings in this category, with the exception of the ruins of Badr al-Dīn's residence (Qara Sarāy).

Destroyed heritage: Mosul mosques of the late Islamic period (14th–19th centuries)

The period covering the reigns of the Mongol and Turkic dynasties (Jala'irids, Timurids, Qaraqoyunlu and Aqqoyunlu), as well as the early Ottoman period, should not be considered eras of artistic stagnation. During the reign of the aforementioned dynasties, Mosul was further improved by the building of numerous mosques and *madrasas*, especially in the southern half of the town. For example, the cult of the prophets, whose graves are allegedly located in the town, was highly developed. In the second half of the 14th century, congregational mosques (*jāmi'*) and mausoleums above the graves of the prophets Jonah (in Nineveh) and George were constructed. Later on, the cults of the prophets al-Khidr, Seth (the son of Adam) and Daniel also found a place in Mosul. In the first two cases, the prophetic complexes originated in the place of an older Christian monastery



Shrine of Yahyā ibn al-Qāsim, photograph by Ernst Herzfeld

(Friedrich Sarre and Ernst Herzfeld: *Archäologische Reise im Euphrat- und Tigris-Gebiet*, Band III, Berlin: Dietrich Reimer / Ernst Vohsen, 1911, Tafel CI)



One of the oldest depictions of the interior of a Mosul church dating back to 1843-1850. Its creator is the lithographer F. C. Cooper. The building depicted is the so-called Chaldean Tahra (al-Tahra Maryam al-'Adhrā'), originally the church of the Upper Monastery, founded during the 7th-8th centuries

(George Percy Badger: *The Nestorians and their Rituals*, Vol. II, London: Joseph Masters, 1852, p. 20)

and it is probable that the official Sunni Islam tried to appropriate and make use of the traditional pilgrimage sanctuaries, worshiped for centuries by local Jews and Christians. The existence of the five graves of the prophets in Mosul gave the town the honorable title of “the town of prophets”. The popular syncretic veneration of the prophets was a thorn in ISIS’s side. All the tombs, as well as adjacent mosques, have therefore been destroyed.

An overall assessment of the late Islamic mosques of Mosul has not yet been conducted. Thus, only the general characteristics can be outlined here. The spatial arrangement of most of the buildings was inspired by the Zengid al-Mujāhidī (al-Khidr) Mosque, and possibly also by early Ottoman buildings. The mosques are of a rectangular, three-tract design. The central tract is occupied by a large prayer hall, standing beneath a massive dome. Both side tracts are divided into two square fields, vaulted by two smaller domes and separated from the central hall and from each other by huge, pointed transverse arches, supported by massive pillars. The entrance facades of the mosques are usually covered by elegant vaulted porticos. The characteristic elements of the late Mosul mosques are minarets with brick conical roofs, decorated with a brick ornament *hazārbāf*, and the use of relief-carved marble elements in the interiors, be they wall decoration, *mihrābs*, *minbars*, capitals, or portals with stalactite-decorated lintels, which originated in Christian architecture.

Destroyed heritage: Christian buildings and cemeteries

The first Christian settlement on the western bank of the River Tigris can be reliably dated back to 570, when the Nestorian monk Īshō’yab bar Qusrē founded a large church with a monastery on the grounds of a Sasanian fortress. However, the majority of Christian expansion started only after the influx of inhabitants into the Islamic garrison town, which was founded in the middle of the 7th century. Apart from the dominant Nestorians (Assyrian Church of the East), the Jacobites (Syrian Orthodox Church) were also invited to the town as early as 657. The Nestorian patriarch commented on their arrival with sarcasm, stating that they “had built the church upon the latrines in front of our city gate”. Nevertheless, relations between individual Christian denominations of the town were mostly amiable. The existence of numerous churches is confirmed by sources from the end of the 8th century. Some of them can be reliably identified (according to their patrociniūm) with currently existing sites. Christian institutions in the town were linked with significant monasteries scattered throughout the province of Nīnawā.

The escalation of sectarian violence at the time of the Iraqi war (after 2003) has not bypassed Mosul’s Christians. Systematic attacks on churches, the murder of church dignitaries and the massacre of ordinary Christians led to the decimation of Iraqi churches, whose members mostly fled either to Iraqi Kurdistan or abroad. After the seizure of Mosul, ISIS ordered Christians to leave the town within one week, under penalty of death. Forty-five Christian institutions belonging to seven denominations, as well as all private Christian properties, were confiscated. In its nearly fourteen centuries long history, Mosul is experi-



The Syrian Orthodox church of the Virgin Mary (al-Tahra al-Fawqaniya). Western facade and view through the middle nave towards the east. The shape and decoration of the church was the result of an extensive reconstruction financed by the governors of the al-Jalili family in 1744-1745 (photographs provided by Petr Justa, June 2012)

encing, for the first time, a period without the presence of any Christian community in the town.

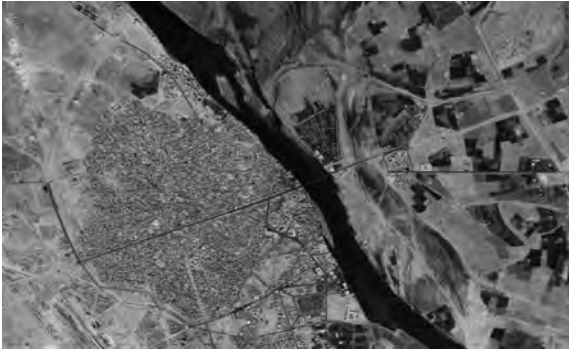
The origin of the Christian architecture associated with Mosul cannot be clarified without further archaeological research. The position of some buildings deep below the current terrain (the church of Mār Ahūdemmeḥ is 7m below the surface, Mār Gīwargīs is 6m, Shim'ūn al-Safā is 5m) provides evidence of their very ancient foundation. The cause of this difference in level is due to unregulated rises in the town's terrain since the early Islamic period. As for medieval architecture and sculptural decoration, only specific items that escaped destruction and extensive renovation have been preserved, as for example the martyrium (crypt) of the church of Mār Yūhanān (Atabeg period), a part of the interior decoration of the Chaldean church of the Virgin Mary (al-Tahra Maryam al-'Adhrā'), or the martyrium and baptistery of the church of Shim'ūn al-Safā. Some of the artistically valuable elements were, as part of earlier reconstructions, transferred to the Baghdad and Mosul museums.

Reports on the destruction of Christian buildings by ISIS in Mosul are contradictory and mostly unverified. Only one church was demonstrably demolished – the Syrian Orthodox Church of the Virgin Mary (al-Tahra al-Fawqāniya, i.e. the Jacobite al-Tahra). The facade of the monastic church of Mār Kūrkiš was also heavily damaged. The alleged destruction of the Mār Ahūdemmeḥ church possibly involved only the above-ground section, which was being used as a mosque. The extent of the devastation of the interiors and church movables will only be possible to assess after the security situation in the town will enable it.

In accordance with the doctrine of *taswiyat al-qubūr* (leveling graves), ISIS also destroyed many cemeteries in the town. The destruction affected Islamic cemeteries (for example, those around the shrine of 'Īsā Dadah and the mosque of Sultan Uways), as well as Christian ones (the cemetery adjacent to the monastery of Mār Kūrkiš and in the courtyard of the Mār Tūmā monastery, the burial site of the Jacobite bishops). ISIS also destroyed the English War Cemetery, the necropolis of the British, Indian, Iraqi and Turkish soldiers who had died in WWI and WWII.

Archaeological survey of the town through remote sensing data

The project *Monuments of Mosul in Danger* is a specific type of archaeological research, based primarily on the use of remote sensing data. Due to the security and political situation in Mosul, we can only examine the architecture of the town through indirect field research, in our case based on the use of satellite images taken using modern satellite systems. Currently, there are a number of commercial satellite systems available on the market, which can take images of the Earth's surface at a very high resolution. The images are created when a satellite flies over the Earth's surface, moving along a predetermined path, usually at a height of 500–800km. The type of satellite image, or more precisely its spec-



Aerial image taken by the Luftwaffe, 1942
(NARA Washington, D.C.)



Satellite image from the Hexagon mission, 1972
(NARA Washington, D.C.)



As a background for the interactive map of Mosul, high resolution satellite imagery provided by the DigitalGlobe system was used. The selected image was vectorized into a high detailed topographic map of Mosul and transformed into a 3D model of the historical center of the city
(archive of the Oriental Institute, the Czech Academy of Sciences)

tral characteristics, determines the parameters of the spatial resolution of individual shots. Panchromatic images (black and white) currently have the highest resolution (up to 0.3m). Multispectral images (color) tend to have a much lower spatial resolution (around 1.2 to 1.8m), although, due to the presence of color spectrum bands, these images are easily readable by the human eye. To obtain the optimum output, the panchromatic and multispectral images, with the use of computer programs, are merged into a single colored image, which retains the spatial resolution of the monochrome version. Through this method (called pan-sharpening), it is possible to get a comprehensive picture of the investigated area with a very high resolution and detail, even when enlarged.

Within the scope of this project, we mostly used data from the WorldView-2 satellite system, with a spatial resolution of 0.46m. Based on an analysis of the images, we are able to look for and map individual architectural objects in the town. Because it is possible to purchase images of an identical area from different time periods, we are also able to efficiently monitor the development of urban building in real-time and track both the deliberate destruction of monuments by ISIS and the collateral damage of monuments that happened during the liberation operation experienced by the town. The high-resolution images allow us not only to identify already destroyed buildings, but also to assess the extent of the damage in detail.

Other than modern satellite images, historical images were also of great use, especially those from the Hexagon American spy system (which operated in the 1970s). At that time, most of the Earth's surface was continuously monitored by an advanced imaging system with a maximum resolution of 0.6 meters.

Satellite data can be used as the basis for 3D virtual models of the town as well as of individual monuments, and also potentially for preparing restoration projects and planning a strategy for the protection of the archaeological and historical heritage of the city of Mosul.

One of the main outputs of the project is a map portal (available at www.monumentsofmosul.com), where visitors can view satellite images of individual destroyed buildings. Part of the map portal consists of a layer where records are stored relating to still-standing historically important buildings. The layer will be made available for scientific purposes.

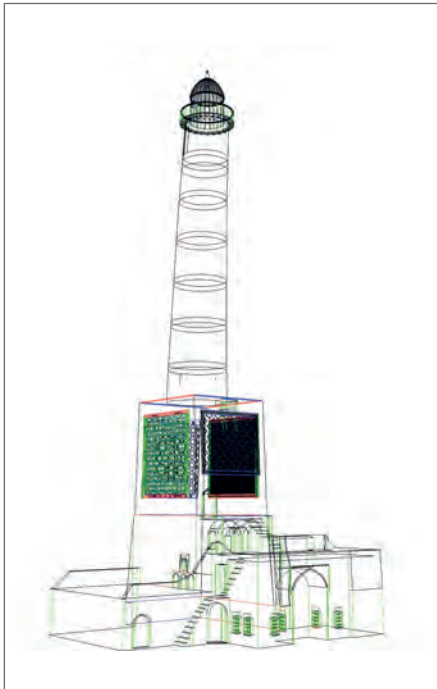
Photogrammetric data processing

One of the main aims of the project *Monuments of Mosul in Danger* is to collect all possible data and documents for the virtual reconstruction of destroyed architecture. The standard procedure, where the reconstruction project is based on plan and drawing documentation, photographs, and structural-historical research of individual architecture, cannot be used in the case of Mosul. Documentation linked to individual ruined monuments, as well as to entire urban blocks of the historical center, is inaccessible today and, for most of the monuments, probably doesn't even exist.

In order to locate buildings, satellite images were used in combination with several urban development plans, starting from the early 20th century. However, these are insufficient for the reconstruction of buildings. Therefore, we decided

to use another method, one that makes it possible, in a relatively simple way, to create virtual 3D models through the use of photographic collections.

The intersection photogrammetry method involves the digital transformation of two or more overlapping images of a given object in such a way that in the resulting image the coordinates and altitudes of any point can be determined. The fundamental step of the data processing activity is calculating the so-called "point cloud" (using the triangulation method), where each point in space is assigned XYZ coordinates. From the point cloud, the polygonal network, which represents the basic geometry and surface of documented object, is calculated. The last step in the whole process is to cover the polygonal network with basic textures captured in the photographs so that the model corresponds, as much as possible, to the actual appearance of the building.



The wire model is the skeleton of a 3D object. There are no surfaces in this type of model; it is composed entirely of points, lines, and curves that describe the edges of the object (archive of the Oriental Institute, the Czech Academy of Sciences)



The surface model. Not only the edges of the 3D object, but also its surfaces are defined (archive of the Oriental Institute, the Czech Academy of Sciences)

Using this method, we are able to create three-dimensional topographic models to the exact scale and, on this basis, to precisely reconstruct the dimensions of individual buildings.

The use of this process is contingent on several factors:

- There must be a sufficient number of images of the object;
- The optimum overlap of adjoining images must be at least 60%;
- The object has to be photographed from different sides and angles, so that identical points can be found in various photographs;
- Pictures must be of good quality (brightness, sharpness, etc.).



Pre-engineered textures of materials contained in the object are applied to individual 3D model areas

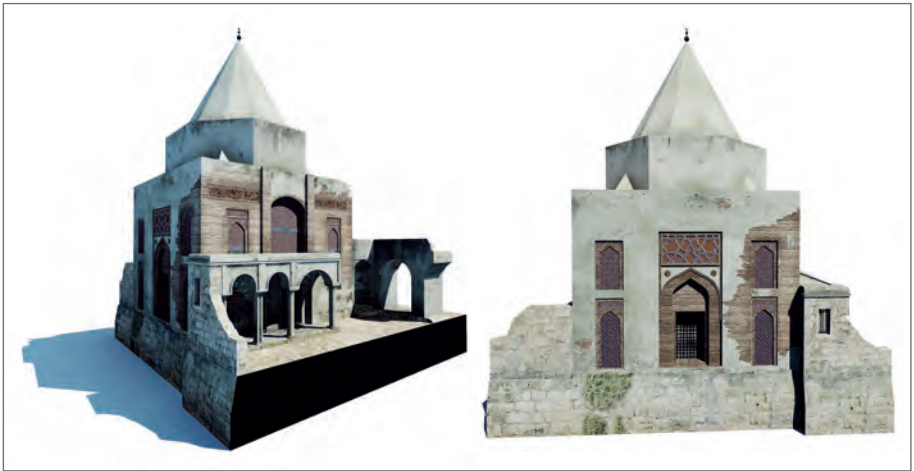
(archive of the Oriental Institute, the Czech Academy of Sciences)



Post-production filters are applied to the 3D model for a more realistic view. The edges are turned off.

The direction and intensity of illumination, as well as the color correction, are properly set and the material properties such as light reflection and surface roughness are adjusted

(archive of the Oriental Institute, the Czech Academy of Sciences)



3D reconstruction of the Shrine of Yahyā ibn al-Qāsim
(archive of the Oriental Institute, the Czech Academy of Sciences)

Photographic collections of Mosul monuments are of very diverse quality. In fact, an insufficient number of usable photographs limits the full use of photogrammetry. Only a few historical buildings have been reconstructed so far, mostly through coarse building models (created as photogrammetrical outputs), which were adjusted through a manual graphical and surveying process, so that the final 3D models were metrically reliable and free of any blind spots. The future of the project rests on the further discovery of photographic and plan documentation, which would enable us to improve the quality of existing models and create similar reconstructions of other Mosul buildings.

The Project Team

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On June 10, 2014, the northern Iraqi metropolis of Mosul was occupied by the radical organization ISIS. A formal proclamation of a new caliphate was issued only three days later and closed with these words: “And now, you should go forth and enjoy a just and peaceful Islamic rule (...), you shall find what a remarkably great difference it is compared to the unjust secular government.” The result of this three-year long “just rule” of ISIS has been the death of about 50,000 Mosul inhabitants, half a million exiles and a totally devastated city, which had been, before the war, one of the most valuable heritage towns in the Middle East. The most precious monuments, which once proclaimed the multifarious ethnical and religious past of the town, have fallen victim to the Mosul cultural genocide. A group of Czech historians and archaeologists, along with their Iraqi colleagues, have started to systematically track these cultural losses. Their project is an attempt to digitally revive the irretrievably destroyed heritage of the city of Mosul.

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