Human Rights Applications of Remote Sensing

Case Studies from the Geospatial Technologies and Human Rights Project
The Geospatial Technologies and Human Rights Project (http://www.aaas.org/geotech) produced this report as part of the Scientific Responsibility, Human Rights and Law Program (SRHRL, http://www.aaas.org/program/srhrl) of the American Association for the Advancement of Science (AAAS). As a program of AAAS – the world’s largest multidisciplinary scientific membership organization – SRHRL engages individual scientists and scientific associations in human rights efforts; applies scientific tools and technologies to enhance human rights work; brings human rights standards to the conduct of science; and promotes the human right to enjoy the benefits of scientific progress.

Acknowledgement:
Primary support for this publication was provided by the Oak Foundation through grant number OUSA-12-011.

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Introduction

Since the creation of the Geospatial Technologies and Human Rights Project in 2005, the Project has worked to expand the applications of geospatial technologies to human rights. Geospatial technologies include a range of modern tools, such as remote sensing, geographic information systems (GIS), and Global Positioning Systems (GPS) that allow for mapping and analysis of multiple layers of georeferenced data.

The Project has conducted numerous case studies around the world. It has documented a wide range of human rights violations using various available technologies. These projects demonstrate the utility of geospatial technologies to document many human rights issues of interest worldwide, by enabling:

- Documentation of remote or dangerous locations where on-the-ground access is limited or prohibited
- Large area analysis to study phenomena across regions
- Historical analysis of past events using archival satellite imagery
- The establishment of timelines of events in critical situations

Geospatial technologies can broaden the ability of non-governmental organizations to rapidly gather, analyze, and disseminate authoritative information, especially during times of crisis. They can also provide compelling, visual evidence to corroborate on-the-ground reporting of conflicts and natural disasters affecting human rights.
Case Studies

Cultural Artifact Destruction

- A cemetery in Azerbaijan containing 16th century Armenian burial monuments was leveled by heavy earth-moving equipment (Page 10).

Civilians in Conflict

- The Lebanese cities of Sayda, Bint Jbeil, and Beirut City suffered bombing of civilians during the 2006 war between Lebanon and Israel (Page 12).
- Heavy fighting took place in Misurata, Libya, including shelling and destruction of civilian structures (Page 13).
- Hundreds of structures were destroyed in four communities in the Niger Delta, Nigeria during conflict between government and separatist forces (Page 14).
- Indiscriminate shelling took place throughout Mogadishu, Somalia during a four-year study period from 2007-2010 (Page 15).
- Evidence of significant military action occurs during communal conflict near the city of Tshkinvali and in the surrounding region of South Ossetia, Georgia (Page 16).
- IDP camps are built and dismantled as mortar and artillery fire hit the Civilian Safety Zone in Sri Lanka (Page 17).
- Tanks, roadblocks, and small artillery appear as intense fighting results in the destruction of many civilian structures in Aleppo, Syria (Page 18).
- Destruction of cultural heritage sites, damage to buildings, proliferation of roadblocks, and shell craters during the conflict in Aleppo, Syria (Page 19).
- The destruction of and damage to medical facilities in Syria (Page 20).

Environmental Rights

- Gas flaring continues in Nigeria in 2010 despite a 2008 moratorium, causing widespread environmental, agricultural, and health impacts on the surrounding area (Page 22).
- Significant oil spills caused widespread plant death and the appearance of rainbow oil slicks near Bodo, Nigeria between 2006 and 2010 (Page 23).
- Over 150 oil spills occurred between February 2000 and December 2012 in the Caspian Sea near Turkmenbashi, Turkmenistan, in addition to a continuously leaking pipeline (Page 24).
- Major changes in Bahrain’s land use and land cover include a 12.5% increase in total land area and double the amount of land classified as urban (Page 25).

Communal Conflict

- Over 1600 structures were destroyed and 116 large “SOS” messages in minority Uzbek neighborhoods appeared during ethnically-fueled conflict in Osh, Kyrgyzstan in 2010 (Page 27).
- Nearly a square kilometer of Jos, Nigeria was destroyed during fighting between Muslims and Christians in 2010 (Page 28).

Forced Relocation

- Rural populations were forcibly resettled in concentrated settlements in the Gambella region, Ethiopia between 2007 and 2011 (Page 30).
- Communities supportive of the opposition party were destroyed between 2002 and 2006 following the 2002 elections in Zimbabwe (Page 31).
- Nearly 4,000 structures were removed from 3 slums in Nairobi, Kenya between 2011 and 2012 (Page 32).
Grave Sites

- Two suspected mass graves in Sheberghan, Afghanistan were excavated and the fill taken away in 2006 (Page 31).
- Possible gravesites and secret detention facilities were identified dating from 1976 to 1978 during the Dirty War in Argentina (Page 35).
- Three gravesites expanded rapidly inside the Civilian Safety Zone in Sri Lanka (Page 36).

Property Rights

- 18 villages disappeared and four military camps expanded during fighting between 2000 and 2009 in Burma while a refugee camp appeared on the Thai border (Page 38).
- A slum housing approximately 13,800 people was demolished along the waterfront in Port Harcourt, Nigeria in 2009 (Page 40).
- An eviction and property destruction order was erroneously issued in 2009 in Githogoro, Kenya in order to make room for a new road (Page 41).
- The beachfront bungalow towns of Avaza and Tarta, Turkmenistan were demolished between 2002 and 2010 in order to construct luxury hotels (Page 42).
- Eight villages in Ogaden, Ethiopia were razed during conflict between government and rebel forces in 2008 (Page 43).
- Approximately 7,000 people lost their homes in Negeha, South Darfur, Sudan, and forced to leave the area in 2010 (Page 44).
- Heavy fighting took place between rebel forces and the Sudanese military in Ulu, Blue Nile region of Sudan in 2013, leading to arson and destruction (Page 45).
- 21 villages were destroyed in Darfur, Sudan and IDP camps in Chad experienced growth in 2006 (Page 46).
Documented Human Rights Violations

This chart depicts all case studies undertaken by the Geospatial Technologies and Human Rights Project, organized by human rights violation.
The above map demonstrates all countries in which the Geospatial Technologies and Human Rights Project of AAAS has conducted satellite imagery analysis.
Cultural Artifact Destruction
Cultural Artifact Destruction

Keywords: Cultural Artifact Destruction, Grave Sites

High-Resolution Satellite Imagery and the Destruction of Cultural Artifacts in Nakhchivan, Azerbaijan

Partner: Amnesty International, USA
Publication Date: 25 September 2012

In May 2009, AAAS investigated reports of the destruction of a cemetery featuring khachkar burial monuments, considered to be important Armenian cultural artifacts, in Djulfa, part of the Nakhchivan region of Azerbaijan. Destruction of the artifacts was reported to have occurred before and during 2005 following the Azerbaijani government’s denial of a request by a UNESCO and European Parliament fact-finding mission to enter the region. The artifacts, a collection of 15th and 16th century burial monuments, are believed to have been destroyed in three separate demolitions in 1998, 2002, and 2005.

With the aid of high-resolution satellite images from 23 September 2003 and 28 May 2005, AAAS found significant changes to the terrain and the removal or destruction of the monuments. In a side-by-side comparison, AAAS noted the absence of the shadows cast by the burial monuments, modifications in the grade of the terrain, and evidence suggesting the use of earth-moving equipment. The investigation concluded that satellite evidence is consistent with on-the-ground reports of the destruction of the Armenian cultural artifacts in the cemetery at Djulfa.

The central part of the Djulfa cemetery (red outline) appears to have sustained damage by September 2003, presumably from previous phases of destruction. To the southwest, however, the uneven terrain and the graves’ distinct pattern of varying sizes and shadows are still visible (subset image).

By 28 May 2005, the entire area has been graded flat, including areas that were intact in 2003, possibly by earth-moving equipment. The shadows and uneven terrain created by the monuments are no longer visible (subset image).
Civilians in Conflict
Civilians in Conflict

Keywords: Civilians in Conflict, Indiscriminate Violence

Lebanon: Destruction in Civilian Areas. Case Study Report

Partner: Amnesty International, USA
Publication Date: 19 March 2010

Following the conflict in southern Lebanon and northern Israel between Hezbollah and Israel during the summer of 2006, AAAS conducted a review of the destruction using satellite imagery analysis. Due to US government restrictions, AAAS’s access to images was restricted to southern Lebanon.

AAAS found evidence of attacks in the three locations examined, Beirut City, Sayda, and Bint Jbeil. The investigation revealed destruction consistent with eyewitness reports to Amnesty International, USA, notably to a significant area of Beirut and to the central market and commercial area of Bint Jbeil.

TOP: Area of central Beirut on 19 June 2006. The area was later targeted heavily by Israeli air strikes.

BOTTOM: Area of central Beirut exhibits extensive damage to numerous city blocks following Israeli airstrikes by 12 August 2006. Many large, multi-story buildings are completely demolished and the debris from the destruction has covered the area with an ash-like coating.
In April 2011, Amnesty International, USA requested AAAS investigate the veracity and details of reports of heavy fighting, indiscriminate shelling, and numerous civilian casualties between government and rebel forces believed to have taken place since early March 2011 in Misurata, Libya. In addition, international forces began conducting airstrikes on Misurata on 23 March 2011.

High-resolution satellite imagery shows significant violence took place between 4 March 2011 and 28 March 2011 in Misurata. There are fresh artillery strikes evident throughout the city and the central market and the main electrical station were completely destroyed. AAAS found a 160-meter long line of possibly displaced individuals at the main gate of the port, as well as many temporary structures nearby, corroborating reports that the port was one of the only locations for aid and evacuation. Also, images indicate airstrikes of high caliber and precision, likely by international forces, occurred at Misurata airport.

This clinic in rebel-held territory has seen a significant increase in activity between 4 March 2011 and 28 March 2011 as patients are evacuated from the center of Misurata.

Between 4 March 2011 and 28 March 2011, the street has become littered with debris and disabled vehicles; black asphalt scars; and three fresh impact craters have appeared.

A 160-meter long line of people wait by the gates of the port of Misurata is visible on 4 March 2011.

By 28 March 2011, the main electrical station in Misurata has been demolished in its entirety.
Civilians in Conflict

Keywords: Civilians in Conflict, Property Rights (Destruction)

Eyes On Nigeria: Technical Report

Partner: Amnesty International, USA
Publication Date: 11 November 2011

In 2010, the AAAS partnered with Amnesty International, USA in its Eyes on Nigeria geovisualization project to create an interactive platform that enables AIUSA members worldwide to explore human rights issues in Nigeria. AIUSA asked AAAS to investigate the veracity of reports of attacks by the Nigerian military on four communities (Kurutie, Benikrukru, Oporoza, and Okerenkoko), during fighting with the Movement for the Emancipation of the Niger Delta (MEND), a militant group.

In an analysis of high-resolution satellite imagery, AAAS found evidence of many removed structures and removed or destroyed roofs. The most extensive damage occurred in Okerenkoko, where 230 structures appear to have been removed or destroyed. AAAS concluded that the evidence corroborated claims that communities in the Niger Delta had been affected by the ongoing conflict.

The village of Okerenkoko, intact on 29 April 2009, has been completely demolished by 5 December 2009. Red arrows in the image from 28 February 2010 indicate where structures are being rebuilt.

The village of Oporoza is intact on 29 November 2007, but the roofs of four structures have been removed or destroyed by 5 December 2009.
At the request of Amnesty International, USA, AAAS undertook a review of satellite imagery of Mogadishu, Somalia to examine incidents of reported violence between February 2007 and January 2010. In particular, AAAS focused on three areas of interest: the 1km area surrounding the KM4 junction, the 1km area surrounding the presidential palace (Villa Somalia), and the 1km area surrounding the Bakara market.

AAAS found evidence of destruction in all three neighborhoods, as well as signs of attacks upon the Martini Hospital. High-resolution imagery show fresh patterns in nearby terrain consistent with bursting artillery shells. In addition, in numerous sites temporary structures decreased in number and many areas were cleared of all structures. Despite the continued instability in Mogadishu, this analysis also indicates that new construction and reconstruction of damage is a major phenomenon within the city, especially in the area surrounding the presidential palace.

LEFT: Multiple structures have sustained significant damage in this image from 24 June 2009. A roof pierced by two large holes is indicated by the lowest arrow.

RIGHT: Red arrows indicate possible mortar strikes at the Martini Hospital visible on 24 September 2009.
Following a request by Amnesty International, USA in August 2008, AAAS worked in cooperation with the UN Institute for Training and Research (UNITAR) Operational Satellite Applications Program (UNOSAT) to provide satellite imagery analysis of a portion of the Georgian region of South Ossetia. This analysis was requested after AIUSA collected eyewitness reports of violence and destruction during the conflict between the Georgian and Russian militaries in the Tskhinvali region of South Ossetia between 7 August and 16 August 2008.

In an analysis covering 24 villages to the east and south of Tskhinvali, AAAS found initial destruction (from 7 August to 10 August) was mostly limited to the city of Tskhinvali, where 182 out of 202 of the destroyed structures were located. However, a much broader range of destruction occurred in the surrounding villages after 10 August, with 420 of the 424 destroyed structures located outside of the city. There were additional signs of significant military actions, including obvious craters from munitions and tracks from the movement of military vehicles in vegetated areas.

The village of Tamarsheni, intact on 10 August 2008, but 152 structures, nearly all in the area, is damaged by 19 August 2008.

The subset shows many damaged buildings are missing roofs.
Civilians in Conflict

Keywords: Civilians in Conflict, IDPs, Indiscriminate Violence

High-Resolution Satellite Imagery and the Conflict in Sri Lanka

Partner: Amnesty International, USA, Human Rights Watch
Publication Date: 13 May 2009

Following a request by Human Rights Watch and Amnesty International, USA in May 2009, AAAS analyzed satellite imagery for the Civilian Safety Zone (CSZ) in northeastern Sri Lanka in order to investigate the status and safety of civilians during heavy fighting on 9-10 May 2009.

AAAS found evidence of shelling, possible artillery and mortar positions, and movement of internally displaced persons (IDPs). Numerous impact craters were identified; some with ejecta patterns that helped AAAS determine the trajectory of shells and the locations of probable mortar emplacements likely created by the Sri Lankan Army.

In this overview image of the Civilian Safety Zone, red represents areas of removed IDP structures, green represents areas with created IDP structures, and yellow indicates possible craters.

A probable mortar emplacement near the CSZ is seen in a “Lazy W” formation.

New craters have formed several hundred meters from IDP structures. The subset reveals circumferential ejecta, suggestive of the use of explosive munitions.
Civilians in Conflict

Keywords: Civilians in Conflict, IDPs, Indiscriminate Violence

Satellite Imagery Analysis for Urban Conflict Documentation: Aleppo, Syria

Partner: Amnesty International, USA
Publication Date: 25 September 2012

In August 2012, Amnesty International, USA requested the assistance of AAAS in their investigation of the veracity and details of reports of violence in Aleppo, Syria. Starting on the morning of 9 August 2012, eyewitnesses described heavy fighting, widespread shelling, and many civilian casualties in the city.

After comparing high-resolution satellite imagery from 9 August and 23 August 2012, AAAS observed the destruction of industrial buildings, the erection of improvised roadblocks and fortifications, the presence of tanks and armored vehicles on city streets, the construction of revetments for small artillery pieces, and a substantial increase in activity at a military base nearby. AAAS concluded that, despite difficulties in performing the analysis (due to shadowing, elevation angle, and robust construction materials), accounts of intense fighting and street battles within Aleppo were largely corroborated by satellite imagery.

84 temporary structures visible on 9 August 2012 are replaced by burn marks (yellow), on roofs of nearby buildings (red) and craters have formed in the streets (green) by 23 August 2012.

Damage in the barracks courtyard of Hnano Military base between 9 August 2012 and 23 August 2012 appears consistent with exploding shells.

LEFT: Three recently constructed portable mortar positions are visible on 9 August 2012 near Aleppo Airport.

RIGHT: Smoke is rising from a destroyed complex of industrial buildings in Aleppo, Syria on 9 August 2012.
As a follow-up report to the August 2012 report, "Satellite Imagery Analysis for Urban Conflict Documentation: Aleppo, Syria," Amnesty International, USA requested that AAAS revisit the conflict to investigate further human rights-related reports. AAAS obtained satellite imagery of Aleppo at consistent time periods over nine months to document changes within the city and to validate reports from media sources.

Analysis revealed a steady and continuous trend of degradation to the city's buildings and infrastructure, including residential, religious, commercial, and industrial facilities. Roadblocks and other makeshift fortifications continued to proliferate, with over a thousand visible in the latest imagery. Other signs of military activity, such as shell craters, armored vehicle tracks, and evidence of aircraft deployments were likewise visible, and were consistent with reports of ongoing combat involving heavy weaponry in civilian areas. Damage resulting from fighting resulted in severe losses to the city's cultural heritage, both in the city as a whole as well as the area designated as a UNESCO World Heritage site.

The spatial distribution of destruction in Aleppo was severely lopsided with respect to political control; of the 713 instances that were observed during the study period, only six occurred in areas reported to be occupied by regime forces. The remaining 99% took place in areas classified as contested, under rebel control, or unknown.

Between 1 March 2013 (LEFT) and 26 May 2013 (RIGHT), the minaret of the Umayyad Mosque was destroyed and a large hole was created in the wall (green arrow). Furthermore, the roof of the Souq al-Madina suffered additional damage (yellow arrows).
Civilian in Conflict

Keywords: Civilians in Conflict, Indiscriminate Violence

Assessing the status of medical facilities in Syria

Partner: Physicians for Human Rights
Publication Date: 14 May 2014

In the spring of 2014, AAAS partnered with Physicians for Human Rights in order to assess the status of medical facilities in five cities across Syria: Aleppo, Douma, Homs, Idlib, and Tafas. The project was instigated in response to reports that many of the medical facilities in these cities had been damaged or destroyed in fighting associated with that country’s civil war.

An analysis of fifteen images covering four of the five cities between 2012 and 2014 revealed that by the summer of 2012, Amal Hospital in Homs had been completely destroyed, and Zahri Azrak hospital in Aleppo had sustained heavy damage consistent with shelling. Additionally, although the facility itself appeared to be unharmed, the area adjacent to Hamdan Hospital in Douma was subjected to significant damage, which raises the possibility that the sides of the hospital building, which are not visible from above, may have sustained damage from ground-level fighting. Contrasting with these observations, imagery of National hospital in Tafas showed no apparent damage, while in Idlib, no imagery was available on the relevant dates.

By 16 July 2012, Amal Hospital had been completely destroyed (red box), as have many buildings in the surrounding neighborhood (red arrows). The destruction is oriented in a roughly north-south line. Smoke can be seen billowing from a building in the northern portion of the image. Coordinates: 34.7357627 N, 36.708954 E. Image ©2014, DigitalGlobe, NextView License | Analysis AAAS.
Environmental Rights
Environmental Rights

Keywords: Environmental Rights

Eyes on Nigeria: Technical Report

Partner: Amnesty International, USA
Publication Date: 11 November 2011

In 2010, the AAAS partnered with Amnesty International, USA in its Eyes on Nigeria geovisualization project to create an interactive platform to enable AIUSA members worldwide to explore human rights issues in Nigeria. AAAS undertook a survey of industrial gas flaring in the Niger Delta region, the practice of burning off the natural gas associated with petroleum extraction for economic reasons. Banned in 2008, gas flaring introduces toxic pollutants and greenhouse gases into the atmosphere, impacting nearby wildlife and inhabited areas.

Using space-borne infrared hotspot detections, as well as high-resolution visible-band satellite imagery, AAAS studied the Niger Delta from 2000 to 2010. The analysis found 14,059 probable land-based gas flares at 74 sites during the study period, 48 of which were located such that their outer thermal radii (+4.3°C / 7.7°F) encompassed settlements or agriculture. AAAS concluded that while the 2008 moratorium is associated with a decrease in active gas flares, the practice remains widespread.

![Currently Active and Former Flares](image1)

41 flares were active in 2010 (black dots). Formerly active flares are in grey. 74 flare sites were located from 2000 to 2010.

![Active Gas Flares by Year](image2)

![Image DigitalGlobe](image3)

Multiple gas flares were observed near villages and agricultural fields, as seen on 16 May 2010. Air temperatures are between 4-12°C above ambient.
Environmental Rights

Keywords: Environmental Rights

Eyes on Nigeria: Technical Report

Partner: Amnesty International, USA
Publication Date: 11 November 2011

In 2010, the AAAS partnered with Amnesty International, USA (AIUSA) in its Eyes on Nigeria geovisualization project to create an interactive platform to enable AIUSA members worldwide to explore human rights issues in Nigeria. AAAS attempted to determine the veracity and the scope of oil spills reported to have taken place in late 2008 and early 2009 near the town of Bodo in the Niger Delta region.

Using multispectral imagery, AAAS found that large swaths of vegetation, especially in proximity to waterways, had died between late 2006 and early 2009. In addition, a rainbow effect was visible in the main waterway leading to Bodo and the adjacent tidal flats had changed from yellow to an oily grey. AAAS calculated that approximately three square kilometers of vegetation had been destroyed. Analysis of an image from early 2011 shows the continued presence of petrochemicals in the area, with little improvement visible.

This false-color image shows the area was healthy on 4 December 2006, before the alleged spill.

By 26 January 2009, after the reported oil spill, approximately three square kilometers of the area had turned black, particularly near the riverbanks, an event linked with plant death.

In this true-color image, a rainbow sheen is visible on the river and the tidal flats have turned from sandy yellow to oily grey, both characteristics of an oil slick.
Environmental Rights

Keywords: Environmental Rights

Satellite Imagery Analysis for Environmental Monitoring

Partners: Crude Accountability
Turkmen Initiative for Human Rights
Publication Date: 6 May 2013

In 2013, AAAS partnered with Crude Accountability and the Turkmen Initiative for Human Rights to investigate environmental concerns in the Caspian Sea near Turkmenbashi, Turkmenistan. Eyewitnesses had reported extensive petroleum-related pollution in the waters adjacent to Turkmenbashi, especially after the opening of the Baku-Tbilisi-Ceyhan pipeline in 2005.

AAAS used multiple sources of remotely sensed imagery to examine the area. Relying upon low-, mid-, and high-resolution imaging of the port of Turkmenbashi from February 2000 to December 2012, AAAS found over 700 potential spills, including 147 “strong” spill candidates. These discharges represented what appeared to be circumstances of continuous discharge.

ABOVE: An overlay of the outlines of eight spill candidates suggests a plausible source point, later confirmed by subsequent observations.

LEFT: On 27 March 2011, an oil slick is flanked by four oil rigs, three of which appear to be derelict. The symmetry of the source of the slick suggests that the source is near a junction point of underwater pipes.
Environmental Rights

Keywords: Environmental Rights

Investigating land use and land cover change in Bahrain: 1987-2013

Partner: Bahrain Center for Human Rights
Publication: 22 April 2014

AAAS worked with the Bahrain Center for Human Rights (BCHR) to examine land use and land cover changes in Bahrain from 1987-2013. Over the past 40 years, the population of Bahrain has increased from 213,000 in 1970 to 1,252,000 in 2010, an increase of 487%. The BCHR has expressed concerns regarding the environmental changes associated with this population growth, particularly the impact of changes on non-affluent citizens. Specifically, AAAS and the BCHR wished to examine the scope of island expansion through landfill, vegetation loss, and urbanization.

To quantify these features, AAAS acquired a time series of low-resolution, free, Landsat imagery. An automated land cover classification algorithm was then used to classify each pixel as water, soil, vegetation, or built-up/urban. These classifications were validated against high-resolution imagery of small areas of Bahrain and were found to have overall accuracies of over 80%. These classifications revealed that between 1987 and 2013, landfill increased the size of the island by 12.5%, from 650-730 km². During the same time, the amount of urban area in Bahrain doubled. No clear trend in the amount of vegetation was observed. This may have been because the loss of native vegetation was offset by the addition of irrigated vegetation, such as agriculture and golf courses.

Between 1987 and 2013, the island of Bahrain grew from 650 km² to 730 km², an increase of 12.5%.
Communal Conflict
Communal Conflict

Keywords: Communal Conflict, Property Rights (Intentional Burning)

High-Resolution Satellite Imagery Assessment of Osh, Kyrgyzstan

Partner: Amnesty International, USA
Publication Date: 25 June 2010

Following reports of a conflict on about 11 June 2010 in the city of Osh, Kyrgyzstan, AAAS conducted an analysis of satellite imagery of the city at the request of Amnesty International, USA. The violence was believed to have begun with clashes between rival gangs of Kyrgyz and Uzbek youths on 10 June 2010 that quickly escalated to arson, looting, and violent attacks, including murders, in mainly Uzbek-populated districts of Osh and the surrounding area. The conflict was reported to have caused the flight of thousands of people, mostly members of the Uzbek minority.

In a comparison of before-before-and-after images, it appears that, though most of the city remained intact, entire neighborhoods were destroyed. The destruction, which was concentrated in five main areas, largely followed the major east-west road in the city, but also occurred in pockets of the northern and eastern suburbs. AAAS counted approximately 1640 damaged structures and 116 appearances of the letters “SOS” on roadways and athletic fields, often quite large and at an orientation that is difficult to read except from above. AAAS concluded that, consistent with eyewitness reports, some neighborhoods of Osh were completely destroyed while adjacent ones were left undamaged and that the presence of many “SOS” messages is indicative of a population looking for outside intervention.

Images show the Cheremushki neighborhood. Large portions of the area were destroyed between 15 March 2007 and 18 June 2010; empty shells of buildings stand in contrast to the few undamaged buildings in the area.

116 “SOS” messages were identified in this image from 18 June 2010, mostly in intact areas of the city. The letters are easily legible to the airborne observer. Inset is an example of the messages identified.
Communal Conflict

Keywords: Communal Conflict, Property Rights (Intentional Burning)

Eyes on Nigeria: Technical Report

Partner: Amnesty International, USA
Publication Date: 11 November 2011

In 2010, the AAAS partnered with Amnesty International, USA in its Eyes on Nigeria geovisualization project to create an interactive platform to enable AIUSA members worldwide to explore human rights issues in Nigeria. At the request of AIUSA, AAAS investigated the extent of damage following communal conflict between Muslims and Christians in the city of Jos. The violence, which lasted four days, resulted in several hundred deaths, burned homes, and other destroyed structures.

AAAS used high-resolution satellite imagery from before and after the event, finding that damage was widespread and fires were likely to have caused collapsed roofs. There was evidence of destruction in 16 locations throughout the city, totaling nearly a square kilometer of damage.

An area of Jos, previously intact on 12 June 2007, had suffered widespread damage to structures by 27 January 2010. The subsets show many buildings have lost roofs and there is evidence of burning visible.

In this image from 27 January 2010, nearly a square kilometer (highlighted in red) of Jos had been destroyed. Damage was found in over 16 separate locations.
Forced Relocation
Forced Relocation

Keywords: Forced Relocation, Property Rights (Expropriation)

Documentation of Villagization:
Gambella Region, Ethiopia

Partner: Human Rights Watch
Publication Date: 17 January 2012

AAAS partnered with Human Rights Watch to investigate allegations of villagization in the Gambella region of western Ethiopia, a process of forced relocation of rural populations into concentrated settlements between 2007 and 2011. The villagers in the region were agro-pastoralists and traditionally practiced shifting cultivation. Reports claimed that once the people had been relocated to permanent villages, the vacated land was made available for the development of commercial agriculture.

Using high-resolution satellite imagery, AAAS documented the disappearance of small structures next to modest cultivated fields, consistent with subsistence agriculture, and the construction of larger, more permanent-looking structures, often in organized arrangements indicative of a planned development. Furthermore, AAAS found a net loss in the per-capita allotment of arable land for the resettled population and the appearance of large-scale industrial agriculture near the areas in question.

LEFT: A conversion of unutilized land into a 19-hectare commercial agriculture facility between 10 March 2010 and 4 May 2011. Approximately 80 structures were constructed in Adobo, a nearby village (not pictured), in the same period.

RIGHT: Between 23 June 2009 and 21 December 2011, 68 structures associated with subsistence agriculture in the top half of the picture had disappeared (red). 124 new structures had been built around a relocation center (yellow) and only 32 hectares of land, or .25 hectares per structure, had been cleared for crop production.
Forced Relocation

Keywords: Forced Relocation, Property Rights (Destruction)

Analysis of Community Demolitions in Zimbabwe

Partners: Amnesty International
Zimbabwe Lawyers for Human Rights
Publication Date: 30 May 2006

Following the government of Zimbabwe's plan to demolish “illegal” settlements, Amnesty International requested that AAAS obtain and analyze satellite imagery of four communities where homes were thought to have been removed. Human rights groups believed that these demolitions were in retaliation against communities that supported the main opposition party, the Movement for Democratic Change, in Zimbabwe’s recent elections. The homes and businesses, often present for decades, were in areas that the government claimed to be illegal settlements and black market areas. The UN estimated that around 700,000 people were rendered homeless by the campaign and that at least 2.4 million people were deprived of housing, work, food, water and education.

Using high-resolution satellite imagery, AAAS found that more than 5,000 structures had been removed from the communities of Porta Farm, Hatchliffe, Chitungwiza, and Killarney. The AAAS analysis is being used as supporting documentation for lawsuits filed in the African Court on Human and Peoples’ Rights by the Zimbabwe Lawyers for Human Rights.

LEFT: Porta Farm, a settlement home to as many as 10,000 people, is seen intact on 22 June 2002.
RIGHT: Almost all structures in Porta Farm have been destroyed by 6 April 2006. The significant color change is due to seasonality.
Forced Relocation

Keywords: Forced Relocation, Property Rights (Expropriation)


Partner: Amnesty International, USA
Publication Date: 3 June 2014

AAAS partnered with Amnesty International, USA to investigate reports of force relocations in multiple locations in Nairobi, Kenya from 2011-2012. AIUSA identified 5 locations from which residents reported being forced to leave their homes between 29 June 2011 and 2 April 2012. At 3 of these locations, forced relocations occurred on 2 separate dates for a total of 8 forced relocation events.

Using high-resolution satellite imagery, AAAS was able to confirm the reports of forced relocations at 3 of the 5 locations. A cluster of 411 structures was removed from the Syokimau neighborhood between 30 June 2011 and 4 September 2012. At 2 slums, Mitumba and Kenya Ports Authority, all structures were removed between 6 October 2011 and 6 August 2012. In total, nearly 4,000 structures were removed from these 3 locations from 2011-2012.

It was estimated that nearly 900 structures were removed from the slum of Mitumba, Nairobi between 6 October 2011 (above) and 6 August 2012 (below).
Grave Sites
Grave Sites

Keywords: Grave Sites

High-Resolution Satellite Imagery and Possible Mass Graves in Sheberghan, Afghanistan

Partner: Physicians for Human Rights
Publication Date: 14 July 2009

Following a request by Physicians for Human Rights in May 2009, AAAS analyzed a collection of satellite images to investigate the August 2006 excavation of two holes, suspected to be mass graves, at the site Dasht-e-Leili, located in the Sheberghan region of the Jowzjan Province of northern Afghanistan. The graves had reportedly been created in 2001 and, at some point before July 2008, two large pits were dug and the fill taken away from the area. AAAS aimed to clarify the date of this excavation.

Using a combination of high- and low-resolution satellite imagery, AAAS determined that two vehicles, likely a dump truck and a hydraulic excavator were present on the site in question on 5 August 2006. Only one of the pits can be seen at this time and the two vehicles are over the future location of the second pit. AAAS concluded that these vehicles may have facilitated the excavation of the possible graveyards. Based on these findings and a separate investigation by Physicians for Human Rights, the Obama administration ordered an official review of the incident at Dasht-e-Leili.
Grave Sites

Keywords: Grave Sites

The Use of Declassified US Government Satellite Imagery for the Investigation of Possible Gravesites in Argentina

Partner: Argentine Forensic Anthropology Team (EAAF)  
Publication Date: 21 May 2010

In October 2009, AAAS reviewed satellite imagery of three areas in Argentina at the request of the Argentine Forensic Anthropology Team (EAAF): San Miguel de Tucumán, Santa Fe, and Loma del Torito. The three locations were believed to be secret facilities and potential mass gravesites created some time between 1976 and 1978 during Argentina’s Dirty War (1976-1983).

AAAS analyzed declassified US Government satellite imagery from the 1970s and recent high-resolution imagery for evidence of mass graves. Through a comparison of 1970s-era and contemporary images, the AAAS found that, though no gravesites are evident, significant modifications in roads and structures merit further investigation. The changes detected to the landscape were sufficient for a judge to grant the group access for preliminary forensic work.

This image of San Miguel de Tucumán from 1977 showed roads and a wheel-and-spoke network of paths (in the upper-right).

The network of paths was no longer visible; perhaps overgrown out of disuse at the same location in 1978.

By 2007, many roads were entirely obscured or overgrown by tree cover.
Grave Sites

Keywords: Grave Sites

High-Resolution Satellite Imagery and the Conflict in Sri Lanka

Partner: Human Rights Watch, Amnesty International, USA
Publication Date: 12 August 2009

Following a request by Human Rights Watch and Amnesty International, USA in May 2009, AAAS analyzed satellite imagery for the Civilian Safety Zone (CSZ) in northeastern Sri Lanka in order to investigate the status and safety of civilians during heavy fighting occurring 9-10 May 2009.

Using high-resolution satellite imagery, AAAS found three gravesites in the CSZ that experienced significant expansion over the study period. Analysis of the sites, two of which were laid out in a regular and consistent fashion, suggests a total of 1346 individual burials. Most of the expansion of the gravesites occurred between 6 May and 10 May, with the exception of an irregularly-designed gravesite that grew 28% during the first period and another 20% from 10 May to 24 May.

A gravesite is created and expanded over four image dates between 19 April - 24 May 2009. The area is filled with IDP structures on 19 April 2009, and several weeks later, on 6 May 2009, a gravesite containing an estimated 195 burials is visible. The gravesite expands significantly over the next four days, as shown in the 10 May 2009 image. In the last image, an area across the street has been cleared for interments as well, bringing the total to 342 estimated graves.
Property Rights
Property Rights

Keywords: Attacks on Civilians, IDPs, Property Rights (Destruction)

High-Resolution Satellite Imagery and the Conflict in Eastern Burma

Partners: Burma Rangers, Karen Human Rights Group
Thailand-Burma Border Consortium
Publication Date: 8 November 2010

AAAS conducted analyses of satellite imagery in 2007 and 2009 to corroborate reports by the Free Burma Rangers, the Karen Human Rights Group, and the Thailand Burma Border Consortium of government attacks on villages in Karen State, Burma and the surrounding region starting in 2005. The suspected human rights violations include the burning and destruction of villages and fields, forced labor, and use of conscripted villagers as human landmine detectors by the Burmese military.

Through comparisons of images from 2000/2001, 2006, and 2009, AAAS found 18 removed or partially removed villages, 4 expanded military camps, 2 possible forcibly relocated villages, and 1 refugee camp on the Thai border in its 2007 analysis. The follow-up analysis in 2009 revealed a further 25 instances of destruction. AAAS findings largely corroborate reports

![Image 14 January 2000](Image DigitalGlobe)

![Image 28 October 2006](Image DigitalGlobe)

![Image 1 February 2007](Image DigitalGlobe)

![Image 14 February 2009](Image DigitalGlobe)
Property Rights
Keywords: Attacks on Civilians, Property Rights (Destruction)

Evidence of Destruction in the Democratic Republic of Congo

Partner: Human Rights Watch
Publication Date: 19 March 2010

In May 2009, Human Rights Watch, a member of the Congo Advocacy Coalition, approached AAAS to request support of their efforts to increase civilian protection through a satellite imagery analysis of the Busurungi area of the Democratic Republic of the Congo following eyewitness reports of attacks on civilians on 9 May 2009. The United Nations Organization Mission in the DRC also reported and condemned the attack. AAAS compared pre- and post-attack satellite images and identified 1494 destroyed structures within the study area, though it is believed that destruction occurred outside of the study area.

60 houses have been destroyed in a village near Busurungi between 22 January 2009 and 22 September 2009.
A village near Busurungi experienced the destruction of 155 houses between 22 January 2009 and 22 September 2009.
Intact on 22 January 2009, 76 houses were destroyed by 22 September 2009 in a village in the area of Busurungi.
Property Rights

Keywords: Forced Relocation, Property Rights (Destruction)

Eyes on Nigeria: Technical Report

Partner: Amnesty International, USA
Publication Date: 11 November 2011

In 2010, the AAAS partnered with Amnesty International, USA in its Eyes on Nigeria geovisualization project to create an interactive platform to enable Amnesty International-USA members worldwide to explore human rights issues in Nigeria. In 2009, AlUSA had obtained information that the Rivers State Government had planned a number of demolitions in Port Harcourt specifically of the slums along the city waterfront.

AAAS obtained high-resolution satellite imagery of the Njemanze neighborhood that was allegedly destroyed on 28 August 2009. In a comparison of images taken before and after the reported date, AAAS conservatively estimated the destruction of 375 structures in the Njemanze neighborhood. The approximately 13,800 people who lived in the area had been displaced and only the footprints of a few structures remained.

Approximately 375 individual structures were cleared by 7 February 2010. The white areas in the subset show where buildings used to stand and vegetation had started to cover the ground.
Property Rights
Keywords: Forced Relocation, Property Rights (Destruction)

High-Resolution Satellite Imagery and Community Demolitions in Kenya

Partner: Amnesty International, USA
Publication Date: 11 August 2009

At the request of Amnesty International, USA, AAAS undertook a review of satellite imagery of Waruku and Githogoro, Kenya. AIUSA received reports of forced evictions and demolition of structures in the two settlements. In Waruku, an eviction order was believed to have been erroneously implemented on 11 August 2009. Residents of Githogoro reported that they were forcibly evicted during the week of 20 July 2009 in order to make way for the construction of the Northern Bypass road. After comparing high-resolution before-and-after images of the two areas, AAAS found no indication of demolitions in Waruku but found significant evidence of removed structures in Githogoro.

Approximately 156 structures were removed in Githogoro between 25 June 2009 and 22 September 2009.

No destruction is evident in Waruku between 25 March 2009 and 13 October 2009.
Property Rights
Keywords: Forced Relocation, Property Rights (Expropriation)

High-Resolution Satellite Imagery and the Destruction of Avaza and Tarta

Partners: Crude Accountability
Turkmen Initiative for Human Rights
Publication Date: 6 May 2013

AAAS partnered with Crude Accountability and the Turkmen Initiative for Human Rights following reports of the destruction of two towns on the coast of the Caspian Sea, Avaza and Tarta, near Turkmenbashi, Turkmenistan. It is believed that Avaza, the larger of the two bungalow towns, was demolished in order to build a series of luxury hotels. Purportedly, the destruction of Tarta was intended to improve the view of the sea from the hotels.

AAAS analyzed high-resolution imaging of Avaza and Tarta and found that 1946 of 1992 (97.7%) structures were destroyed in Avaza between 2002 and 2010 and that 326 of 502 (64.9%) structures disappeared in Tarta. In their place, a network of highways and nine new hotels were constructed, as well as a 7 km long canal and expanded beaches. AAAS concluded that the conversion from local vacation destination to international resort was possible in large part due to the demolition of over two thousand structures in Avaza and Tarta.

On 3 August 2002, all structures (red) were still intact in Avaza. The Avaza and Seder hotel are labeled in the subset.

By 26 October 2010, nearly all the structures had been replaced by six hotels, a canal, and new highways with the exception of the Avaza and Seder hotels (visible in the subset).

Almost the entire town had been demolished and a new warehouse (red arrow) had been built by 26 October 2010.
Property Rights

Keywords: Attacks on Civilians, Property Rights (Intentional Burning)

High-Resolution Satellite Imagery and the Conflict in Ogaden, Ethiopia

Partner: Human Rights Watch
Publication Date: 24 June 2008

AAAS conducted a review of satellite imagery of the Ogaden region of Ethiopia in early 2008 at the request of Human Rights Watch. Eyewitness reports claimed that towns and villages in the area, both nomadic and permanent, were razed and burned in 2007. AAAS formally examined eight locations believed to have been attacked and destroyed.

Through an analysis of high-resolution satellite imagery, AAAS found that all eight locations exhibited characteristics consistent with reports, including the significant removal of structures, burn scars and ash, and new construction corresponding to forced relocations. These conclusions were used in the Human Rights Watch report, Collective Punishment.

Approximately 40 structures were removed between 26 September 2005 and 28 February 2008. The white/gray areas may be ash.

Approximately 65 structures, nearly the entire town, had disappeared, and perhaps burned between 23 December 2006 and 7 March 2008.

About 85 structures disappeared between 23 December 2006 and 24 March 2008, especially along the road.
Property Rights

Keywords: Attacks on Civilians, Property Rights (Intentional Burning)

High-Resolution Satellite Imagery and the Destruction of Housing Structures in Negeha, South Darfur
Partner: Amnesty International, USA
Publication Date: 3 February 2011

In 2011, AAAS, at the request of Amnesty International, USA, investigated the extent of observable damage in the Negeha area of Darfur, Sudan, following the online humanitarian gateway ReliefWeb’s reports of attacks in the region. The fighting was believed to have resulted in burned homes and approximately 7,000 internally displaced persons.

AAAS reviewed satellite imagery of seven villages in the Negeha area from January 2010 and December 2010 and identified 819 destroyed or damaged structures, approximately two-thirds of which were attacked in 2010. The analysis revealed charred earth and hollowed structures, providing support to reports of an attack in the area in December 2010.

55 of the original structures were destroyed between 13 January 2010 and 24 December 2010. The darkened ground is likely from charring.

ABOVE: Attacked structures in the Negeha area of Sudan.

LEFT: 171 Structures in this community were destroyed. The fences that surrounded the homes were likely burnt or destroyed.
Property Rights

Keywords: Attacks on Civilians, Property Rights (Intentional Burning)

High-Resolution Satellite Imagery and Housing Destruction in Ulu, Sudan

Partner: Amnesty International, USA
Publication Date: 5 June 2013

In February 2013, Amnesty International, USA reported that several villages in the Sudanese border state of Blue Nile were targeted with aerial bombardment, heavy artillery, and ground forces during fighting between rebel forces and the Sudanese Armed Forces. These villages were believed to have suffered destruction, burning, and other conflict-related damaged.

AAAS investigated these reports with a comparison of high-resolution satellite imagery of areas in and around Ulu, Blue Nile state, Sudan. The images revealed 27 structures, clustered in two separate areas (A & B), had been destroyed or damaged between 12 December 2012 and 28 January 2013. In addition, over 25000 m2 of land had been burned. Analysis of the later image showed that the area was still on fire at the time, a blaze believed to be responsible for the destruction of the 12 structures nearby and threatening at least one more structure. Though it was not clear if the fires were started by military activity, there is some evidence that the fire in cluster B started from a single ignition point.

Two clusters of structures near Ulu, Sudan contain 27 structures and appear intact on 12 December 2012. Areas previously damaged are outlined in black.

All of the structures were destroyed by 28 January 2013 and extensive fires have burned much of the land nearby, including a large area across the street. The subset of cluster B shows fires continue to burn.
Property Rights

Keywords: Attacks on Civilians, Property Rights (Intentional Burning)

High-Resolution Satellite Imagery and the Conflict in Chad and Sudan

Partner: Amnesty International, USA
Publication Date: 25 September 2007

In a contribution to Amnesty International, USA’s Eyes on Darfur website, AAAS monitored and documented the destruction of villages and the growth of camps for internally displaced persons in Darfur, Sudan and in Eastern Chad since 2006. The attacks, suspected to be perpetrated by government-supported Arab militias since early 2003, involved burning villages and food supplies, murdering and raping of civilians, and poisoning water sources.

AAAS studied 28 locations through a comparison of satellite imagery before and after the dates of reported attacks. 75% of the areas showed evidence of attacks including burn scars and destroyed or removed structures. These results have been provided to the International Criminal Court and used in various other advocacy and investigation efforts.

Madoua, Chad, located along the Chad/Sudan border, was completely destroyed between 2 March 2006 and 4 November 2006.

Every structure and fence near Ishma, Sudan was destroyed after a “road-clearing” attack between 25 December 2004 and 10 February 2007.

All structures in this settlement in the Tigla region of Sudan were removed between 30 September 2004 and 8 September 2006.
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