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United Nations
Educational, Scientific and
Cultural Organization



Satellite-Based Damage Assessment of Cultural Heritage Sites

2015 Summary Report of
Iraq, Nepal, Syria & Yemen

June 2016



FOREWORD

Thanks to the Memorandum of Understanding signed between UNESCO and UNITAR in 2015, and building on our previous report on damage to archeological sites in Syria (2014), satellite imagery analysis is now a routine tool for assessing potential damage to cultural heritage sites. UNITAR's UNOSAT programme ensures timely access to imagery derived information over areas of conflict inaccessible to the international community and provides supplemental information to field data when access is possible. This applies to the protection of cultural heritage both in conflict situations and during natural disasters. The complementary roles of UNESCO and UNITAR-UNOSAT are important as they ensure an objective One UN assessment of the status of cultural heritage, free from political bias and founded on scientific methods. This is of particular significance during conflict situations, such as in Syria and Iraq.

The examples given in this report illustrate both the invaluable heritage of the specific sites through UNESCO's contribution and the resulting technical analysis performed by UNITAR-UNOSAT. With World Heritage properties and other cultural heritage under increasing risk of destruction, objective and timely information is crucial for UNESCO and affected governments to call for and take action towards its protection. UNOSAT is pleased to contribute to this important work and to once again guide the way to apply innovative satellite imagery solutions for UN sister agencies and Member States.

Our partnership with UNESCO is a good example of how innovative applications of satellite imagery and other geo-spatial technologies make a difference in the way the United Nations supports its member states.



EINAR BJORGØ

Manager, UNOSAT
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FOREWORD

Since the signing of the Memorandum of Understanding between UNITAR-UNOSAT and UNESCO in June 2015, cultural heritage around the world has continued to suffer on an unprecedented scale from intentional attacks, collateral damage, widespread looting and the effects of natural disasters. Many of the countries affected by conflicts remain inaccessible, while those hit by disaster are also often hard to enter immediately.

However, thanks to their collaborative efforts, UNITAR-UNOSAT and UNESCO are now able to monitor damage to cultural heritage via satellite imagery, as shown in this report. While UNOSAT provides technical expertise in remote monitoring, UNESCO contributes to this partnership through its vast network of cultural heritage experts, who help identify damage and put it into context. Satellite images are then corroborated by data collected on the ground, where available.

Satellite imagery helps to clarify situations, deploy cultural first aid wherever it is most needed, if the security conditions allow, and plan for future recovery. This report provides a glimpse of the potential of this technology and cooperation between UNESCO and UNITAR-UNOSAT, which we hope will be considerably developed in the future.

Monitoring cultural heritage in areas affected by conflict or natural disasters, including through the use of satellite imagery, is a critical step to preserve the memory of our past as it supports damage assessment and allows to start planning for recovery.

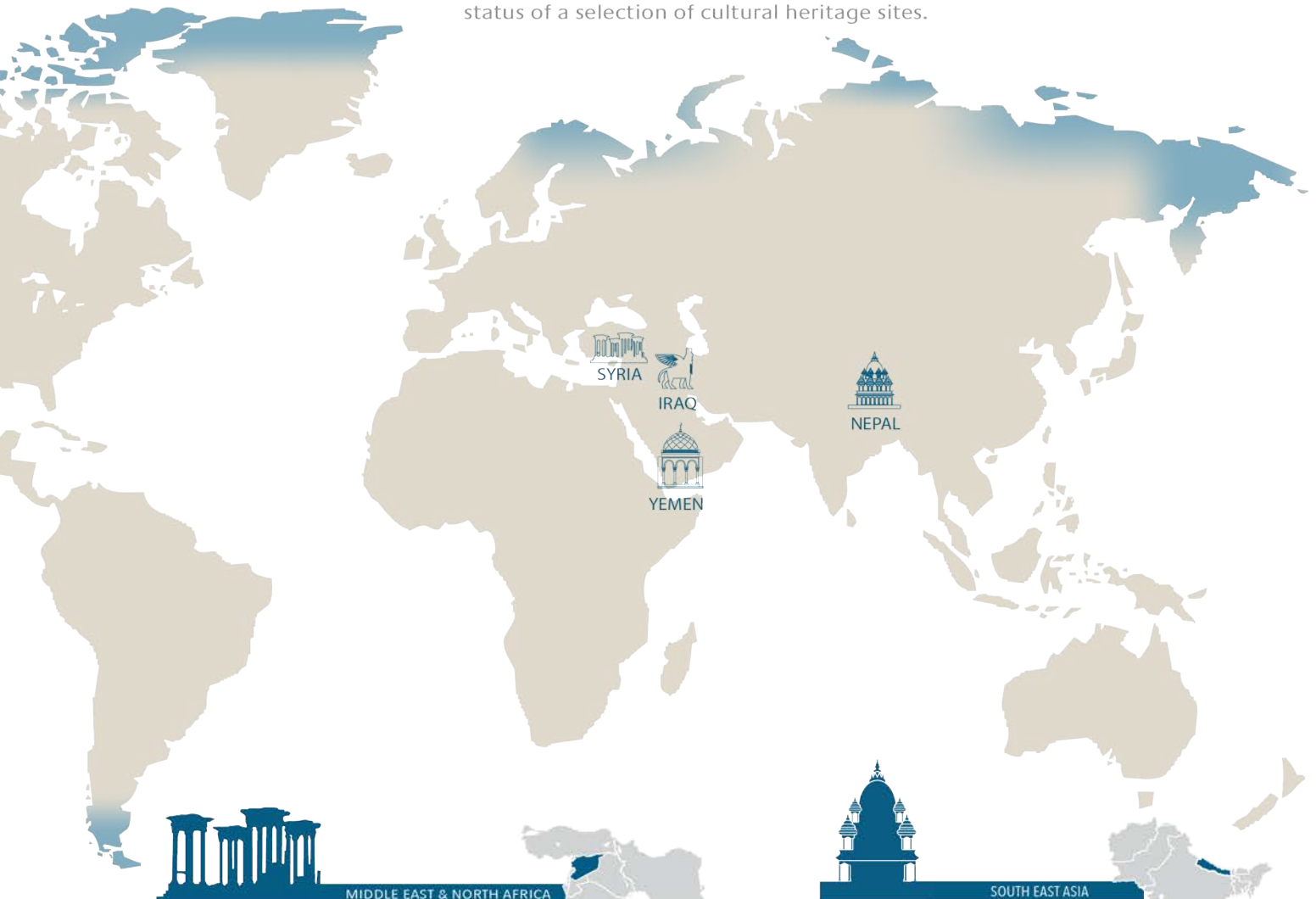


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Francesco Bandarin
Assistant Director-General
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CULTURAL HERITAGE SITES ASSESSMENTS IN 2015

During the ongoing conflicts in Iraq, Syria and Yemen and the earthquake that affected Nepal in 2015, the UNITAR's UNOSAT programme has been supporting the humanitarian community with satellite imagery derived analysis. While conducting damage assessments of civilian infrastructure in those countries, it became evident that widespread destruction and damage has been inflicted on cultural heritage locations. This report is the result of a dedicated, combined effort between UNOSAT and UNESCO to assess the current status of a selection of cultural heritage sites.



MIDDLE EAST & NORTH AFRICA

SYRIA

Since March 2011, Syria's exceptional cultural richness has continuously suffered as a result of the ongoing conflict. Many of its important monuments, including some on UNESCO's World Heritage List, have been severely damaged due to the conflict.



MIDDLE EAST & NORTH AFRICA

IRAQ

Since early 2003, Iraq's rich cultural heritage, one of the oldest in the world, has been at risk of destruction and looting by various actors.



SOUTH EAST ASIA

NEPAL

The April 2015 earthquake heavily affected most of the cultural heritage sites in Nepal, in particular within the Kathmandu Valley World Heritage property.



MIDDLE EAST & NORTH AFRICA

YEMEN

Since March 2015, Yemen's abundant cultural heritage has been put at risk by the ongoing conflict in the country, including a number of sites inscribed on UNESCO's World Heritage List.

IRAQ

The story of civilization in Iraq spans some 10,000 years. As the birthplace of writing, the wheel, and countless other human inventions, Iraq's past has shaped our present. Iraq, a country in turmoil within an unstable region, is fighting a cultural battle in every sense of the word, as its cultural heritage is deliberately being destroyed.



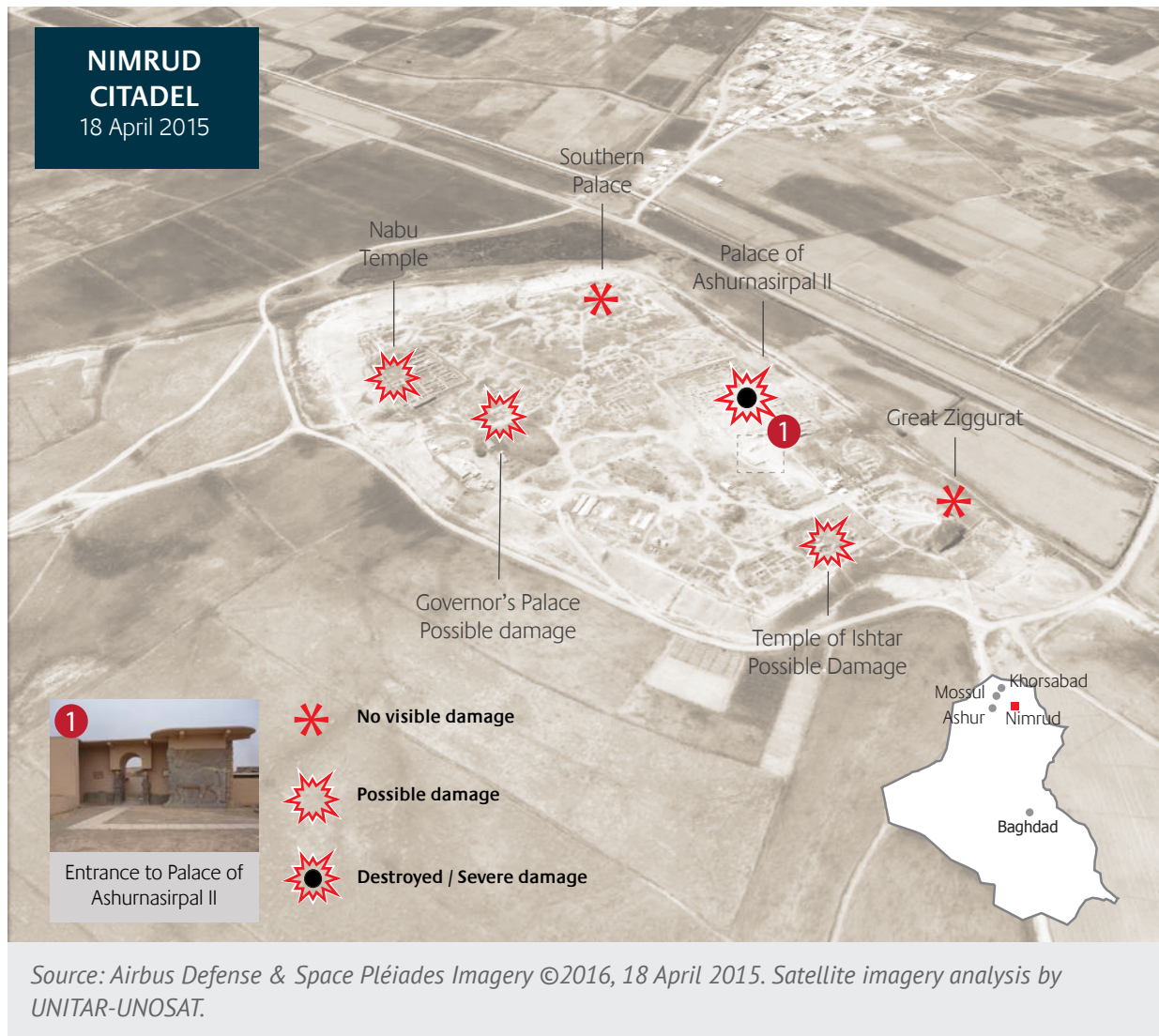
The archaeological site of **Nimrud**, located on the east bank of the Tigris River and 37 km to the south-east of Mosul, was the second capital of the Assyrian Empire, founded in 883 BC and known as Kalhu or Kalah. It had been a well-settled place for a thousand years before it was built as a centre of the kingdom of Shalmaneser I (1273-1244 BC). Under King Ashurnasirpal II (883-859 BC), the city was first designated as the Assyrian capital in 879 BC and housed up to 100,000 inhabitants. The city had a four-sided wall measuring 8 km, and several buildings raised on mud-brick platforms as high as 12 m above river-level. Some of the buildings included the temple of Ninurta, the North West Palace (Ashurnasirpal II's) and the South West Palace (Esarhaddon's), Sargon's palace, and others, notably the so-called ziggurat, which resembled a conical hill, with its remains rising to a height of 17 m. Some beautiful bas-relief slabs were still featured on the site, though most of them were taken abroad by excavators, including a large number of exquisite ivory carvings, such as the so-called "Mona Lisa of Nimrud" and a gilded lapis lazuli and agate-set piece showing a lioness mauling an Ethiopian, found in the 45.5x10.5m throne room. The Palace of Ashurnasirpal, also known as the North West Palace, was first excavated by the British explorer Austen Henry Layard in the 1840s. His excavations are the source of the winged bull gatekeeper statues currently displayed at the British Museum.

In early March 2015, the Islamic State in Iraq and the Levant (ISIL/Daesh) commenced the gradual destruction of Nimrud by bulldozing and hammering down many of the ancient artefacts. This intentional act followed several reports of looting and other destructive activities at the site.

Nimrud has been listed on Iraq's Tentative List of World Heritage since 2000. UNOSAT documented the acts of destruction and looting using a satellite image from 7 March 2015, compared with imagery collected 2 June 2010 identifying a breach close to the main entrance to the Ashurnasirpal II Palace (see image inset in page 5). A month later ISIL/Daesh reportedly placed explosives inside the Ashurnasirpal II Palace destroying the vast majority of the main structure.

Hatra was founded as an Assyrian city by the Seleucid Empire during the 3rd century BC. A religious and trading centre of the Parthian Empire, Hatra flourished during the 2nd and 1st centuries BC. Later, the city became the capital of what is believed to be the first Arab Kingdom in the chain of Arab cities running from Hatra, in the north-east, via Palmyra and Baalbek to Petra, in the south-west. The region controlled from Hatra was the Kingdom of Araba, a semi-autonomous buffer kingdom on the western limits of the Parthian Empire, governed by Arabian princes. Hatra became an important fortified frontier city and withstood repeated attacks by the Roman Empire from Trajan (116/117) and Septimius Severus (198/199) before eventually falling to the Sassanians in 241 AD who razed the city.

The remains of the city, especially the temples where Hellenistic and Roman architecture blended with Eastern decorative features, attested to the greatness of its civilization.



They provided, moreover, exceptional evidence of an entire facet of Assyro-Babylonian civilization subjected to the influence of Greeks, Parthians, Romans and Arabs. Impressive examples of Hatran art, with its statues of kings and precious collections of gold, silver and copper objects, can be admired at the National Museum of Iraq.

On 4 April 2015, ISIL/Daesh released a video showing the destruction of Hatra, which has been inscribed on UNESCO's World Heritage List since 1985 and was inscribed on the List of World Heritage in Danger in 2015, owing to its location in the area around Mosul controlled by the extremist group. However, using a 17 October, 2015 satellite image, UNOSAT found no visible signs of damage or looting in the immediate vicinity of Hatra.

The ancient city of **Ashur** is located on the Tigris River in northern Mesopotamia in a specific geo-ecological zone, at the borderline between rain-fed and irrigation agriculture. The city dates back to the 3rd millennium BC. From the 14th to

the 9th centuries BC it was the first capital of the Assyrian Empire, a city-state and trading platform of international importance. It also served as the religious capital of the Assyrians, associated with the god Ashur, and the place for the crowning and burial of its kings. The city was destroyed by the Babylonians, but later revived during the Parthian period in the 1st and 2nd centuries AD.

The excavated remains of the public and residential buildings of Ashur provided an outstanding record of the evolution of building practice from the Sumerian and Akkadian period through the Assyrian empire, as well as the short revival during the Parthian period.

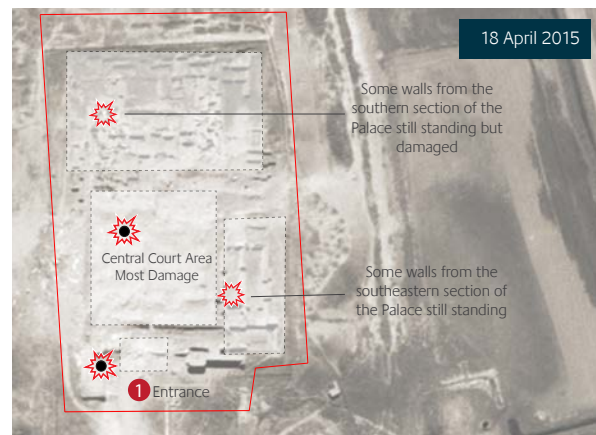
Ashur was inscribed on UNESCO's World Heritage List and the List of World Heritage in Danger in 2003. In May 2015, local sources reported the destruction of the site by ISIL/Daesh but satellite imagery analysis using an image collected on 26 February, 2015 detected no visible damage inside the city remains.

Khorsabad or Dar Sharrukin was the fourth capital of the Kingdom of Assyria, located 15 km to the north-east of Mosul, and built by King Sargon II (722-705 BC) as the centre of his reign. It was constructed in a square form surrounded by a fence that comprised 150 towers and 8 entrances. Each of the entrances was decorated with several winged bulls and named after one of the Assyrian kings. The city walls enclosed an area measuring about 1,600 by 1,750 metres. The great palace of Sargon and the temple area were built on a terrace straddling the north-west wall of the city, while the

arsenal lay near the southern corner. Since it was a single-era capital, few objects linked to Sargon II himself were found. However, the site is renowned for shedding light on Assyrian art and architecture.

The most famous buildings in Khorsabad are the Palace of the King, the departments close to it, and several nearby temples such as the recently reconstructed Temple of the Sibitti ("The Seven Gods"). The Ziggurat is situated behind these temples on the north-western side. It has spiral staircases which surround the body of the Ziggurat. The inside walls of the King's Palace were covered with magnificent marble and some bronze bas-relieves, which were taken by archaeologists to the Louvre Museum in the last century. The massive winged bulls that guarded the doorways were also scattered among a number of museums around the world. Two of them are in the National Museum of Iraq in Baghdad.

Satellite imagery collected on 13 March 2015 showed no damage to the palace or any of the structures.



PALACE OF ASHURNASIRPAL II - UNOSAT confirmed the destruction and extent of the damage using satellite imagery from 18 April, 2015 compared to imagery collected on 7 March 2015 (see before and after images). The satellite derived damage assessment showed extensive damage over the Ashurnasirpal II Palace, inside the Nimrud Citadel. The main court area inside the palace and the surrounding building structures, including the entrance, appeared to be completely destroyed. Some of the surrounding corridors walls appeared to be intact, but most likely damaged. (Source: Before image (left) - Airbus Defense & Space Pléiades Imagery ©2016, 7 March 2015. After image (right) - Airbus Defense & Space Pléiades Imagery ©2016, 18 April 2015. Satellite imagery analysis by UNITAR-UNOSAT.)

NEPAL

Located in the foothills of the Himalayas, the Kathmandu Valley World Heritage property was inscribed in 1979 as seven Monument Zones. These monument zones include the Durbar squares, or urban centres, with their palaces, temples and public spaces of the three cities of Kathmandu (Hanuman Dhoka), Patan and Bhaktapur; and the two Hindu centres of Pashupatinath and Changu Narayan and the two Buddhist centres of Swayambunath and Boudhanath.



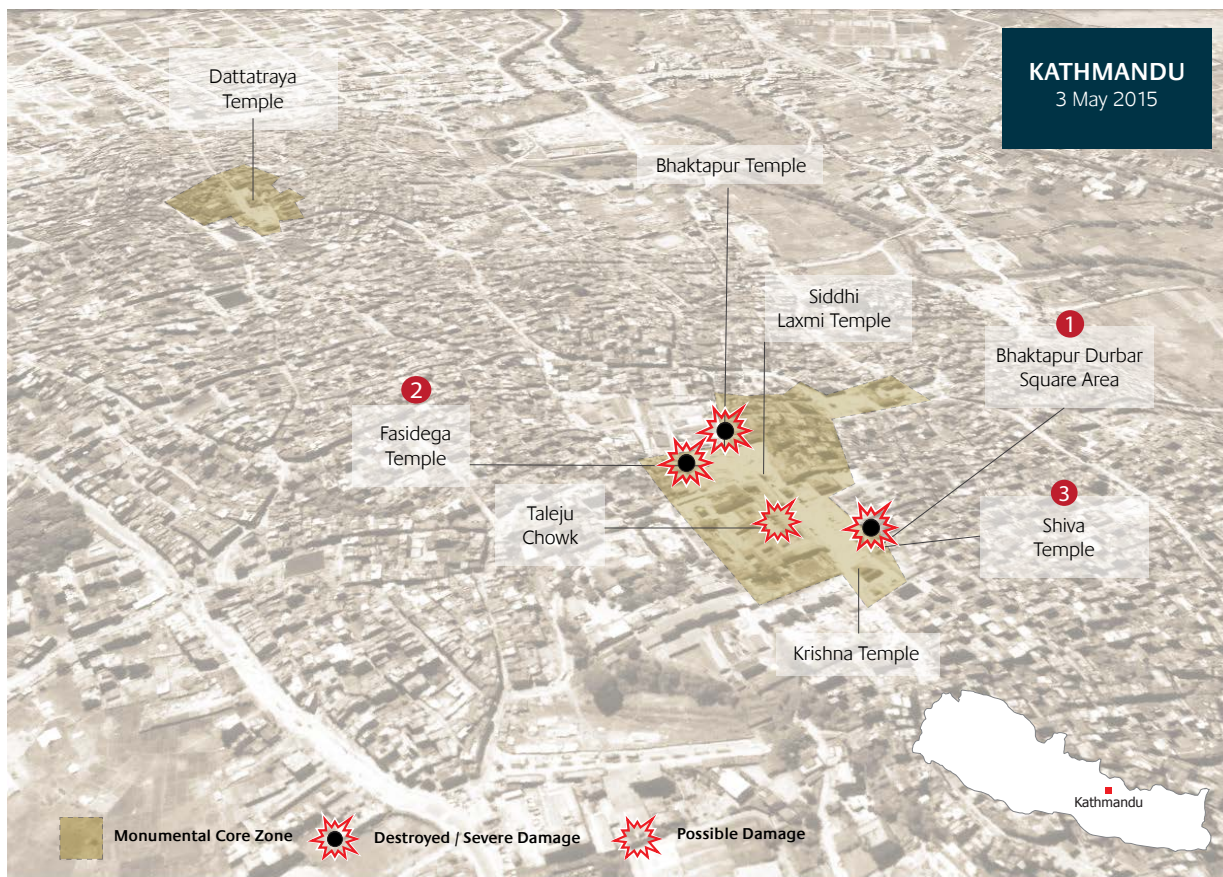
The religious ensemble of **Swayambhu** includes the oldest Buddhist monument (a stupa) in the Valley; Boudhanath includes the largest stupa in Nepal; Pashupati has an extensive Hindu temple precinct, and Changu Narayan comprises a traditional Newari settlement, and a Hindu temple complex with one of the earliest inscriptions in the **Kathmandu Valley** dating from the 5th century AD. The unique tiered temples are mostly made of fired brick with mud mortar and timber structures. The roofs are covered with small overlapping terracotta tiles, with gilded brass ornamentation. The windows, doorways and roof struts have rich decorative carvings. The stupas have simple but powerful forms with massive, whitewashed hemispheres supporting gilded cubes with the all-seeing eternal Buddha eyes. As Buddhism and Hinduism developed and changed over the centuries throughout Asia, both religions prospered in Nepal and produced a powerful artistic and architectural fusion beginning as early as the 5th century AD, but truly coming into its own in the 300-year period between 1,500 and 1,800 AD. These monuments were defined by the outstanding cultural traditions of the Newars, manifested in their unique urban settlements, buildings and structures with intricate ornamentation displaying outstanding craftsmanship in brick, stone, timber and bronze, which are some of the most highly developed in the world.

On 25 April 2015, an earthquake with an estimated magnitude of 7.8 hit the region. The monuments and sites of six of the seven Monuments Zones within the Kathmandu Valley World Heritage property suffered extensive damage, as well as most of the other cultural and natural heritage sites located in the affected area.

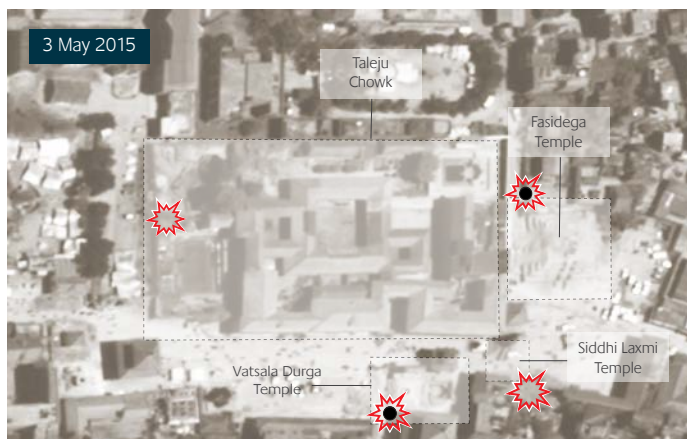
Boudhanath was the only monument zone which did not suffer visible damage that could be observed in satellite imagery. Regarding the other six monumental zones, a total of 175 structures (monuments and buildings) located in the core and buffer zones were affected: 43 structures have been destroyed, 53 structures show severe damage and 79 have been moderately damaged. Satellite image analysis of Bhaktapur Durbar Square Monumental Zone from 3 May 2015 shows severe damage to Fasidaga Temple and Vatsala Durga Temple and moderate damage to Taleju Chowk and Siddhi Lazmi Temple as seen in the UN-ASIGN* pictures on page 8. Inside the perimeter of the monumental zone, a total of 45 structures were identified in satellite imagery as affected by the earthquake.



*Free mobile phone app for taking geo-located pictures and sending these automatically to UNOSAT server at CERN.
Scan QR Code to download



Source: Digital Globe WorldView 2 ©2016, 3 May 2015. Satellite imagery analysis by UNITAR-UNOSAT.



Bhaktapur Durbar Square Monument Zone shows severely damage to the Fasidega Temple and Vatsala Durga Temple and moderate damage to the Taleju Chowk and Siddhi Lazmi Temples. Inside the perimeter of the monument zone a total of 45 structures were affected by the earthquake.

Source: Digital Globe WorldView 2 ©2016, 3 May 2015. Satellite imagery analysis by UNITAR-UNOSAT.



Bhaktapur Durbar Square, 5 May 2015. Photo: UNOSAT UN-ASIGN ©2015.



Fasidega Temple, 5 May 2015. Photo: UNOSAT UN-ASIGN ©2015.



Shiva Temple, 5 May 2015. Photo: UNOSAT UN-ASIGN ©2015.

SYRIA

Escalating violence in Syria since 2011 has had a devastating effect on the country's cultural heritage. From the ancient souk, or marketplace in Aleppo, to the iconic Crac des Chevaliers; and the ancient city of Palmyra, the destruction of Syria's most significant and symbolic sites is of urgent and primary concern, with irreversible implications for the country's and humanity's cultural legacy.



Standing at the crossroads of several civilizations, the art and architecture of **Palmyra** from the 1st to the 2nd century married Graeco-Roman techniques with local traditions and Persian influences. Palmyra was inscribed on UNESCO's World Heritage List in 1980 and, threatened by the conflict in Syria, was added on the List of World Heritage in Danger in 2013. Three of the greatest and best-preserved examples of this exceptional blending of styles were intentionally destroyed by ISIL/Daesh in 2015:

- The **Baalshamin Temple** was built nearly 2,000 years ago, and bore witness to the depth of the pre-Islamic history of the country. Its structure dated to the Roman era, erected in the 1st century AD, and was further enlarged by Roman emperor Hadrian.
- The **Temple of Ba'al** represented a remarkable fusion of the architectural styles of the ancient Near East and the Greco-Roman tradition, visible in its sculptured ceilings, monumental podium and friezes, which told the story of the city and featured camel caravans and the constellations. It was one of the most important religious edifices of the 1st century in the Orient. Only the cement-reinforced portico survived the act of destruction.
- The **Arch of Triumph**, built by Septimius Severus between 193 and 211 AD, marked the junction between an immense colonnade more than one kilometer in length and the Temple of Bel. A masterpiece of civil architecture and urban planning, the Arch was topped by geometric and floral ornaments. The treatment of sculptures and engravings was an outstanding example of Palmyran art.

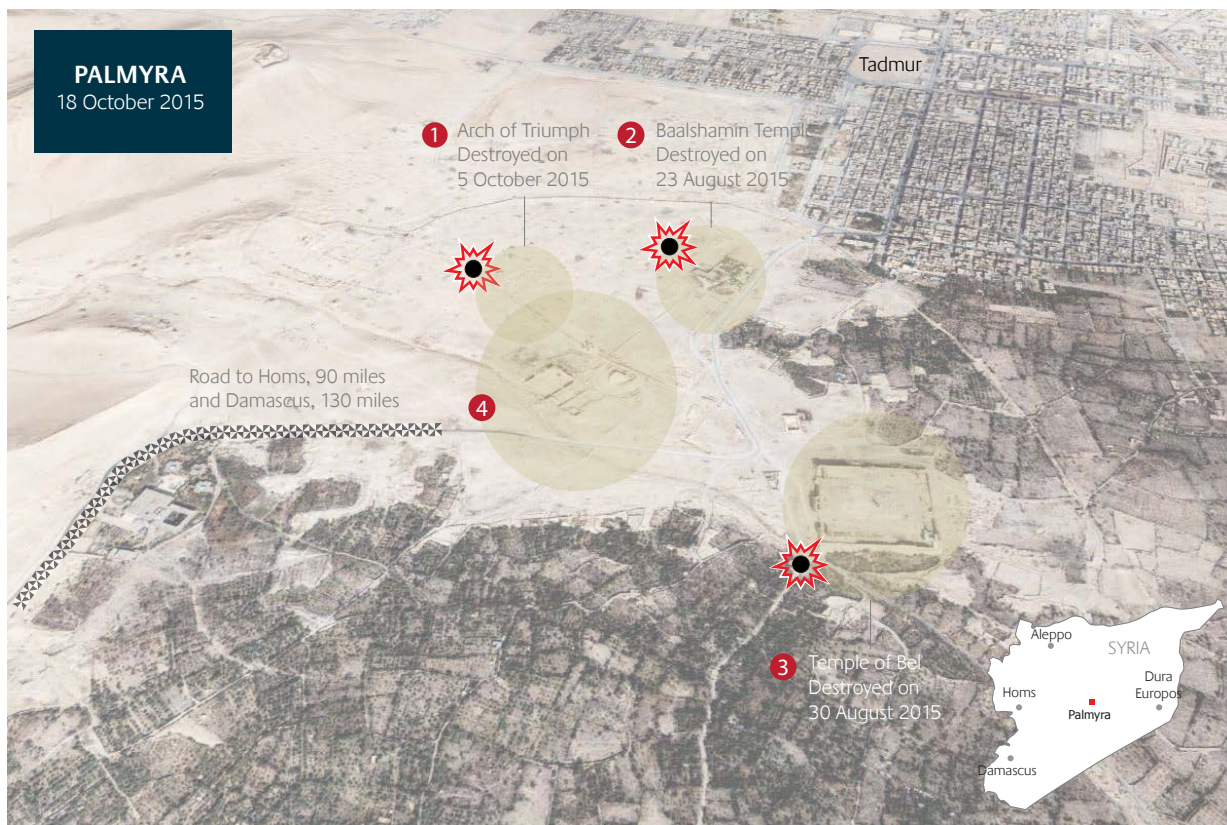
On 13 May 2015, ISIL/Daesh launched an attack on the modern town of Tadmur, sparking fears that the group would destroy some of the many heritage sites in the adjacent ancient site of Palmyra (see QR Code). On 23 August 2015 ISIL/Daesh militants reportedly detonated a large quantity of explosives inside the Baalshamin Temple. Using a 25 August 2015 satellite collected image compared to a 26 June 2015 satellite image, UNOSAT assessed the extent of the damage and reported the complete destruction of the temple, which is estimated to have occurred between the 25 and 27 August 2015 (see page 11).

Shortly after, on 30 August 2015, ISIL/Daesh reportedly destroyed the Temple of Ba'al. Using a satellite image collected on 31 August 2014 compared with a satellite image collected on 27 August 2015, UNOSAT confirmed the destruction of the main temple inside the temple grounds. On 5 October 2015 ISIL/Daesh destroyed the Arch of Triumph at the entrance of the Great Colonnade of Palmyra. Using a satellite image collected on 18 October 2015 and comparing it to a 14 February 2014 satellite image, UNOSAT assessed the extent of the damage and reported the complete destruction of the Arch (see page 11).

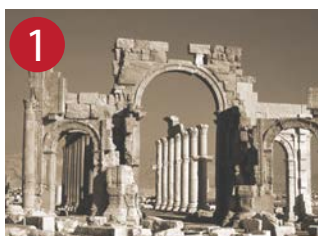


Near real-time imagery was received from UrtheCast permitting timely information to UNESCO and its partners. This image was acquired on 31 August 2015. It was analyzed and distributed to UNESCO that same day, and immediately featured in

numerous international media reports following initial dissemination by UNOSAT on Twitter. **Scan the QR code to read the article and watch the video** (Satellite images show Palmyra temple destruction, 1 September 2015. BBC News)



Damaged Locations in Palmyra - Between 23 August 2015 and 5 October 2015 (43 days) ISIL/Daesh destroyed a total of three Cultural Heritage Sites in Palmyra, Syria. (Source: Airbus Defense and Space Pléiades Imagery ©2016. Satellite imagery analysis by UNITAR-UNOSAT.)



1 Arch of Triumph

Scan QR Code for the UNOSAT Arch of Triumph Damage Assessment (18 October 2015).
Photo credit: UNESCO, Degeorges, G.



3 Temple of Ba'al

Scan QR Code for the UNOSAT Damage Assessment of Temple of Ba'al (31 August 2015).
Photo credit: Bernard Gagnon, Wikimedia Commons.



2 Baalshamin Temple

Scan QR Code for the UNOSAT Damage Assessment of Baal Shamin Temple (25 August 2015).
Photo credit: Wikimedia Commons.



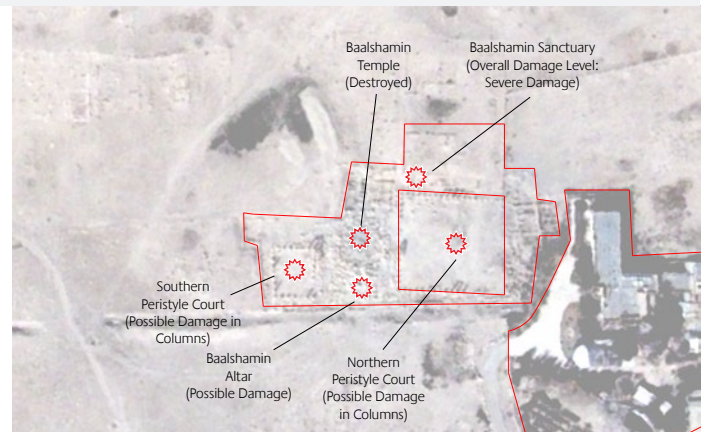
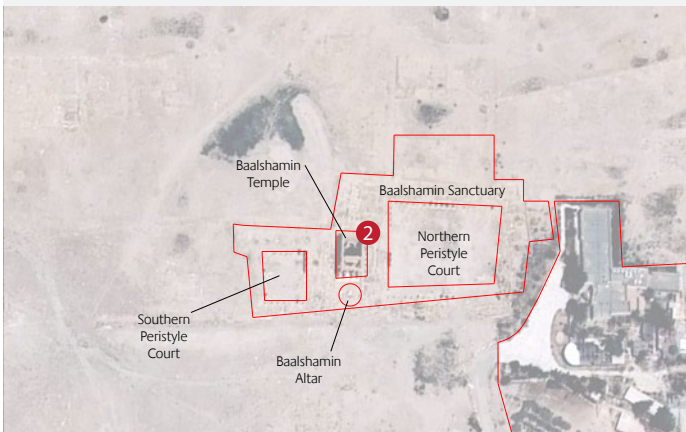
4 Ancient City of Palmyra

Scan QR Code for the UNOSAT Satellite-based Damage Assessment to Cultural Heritage Sites in Palmyra (30 March 2016).
Photo credit: Bernard Gagnon, Wikimedia Commons.

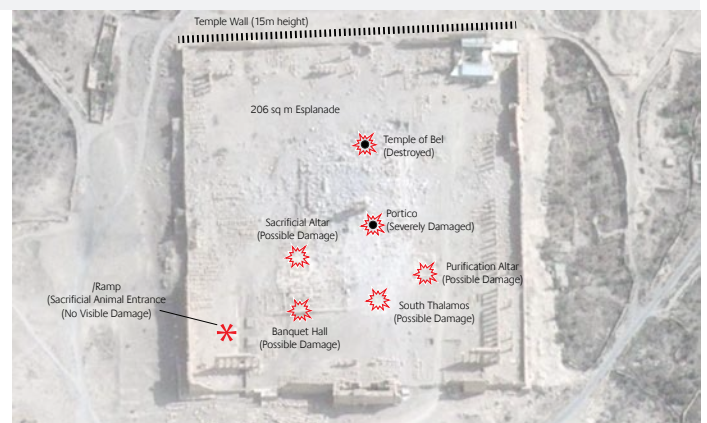
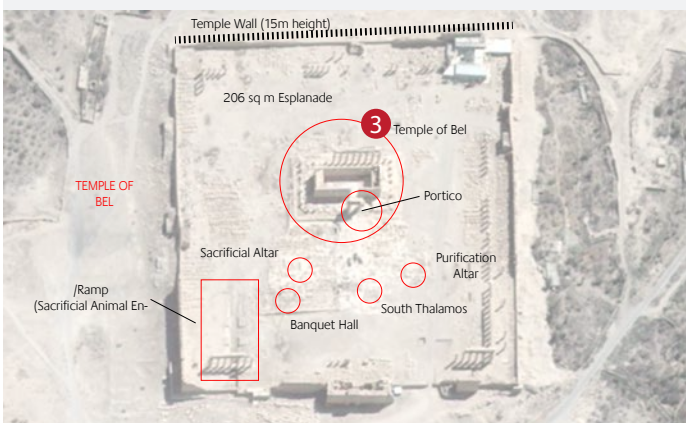




Arch of Triumph - The damage caused by the alleged explosive devices placed at the Arch of Triumph in Palmyra, Syria, destroyed the arch and most likely damaged many of the adjacent columns of the colonnade. (Source: Before image (left) - Airbus Defense & Space Pléiades Imagery ©2016, 26 June 2016. After imagery (right) - Airbus Defense & Space Pléiades Imagery ©2016, 18 October 2016. Satellite imagery analysis by UNITAR-UNOSAT.)



Baalshamin Temple - The damage caused by the detonation of a large quantity of explosives placed inside the Baalshamin Temple destroyed the temple and the Baalshamin Altar inside the sanctuary grounds. The expansive explosion possibly damaged all the other surrounding columns and structures that are within the sanctuary. (Source: Before image (left) - Airbus Defense & Space Pléiades Imagery ©2016, 26 June 2015. After image (right) - Airbus Defense & Space Pléiades Imagery ©2016, 18 October 2016. Satellite imagery analysis by UNITAR-UNOSAT.)



Temple of Ba'al - The damage caused by the alleged explosive devices placed inside the Temple of Ba'al in Palmyra, Syria, destroyed the Temple of Ba'al at the centre of the esplanade, severely damaged the portico and possibly damaged all the other surrounding structures that are within the temple walls. (Source: Before image (left) - Airbus Defense & Space Pléiades Imagery ©2016, 27 August 2015. After image (right) - Airbus Defense & Space Pléiades Imagery ©2016, 18 October 2016. Satellite imagery analysis by UNITAR-UNOSAT.)

YEMEN

Yemen has long stood at the crossroads of cultures, with its strategic trading location in the west of the Arabian Peninsula. Since the outbreak of the conflict, UNESCO has been cooperating closely with the General Organization of Antiquities and Museums (GOAM) and the General Organization for the Preservation of Historic Cities in Yemen (GOPHCY) to safeguard Yemen's cultural heritage.

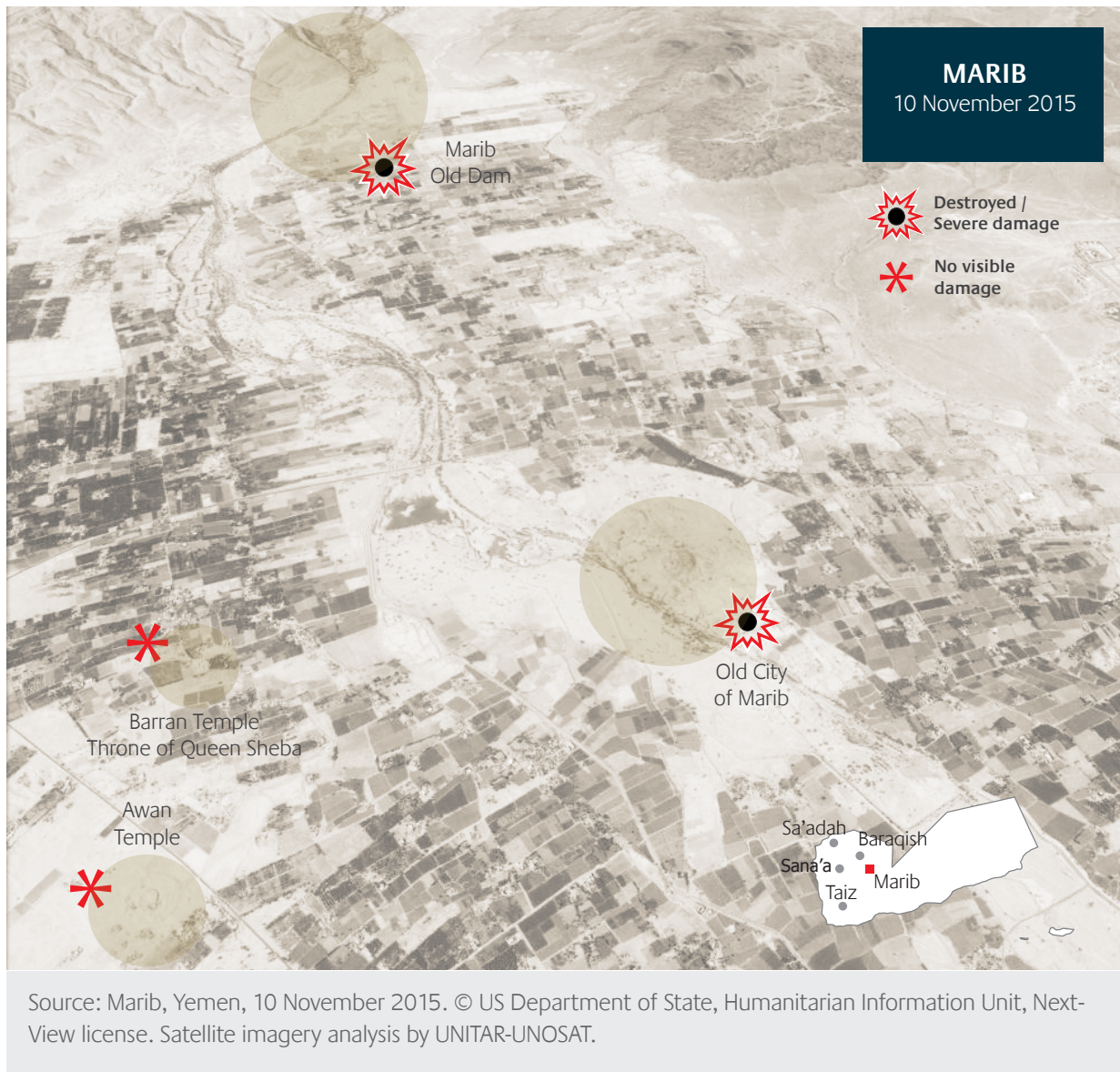


With an expanse of 98 hectares, the Sabaean capital **Marib** was the largest ancient city in Southern Arabia and is considered one of the most significant historic sites in the Arabian Peninsula. Despite climatically unfavourable conditions, at the end of the 2nd millennium BC, a complex society emerged there, whose economy relied on a highly developed irrigation system. Thanks to its economic prosperity and geographic location, Marib became the most important trading station along the Incense Route. Marib hosts several important cultural sites such as the Bar'an Temple, the Awam Temple with its necropolis, the Wadi Ghufaina settlement and al-Mabna dam, and the Great Dam of Marib, which is considered to be a wonder of technical engineering and also appears in a verse of the Qur'an. Both the Great Dam of Marib as well as the Ancient City, part of the Archaeological site of Marib listed on Yemen's Tentative List of World Heritage since 2002, have been bombed and looted on several occasions over the course of the current conflict, severely damaging the site's historic structures. The Dam of Marib, twice as long as the Hoover Dam, sustained the largest city in ancient southern Arabia for more than a thousand years. Satellite imagery collected on 29 October 2015 confirmed the severe damage sustained by the two remaining sluices in the ancient dam system (see before and after images on page 14). Satellite imagery collected on 29 October 2015 also showed extensive damage to the ruins of the Ancient City of Marib and increased looting activities within the citadel, as well as new construction activities in the immediate vicinity of the area.

The ancient walled town of **Baraqish** once had more than fifty towers and two gates, and its walls reached a height of up to 14 m. Located in the

wide Wadi Fardha, it was previously known as Yathil, the dominant town in the Minean Kingdom and an important centre on the Incense Route. The Minean Temple of Nakrah, part of the ancient city, dates from the 1st millennium BC. The ancient city, and specifically the Temple of Nakrah, have suffered substantial damage as a result of bombing on several occasions. Satellite imagery collected on 29 October 2015 shows the extent of the damage to the Temple of Nakrah and numerous impact craters in the immediate vicinity of the Old City of Baraqish.

Taiz is the third largest city in Yemen, after Sana'a and Aden. Taiz, also written Ta'izz, dates back to at least the 11th century AD. It served as a dynasty capital during the late medieval period and as a capital of Yemen from 1948 to 1962, during the rule of Imam Ahmed. The city has many old and beautiful quarters, with houses built in the typical Yemeni burnt brick style. The historic Cairo Citadel, located on top of a mountain spur 450 metres above the city centre, was severely damaged in airstrikes. Satellite imagery from 26 June 2015 shows extensive damage to the main building in the centre of the castle mount. Built in the 5th century, it used to play an important military and political role throughout the history of the region, owing to its strategic position overlooking the city as well as the latter's location along the caravan routes.



Sallah palace, built in the 20th century and used as a museum until the beginning of the conflict, was also targeted and severely damaged. Satellite imagery from 1 November, 2015 shows severe damage to the north-eastern corner of the main museum buildings.

Sa'adah is one of the oldest medieval cities in Yemen, of great importance for its historic, architectural, urban and spiritual value. Founded in the 9th century, it became the cradle of Zaydism, an influent school of thought in Yemeni Islam. Continuously inhabited, it is constructed in the typical Yemeni burnt brick style, and surrounded by an exceptional earthen wall, 3,000 metres long and 4 metres large, enriched with 52 towers and 16 gates. Houses and palaces are built of mud and brick and are several stories high. Fourteen mosques in the city dated back to the 10th to 16th centuries. The Great Mosque, which houses the

final resting places of the eleven successors of the first Zaydite Imam, as well as the An-Nisari Mosque, are considered high places of spiritual education and are of undeniable architectural value, their minaret and domes being of rare beauty.



Source: Marib, Yemen, 29 October 2015. © US Department of State, Humanitarian Information Unit, NextView license. Satellite imagery analysis by UNITAR-UNOSAT.

The Historic city of Sa'adah, listed on Yemen's Tentative List for potential nomination for World Heritage inscription since 2002, has suffered extensive damage as a result of the ongoing conflict, with many historic buildings, including the Imam al-Hadi mosque, severely affected. UNOSAT's satellite imagery, based damage assessment identified a total of 136 affected structures. Approximately 31 structures were destroyed, 38 were severely damaged, and 67 were moderately damaged within the Old City of Sa'adah limits.

Situated in a mountain valley at an altitude of 2,200 m. the Yemeni capital, **Sana'a**, has been inhabited for more than 2,500 years and bears witness to the wealth and beauty of Islamic civilization. This religious and political heritage can be seen in the 103 mosques, 14 hammams and over 6,000 houses, all built before the 11th century. By the first century AD, it emerged as the centre of the inland trade route and its houses and public buildings are an outstanding example of a traditional, Islamic human settlement. Sana'a's dense rammed earth and burnt brick towers, strikingly decorated, are famous around the world and are an integral part of Yemenis's identity and pride. The Old City of Sana'a was inscribed on UNESCO's World Heritage List in 1986. In 2015, it was added to the List of World Heritage in Danger, owing to the ongoing conflict that has severely damaged many of the historic buildings of the city. Satellite imagery collected 8 July and 23 September, 2015 identify several 11th century houses which were completely destroyed.



Marid Old Dam before and after image. Photo credit: Hussain Bukhaiti. Satellite imagery collected on 29 October 2015 shows one of the retention towers severely damaged with visible debris in the middle section of the Southern Dam sluice.



Marib Old Dam before destruction. Photo credit: Jordi Zaragoza Anglès, Mikaku planet, 1995(www.mikakuplanet.com).

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