EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

FRAGILITY, CONFLICT AND SECURITY

fragility, conflict and security
eo4sd

esa

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Introduction

The remit of many international development institutions often includes crisis response or crisis management, especially in States affected by fragility, conflict and security issues resulting in widespread and cross-cutting challenges to the survival, livelihood, and dignity of people, thus making the achievement of the Sustainable Development Goals more difficult.

The EO4SD-FCS project is an ambitious initiative funded by ESA. It provides international institutions such as the World Bank with the latest Earth Observation-based tools and services in order to support them in their activities.

As a result of this support, staff members of these institutions can learn how to best use these highly technical services and introduce them as standard solutions in all their projects addressing fragility. This is achieved through service demonstrations and training as well as regular contact with the stakeholders to present and explain the possibilities offered by the tools.

This final report presents an overview of the activities conducted during the project as well as its main achievements.

Conflict impact assessment and infrastructure (re)construction monitoring

Field interventions in territories affected by armed conflicts are particularly risky and difficult, even after the fighting stops. Earth observation satellites offer a secure and cost-efficient way to get an overall picture of the situation and assess the impact on assets and population, as well as on land use and land cover. During the recovery phase, they also enable the regular monitoring of reconstruction efforts.

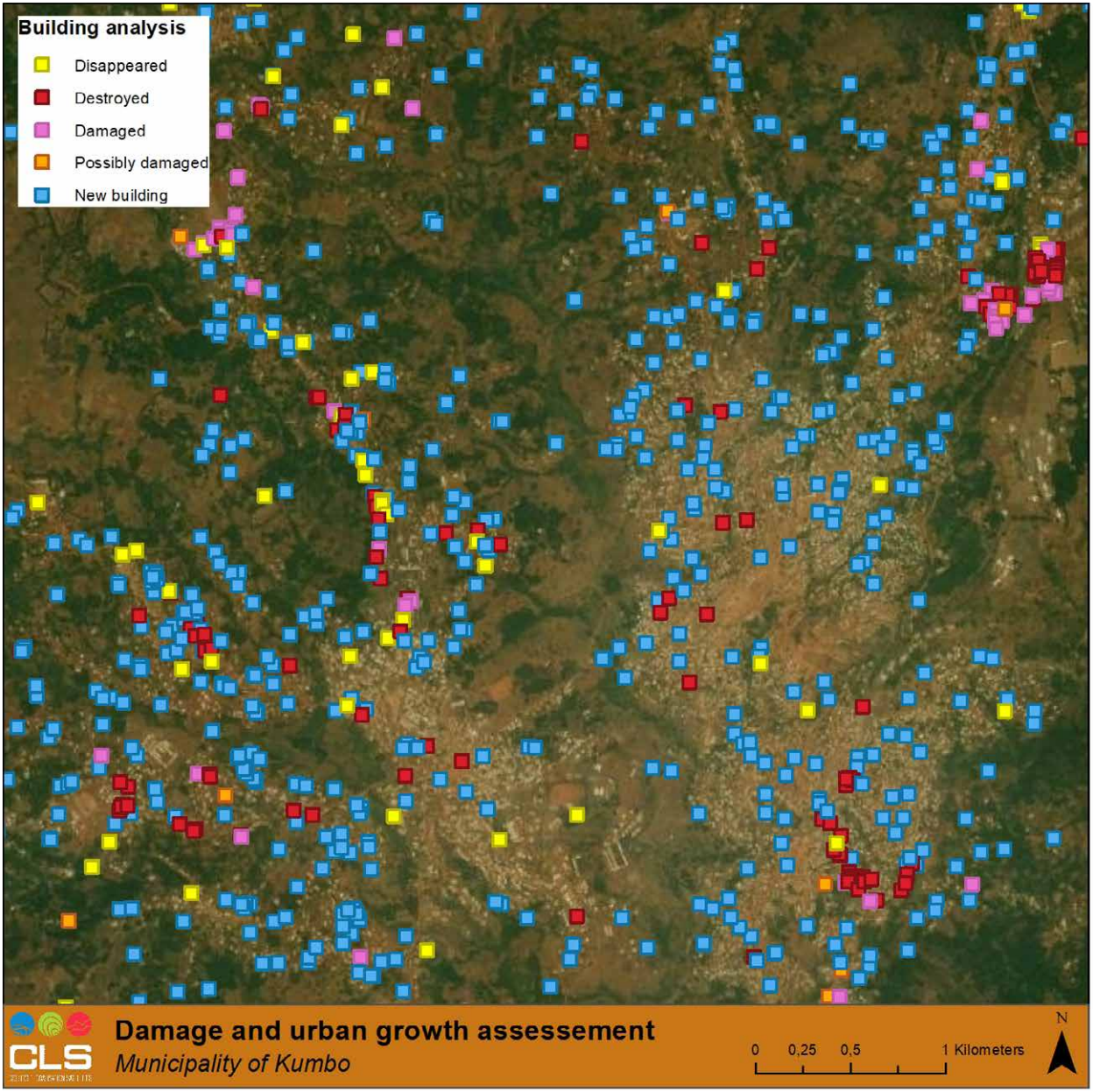
The EO4SD FCS consortium supported several initiatives led by the World Bank to assess the impact of armed conflicts and/or monitor infrastructure (re)construction efforts.

Damage Assessment in Northern Cameroon

Since 2017, the English-speaking part of Cameroon has been experiencing an unprecedented crisis, a conflict between separatists and government armed forces with dramatic consequences for the population. A World Bank team therefore approached the EO4SD FCS consortium in 2020 for support in assessing the impact of the conflict. As a result, physical damage to buildings was analysed in fifteen localities via very high-resolution satellite images. While many of the targeted municipalities exhibited signs of damages to buildings, all areas also showed an unexpected number of new constructions and buildings.

The results were included in a study report published in January 2021, entitled "The Socio-Political Crisis in the Northwest and Southwest Regions of Cameroon: Assessing the Economic and Social Impacts and Implications for the World Bank Group".

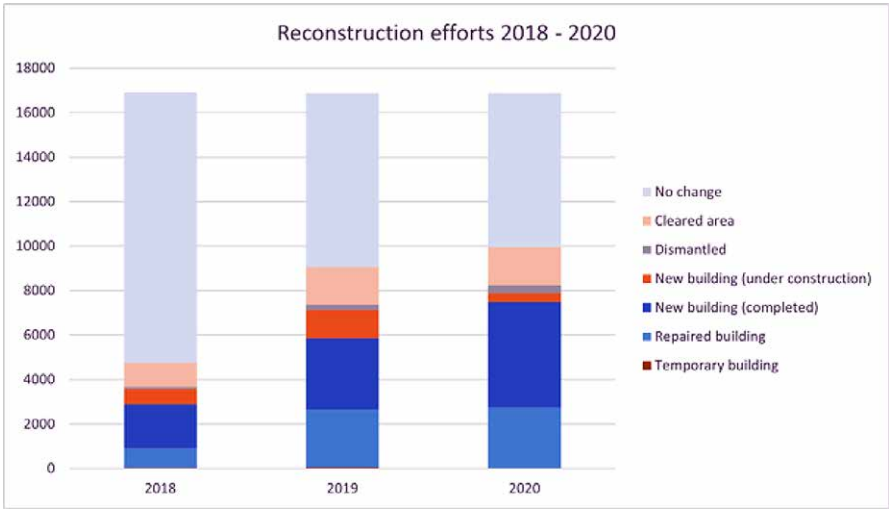
Image © CNES (2017), Distribution AIRBUS DS Image © 2020 Maxar Technologies

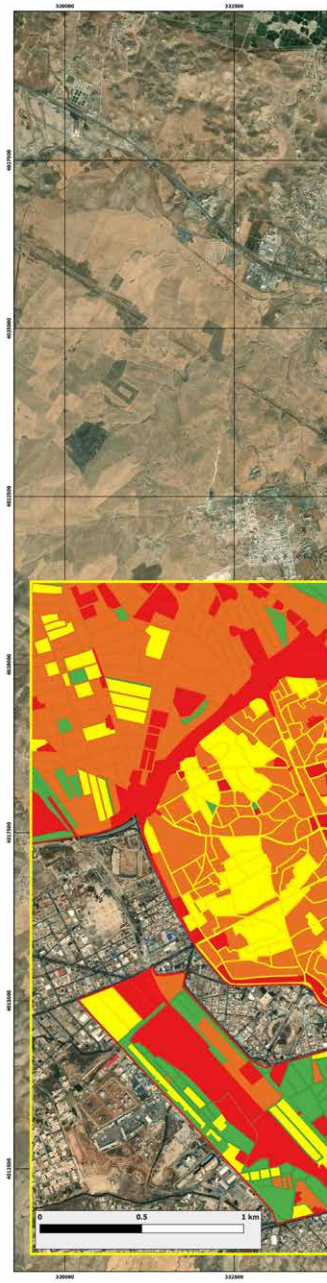

Building analysis
Disappeared
Destroyed
Damaged
Possibly damaged
New building
CLS
Damage and urban growth assessement
Municipality of Kumbo
0 0,25 0,5 1 Kilometers
N

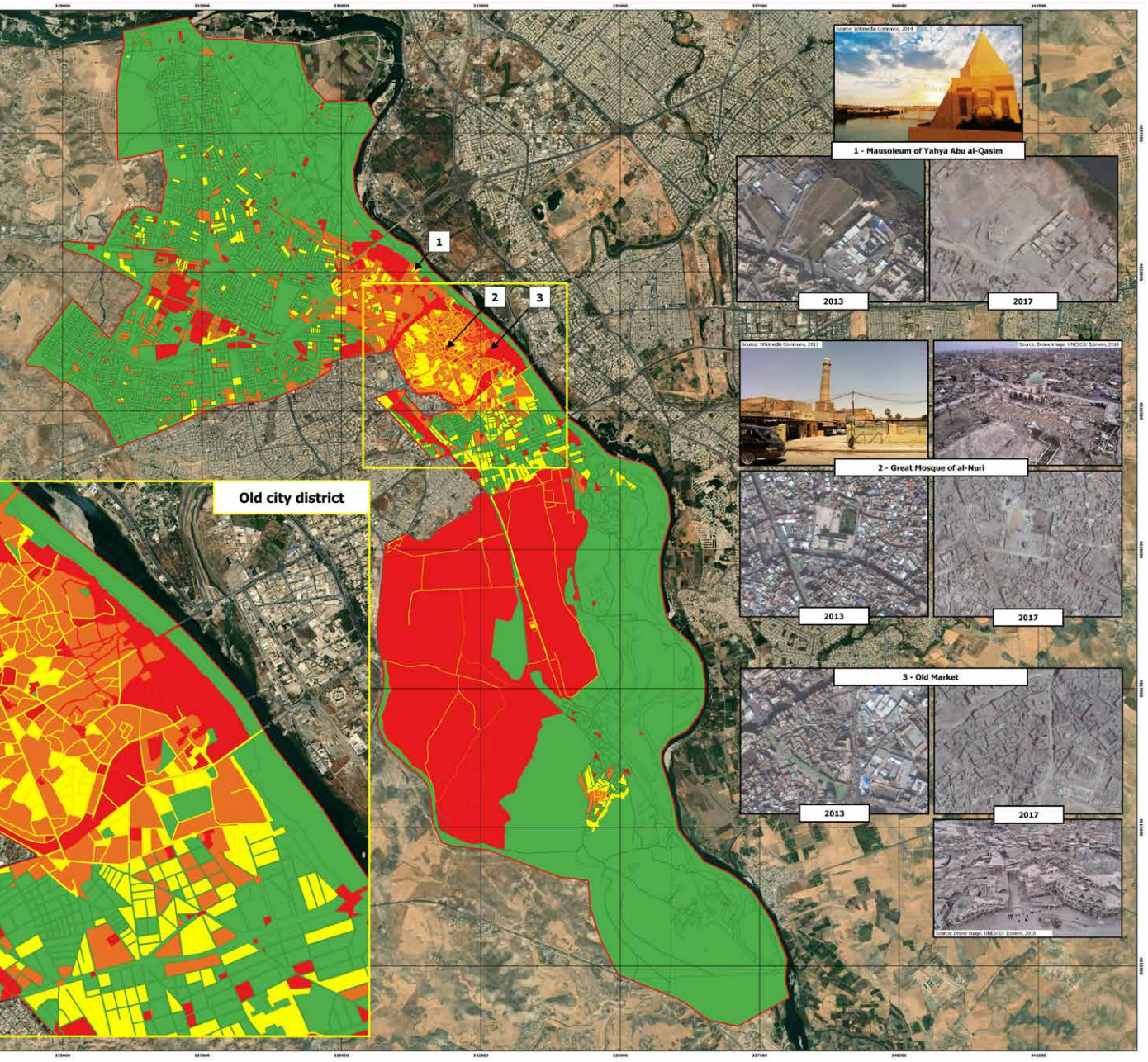
Reconstruction in Mosul, Iraq

The armed conflict between the Iraqi government and its allies and the terrorist organisation well known as the Islamic State began in 2013 and ended in December 2017. This time, in addition to mapping the land use before and after the war and specifying the level of damage caused, the World Bank team asked the EO4SD FCS consortium for support in monitoring the reconstruction process as part of the Emergency Operation for Development.

The consortium was requested to focus on three districts of Mosul which suffered extensive damages, including the old city. Reconstruction efforts were monitored from 2017 to 2020, using very high-resolution satellite images. Moreover, the team carried out a yearly analysis, updating the original damage assessment mapping from UNOSAT (2017). The status of each individual building identified as damaged by the conflict was re-examined every year, and all new constructions were inventoried. Cleared and rubble-free areas were also identified for potential future developments. The results highlight the massive ongoing efforts to rebuild 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, and 7,900 were repaired or new.

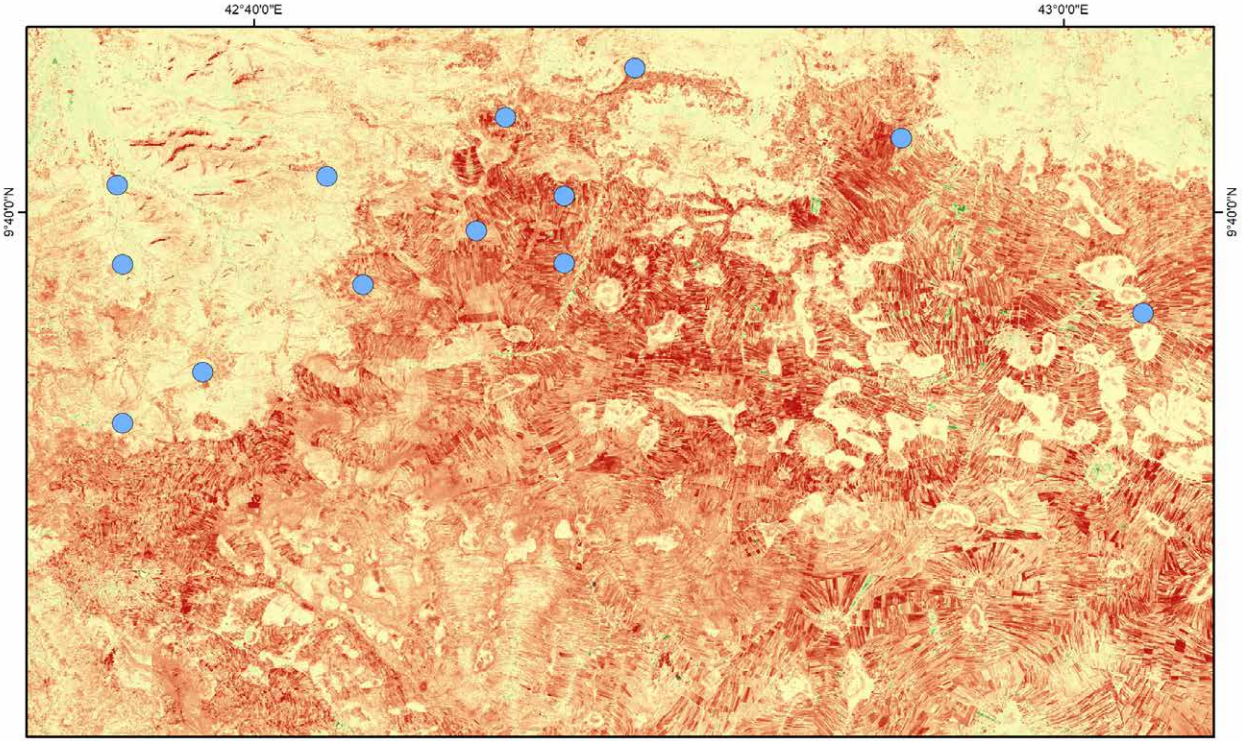





Source: Wikimedia Commons, 2014
1 - Mausoleum of Yahya Abu al-Qasim
2013
2017
Source: Wikimedia Commons, 2013
Source: Drone image, UNESCO/ Iconem, 2018
2 - Great Mosque of al-Nuri
2013
2017
3 - Old Market
2013
2017
Source: Drone image, UNESCO/ Iconem, 2018
1
2
3
Old city district

Crop monitoring for agriculture and food security – Desert Locust Upsurges

In late 2019 and early 2020, unusually wet conditions along with abundant vegetation in East Africa resulted in the most serious upsurge of desert locust seen in decades, threatening food security and livelihoods of millions of people. It is reported that a locust swarm the size of one square kilometer can consume the same amount of food as 35,000 people in one day, and swarms can reach up to several hundreds of square kilometers (FAO 2015).*



NDVIre Difference (11 November 2019 minus 23 October 2019), Somali Region, Ethiopia

N
20 Kilometers
NDVIre Difference
≤ -0.5
0
≥ +0.5
November 2019 swarm location
Hatfield

Data source a) eLocust3 data, Food and Agriculture Organization of United Nations (FAO); b) Sentinel-2 imagery, European Space Agency (ESA)

*FAO 2015, FAO Desert Locust Information Service, Consulted on April 28, 2020. www.fao.org/emergencies/resources/documents/resources-detail/en/c/278608/

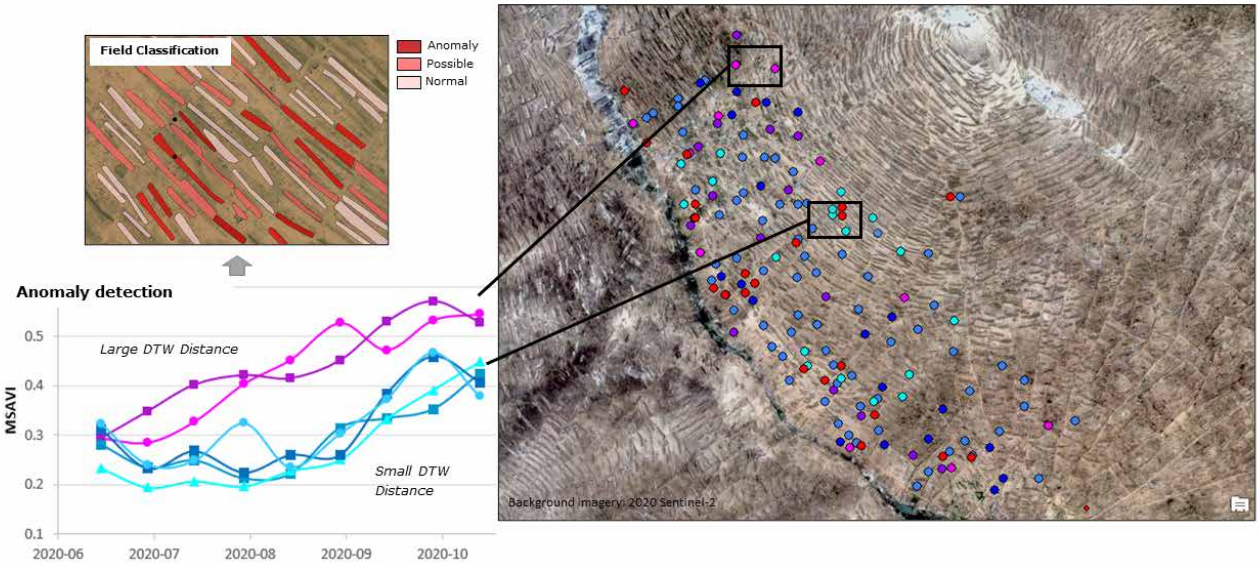
Satellite Earth Observation (EO) technology already provides synoptic information on vegetation vigour and stress, climate, soil moisture, and other variables that help manage outbreaks and mitigate impacts. The EO4SD FCS consortium supported the World Bank's Agriculture Global Practice, using systematically collected EO data and novel data mining approaches, to provide information on desert locust presence by monitoring vegetation anomalies.

Detailed information on the impacts from the 2019-2020 upsurge on crops and agriculture for important regions in Kenya, Ethiopia, and Somalia.

The consortium evaluated time series of Sentinel-2 data and the Dynamic Time Warping (DTW) algorithm to detect these impacts.

The methodology included the identification of agricultural fields impacted by desert locusts, using FAO's eLocust3m data and generating time-series data to capture suppressed vegetation signatures (i.e., MSAVI - modified soil-adjusted vegetation index) resulting from locust impacts. Using these reference temporal profiles and the DTW algorithm, the consortium detected and identified agricultural fields at high-resolution (20 m) with similar temporal profiles (e.g., suppressed vegetation). The results suggest that the DTW algorithm, when used with robust field training data, could be used as a screening tool to help target locust control operations and mitigation efforts.

The products generated are scalable across all regions and deliver detailed information to support activities such as monitoring of food security issues.



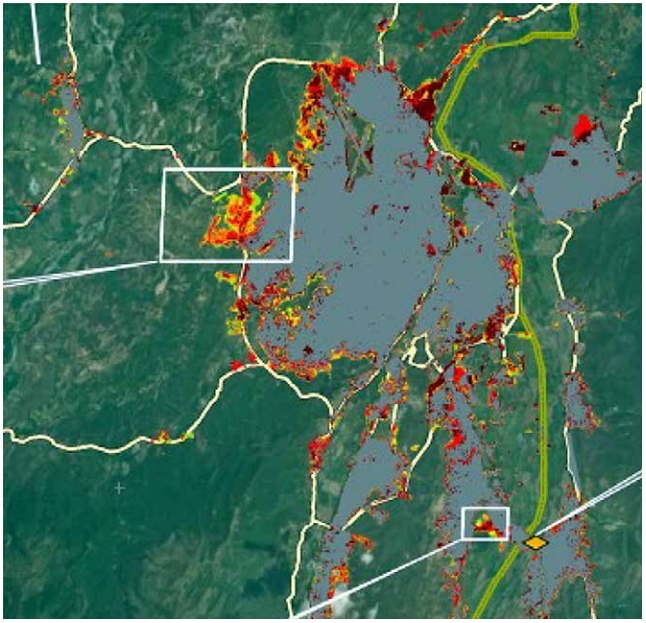
Detection and monitoring of in-region population displacements

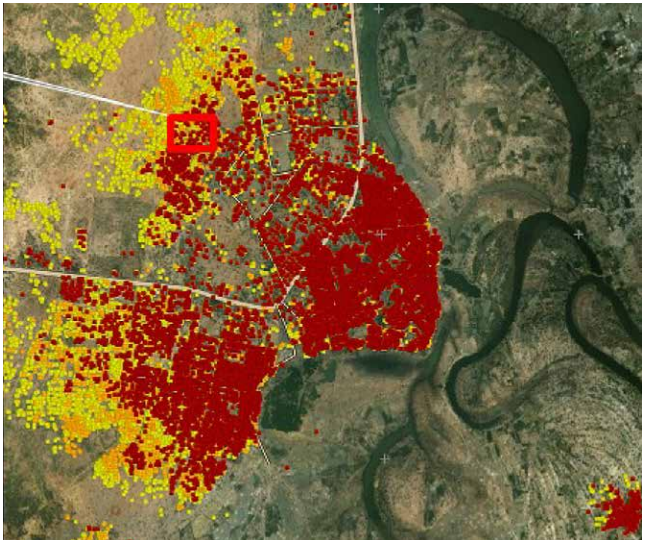
Remote sensing technologies can prove very useful in assessing population displacements caused by conflicts, natural disasters, famine or other factors that can have an especially significant impact in contexts of fragility.

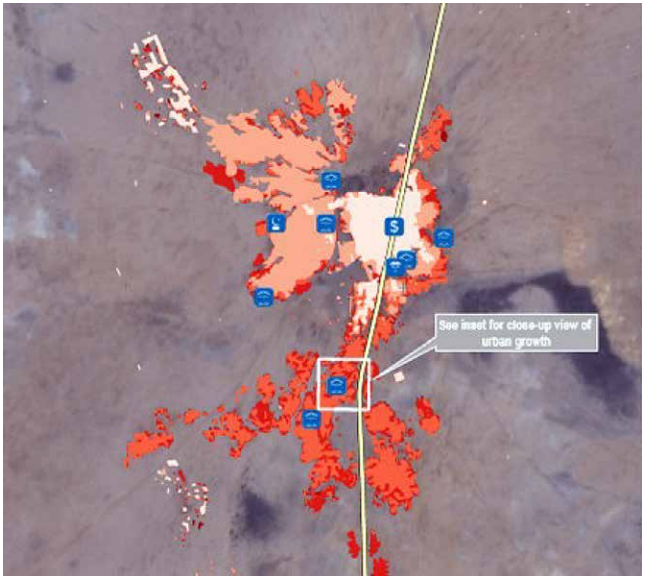
The consortium supported several projects to detect and monitor such displacements, some of them in Colombia and Niger.

Over the past few years Colombia received a significant number of Venezuelan refugees, reportedly often coming through the Cúcuta border crossing and living in permanent structures in urban areas. The World Bank regional office showed interest in getting data on the evolution of urban areas which might have been impacted by the Venezuelan migration. They requested an analysis of several areas including Cúcuta, Barranquilla, Ibagué, Arauca and Puerto Carreño. Using Sentinel (ESA) and very high-resolution satellite imagery, the consortium produced urban growth analyses of these areas over the past few years.

The results were included in an online World Bank article entitled "How Venezuelan migration is changing urban expansion in Cucuta, Colombia".







In the case of Niger, the World Bank Development Impact Evaluation (DIME) team asked the EO4SD FCS consortium for support in the context of refugee and internally displaced people's (IDP) flows escaping Boko Haram violence in the Lake Chad area.

They sought to obtain detailed information on the evolution of the built environment in specific communities in Niger including Diffa, Chetimari, Bosso, Gueskerou, Maïne-Soroa, N'Guigmi and Kindjandi. The consortium used ESA and very high-resolution satellite imagery to produce urban growth analyses, fulfilling this request. Very significant increases could be seen in some of the said communities. For instance, Kindjandi saw its urban area grow by 386% between 2014 and 2019.

In order to provide a further refined overview of the situation, the consortium also shared data regarding the number of metal roofs (proxy for economic development) and of various structures linked to education, health, religion and economic activity.

Iraq Water Resources assessment

The UN Department of Political and Peace Building Affairs has been investigating the link between water scarcity and conflict. To this end, it has been gathering all the available water related information and data to compile an extensive database. With this database, coupled to an online exploration, it will investigate new methodologies and techniques to understand the link between conflict and water availability in the fragility context.

The project initially focused on water resources in Iraq, and the UNDPPA turned to the FCS consortium to investigate what type of novel EO data could be added to the database. The consortium proposed water bodies elevation derived from open-source altimetry data as well as ground elevation data from InSAR.

Two demonstration services with different areas of interest were initiated. Long time series data was provided based on altimetry of lakes and rivers throughout the country, whereas for the InSAR demonstration, the data was limited to a 40km by 40km area in the vicinity of Mosul specified by the UNDPPA.

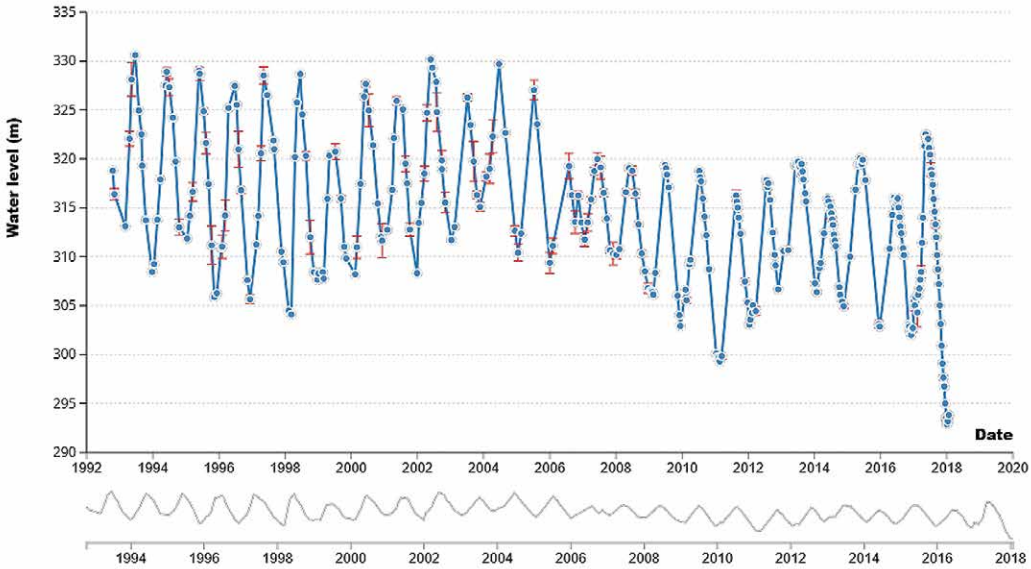


Figure 2: Water level time series based on altimetry data on lake Tathar.
Image credit: ESA, the image contains modified Copernicus Sentinel data (2020), processed by Hatfield.

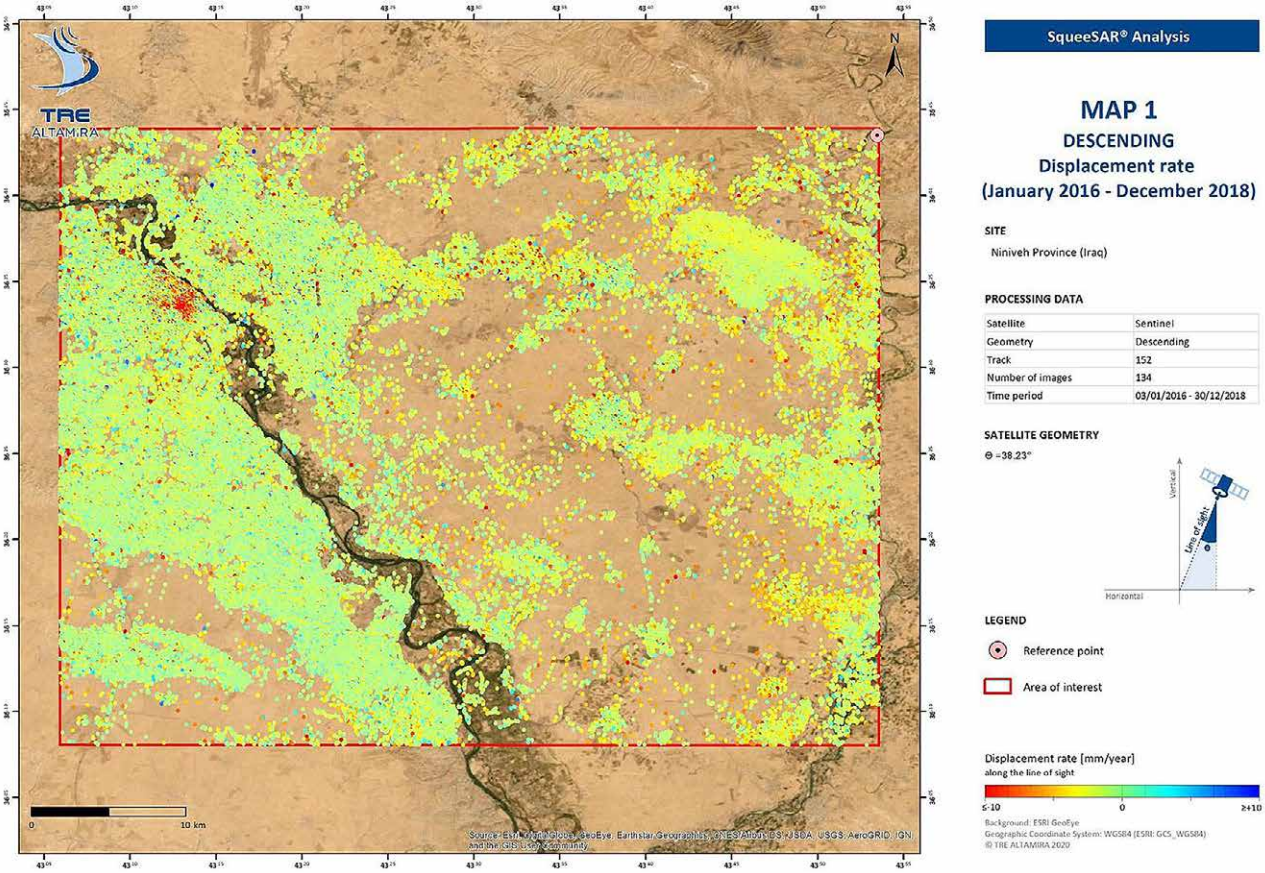


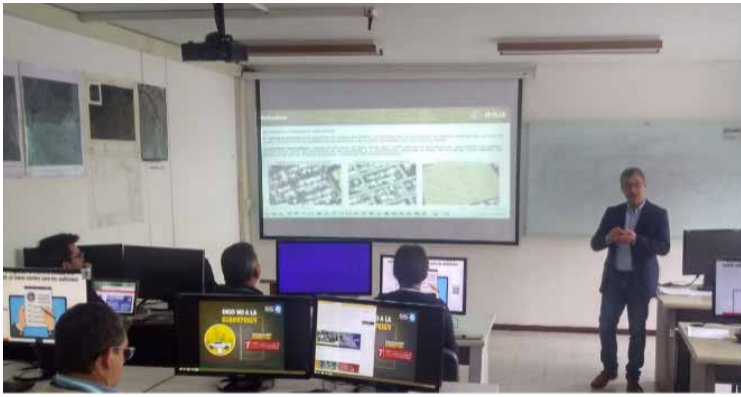
Figure 3: Example of results from the InSaR Analysis around Mosul

The altimetry data was processed by the CLS hydrology department via the work it is doing for the Copernicus land initiative. The InSAR analysis was performed by TRE-Altamira, a CLS subsidiary based in Italy and Spain, specializing in ground movement analysis.

The feedback from the 2 demonstrations was very positive, illustrating a particular interest in InSAR analysis data. The resulting data was of high resolution and accuracy, and the UNDPPA is now looking to integrate these two new sources of water resources data into its comprehensive database.

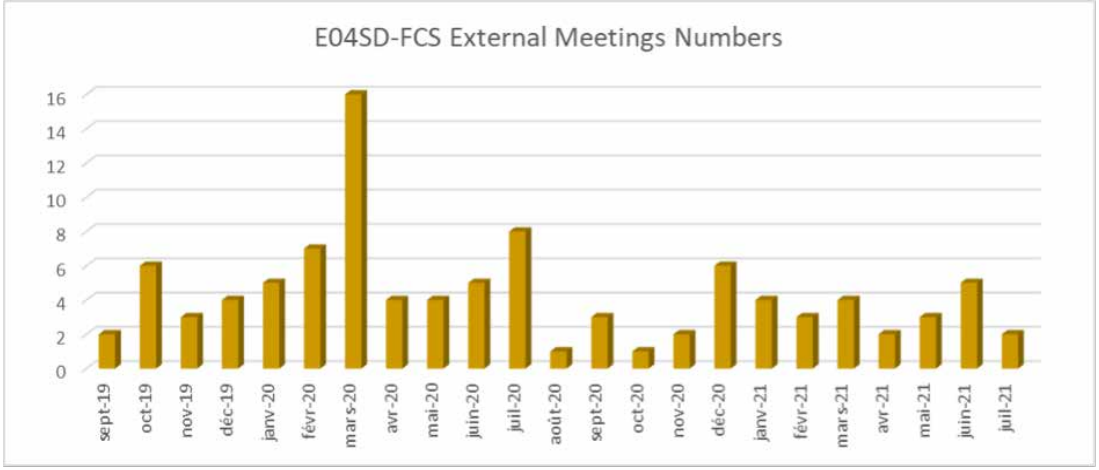
Capacity Building

One of the principal goals of EO4SD FCS is to raise the visibility and knowledge of Earth Observation (EO) technologies within the main IFIs and their client states, so as to increase their uptake in contexts of fragility. Indeed, EO specific attributes enable it to offer unique solutions to the needs of such projects. Under UNITAR's leadership, the consortium organized and implemented an agenda of capacity building and knowledge sharing activities. This included trainings in Colombia, Pakistan and Iraq, as well as the release of a free online course accessible to all.



Engagement

Engagement was a continuous activity during the lifetime of the project. Over 100 formal meetings were held throughout its duration. Through engagement activities, the project consortium was able to increase the project visibility, gather the stakeholders needs, explain the benefits and limitations of EO services, define an appropriate service demonstration and collect the user feedback. Moreover, the project team created a service portfolio to support the engagement process and help potential stakeholders understand the service that could be provided by the consortium over the duration of the project.



EO4SDFCS in a Nutshell

8 consortium partners

2 videos produced

27 engagement initiatives undertaken

103 meetings held

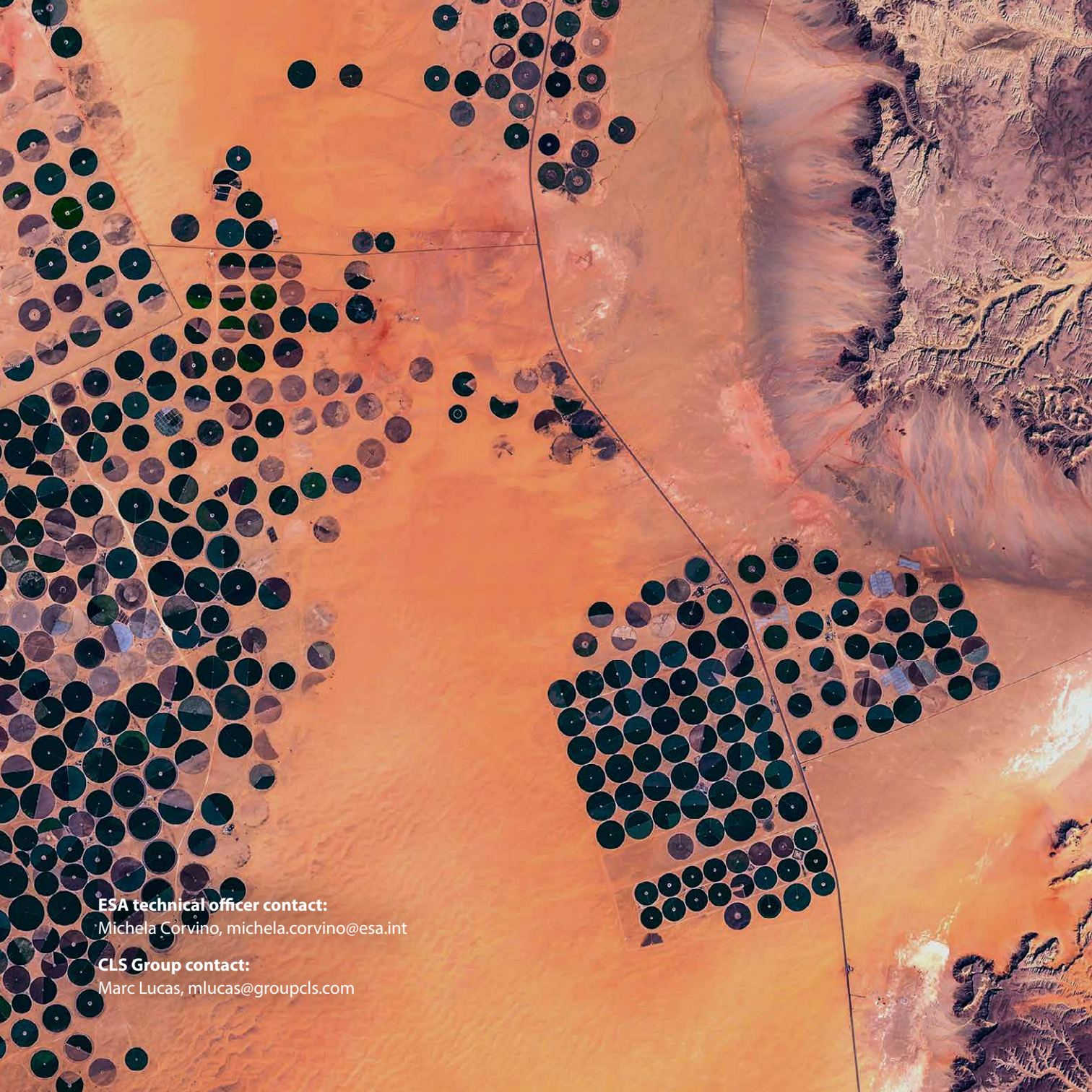
4 capacity building events run locally or remotely

1 online capacity course with over 2000 registered users created

5 high-level international stakeholders: The World Bank, the Asian Development Bank, the FAO, the UNDPPA and the WCO

Consortium

There are 8 different organizations and companies in this consortium with expert knowledge and competencies within the fields of earth observation, development and communication. Fragility, conflict and security is led by CLS with the partners listed below.



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