Heritage from Space for Peace

United Nations Satellite Centre (UNOSAT)

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Introduction

• Division for Satellite Analysis and Applied Research at the United Nations Institute for Training and Research (UNITAR)

• Operational since 2001, recognized as the United Nations Satellite Centre in June 2021

• Mandate: “provide United Nations funds, programmes and specialized agencies with satellite analysis, training and capacity development, at their request, as well as to continue supporting Member States with satellite imagery analysis over their respective territories and to provide training and capacity development in the use of geospatial information technologies”
Offices

UNOSAT HQ, Geneva

New York office

Regional Liaison, Bangkok

Regional Liaison, Nairobi

Countries:
- Bangladesh
- Bhutan
- Lao PDR
- Nigeria
- Uganda
- Solomon Islands
- Vanuatu
- Fiji
Operational Pillars

- **Training and Capacity Development**: Hands-on technical training, awareness raising and technical backstopping
- **Satellite Analysis**: Satellite imagery derived geospatial products
- **Applied Research and Innovation**: EO, AI, Machine Learning, Big Data Analytics, crowdsourcing
Operational Satellite Imagery Analysis & Mapping Support to Humanitarian Emergencies

- Provides satellite image analysis during humanitarian emergencies, both natural disasters and conflict-situations.
- 24/7 operational service: team of experience analysts ensure timely delivery of satellite imagery derived maps, reports and data.
- 2021: 315 analyses to partners over 54 countries
Advantages of satellite imagery analysis

1. Primary and objective information
2. Cover inaccessible areas
3. Near real time
4. Access to historical archives and monitoring
5. Multiple applications: agriculture, environment, disaster management, population movement, conflicts, project monitoring, etc.
6. Improvement of employee safety conditions in the field thanks to fact-based situational awareness.
7. Same information available to all at the same time - improves coordination
GIS advantages

• Gather, manipulate and display geographically referenced information
• Provide comparable information collected systematically at multiple scales
• Easier visual interpretation and detection, high-resolution satellite imagery and wide coverage
• Combine data in near-real time Information: location, scale, disaster severity, affected population, damaged buildings and infrastructure
• Integrate different types of data and foster collaboration between different actors: improve planning, response time and communication
Limitations

- Coverage, accuracy and reliability of the available baseline, population census
- The view only from above: a degree of uncertainty in identifying the characteristics and value of damage
- Time constraints: availability of usable post-event imagery is essential to provide information to the end user in a timely manner
- Data quality requirements: spatial resolution, temporal resolution, spectral resolution, cloud cover
- Availability of and access to accurate, up-to-date spatial data at an appropriate map scale and with global coverage
- Availability of official and authoritative data sets
- Availability of financial resources and predictability
Acquiring Satellite Imagery
Airspace Sovereignty

- **Space Law Principle:** Remote sensing activities shall be carried out for the benefit and in the interests of all countries.

- There is no international agreement on the vertical extent of sovereign airspace, with suggestions ranging from about 30 km = the extent of the highest aircraft and balloons.

- **Air sovereignty** is the fundamental right of a sovereign state to regulate the use of its **airspace** and enforce its own aviation law.
Commercial Satellite Image Providers

High Resolution 1-5m

Medium Resolution 5-30m

Low Resolution >30m

Very High Resolution <1m
# Our Main Satellite Image Sources

## International Charter: Space and Major Disasters

## Open Data Satellites

<table>
<thead>
<tr>
<th>Landsat</th>
<th>Sentinel</th>
</tr>
</thead>
<tbody>
<tr>
<td>+30 m</td>
<td>+3 m</td>
</tr>
<tr>
<td>U.S.A</td>
<td>E.U.</td>
</tr>
</tbody>
</table>

## Commercial Satellites

**Active: 19 Constellations**

<table>
<thead>
<tr>
<th>WorldView</th>
<th>QuickBird</th>
<th>Pléiades</th>
<th>Pléiades NEO</th>
<th>SuperView</th>
<th>GaoFen</th>
<th>TripleSat</th>
</tr>
</thead>
<tbody>
<tr>
<td>+.50 cm</td>
<td>+.50 cm</td>
<td>+.50 cm</td>
<td>+.30 cm</td>
<td>+.50 cm</td>
<td>+.80 cm</td>
<td>+.80 cm</td>
</tr>
<tr>
<td>USA</td>
<td>USA</td>
<td>EU</td>
<td>EU</td>
<td>China</td>
<td>China</td>
<td>Singapore</td>
</tr>
</tbody>
</table>
Since July 2020, the U.S. Department of Commerce eliminated most restrictions on how licensed remote sensing systems may be operated, such as limits on the resolution of imagery, and prohibit the government from imposing additional conditions after a license has been issued. The new rules increase openness and transparency in the licensing process. More: Kyl–Bingaman Amendment - H.R. 3230 (1997)
Using satellite imagery for cultural heritage protection
EO for Cultural Heritage protection

- First satellite-derived damage assessment over a cultural heritage site in Georgia in 2008.
- Support to the ICC starting in 2013 with damage assessment of cultural heritage sites in Timbuktu, Mali (Al-Hassan case)
- In 2015, assessment over Nepal and the Kathmandu Valley World Heritage property following the earthquake.
- MoU with UNESCO signed in 2015.
- Extensive work done over Iraq, Yemen, Syria
Earthquake, Nepal

25 April 2015

Temple of Bel
27 August 2015 / 2 September 2015

Citadel of Aleppo
21 November 2010 / 20 February 2017
Iraq, Syria, Yemen & Nepal

Satellite-Based Damage Assessment of Cultural Heritage Sites.

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.

NEPAL

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

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.

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.

More Publications

- Four years of Human Suffering in the Syrian Conflict
- Satellite Based Damage Assessment to Cultural Heritage Sites in Syria
- Impact of the 2014 Conflict in the Gaza Strip
- Satellite Based Damage Assessment to Cultural Heritage Sites in Iraq, Nepal, Syria and Yemen
- The State of Cultural Heritage in the Ancient City of Aleppo
Damage to cultural heritage properties

Activities that can detriment the welfare of the cultural property

Urban encroachment

Looting activity

Preservation efforts

Deforestation of natural reserve

Ancient routes analysis
Damage Assessment

Palmyra, Syria

Tetrapylon & Theatre

26 December 2016 - 10 January 2017
Urban encroachment

Ptolemain, Libya

Monitoring of urban development in the vicinity cultural heritage site

11 November 2015
Looting Activity

Apamea, Syria

Monitoring of looting activity

16 May 2011 - 15 December 2012
Preservation Efforts

Leptis Magna, Arch of Septimius Severus, Libya

Entombment of cultural property as a protection effort

24 February 2016
Damage Assessment Methodology

**Phase 1**
- **Purpose**: Count all damage instances within the World Heritage property.
- **Elements**: Satellite Images
- **Processes**: Damage Assessment Analysis
- **Results**: Cumulative Damage Point Analysis

**Phase 2**
- **Purpose**: Assess damage per land plot.
- **Elements**: Cumulative Damage Point Analysis, Cadastre Map (building plots)
- **Processes**: Computer script that sums damage points
- **Results**: Land Plot Damage Assessment

**Phase 3**
- **Purpose**: Determine total number of damaged historic buildings.
- **Elements**: Land Plot Damage Assessment, Historic Building List within the World Heritage site boundary
- **Processes**: Data pairing & statistical analysis
- **Results**: Historic Building Damage Assessment
## Damage Assessment

### Satellite Damage Assessment Categories

**Site Destroyed**
All or most of the visible key elements of the assessed site have collapsed (80-100 per cent of structure destroyed due to military or civilian activity).

**Site Severely Damaged**
A significant part of the visible key elements of the site has collapsed or is partially damaged (40-80 per cent of structure damaged) or significant military or civilian activity has contributed to extensive damage at the site.

**Site Moderately Damaged**
Limited damage observed relating to key elements of the site (5-40 per cent of structure damaged) or where military or civilian activity has contributed to damage at the site.

**Site Possibly Damaged**
Assessed site structures do not appear to be damaged, but debris is visible around key site structures.

### Historical Loss Assessment Categories

**Critical Loss**
All the main historically valuable elements inside the cultural heritage site are destroyed causing critical loss.

**Severe Loss**
Many of the main historically valuable elements of the cultural heritage site are severely damaged causing severe loss.

**Moderate Loss**
Some of the main historically valuable structures inside the cultural heritage site are moderately damaged causing moderate loss.

**Minimal Loss**
None of the main historically valuable elements of the cultural heritage site are damaged.
Damage Assessment Methodology

POSSIBLE DAMAGE

- **Definition:**
  Assessed building does not appear to be damaged but debris is visible around the building.

- **What you see on imagery:**
  Visible debris around the building structure or some small sections of the building are missing.

MODERATE DAMAGE

- **Definition:**
  Limited damage observed to the building structure. On many occasions, adjacent to destroyed or heavily damaged buildings.

- **What you see on imagery:**
  Ammunition impacts on roof of building or some small sections of the roof missing.
Damage Assessment Methodology

**SEVERE DAMAGE**

**Definition:**
Part of the building structure collapse, such as part of the roof or one or more fallen walls.

**What you see on imagery:**
Part of the building structure fallen into street and visible debris on one side of the building.

**DESTROYED**

**Definition:**
All or most of the building structure is collapsed.

**What you see on imagery:**
Collapsed or broken roof, walls or pillars destroyed and debris surrounding building.