



# Conflict impact assessment and infrastructure (re)construction monitoring in States affected by fragility

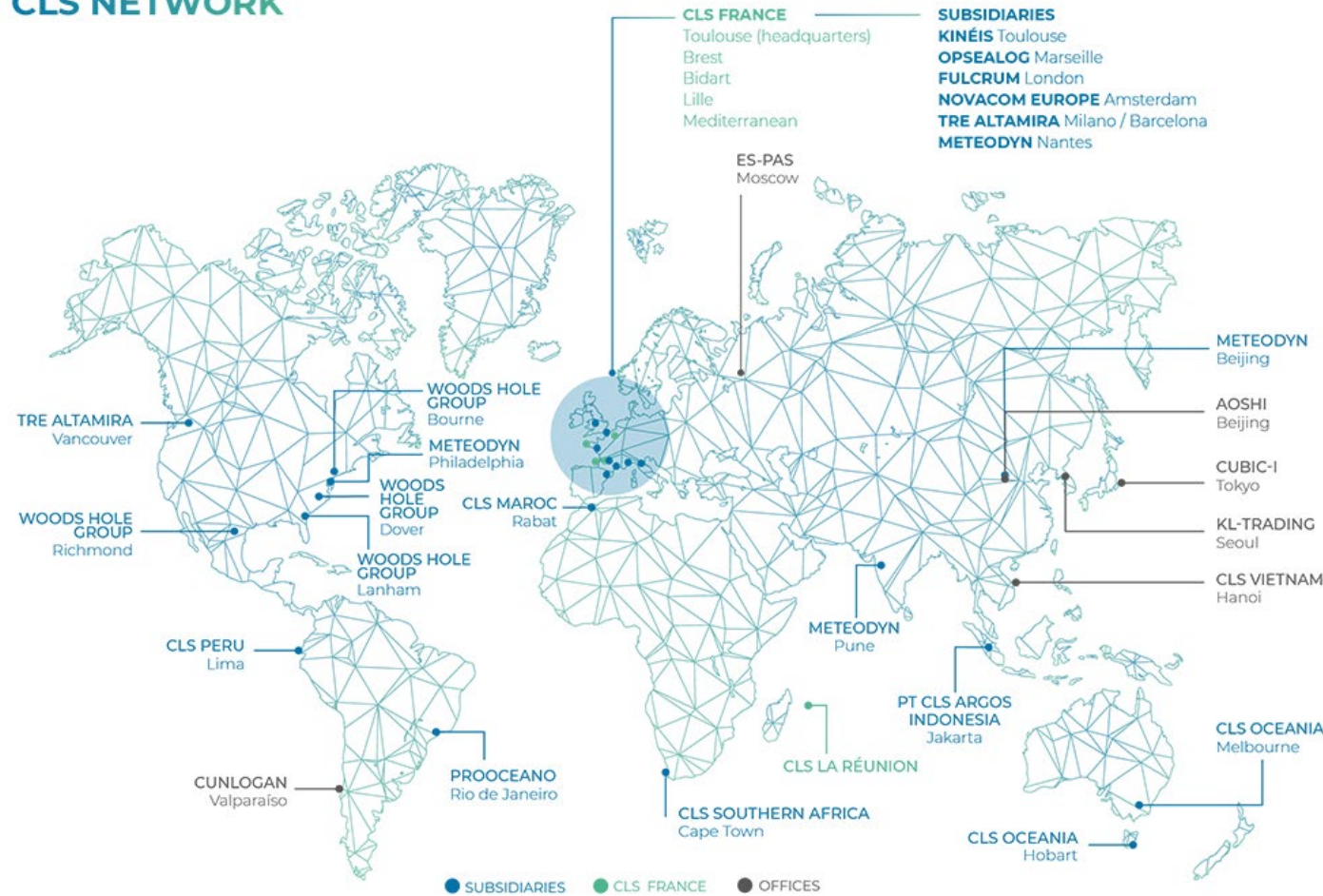
Sébastien DELBOUR

ESA Living Planet Symposium, Bonn, May 2022



# CLS in a nutshell

## CLS NETWORK



Subsidiary of the French Space Agency (CNES) since 1986

900 employees & 34 locations worldwide

## Our Vision

- Design and deploy **space-based solutions** to understand and protect our planet and manage its resources sustainably.
- **87%** of CLS activities are directly linked to achieving UN Sustainable Development Goals (SDGs).



Turnover  
138.4 M€

# Environmental & Climate Change Monitoring

AGRICULTURE



FOREST



HYDROGRAPHY



URBAN PLANNING



RISK MANAGEMENT



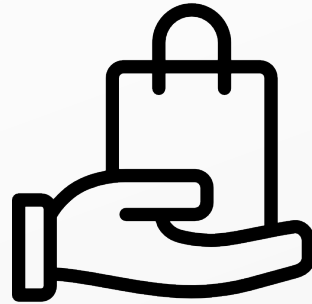
ENVIRONMENT





This project is a part of E04SD, an ESA initiative to support the uptake of information derived from Earth Observation (EO) satellites for use in sustainable development. Target users are International Financing Institutions and their clients

## 3 project streams



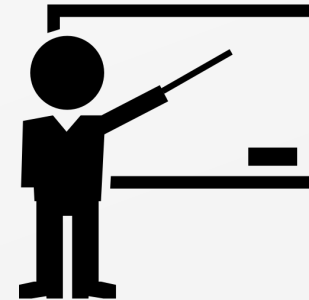
### □ Provide & Deliver

- Adaptability
- Recognized expertise
- Dedicated web platform



### □ Inform & Engage

- Meet
- Discuss
- Understand



### □ Educate & Train

- Dedicated material
- Online courses
- Webinars

# E04SD Fragility, Conflict & Security (FCS)



## Consortium partners



## Project achievements

- 20 EO-based services deployed addressing:
  - ✓ Support to natural resources management
  - ✓ Detection and monitoring of in-region population displacements
  - ✓ Support to reconstruction and infrastructure development monitoring
  - ✓ Critical habitat status assessment
- Exploratory platform
- Capacity building events
- Follow up activities



WORLD BANK GROUP  
Open Learning Campus  
ACCELERATING SOLUTIONS THROUGH LEARNING

Log In | Register Now

Search

OLC Home | WBx Talks | **WBa Academy** | WbC Connect | Calendar | About OLC | Partners | Select a Topic

Self-Paced eLearning  
**Geospatial Information Technology (GIT) in Fragile Contexts**  
★★★★★ (1) | 12 Discussions  
[SIGN-IN TO ENROLL](#)

This is a short course designed to convey essential concepts of GIT (with a focus on remote sensing) and how such technologies can be used in situations of fragility. It offers an introduction to key ideas about the technology's capacities and limitations and then focuses on specific types of earth observation services that can prove useful in projects focusing on development, disasters, illegal activities, environmental resources and conflicts.

# Use case: Conflict impact assessment in Cameroon

## Context & objective

Key stakeholder: **World Bank** - Project: **Environmental Social Impact Assessment**

Objective: Assess the impact of the ongoing conflict between the English-speaking part of Cameroon (located northwest/southwest) and the rest of the country

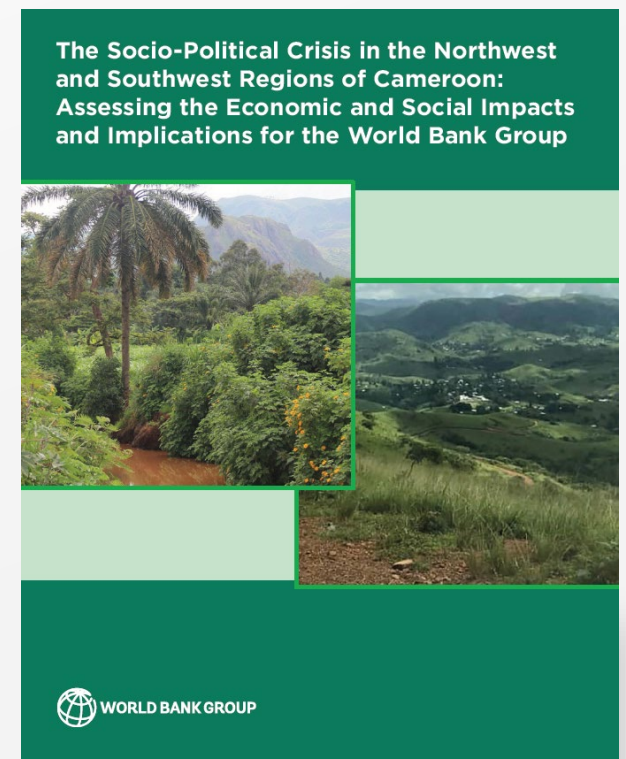
## EO-based services offered

1. Vessel traffic analysis through AIS
2. **Building damage assessment** using VHR optical satellite imagery over 18 affected localities covering 400 km<sup>2</sup>

## Achievements

**Concrete use of the results** for a report publication by the WB

**Adoption level achieved** considering the service contract got by CLS to support conflict impact assessment in Mozambique



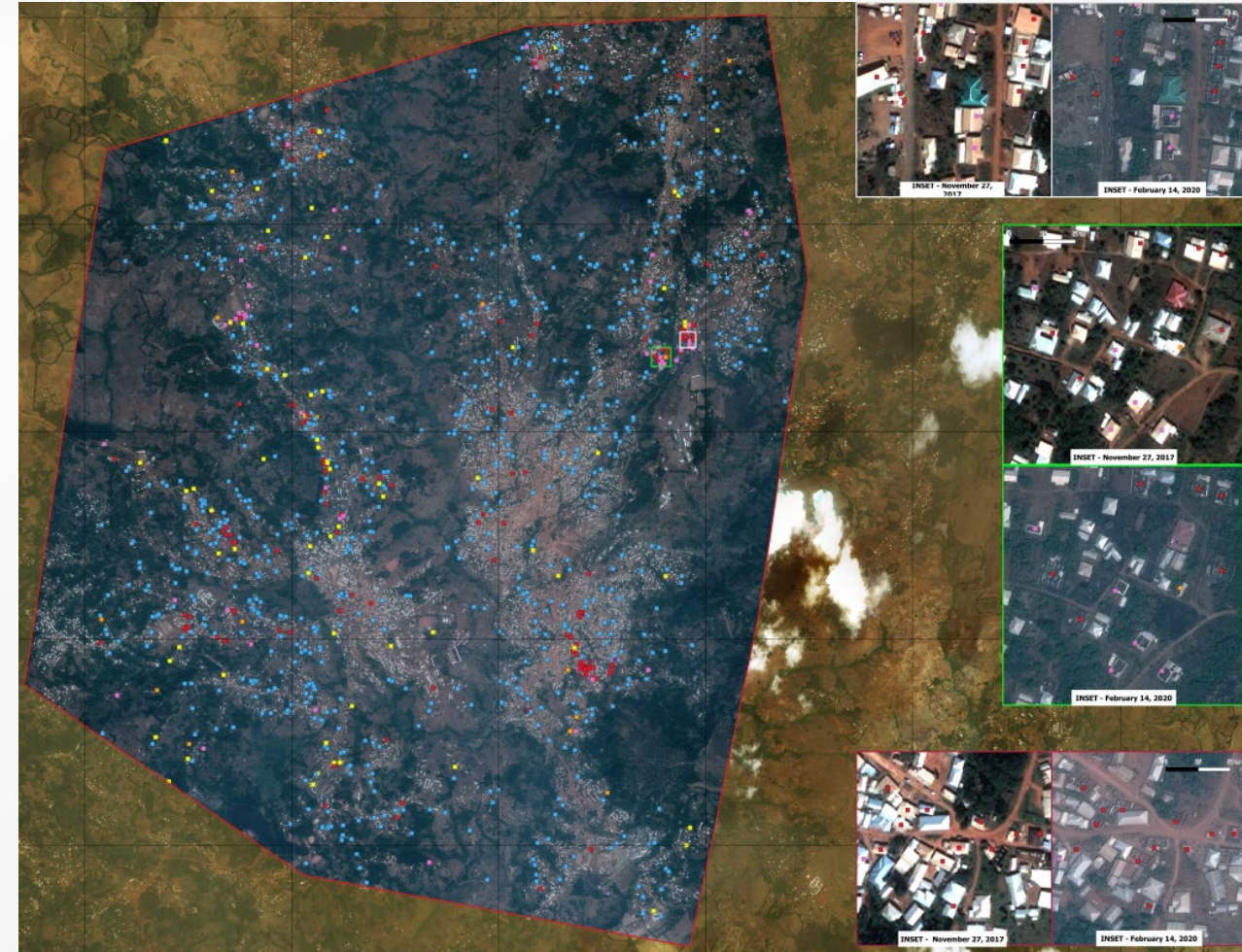
# Use case: Conflict impact assessment in Cameroon

## Assessment results over 18 AOIs

- 307 destroyed buildings
- 130 damaged buildings
- 116 possibly damaged buildings
- 437 disappeared buildings
- 6116 new structures

## First-level analysis of the results

- ✓ No obvious logic in the intensity level of damages per AOI
- ✓ Damage is usually clustered in specific areas, often along main roads
- ✓ Unexpected number of new constructions confirmed in all AOIs



# Use case: Reconstruction monitoring in Mosul, Iraq

## Context & development challenges

Key stakeholder: **World Bank** - Project: **Iraq Emergency Operation for Development**

- Iraq is still in a crisis and requires major reconstruction and development support.
- **Significant gaps in urban service delivery** across all key sector. Security, social tensions and youth unemployment continue to be severe issues in reconstruction and recovery.
- Access constraints on the ground → Lack of insights in the reconstruction
- Gradual, dynamic & complex process → Need for better sequencing & prioritizing investments

**EO and related geospatial technologies can help overcome some of such challenges.**

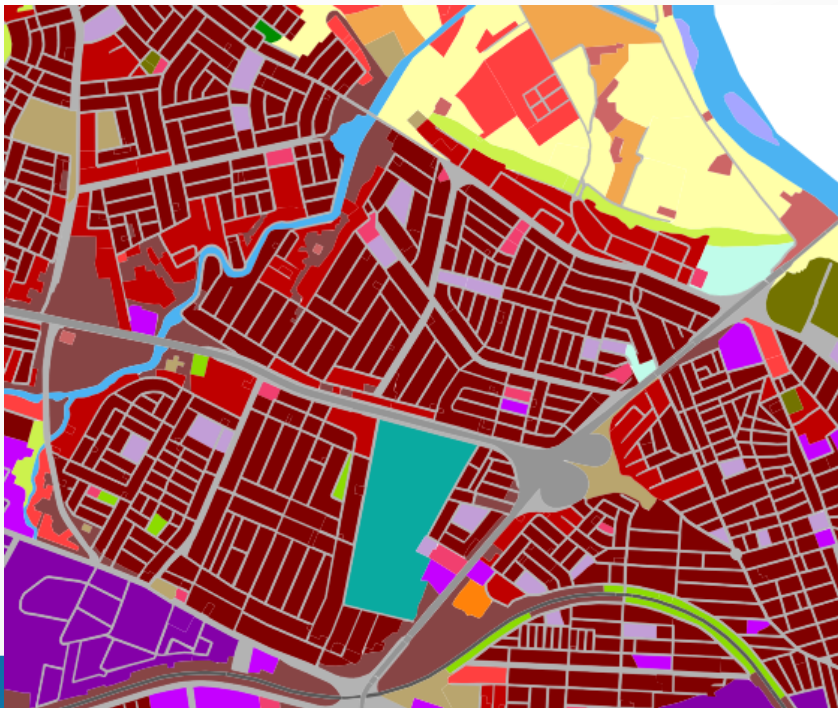
*Mosul, Ninawa Governate  
Old City, 2013 – 2017  
Nearly 80% damaged or destroyed*



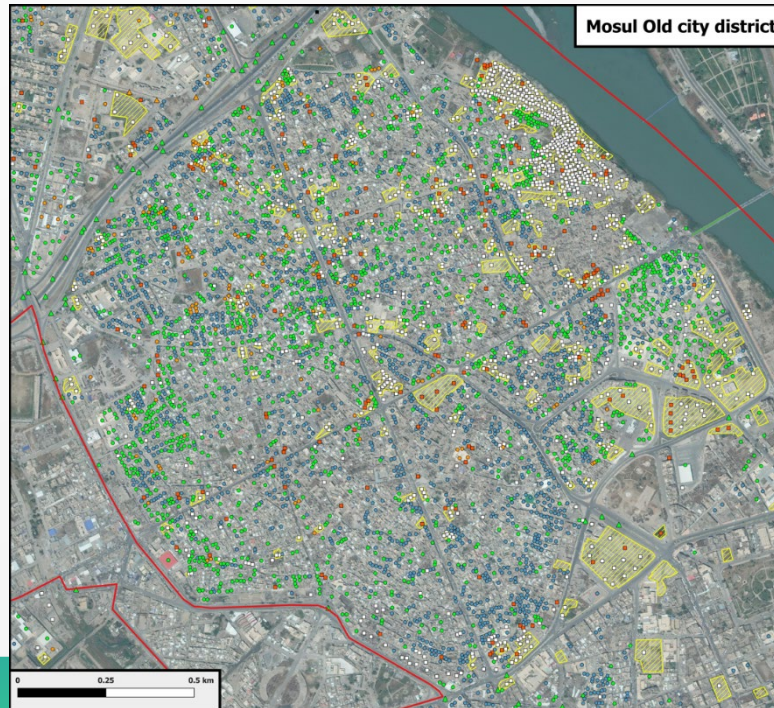


# Use case in Mosul: EO-related analytical service request & highlights

**1. Damages:** A land use land cover on key sectors of Mosul before the conflict (2013) and just after the conflict (2017) to identify damages and lay the basis of the reconstruction analysis.



**2. Reconstruction:** An inventory of the reconstruction efforts undertaken in the same area, that includes building-level status assessment and yearly monitoring 2017 - 2020.



**3. Implementation:** An infrastructure subproject implementation monitoring of a remote small-scale water purification station at Al-Ghuwair in Ninawa (outside of Mosul).



# Use case in Mosul: Overall approach for the service demonstration

## Input data

- Optical satellite images with 0.5m resolution
- Other data: Open Street Map dataset + Wikimapia + UNOSAT Mosul damage assessment

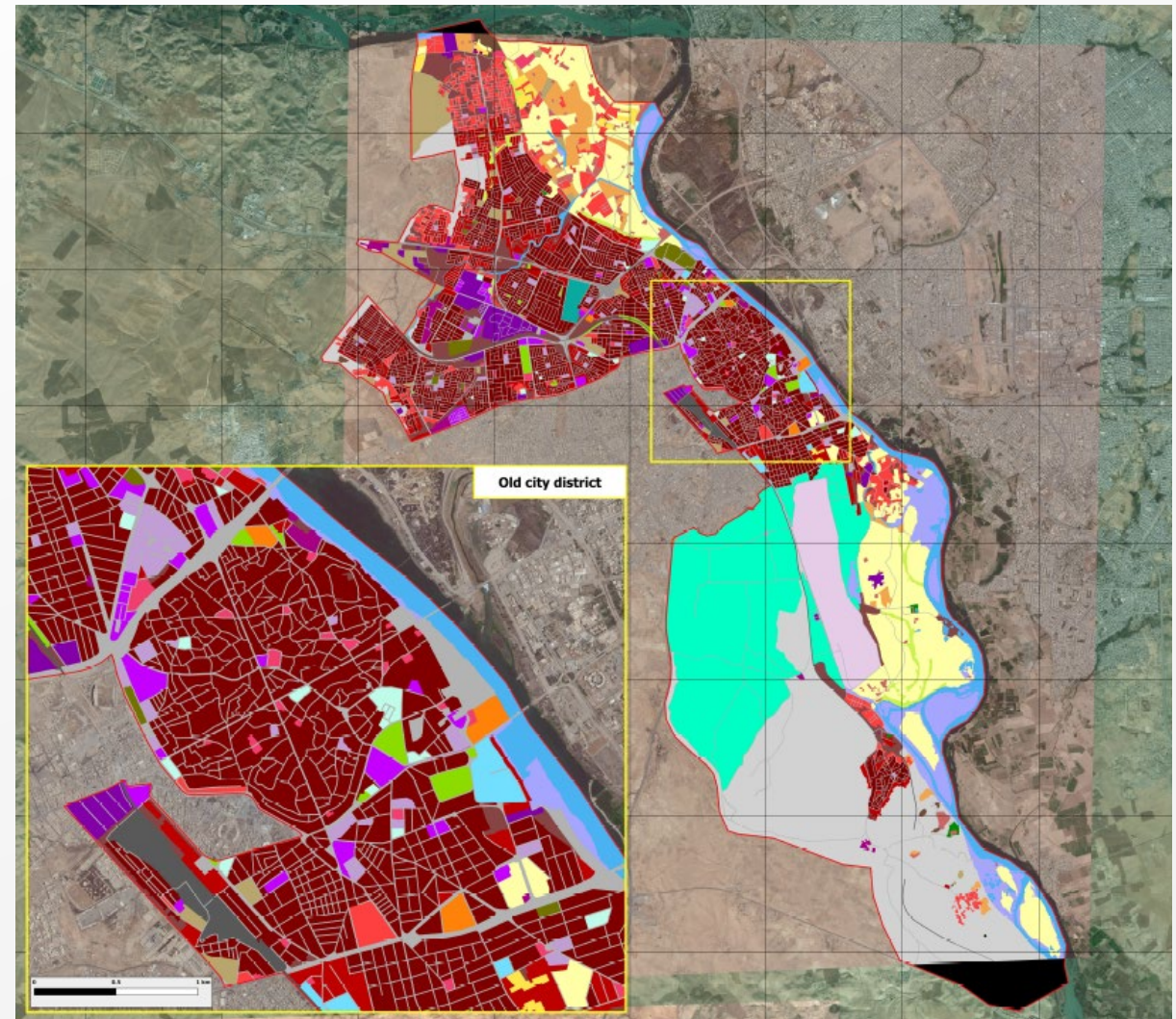
## Methodological process

- Data collection & pre-processing
- Thematic information extraction (LU/LC, damage assessment, reconstruction efforts) by means of visual interpretation and comparison of the satellite images
- Internal quality control
- Social media and online sources comparison

## Land Use / Land Cover (LU/LC) mapping

Description of physical coverage on the ground and its use

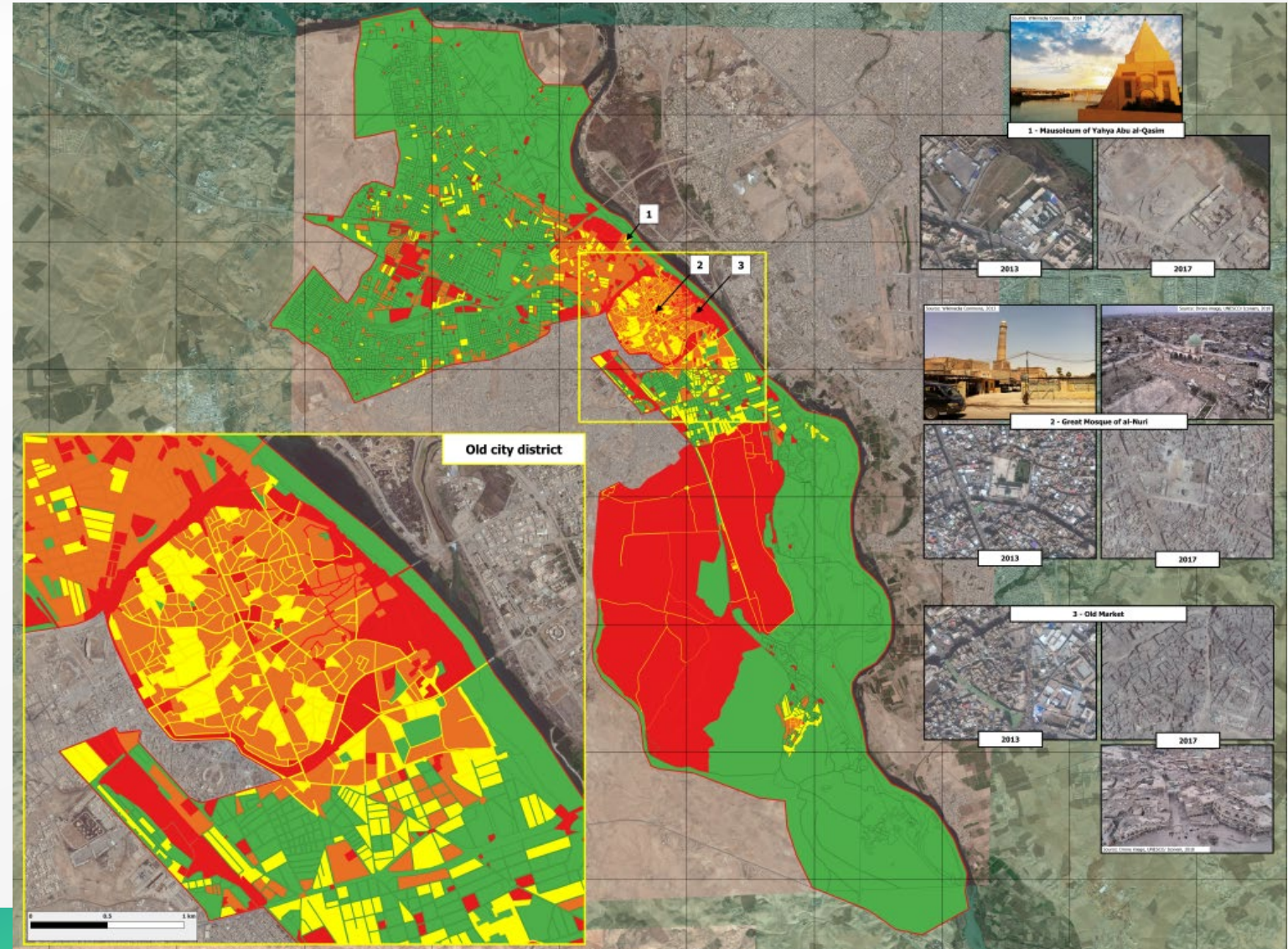
*LU/LC map of three districts including Old City in 2017*



# Use case in Mosul: Conflict damage assessment in 2017

## Main damages per LU/LC types

Class	Destroyed	Damaged
Government	46%	46%
Educational	12%	33%
Health	84%	4%
Religious	25%	23%
Commercial - tertiary	43%	36%
Industrial	66%	9%
Airport	100%	-
Military	99%	-
Continuous densely urban fabric units	4%	25%
Discontinuous medium density	6%	21%

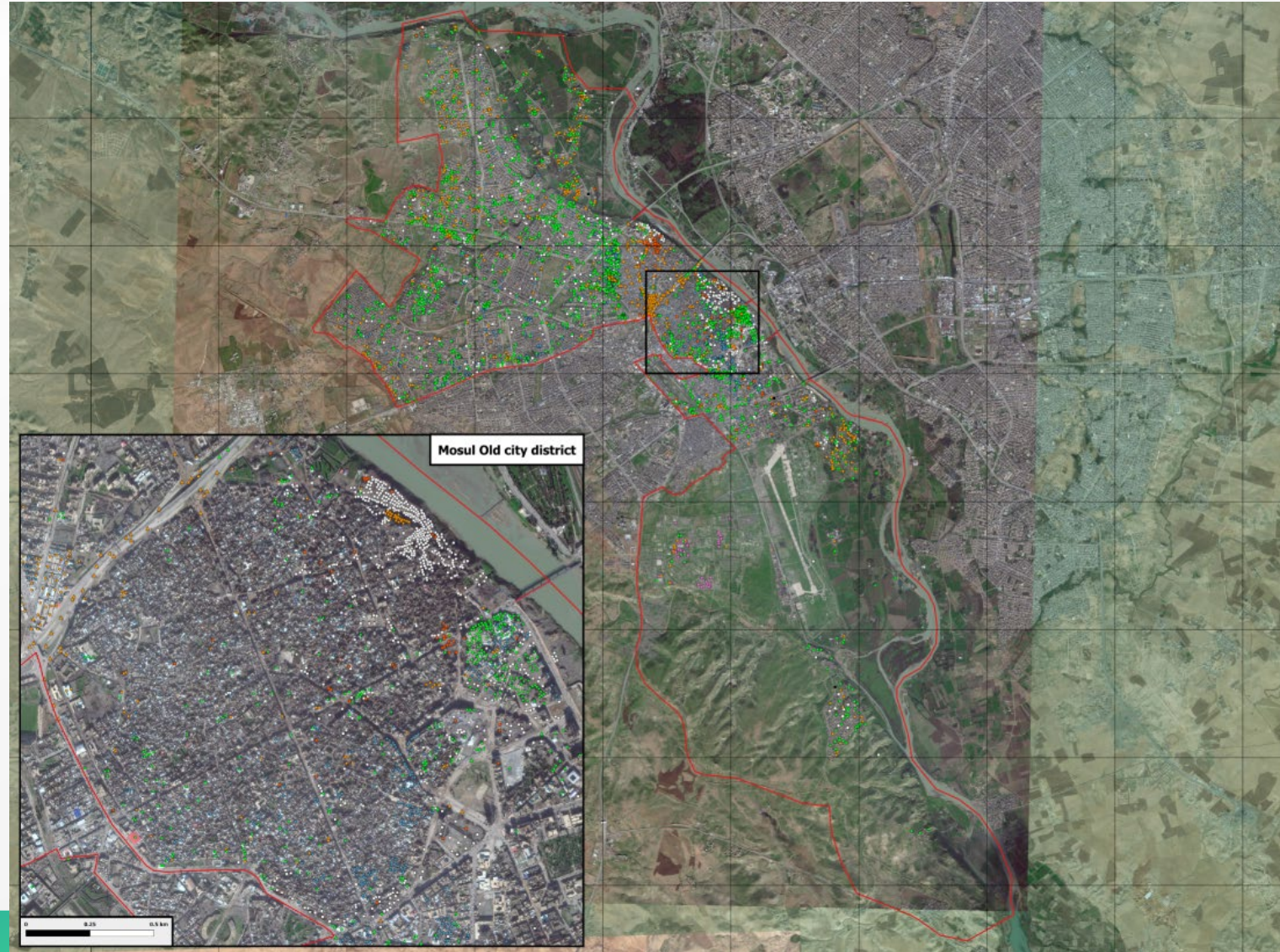
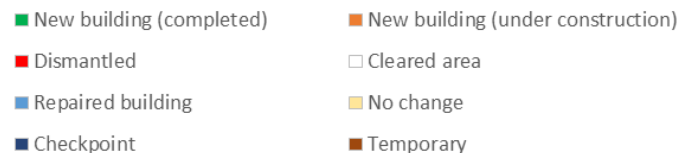
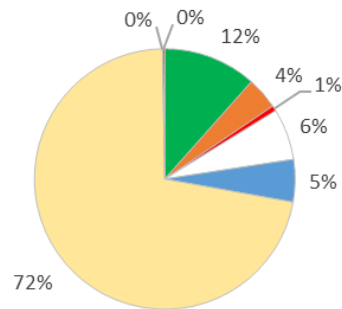


# Use case in Mosul: Reconstruction efforts observed in 2018

## Results of the analysis

- 72% of the inventoried buildings show no signs of change
- Rebuilding work started near the Old Bridge and Babal-Saray market
- Temporary installations are visible in the Ghazlani Military base

Reconstruction Monitoring in Mosul in 2018

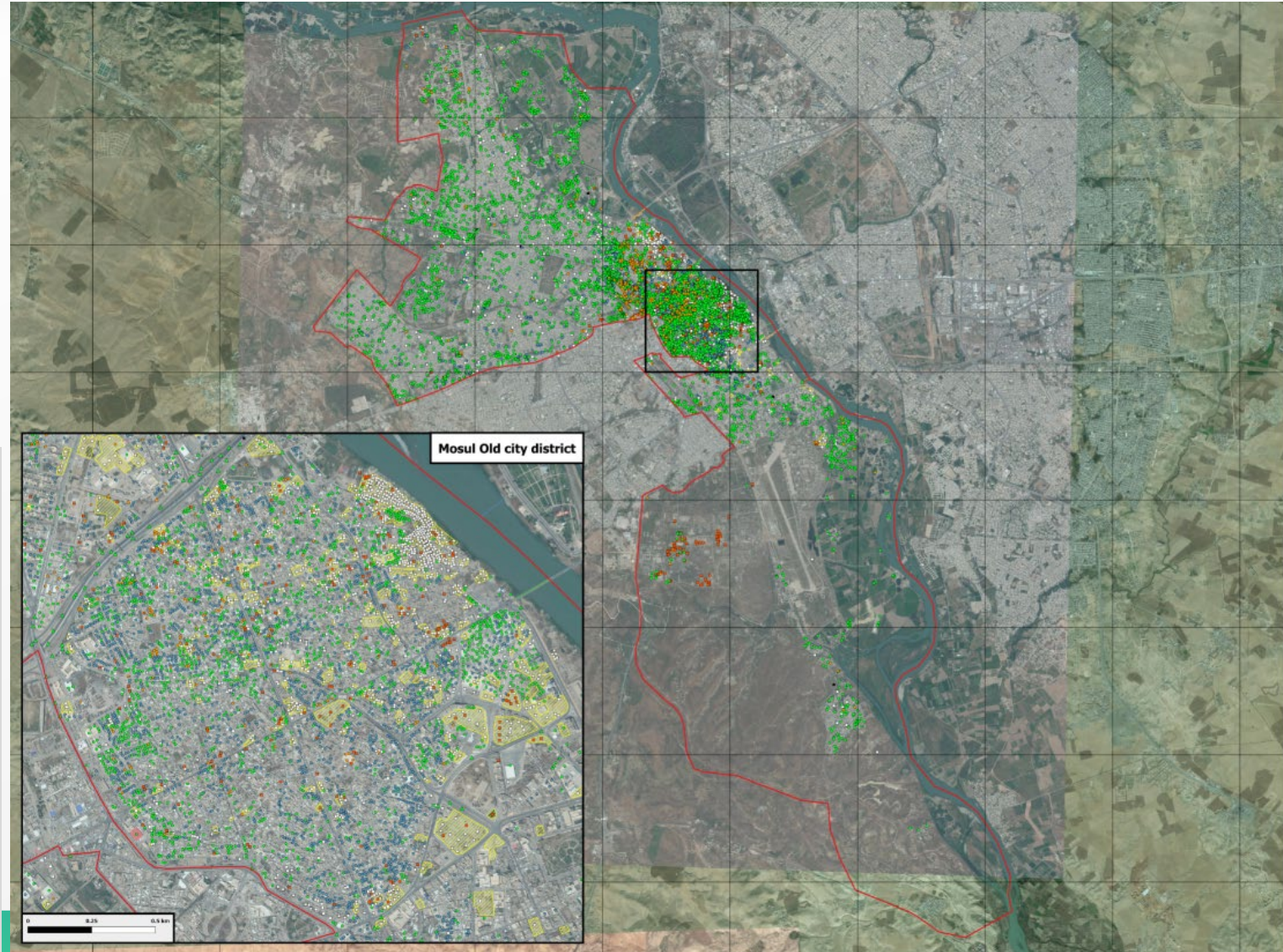
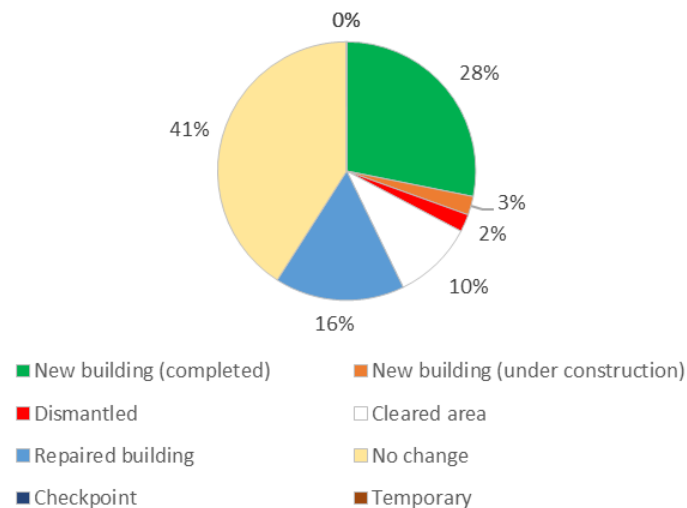


# Use case in Mosul: Reconstruction efforts observed in 2020

## Results of the analysis

- 41% of inventoried buildings show no signs of change
- 44% are repaired or rebuilt
- 3% are under construction
- 12% are cleared or dismantled (total of 57.7 ha available)

Reconstruction Monitoring in Mosul in 2020



# Use case in Mosul: Results from the reconstruction monitoring

## Massive ongoing efforts for rebuilding Mosul, at different levels

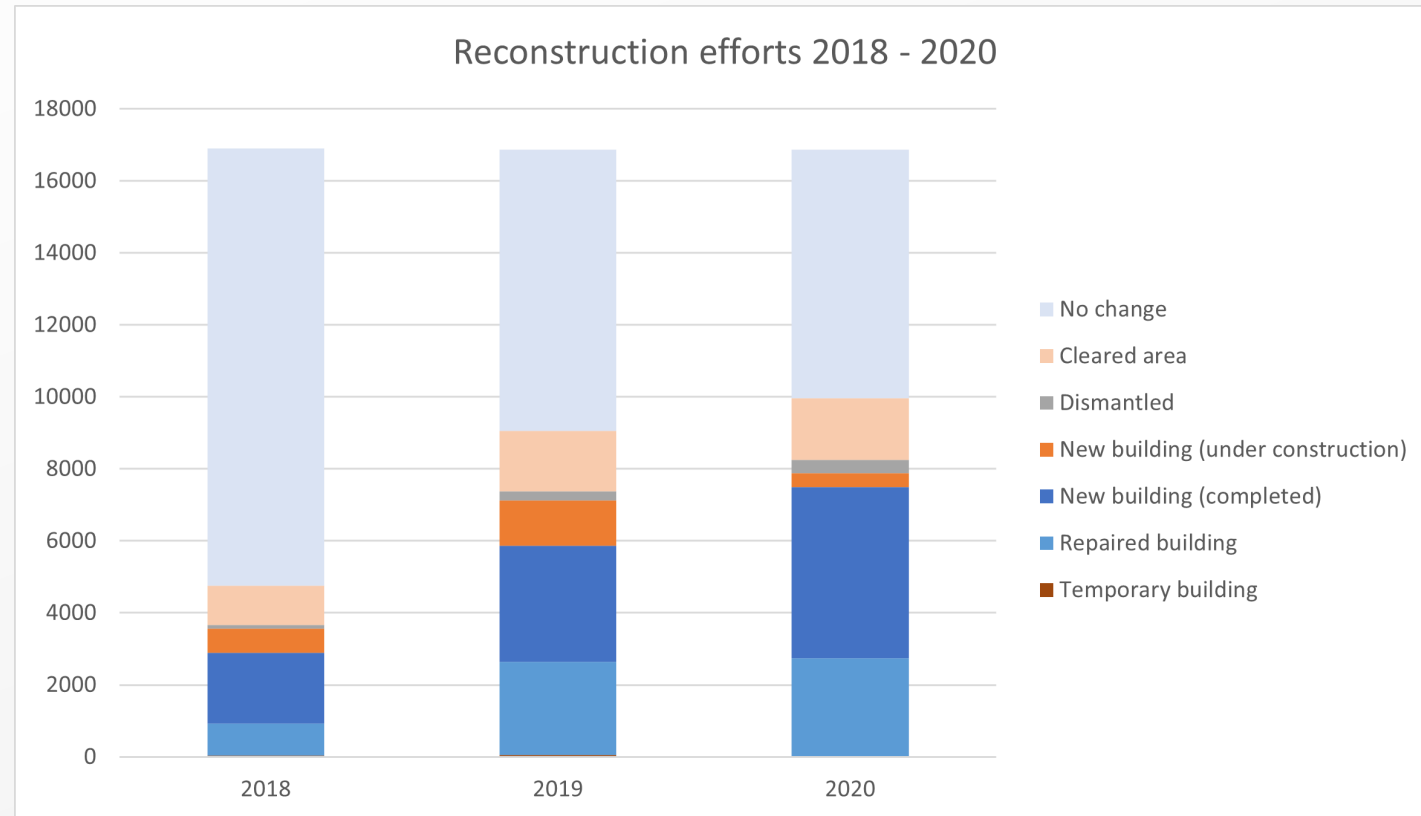
In 2020, out of almost 17,000 buildings inventoried:

- Only 7,000 showed no signs of evolution
- 2,000 were cleared or dismantled
- 7,900 repaired or new

## Most buildings reconstructed are in former high density urban fabric areas.

The old city district - the most affected one - also benefited from intense efforts to rebuild, especially in the market area.

About 40% of new constructions took place in less dense former urban fabric, or spaces that were dedicated in 2013 to tertiary activities.



# EO-related analytical services - Potential for mainstreaming and scaling up



## High value-added solutions

Worldwide / On-demand

Affordable / Reliable & Accurate



## Main criteria for the most cost-effective choice of method for image analysis

Time availability / Potential for replication

Reference dataset availability

Requirements in terms of area to be covered and features/information to be extracted (level of detail)

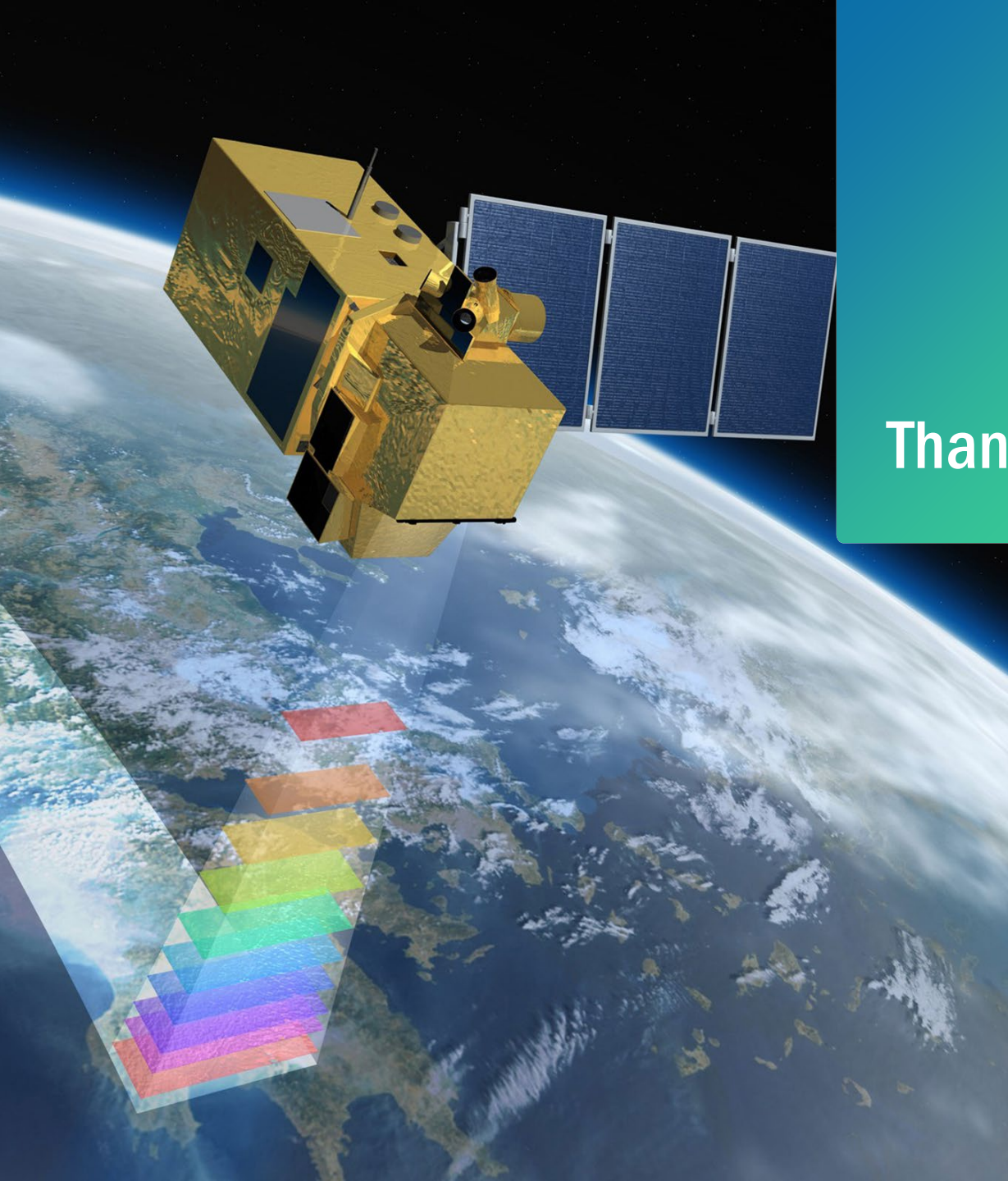


## EO-based analysis at building level

Visual analysis for emergency situations and/or limited area coverage

Worth to explore AI methods in case of large areas and/or longterm monitoring even if ready-to-use algorithms not yet available





Thank you

## CLS website

<https://www.cls.fr/en/>

## CONTACTS

Sébastien Delbour, Head of Rapid Mapping Unit & Project Manager  
[sdelbour@groupcls.com](mailto:sdelbour@groupcls.com)

Vera Gastal, Remote Sensing Expert & Technical Manager  
[vgastal@groupcls.com](mailto:vgastal@groupcls.com)

Marc Lucas, PhD, Senior Oceanographer & Project Manager  
[mlucas@groupcls.com](mailto:mlucas@groupcls.com)