

Satellite-Based Damage Assessment for Town of Baga, Borno State, Nigeria

(Assessment based on satellite imagery recorded on the mornings of April 6 and 26, 2013)

Summary of main findings: A total of 2,275 destroyed and 125 severely damaged buildings were identified within the town of Baga (Borno State, Nigeria) based on a change detection analysis of two very high resolution satellite images collected on the mornings of April 6, before the violence, and April 26, 2013, after the violence. Damages were widely distributed across the southern half of Baga, with multiple clusters of near total building destruction measuring approximately 8 hectares in total area. Virtually all identified building damages exhibit signatures fully consistent with fire, including the presence of burn scars, destroyed trees as well as intact load-bearing walls without a roof. Further, damages match the spatial extent of satellite-detected active fire zones recorded on the night of April 16 (20:55 UTC, 21:55 local time) and the afternoon of April 17, 2013 (12:15 UTC, 13:15 local time) strongly suggesting identified building damages occurred during this period. It is likely that a small percentage of destroyed or severely damaged buildings have not been identified because of tree cover. Total building damages are therefore likely to be higher.



Town Coordinates: 13.094N 13.821E

Baga - Overview of Building Damages as on April 26, 2013:

MAIN DAMAGE AREA: over 2,400 residential and commercial buildings likely destroyed and severely damaged within southern Baga.

The total area of damaged building and burnt vegetation cover measures over 80,000m² (8ha) in size.

Virtually all identified building damages exhibit signatures fully consistent with fire and correspond closely with areas of satellite-detected active fires on the night of April 16 and the afternoon of April 17, 2013

0 250m 500m

Baga – Focus Area 1 of Building Damages as on April 6, 2013: (Pre-violence view of concentration of building damages)



Baga – Focus Area 1 of Building Damages as on April 26, 2013: (Post-violence view of concentration of building damages)



285 destroyed and severely damaged buildings, burnt trees and fire burn scars visible within this section of Baga

Baga – Focus Area 1 of Building Damages as on April 26, 2013: (Post-violence view of concentration of building damages– Damages Annotated)



Baga – Focus Area 2 of Building Damages as on April 6, 2013: (Pre-violence view of concentration of building damages)



Baga – Focus Area 2 of Building Damages as on April 26, 2013: (Post-violence view of concentration of building damages)

345 destroyed and severely damaged buildings, burnt trees and fire burn scars visible within this section of Baga



Baga – Focus Area 2 of Building Damages as on April 26, 2013: (Post-violence view of concentration of building damages– Damages Annotated)

345 destroyed and severely damaged buildings, burnt trees and fire burn scars visible within this section of Baga



Baga – Focus Area 3 of Building Damages as on April 26, 2013:

(Pre-violence view of concentration of building damages, satellite imagery displayed in false-color, near-infrared to highlight areas of extensive fire-related damages and burn scars)



Baga – Focus Area 3 of Building Damages as on April 26, 2013:

(Post-violence view of concentration of building damages, satellite imagery displayed in false-color, near-infrared to highlight areas of extensive fire-related damages and burn scars)

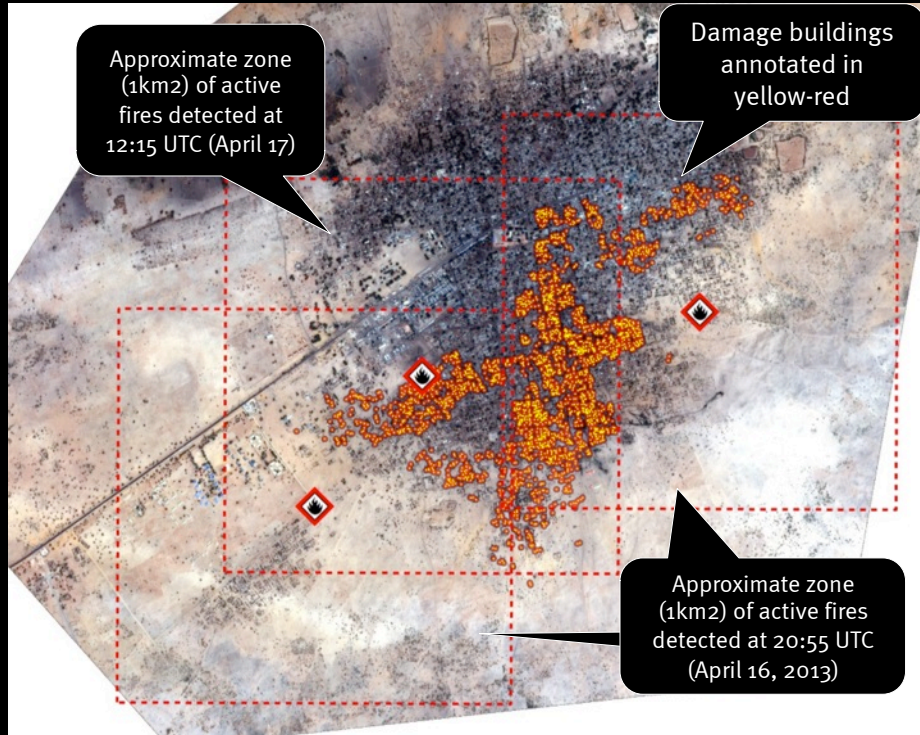


Extensive fire burn scars, burnt trees and large buildings with intact load-bearing walls without a roof

Review of Satellite-Detected Active Fires Detected over town of Baga on evening of April 16 and afternoon of April 17 2013:

(Active fires detected by NASA environmental satellite sensors: MODIS Aqua and Terra)

Satellite-detected active fires zones on April 16 and 17, 2013 closely match building damage locations.



Active fire and associated smoke plume visible from Baga at 12:15 UTC April 17, 2013.



Technical attributes of active fires detected over town of Baga

Latitude	Longitude	Date	Time	Brightness	Confidence	Scan	Track	Satellite	Version	Bright.T31	FRP
13.091	13.829	2013-04-16	20:55	323.2	100	2.7	1.6	T	5.0	293.2	123.9
13.082	13.811	2013-04-16	20:55	306.7	48	2.7	1.6	T	5.0	292.4	51.0
13.088	13.816	2013-04-17	12:15	334.9	76	1.5	1.2	A	5.0	320.9	21.5

Notes on Data Sources and Methodology:

- All imagery analysis was conducted by Human Rights Watch in support of ongoing research on violence in Nigeria, based on a time series of two very high resolution satellite images recorded on the mornings of April 6, (pre-violence) and April 26, 2013, (post-violence).
- Pléiades commercial satellite imagery was purchased through Astrium Services Geo-Information Division. Imagery copyright Centre National d'Études Spatiales (CNES) 2013.
- Multiple active fires were detected across the southern sections of Baga on the night of April 16 (20:55 UTC) and afternoon of April 17, 2013 (12:15 UTC) by the MODIS sensor aboard NASA satellites Aqua and Terra.
- These results are preliminary and are subject to revision or correction pending additional imagery review, new testimony and/or ground verification. It is likely that a small percent of destroyed or severely damaged buildings have not been identified because of tree cover.
- The determination of fire as the probable source of damages identified from satellite imagery is normally made at the level of individual buildings, each evaluated separately based on the relative presence (or absence) of a set of usually distinct signatures including, for example: the presence of intact, load-bearing walls with a collapsed rooftop, the presence of fire burn scars on or immediately adjacent to the property, destroyed adjacent tree/vegetation cover, along with the absence of significant debris fields external to the building foundation. When possible, this is corroborated with thermal anomaly data collected by environmental satellite sensors, which can generally locate the presence of active fires to within one square kilometer.
- Ancillary GIS data from NGA, NASA and ESRI was also used.