Geospatial Technologies and Human Rights Project

Negeha, South Darfur: High-Resolution Satellite Imagery and Destruction of Housing Structures

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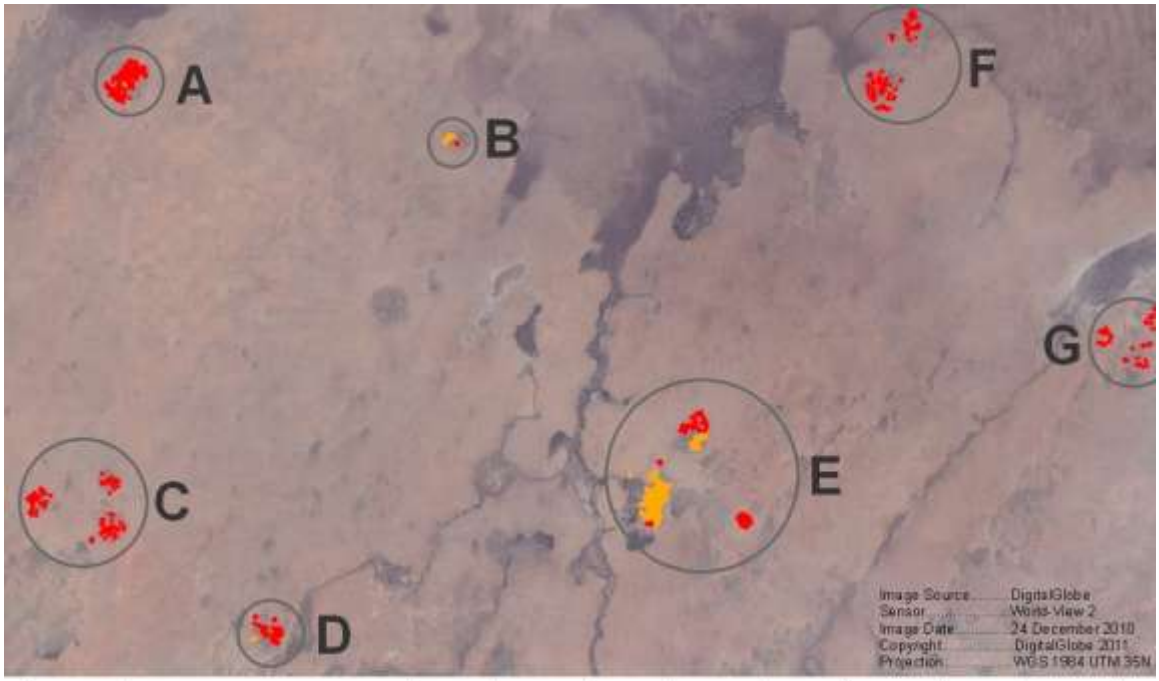
I. Introduction

The Darfur region is an area that continues to experience conflict, and remains an area of interest for the American Association for the Advancement of Science (AAAS) and Amnesty International, as evidenced by the Eyes on Darfur project. Part of Eyes on Darfur focuses on a series of "Villages at Risk." These are villages that were deemed in danger of being attacked. AAAS periodically acquires imagery of these 13 locations to determine if they have experienced attacks. Four of these locations were documented to have sustained attacks in 2008-2009, which is documented on the project web site. In December 2010, reports were published by ReliefWeb regarding new attacks in the Negeha area of South Darfur, which is within the "Villages at Risk" study area. The AAAS Science and Human Rights Program undertook a survey of the area. The survey, looking for evidence of violence, covered approximately 96 square kilometers in the Negeha area. The fighting is said to have resulted in burned homes and newly displaced persons in Negeha and surrounding areas (Figure One). To determine the extent of the destruction, AAAS initially examined satellite imagery of the area taken on December 31, 2005 and December 24, 2010. AAAS documented several hundred damaged or destroyed structures.

Figure One: Map of Darfur

Following this initial effort, an image from January 13, 2010 was acquired to narrow the time frame of the analysis. After reviewing this image, two phases of destruction in the Negeha area were identified. AAAS ultimately found 265 structures damaged or destroyed between December 2005 and January 2010, and an additional 554 damaged or destroyed between January 2010 and December 2010. Figure Two shows these structure counts for seven village areas covered by the imagery.

Figure Two: Damaged or Destroyed Structure Count



Symbol	Destroyed Structures	A	B	C	D	E	F	G	*Total*
●	2005-1/13/2010	3	15	0	4	243	0	0	265
●	1/14/2010-12/24/2010	171	2	99	55	81	100	46	554
	Total	174	17	99	59	324	100	46	819

II. Methods and Technologies

According to a report by ReliefWeb, the villages of Negeha and Jaghara were burned in December 2010, resulting in more than 7,000 internally displaced persons. AAAS examined Negeha and its surroundings for signs of violence by analyzing high-resolution satellite images taken before and after the reported events.

The earliest image used in the study was captured by DigitalGlobe's QuickBird satellite on December 31, 2005. This image was available on the Google Earth platform. The next image, from January 13, 2010, was acquired by GeoEye's GeoEye-1 satellite. The final

image, taken after the reported violence, was acquired by DigitalGlobe's WorldView-2 satellite on December 24, 2010. These three images were visually compared using the ERDAS Imagine and ESRI ArcMap software packages.

AAAS identified housing and other structures that were visibly intact in 2005, but which appeared to have been destroyed shortly prior to January 2010. Other structures were found to have been damaged between January 2010 and December 2010. While many of the changes to structures appear to be a result of attacks on the community, other changes may be attributed to rebuilding, families relocating, and other non-conflict related factors.

Destroyed structures were identified by their fuzzy, undefined outlines, their dark appearance due to charring from fire, and their lack of shadows. An intact house tends to cast a darkened shadow along the wall opposite the sun. A burned structure will often have had its roof collapse and its walls crumble, meaning it will no longer cast a significant shadow. Fires may also leave the ground appearing blackened and charred from the scattering of ash. Similar evidence of violence was found throughout the Eyes on Darfur project, which analyzed imagery of several communities close to Negeha.

III. Results

In total, 819 individual structures were identified as damaged or destroyed. Of these, 265 suffered damage between December 2005 and January 2010, while 554 did so between January and December 2010. Figure Two shows the extent of damage in the area of interest and the time periods during which it occurred. The figure also depicts the locations of Figures Four through Eight, which show the observed damage in detail.

Figure Three: Overview of Damage in Negeha, Darfur

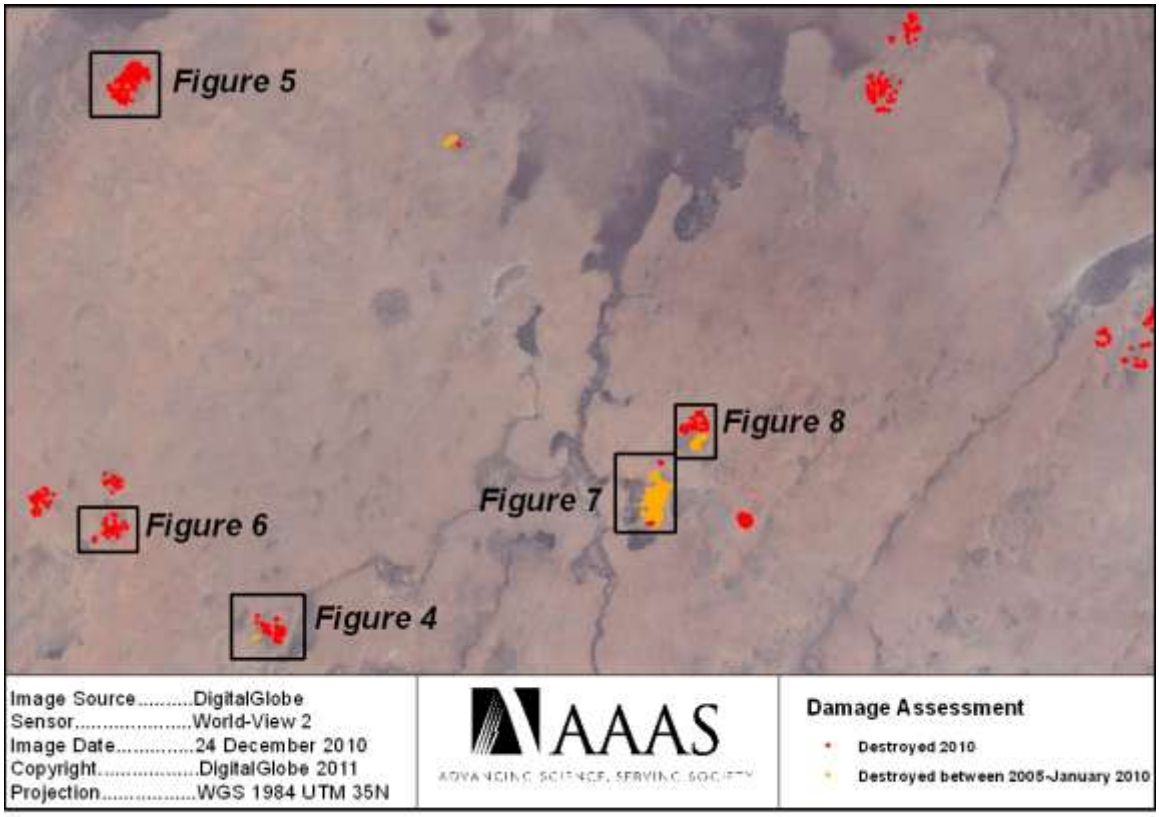
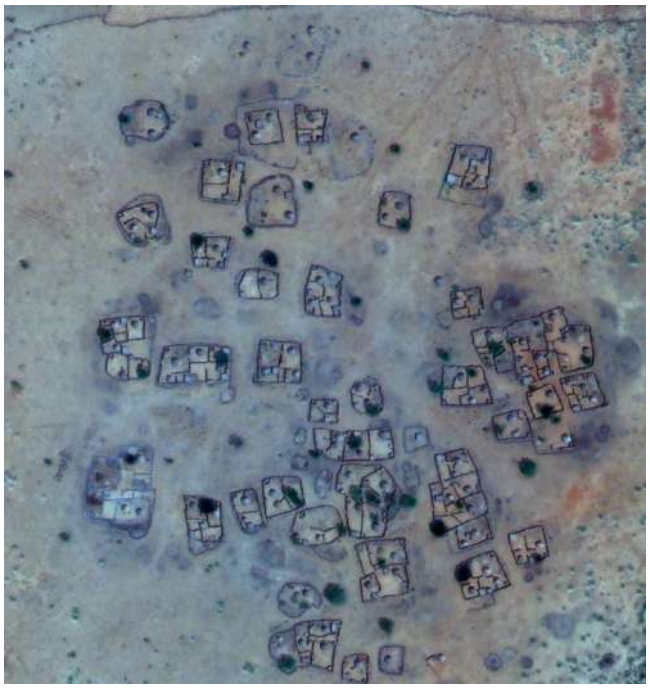
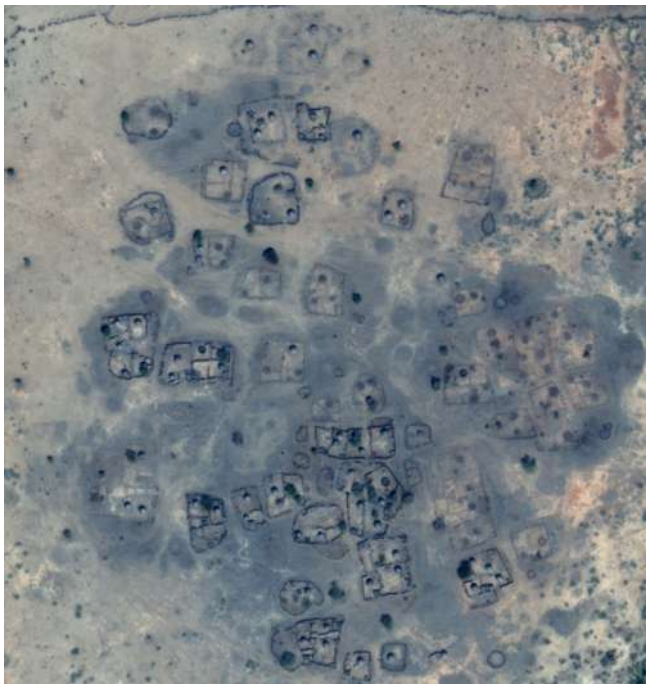


Figure Four

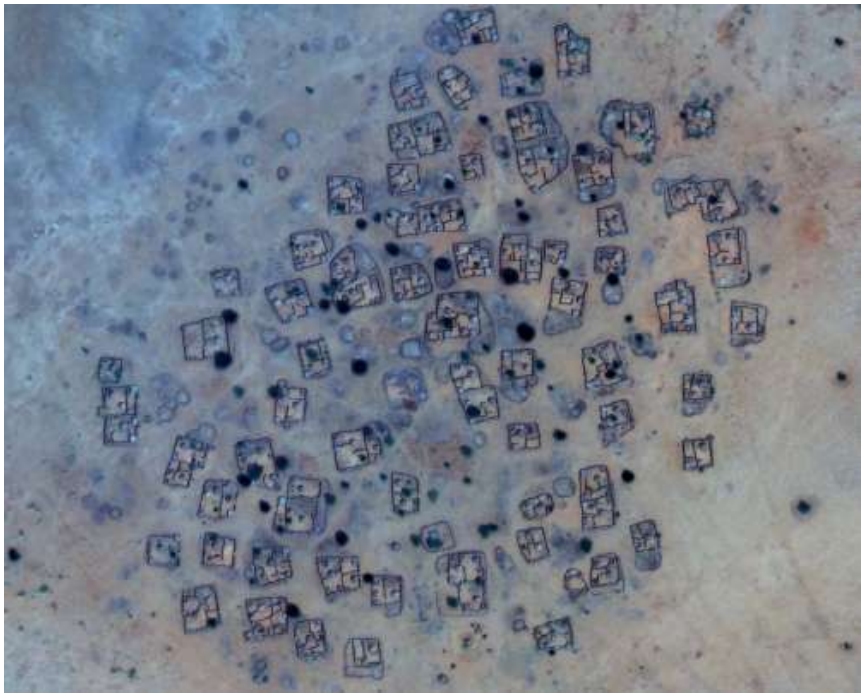


January 13, 2010: This cluster of homes appears to be relatively intact, although outlines of former homes can be seen on the ground. (12.884 N, 25.369 E) Image © 2011 GeoEye, Inc.

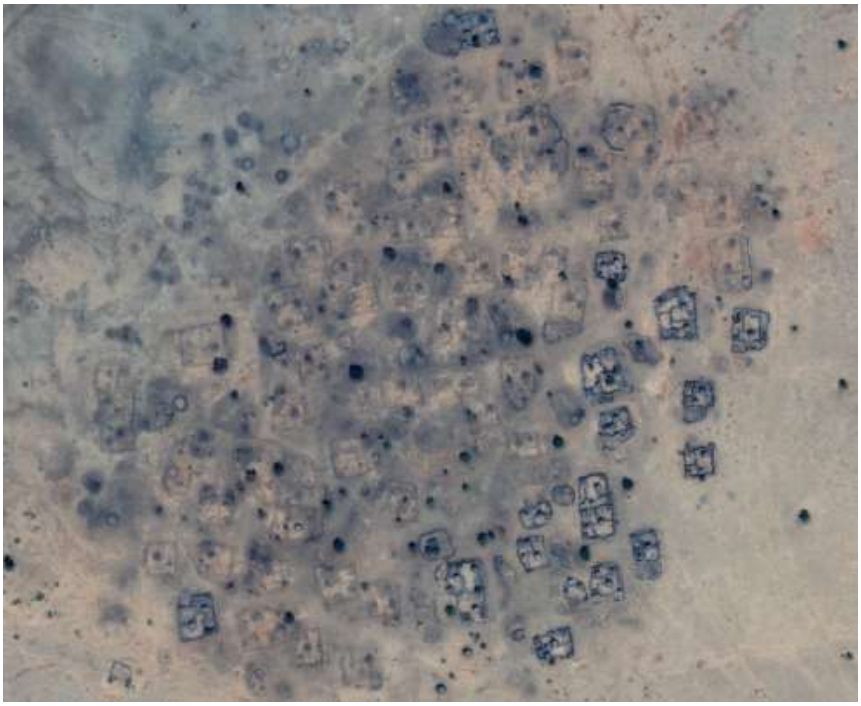


December 24, 2010: In this more recent image, 55 of the original structures are no longer visible. The darkened appearance of the ground is likely from charring that occurred during a fire. (12.884 N, 25.369 E) Image © 2011 DigitalGlobe, Inc.

Figure Five

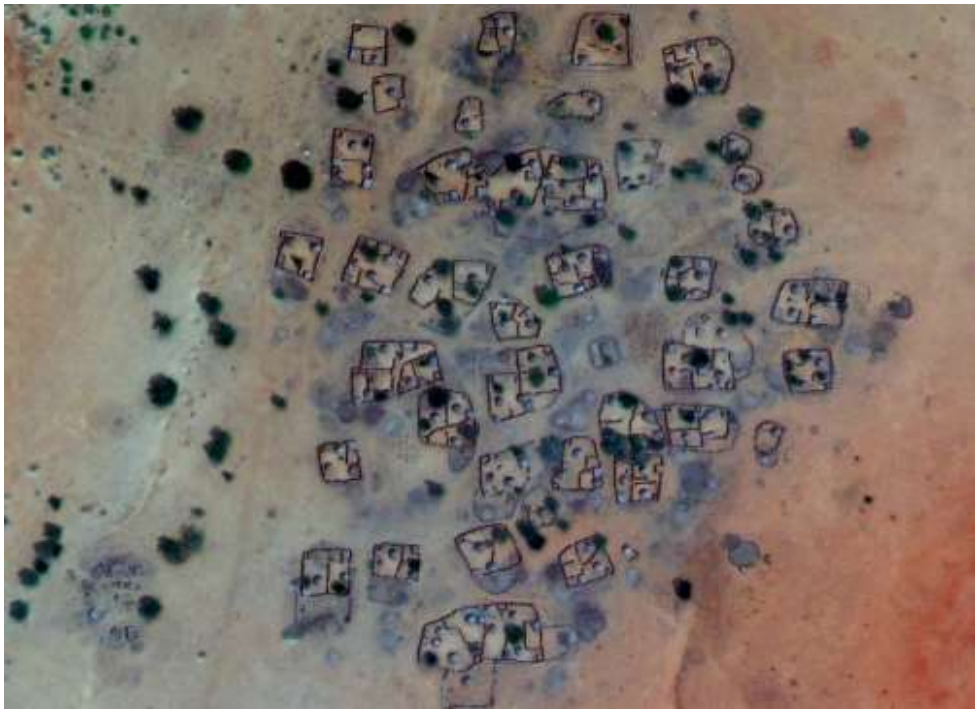


January 13, 2010: Another community of housing structures. (12.938 N, 25.355 E)Image © 2011 GeoEye, Inc.



December 24, 2010: 171 structures in this community have been destroyed. The fences that once surrounded homes appear to blur into the ground, suggesting they were knocked down or suffered fire damage. (12.938 N, 25.355 E) Image © 2011 DigitalGlobe, Inc.

Figure Six



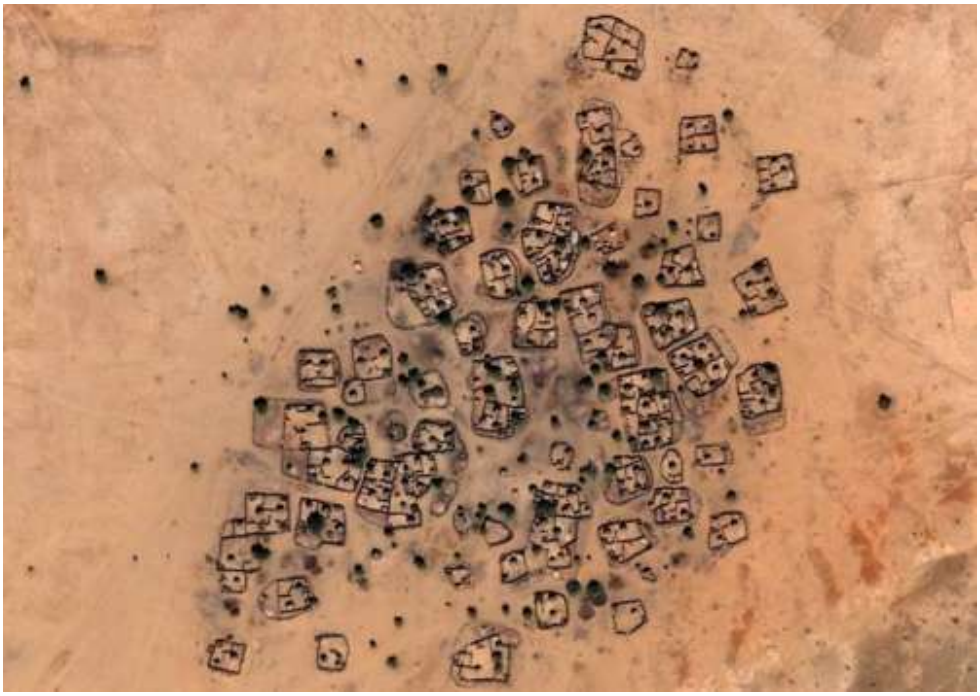
January 13, 2010: This village area appears undamaged. (12.894 N, 25.353 E) © 2011 GeoEye, Inc.

December 24, 2010: While some of the original structures appear intact, 42 others have been completely destroyed. (12.894 N, 25.353 E) Image © 2011 DigitalGlobe, Inc.

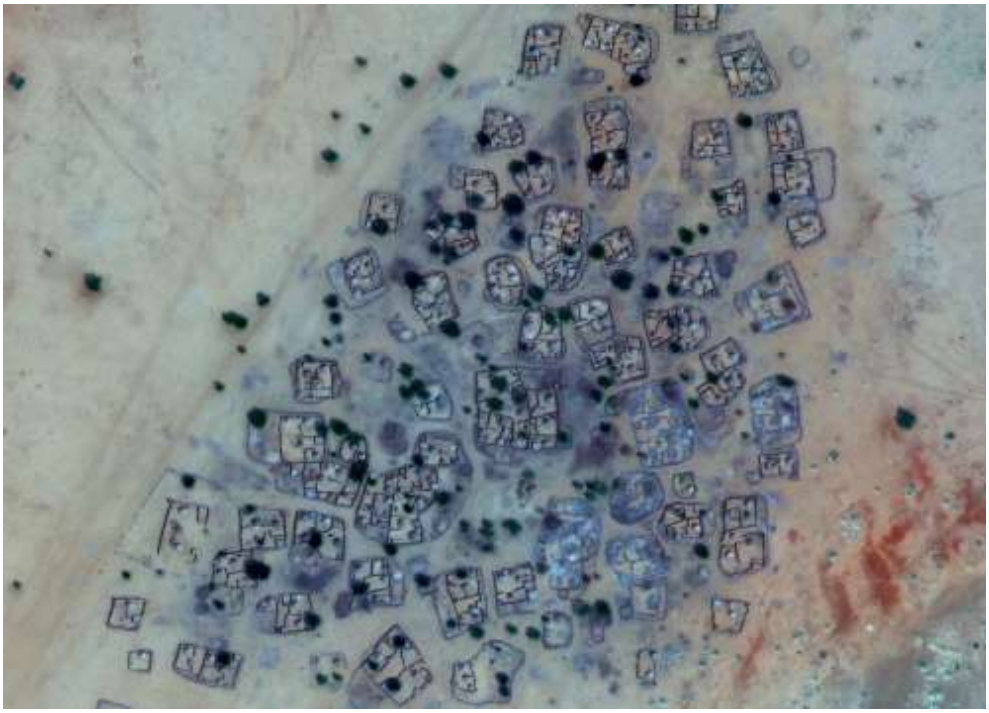
Figure Seven

The image on the left, from December 31, 2005, shows a community of intact structures. By the January 13, 2010 image on the right, 206 structures in the settlement (whitish-gray color) have been completely destroyed. Additionally, seven structures were found damaged between January and December 2010. (12.898 N, 25.408 E) Left image courtesy of Google Earth. © 2011 DigitalGlobe, Inc. Right image © 2011 DigitalGlobe, Inc.

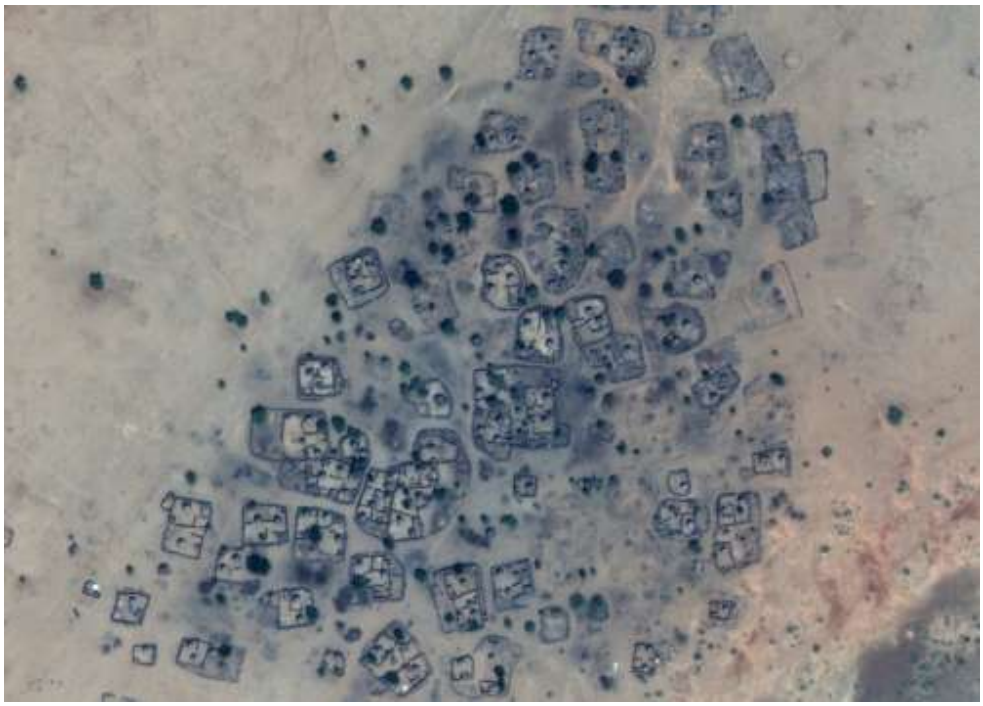
Figure Eight



December 31, 2005: This area, just to the northeast of Figure Six, appears fully intact. (12.902 N, 25.411 E) Image courtesy of Google Earth. Image © 2011 DigitalGlobe, Inc.



January 13, 2010: 37 damaged buildings are apparent in the lower-right quadrant of the image. The whitish-gray color indicates ash that was likely a result of fire.(12.902 N, 25.411 E) Image © 2011 GeoEye, Inc.



December 24, 2010: Since January, an additional 39 dwellings in the northern portion of the image have been destroyed. (12.902 N, 25.411 E) Image © 2011 DigitalGlobe, Inc.

IV. Conclusion

The Negeha analysis conducted by AAAS involved a review of satellite imagery from December 2005, January 2010, and December 2010. The analysis revealed charred earth and hollowed structures affecting 554 structures in total, largely corroborating reports of an attack on the area in December 2010. Given the findings in this report, AAAS will continue to monitor the region as reports of attacks are reported by ReliefWeb and other humanitarian organizations.