
UNITAR-UNOSAT satellite imagery analysis in Central African Republic on behalf of the International Criminal Court - Office of the Prosecutor

28 October 2020

Geneva, Switzerland

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Introduction

The United Nations Institute for Training and Research Operational Satellite Applications Programme (UNITAR-UNOSAT) was requested by the International Criminal Court - Office of the Prosecutor (OTP) to provide assistance with satellite imagery analysis concerning events in Central African Republic (CAR). Specifically, UNOSAT was requested by the OTP [REDACTED] to assess several locations in the western half of CAR during the period between mid-2013 and the end of 2014. This analysis responds to the Amended Letter of Instruction dated 09 March 2020 and takes into account correspondence and discussions dating to an initial 06 August 2018 Letter of Instruction, and also subsequent correspondence dated 1 June 2020.

UNOSAT was specifically requested by OTP to assess areas of Bangui, Bossangoa, Berberati, Boda, Carnot, and Yaloke in CAR using satellite imagery acquired before and after specific events occurring in 2013 and 2014. UNOSAT was generally asked to assess damage to structures and also look for signs of graves, checkpoints, barricades, and groups of people, as detailed in the Letter of Instruction. The following pages provide an overview of satellite imagery sources, methods used for analysis, and results. An accompanying Annex 1 provides graphical satellite imagery maps and Annex 2 provides an overview of relevant satellite images available and those acquired for this analysis.

Satellite imagery and methodology

Satellite imagery used in this analysis was collected by commercial satellites operated by the DigitalGlobe¹ and Airbus Defence and Space² corporations. At the time of the events in question both corporations operated multiple satellites and collected imagery based on client orders and according to their own priorities. Given the high interest of some governments and international organizations in CAR during the period in question there were relatively frequent image collections over most of the locations referenced by OTP. Other commercial satellites also imaged CAR during 2013 and 2014 but those images were not acquired for this analysis, though in general UNOSAT considered all commercial satellite imagery with a resolution of one meter or less when searching for imagery³.

UNOSAT used a publicly available online catalogue⁴ and searched for satellite images intersecting the locations provided by OTP in their Letters. Imagery located via the catalogue that was potentially useful for answering the OTP request was purchased whenever possible. In addition, imagery was sourced from Google Earth Pro⁵ as needed. Google Earth Pro is publicly available software which allows viewing of a great deal of commercial high-resolution satellite imagery and with good coverage of CAR. Most of these images around the world likewise originate from DigitalGlobe and to a lesser extent Airbus, and some from other companies. Note that imagery accessed in Google Earth Pro is of somewhat reduced quality than if the same images were purchased in their full form and this had a small influence on the Boda analysis.

¹ See: <https://www.digitalglobe.com>

² See: <https://www.airbus.com/space.html>

³ Due to the relatively small size of the details required in this analysis, including small destroyed structures and groups of people, only one meter resolution or better images were considered. While other imagery at lower resolution is available it would not often definitively describe the damage visible at higher resolutions and would miss many destroyed structures altogether.

⁴ See: <https://imagehunter.apollomapping.com>

⁵ See: <https://www.google.com/earth/versions/>

For each location referenced in the OTP Letters a pair of satellite images were generally obtained, one collected prior to the events in question and one collected after. In some cases to compensate for clouds additional imagery may also have been acquired and used as needed. After relevant satellite imagery was identified and acquired by UNOSAT, either by purchase or by extraction from Google Earth Pro, it was saved to the UNOSAT computer network. The satellite imagery addressing each of the OTP locations was then loaded into an ArcGIS Pro⁶ geographic information system (GIS) software, along with data representing the coordinates provided by OTP. Analysis was done visually by a UNOSAT staff member (Lars Bromley) who used the GIS software to directly view the imagery and determine results.

In the cases of assessing damage, for example, the analyst visually compared the two images, traversing from top to bottom and left to right until 100% of the analysis area was reviewed⁷ at full resolution. Damage or destruction of structures occurring in the time between the acquisition of the two satellite images is usually readily visible when doing this comparison, assuming sufficient damage was done⁸. For example, rooftops easily visible in the 'before' image have disappeared in the 'after' image and often structural remains are visible in their place.

Other details may be gleaned from the imagery analysis, for example if structural remains are blackened and somewhat collapsed in appearance then arson may be the cause. Alternatively, structures razed or demolished via explosives appear distinctly different. This simple comparative analytic method is standard at UNOSAT and other organizations and is conceptually easy to undertake. Notably, more complex analyses are possible, for example assessing whether a structure is destroyed, or rather is severely or moderately damaged. However for the OTP CAR analysis a simple, single class assessment of 'damaged or destroyed' was generally used.

Importantly, during the visual review of the satellite imagery the analyst makes note of destroyed structures visible by creating a vector data point within the GIS for each destroyed structure. Following the analysis the vector dataset becomes the summary of what is visibly destroyed in the satellite imagery and is also used to mark locations of destruction in the GIS and in maps, such as those in Annex 1. This kind of vector dataset can also capture other details of interest that are visible in the imagery, such as gatherings of people or tent shelters.

Analysis of this kind was done on almost all locations described in the OTP Letters. However, in two locations discussions with OTP staff led to a decision to not purchase imagery, as it seemed unlikely to be useful. A review of the locations analyzed and results is below.

Results

Results are presented in following pages and follow the same structure and pattern as the Amended Letter of Instruction from 9 March 2020, addressing each location as it is described in the letter. Written explanations are provided within this document and the accompanying Annex 1 contains a series of satellite imagery maps with graphical examples of what is visible in the imagery, including destruction, tent shelters, and other details. The maps in Annex 1 are annotated with, for example, the

⁶ See: <https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview>

⁷ In most locations the entirety of the imagery purchased was analyzed. However in Bangui a smaller analysis area was designated to shorten time required for analysis.

⁸ Damage must be of sufficient degree to be visible in imagery, involving some form of external structural damage, visible from above. Broken windows, kicked-in doors, internal destruction, and other signs of violence are simply not visible in commercially available satellite imagery.

locations provided by ICC OTP in their Letters of Instruction, as well as symbols to indicating destroyed structures or other details viewed by the analyst. The Annex 1 maps also have insets which provide a close-up view of the satellite imagery. Insets may have graphical arrows highlighting key details, such as damage, or text boxes providing information. Annex 1 is intended to either be viewed on a larger high-resolution computer screen or printed onto A3 pages using a relatively high-quality printer to preserve important image details. Annex 1 maps and insets are referred to in following pages along with explanatory text, and a summary of findings with reference to Annex 1 maps is presented in Table 1.

Table 1: Summary of Findings		
Location	Findings	Annex 1 Map
Bangui – Boy Rabe	Not analyzed	None
Bangui – Boeing Mosque	Five structures were damaged or destroyed close to the Mosque GPS location by 8 December 2013. An additional six were damaged or destroyed nearby.	1a Inset 1
Bangui – Boeing – Bimbo	Ninety four structures were damaged or destroyed within the analyzed area by 30 December 2013. Bimbo was not analyzed.	1a Inset 2
Bangui – Yamwara School	No gatherings or gravesites observed as of 30 December 2013 (normal schoolyard activity seen on 27 November 2013).	1a Inset 3
Bangui – PK9	People and vehicles visible on east side of bridge on multiple dates, within a preexisting market-like area. Existence of checkpoint uncertain.	1b Inset 1
Bossangoa	Seventeen structures damaged or destroyed by 12 December 2013. Tent shelters at <i>Ecole de la Liberté</i> appear by 12 December 2014. Possible checkpoint visible at Ouham River bridge.	2 Inset 1: Damage Inset 2: Ecole Inset 3: Bridge
Berberati	Fifteen structures damaged or destroyed by 9 March 2014. Catholic mission not located.	3 Inset 1 and 2
Boda	Seven-hundred forty-seven structures damaged or destroyed by 28 February 2014. IDP area visible in north.	4 Inset 1 and 2: Damage Inset 3: IDP
Carnot	No visible damage as of 4 March 2014. Catholic compound not located.	None
Yaloke	Sixty-two destroyed structures visible as of 14 February 2015. Barricades not observed. Possible enclave area located but confidence low.	5 Inset 1: Damage Inset 2: IDP

Location: Bangui and environs

Concerning the possibility of a gathering at Boy Rabe, the only possible relevant satellite imagery near the end of November but before 5 December 2013 included images collected 21 and 27 November 2013. Following discussion with OTP these images in the area of Boy Rabe were not purchased and therefore no analysis was done.

Concerning attacks against Boeing and Cattin on 5 December 2013, as well as attacks in the Bangui and Boeing areas, suitable satellite images were collected on 27 November, 8 December, 28 December, and 30 December 2013 and were purchased for this analysis. Note that no imagery was acquired for the Bimbo area. To assess both the possible 5 December attack and the subsequent possible attacks within the time available UNOSAT designated an analysis area of about 6.5 square kilometers. This analysis area was delineated to include the '*BOEING (GPS coordinates taken by OTP investigators at the mosque)*' coordinates as well as the '*Yamwara School*' coordinates, and extended as far towards the '*BANGUI (GPS coordinates taken by OTP investigators at the PK5 crossroads)*' as possible. Note that no information was provided on the location of Cattin and it could not be reliably located so it may or may not be included in this analysis area. The analysis area is shown in Annex 1: Map 1a.

Within the analysis area an initial review of the 27 November and 8 December images located approximately 11 structures destroyed by 8 December 2013. One of the structures is within 20 meters of the '*BOEING (GPS coordinates taken by OTP investigators at the mosque)*' coordinates and four other structures are adjacent. Structural remains are visible and some may be blackened, indicating arson, but shadows from trees preclude complete assessment. These satellite images are visible in Annex 1: Map 1a, Inset 1. Of the six structures assessed to be destroyed nearby, towards the airport, all show blackened remains consistent with arson.

A subsequent review in the analysis area was done to compare the image from 8 December with the image collected 30 December 2013, and at times the image from 28 December 2013 was also referenced if needed. This analysis located 94 newly destroyed structures, almost all east of the Bangui-Mosque location and south of the airport grounds. Two additional structures adjacent to the mosque location were also destroyed. Blackened remains consistent with burning are somewhat visible but image-color quality for 28 and 30 December is limited due to the sensor source. These satellite images are visible in Annex 1: Map 1a, Inset 2.

Concerning the immediate vicinity of the Yamwara School coordinates between the period of 5 December 2013 and 15 January 2014, analysis was done on satellite imagery collected 8 December, 28 December, and 30 December 2013. No obvious gatherings of individuals or gravesites are visible on any of those days, nor any significant changes of any kind that may indicate graves. Note the image from 27 November 2013 was also checked and there is at least one group of people visible with multiple other individuals visible, though this would be expected in a schoolyard at that time of day. These satellite image are visible in Annex 1: Map 1a, Inset 3.

Concerning the existence of a checkpoint at or next to the bridge crossing the M'Poko River after early January 2014, UNOSAT assessed the location identified by OTP as "*PK9 (GPS coordinates taken by OTP investigators at the PK9 bridge)*". An image from 30 December 2013 was purchased by UNOSAT and other images from 28 February and 17 August 2014 were viewed on Google Earth. The OTP coordinates indicate the center of a bridge visible in satellite imagery. The eastern side of the bridge features a

market or small commercial area while the western side is sparsely populated with some possible agricultural and commercial properties.

The viewed satellite images from 30 December 2013, 28 February 2014, and 17 August 2014 did not show any clear indications of a checkpoint. All images indicated an active market-like area at the eastern end of the bridge, usually with at least one car stopped and numerous people in groups together. While this could be an informal checkpoint there is nothing in the imagery to indicate that. Imagery visible on Google Earth indicates this location saw similar market-like activity for some years prior. These images are visible in Annex 1: Map 1b, Inset 1.

Location: Bossangoa

Concerning the possibility of an attack on Bossangoa on 5 December 2013 UNOSAT primarily analyzed imagery collected 4 December 2013 and 12 December 2013. UNOSAT assessed that at least 17 structures were destroyed in various areas of Bossangoa by 12 December 2013. Indications of burning are relatively frequent in Bossangoa on both the assessed dates and at least a few destroyed structures were burned. These images are visible in Annex 1: Map 2, Inset 1. Notably, the image from 4 December includes hundreds of structures that exhibit signs of destruction but would need comparison with a previously acquired image for verification⁹.

Concerning attacks on Bossangoa after 5 December 2013 there is strong evidence in satellite imagery for this. In 2014 UNOSAT documented continuing damage using imagery from 22 January and 28 February 2014 at the time and as part of its rapid emergency response. UNOSAT found an additional 893 damaged or destroyed buildings by 22 January 2014 and 114 more by 28 February 2014¹⁰.

Concerning the gathering of thousands of individuals at the *Ecole de la Liberté* location a tent encampment is not visible as of 4 December 2013 and is clearly visible as of 12 December 2013, and numbers about 100 tent-like structures clustered around the existing buildings. These images are visible in Annex 1: Map 2, Inset 2. Using satellite imagery from 16 December 2013, 8 January 2014, and 22 January 2014 visible on Google Earth Pro the *Ecole de la Liberté* encampment does grow to perhaps several hundred tightly grouped tent structures by 22 January 2014. Note that with such dense structures it can be difficult to differentiate them so these numbers are estimates only.

Concerning road-blocks or checkpoints the main roads into Bossangoa were reviewed using a poor-quality image from Google Earth Pro collected 16 December 2013. This image extended much farther than the images purchased by UNOSAT so allowed greater range for this analysis. The road to the north was reviewed for about 8.5 km, to the west for about 10.5 km, and to the south for about 8.8 km. No obvious signs of road-blocks or checkpoints were visible. However, a possible group of people, estimated at 10-20, are visible on the east side of the bridge over the Ouham River. This may be the only potential checkpoint based on the location. This image is visible in Annex 1: Map 2, Inset 3. Note that purchased images from 4 and 12 December 2013 were also reviewed for checkpoints with none visible.

⁹ In 2014 during the emergency in Central African Republic [UNOSAT analyzed an image acquired 5 December 2013](#) (CAR-OTP-2079-0671) in rapid analysis mode and located 227 potentially destroyed structures as of that date. This analysis also lacked a previously acquired image for comparison.

¹⁰ This analysis is CAR-OTP-2079-0671.

Location: Berberati

Concerning the existence of an attack on 8 February 2014 UNOSAT reviewed imagery collected 16 January and 9 March 2014. As the 9 March 2014 image had intermittent clouds an image from 21 March 2014 was also used to view cloudy areas. UNOSAT analyzed the city of Berberati using these images and found sparse signs of damage with 15 structures visibly damaged or destroyed by 9 March 2014. Occasional blackened remains indicates arson as a possible cause of destruction. These images are visible in Annex 1: Map 3, Insets 1 and 2.

Concerning the existence of a gathering of 300 people in the compound of the Catholic mission, no such gathering was visible but more information on the location of the mission is needed. The coordinates provided by OTP are adjacent to a church compound labeled Pairoisse Sacre-Coeur on some maps. Satellite imagery shows no obvious gatherings in the compound on 16 January, 9 March, or 21 March 2014, though 9 March is slightly obscured by clouds. On the western outskirts of Berberati is another church compound labeled variously on maps as Belle Vie, Catedral, Eglise Catholique, and Centre de Sante Saint Frances. Unfortunately imagery purchased did not cover this area and no imagery from 2014 is available on Google Earth. Additional purchases may be possible to provide more information if OTP can clarify the location of the Catholic mission.

Location: Boda

Concerning the existence of an attack on Boda on 29 January UNOSAT reviewed imagery collected 8 January and 28 February 2014. Damage and destruction in Boda was widely visible as of 28 February 2014 and a rapid UNOSAT analysis found at least 747 damaged or destroyed structures in the town. Further review would certainly locate more destroyed structures, especially in the denser downtown area. An obvious market area and many large commercial or community structures are also destroyed. The cause of the damage is probably fire, based on blackened remains and often collapsed structures. Note that UNOSAT purchased a high-quality version of the 28 February 2014 image but used a lower quality version of the 8 January 2014 acquired from Google Earth Pro. Given the high visibility of the damage this would only minimally degrade the analysis in that it makes damage in denser areas slightly more difficult to see, this the possible undercount mentioned above. These images are visible in Annex 1: Map 4, Insets 1 and 2.

Regarding the enclave surrounded by water a possible location was identified though uncertainty is high. UNOSAT was unable to find information on the area of the 5th arrondissement of Boda and there is no obvious compound immediately surrounded by water in the area. However, if 'water' is considered to be the two small waterways, often fashioned into pools, which envelope an area of the north of Boda then there is a possible candidate. Specifically a compound with about 5 buildings and measuring 118 m long and 53 m wide, with a possibly adjoining section of 70 m x 85 m with perhaps 10 buildings and several trees inside, is visible in the north edge of Boda. This compound lies about 390 m from each of the waterways and could conceivably be 'surrounded' by water if terrain to the north was not considered. The compound is remarkable as on 8 January it is relatively empty and with well-kept grounds while on 28 February 2014 it seems filled with materials which often resemble tarps and other items which could indicate dense habitation by displaced persons. These images are visible in Annex 1: Map 4, Inset 3. Note this site is identified as an IDP area in CAR-OTP-2080-1476.

Location: Carnot

Concerning the possibility of an attack on Carnot during the first week of February 2014 UNOSAT reviewed imagery collected 19 January and 4 March 2014. No indications of destruction or damage to structures in the town of Carnot was visible in the imagery acquired 4 March 2014.

Concerning the existence of a gathering at the Catholic compound unfortunately no clear indication of a Catholic compound was visible in the imagery, and no apparent gatherings of 1,500 – 2,000 people were visible on 4 March 2020.

As nothing significant was found in these images they are not included in Annex 1.

Location: Yaloke

Concerning the possibility of an attack at the end of January 2014, unfortunately satellite imagery is limited in this area. UNOSAT purchased imagery acquired on 19 January 2014 and 14 February 2015, and note the latter was acquired a year after the event in question. The only additional imagery which may be helpful was acquired 20 and 25 January 2014 which were not purchased. Review of the image from 14 February 2015 does show 61 locations where buildings visible on 19 January 2014 were removed, and often with structural remains visible. Given the amount of time passed before the February 2015 no attempt was made by UNOSAT to determine cause of structural removal. These images are visible in Annex 1: Map 5, Inset 1.

Concerning the presence of barricades in the northern area of Yaloke, both images from 19 January 2014 and 14 February 2015 were reviewed. No visible indications of barricades were found in either image.

Concerning the enclave a possible location was identified on the 14 February 2015 image which had what could be a scattering of tent shelters consistent with displaced persons. This location is along the main road entering Yaloke from the west and includes a circular formation of large trees and five relatively large structures and several smaller ones. However a large truck convoy is parked on the road adjacent and so perhaps a social event relating to the trucks is occurring, not an IDP encampment, and also considering the late date of the image. These images are visible in Annex 1: Map 5, Inset 2.

Conclusion

Based on the request from the OTP described in their Amended Letter of Instruction dated 09 March 2020 UNOSAT assessed high-resolution satellite imagery collected over Bangui, Bossangoa, Berberati, Boda, Carnot, and Yaloke in CAR. Specifically, UNOSAT used ArcGIS Pro GIS software and visual analysis methods to assess each location using satellite imagery acquired before and after specific events occurring in 2013 and 2014. UNOSAT analysis detected damage and destruction in Bangui, Bossangoa, Berberati, Boda, and Yaloke, while possible encampments in Bossangoa, Boda, and Yaloke were also identified with varying degrees of confidence. Other details were assessed as possible, including checkpoints and groups of people. Annex 1 provides graphical examples of the satellite imagery and features of interest.

Report prepared by Lars Bromley, Specialist, UNITAR-UNOSAT.

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Date: 15 October 2020