Monitoring Border Conflicts with Satellite Imagery: Ukraine and Russia—2014
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Introduction

The Geospatial Technologies and Human Rights Project of the American Association for the Advancement of Science (AAAS) has undertaken analysis of the crisis between Ukraine and Russia using high-resolution satellite imagery. This analysis forms part of a broader study aimed at investigating cross-border conflicts to identify early warning signs to aid in future conflict prevention efforts. High-resolution satellite imagery provides a particularly useful tool for monitoring and quantifying key metrics in border conflicts, such as troop deployments and the movement of military vehicles. By documenting these indicators, geospatial analysis can provide clarity in circumstances where other data are ambiguous, incomplete, disguised, or concealed.

Conflicting narratives regarding events on the ground have defined the situation in Ukraine. Following months of protest in the Ukrainian capital of Kiev, which culminated in the ouster of former president Viktor Yanukovich, pro-Russian protests in the southern Ukrainian region of Crimea emerged in early 2014. These quickly escalated on 27-28 February, when uniformed armed troops lacking identifying insignia seized Simferopol International Airport and a military airfield in Sevastopol. While the Russian government initially denied involvement in these events, the vehicles and military hardware associated with the unidentified armed groups led many observers to suspect that they were Russian troops acting as part of a coordinated military campaign – a deployment to which Russia admitted on 17 April 2014.

Following a referendum, the legitimacy of which was strongly questioned by international bodies, including the Organization for Security and Cooperation in Europe (OSCE) and the European Union, Russia formally annexed Crimea on 18 March. Ten days later, United States (US) President Barack Obama expressed concern about the large numbers of Russian troops reported to be massing near Ukraine’s borders, and called on Moscow to de-escalate the tensions in the region. Russian president Putin reportedly ordered a partial withdrawal of those troops on 31 March, although NATO reported that it had seen no evidence of a redeployment of forces. Tensions heightened further on 7 April, when pro-Russian groups occupied government buildings in the eastern Ukrainian cities of Donetsk, Luhansk, and Kharkiv, in a move that US Secretary of State John Kerry claimed was the result of paid agents provocateurs “determined to create chaos.” On 10 April, Supreme Headquarters Allied Powers Europe (SHAPE), the headquarters of one of NATO’s two military commands, released commercial satellite imagery depicting what it claimed was evidence of the Russian military

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3 See note 1.
4 See note 1.
buildup on Ukraine’s borders. Russian state media contested the validity of this imagery the same day, quoting an unnamed “senior official at the General Staff of the Russian Armed Forces,” who claimed that the images showed routine exercises which took place “in the summer of [2013]...including near the Ukrainian border.”

Due to the volatile situation, the high level of uncertainty related to events on the ground, and conflicting accounts being disseminated by the actors involved, AAAS conducted research on multiple locations in Russia and Ukraine using high-resolution satellite imagery. This investigation is focused on military installations and activities in Russia and Ukraine, particularly those sites that have been identified as areas of conflict or of a buildup of offensive forces, including the port and city of Sevastopol, the base of Russia’s Black Sea Fleet, other areas on the Crimean peninsula, and areas of reported military deployments in southwestern Russia. The objectives of this study are to characterize accurately the situation on the ground; provide clarification regarding the controversy over the imagery released by NATO; and by so doing, identify features that could serve as warning signs should the crisis escalate into a broader armed conflict.

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Figure 1: Locations of sites analyzed in this report
Data and Methods

Using information regarding the locations of Russian and Ukrainian military bases\(^8\) as well as official statements and news media reports, AAAS acquired multiple images of the area of Sevastopol, as well as southwestern Russia and eastern Ukraine. The region was imaged frequently in the days following the escalation of events in Crimea, and the increase in tensions in Russia and eastern Ukraine. Figure 1 provides an overview of the locations analyzed in this report, and Table 1 provides an accounting of the imagery analyzed. The dates of acquisition were provided by DigitalGlobe, the commercial vendor that owns and operates the satellites used to capture the imagery.

Table 1: Imagery Acquired*

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*All imagery acquired via DigitalGlobe, NextView license
**Image does not cover full extent of study area

Results

Sevastopol

Analysis of Sevastopol focused on the documentation of Russian military bases and port facilities within and near the city. Analysis of the imagery resulted in a number of observations that can be grouped into two broad categories: those involving land-based forces (e.g., vehicle and troop deployments); and those associated with naval activity, such as ship movements.\(^9\)

\(^8\) Obtained via globalsecurity.org and other online sources.
\(^9\) Although both a military airfield and a helicopter facility are present in Sevastopol, AAAS noted no aircraft activity in the city during the study period.
Russia operates numerous shore-based military facilities in and around Sevastopol. Analysis of these facilities revealed hundreds of military vehicles parked in depots throughout the area. In itself, the presence of these vehicles is not suggestive of any build-up of forces or offensive military preparations - the vast majority of the vehicles were present prior to the crisis and remained stationary throughout the duration of the study period. In some instances, however, changes in the distribution of vehicles were noted that could be explained by engagement in operations outside the confines of their bases, as shown in Figure 2. Particularly notable is the absence of nine BTR-80/82 armored personnel carriers, which the Black Sea Fleet’s marine garrison is known to possess.\textsuperscript{10} Caution is necessary when advancing this interpretation, however, as other explanations for their activity are also plausible, such as routine maintenance. If the disappearances of these vehicles were related to military activity, one possible destination for them was identified southeast of Sevastopol, where by 10 March a roadblock was observed to have been erected across both lanes of an overpass of the N-19 highway leading into and out of the city (Figure 3).
Between July 2013 and March 2014, nine vehicles whose dimensions and camouflage patterns matching those of Russian BTR-80/82 armored personnel carriers (arrows) were no longer visible in the yard of the 810th Separate Marine Brigade’s vehicle depot at Cossack Bay (top). During the period from 5 February to 10 March 2014 (bottom) a number of heavy trucks (arrows) have arrived in the courtyard of the Russian Naval Barracks at Pivdenna Bay. Coordinates (top): 44.56N, 33.41E, (bottom): 44.61 N, 33.54 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.
The N-19 highway, unobstructed in on 5 February 2014, is one of the principal roads leading to and from Sevastopol, and was the site of a roadblock that was erected prior to 10 March 2014. By placing the checkpoint on an overpass, those controlling it are able to prevent vehicles from circumventing the barrier. Coordinates: 44.53 N, 33.62 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.

As both the base of operations for Russia’s Black Sea Fleet and a major commercial port, Sevastopol is a large regional center for maritime traffic. Similar to the trends observed on land, observations of vessels in Sevastopol’s many harbors and bays revealed trends consistent with a tightening of military control of the seas. At the entrance to Sevastopol Bay, for instance, the gap between the two breakwaters that separate the port of Sevastopol from the Black Sea itself was observed to be open to navigation on 14 July 2013. By 10 March 2014, however, and
continuing through 18 March, the opening is controlled by a tugboat towing a floating chain or net attached to a new mooring buoy on the south side of the channel (Figure 4). The dimensions and superstructure configuration of this vessel are both consistent with those of an Okhtenskiy class seagoing tug, of which the Black Sea Fleet possesses seven, and whose color schemes match with that of the tug in question (Figure 5). During the same period, a similar obstacle was observed to have been erected at the entrance to Striletska Bay, located 2.5 kilometers to the west. Despite these controls, however, vessels of the Russian Navy were observed to have departed from their moorings and exited Sevastopol Bay; their current locations are unknown (Figure 6). Noteworthy among this military traffic are two Ropucha class landing ships, each of which is capable of transporting up to 24 armored personnel carriers of the type that are no longer visible at the Cossack Bay Marine Garrison, and a Kashtan class mooring buoy tender that would be ideal for anchoring the ends of additional barricades of the type shown in Figure 4.11 Taken in sum, these observations strongly suggest that it is the Russian Navy that controls the entrances to the harbors.

Navigation into Sevastopol and Striletska Bays, open on 5 February 2014, has been restricted by the placement of nets or booms by March 12, 2014. Coordinates: (top, Sevastopol Bay): 44.62N, 33.51E, (bottom, Striletska Bay): 44.61N, 33.47E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.
Figure 5: Detail of tug and mooring buoy

The dimensions, superstructure, and color scheme of the tug which controls access to Sevastopol Bay are very similar to Russia’s Okhtenskiy class of seagoing tugs, such as MBN173 (inset). Coordinates: 44.62 N, 33.51 E. Inset photo by A. Brichevsky, Black Sea Fleet Information Resource. Satellite image ©2014, DigitalGlobe, NextView License | Analysis AAAS.
Despite the barriers to navigation described above, in Sevastopol Bay, two Ropucha class landing ships (A, B), a Nanuchka class missile corvette (C), and a Kashtan class mooring buoy tender (D) departed the naval base between 12 March (top) and 18 March (bottom), while a third Ropucha class landing ship (E) arrived. Coordinates: 44.62 N, 33.56 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.

Belbek and Kacha Airbases

Prior to Crimea’s annexation, Belbek airbase, located eight kilometers north of downtown Sevastopol, was a Ukrainian Air Force base hosting that country’s 204th Tactical Aviation
Brigade, outfitted with the MiG-29 Fulcrum. During the crisis that preceded the referendum on annexation, the base was reportedly the site of a tense standoff between its personnel and pro-Russian forces. Analysis of satellite imagery reveals features that are consistent with these reports. The gates of the base, unobstructed on 5 February 2014, have been barricaded by roadblocks by 10 March. Elsewhere in the image, ten MiG-29s can be clearly identified, and are parked across the centerline of the runway at regular intervals in a configuration that appears designed to render the airstrip unusable by incoming aircraft (Figure 7). At the time, the pro-Russian forces were described by that country’s media as spontaneous “self-defense squads.”

**Figure 7: Obstacles deployed at Belbek airbase**

On 5 February 2014 (left), both the runway and the main gate of Belbek airbase are unobstructed. By 10 March (right), however, roadblocks have been constructed (red arrows), and MiG-29s have been placed across the runway (yellow arrows). Coordinates: 44.69 N, 33.58 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.

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In contrast to these defensive measures, the Russian airbase at Kacha, located nine kilometers to the north of Belbek, saw the arrival of numerous additional aircraft during the same interval (Figure 8). As the base of the Black Sea Fleet’s maritime patrol and surveillance aircraft, the units visible at the base prior to the crisis consisted primarily of Ka-27 “Helix” and Mi-14 “Haze” antisubmarine helicopters, as well as Be-12 “Mail” patrol aircraft. By 10 March 2014, however, these forces have been augmented by the arrival of seventeen additional helicopters, a level of activity that was not apparent in any imagery acquired from prior to the crisis. Although some of the new arrivals were of dimensions consistent with the Mi-14s based at Kacha, others were observed that more closely match Mi-24 “Hind” attack helicopters, which are not typically used in a naval role. Furthermore, the dimensions of the Mi-14 are nearly identical to those of the Mi-8 troop transport, from which it was derived. It is therefore possible that the aircraft that arrived at Kacha during the crisis were part of a combined force consisting of attack and troop transport helicopters. Further evidence in support of this hypothesis exists in the form of amateur video that appears to show a formation of Mi-24s and Mi-8s violating Crimean airspace during the opening hours of the crisis.


On 5 February 2014 (top), only Ka-27 antisubmarine helicopters (blue arrows) and one Mi-8/14 (yellow arrows) are present on the apron at Kacha airbase. By 10 March (bottom), numerous additional helicopters, including ground-attack Mi-24s (red arrows), are visible. Coordinates: 44.78 N, 33.55 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.
Belgorod

In a statement released on 9 April by the US ambassador to the OSCE, the region surrounding the western Russian city of Belgorod was identified as the location of a Russian military buildup. If present, such forces would be located less than 40 kilometers from the Ukrainian border. Subsequent imagery released by NATO purported to show imagery of this force on 26 March 2014, specifically Mi-8 and Mi-24 attack helicopters along with dozens of tanks and over one hundred infantry fighting vehicles and their associated logistics and support equipment. AAAS acquired imagery of the site on four dates (see Table 1), including one scene from 26 March 2014, which appears identical to the image released by NATO on 10 April. The site, located on the outskirts of the city, appears deserted on 10 November 2013 and 11 December 2013. By 22 March 2014, however, hundreds of vehicles are present, along with associated tents and materiel. Dozens more such vehicles were observed to have arrived between 22 and 26 March (Figure 9), along with 21 helicopters whose dimensions match those of the Mi-8s and Mi-24s reported by NATO. Analysis of this imagery by AAAS corroborates NATO’s observations.
On 11 December 2013 (top), this military base on the outskirts of Belgorod is nearly deserted. By 22 March 2014 (middle), hundreds of combat and support vehicles are present. Four days later, on 26 March (bottom), further reinforcements have arrived. Coordinates: 50.65 N, 36.52 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.
Located approximately 35 kilometers northeast of Rostov (Figure 1), the area surrounding the city of Novocherkassk was one of several sites for which NATO released imagery on 27 March 2014. According to that analysis, imagery showed elements of a Motorized Rifle Regiment, a probable anti-tank battalion, and an artillery battalion. As at Belgorod, AAAS was able to acquire imagery with dates identical to those reported by NATO. As in Belgorod, an area that had been an empty field in late 2013 was filled with hundreds of military vehicles, tents, supplies, and logistics equipment by 27 March. The widespread construction of earthen defensive positions and numerous serpentine tracks observed in the terrain were consistent with large-scale military exercises, as were the changing positions and formations of many vehicles and weapons systems (Figures 10-11). Unlike Belgorod, however, no helicopters or other aircraft were observed at Novocherkassk.

A final notable observation at this site had nothing to do with military activity. The imagery that AAAS analyzed to evaluate the area before the reported buildup was acquired on 2 July 2012, and shows the site’s trees in full leaf. The imagery of large-scale military activity, by contrast, shows trees that are almost completely bare, as would be expected for early northern-hemisphere spring (Figure 12). Furthermore, the matching dates and extreme visual similarity between the imagery obtained by AAAS and those released by NATO suggests a very high probability that they are, in fact, the same images. In light of these facts, the assertion\(^\text{19}\) that this imagery depicts exercises from midsummer 2013 appears incongruous.

**Figure 10: Deployed artillery and infantry fighting vehicles near Novocherkassk**

*In this image from 27 March 2014, artillery pieces (red arrows) have been deployed in the fields northeast of Novocherkassk. Infantry fighting vehicles –likely BMP-3 or BMD-3 type, based on their dimensions– maneuver nearby (yellow arrows). Coordinates: 47.52 N, 40.22 E. Image ©2014, DigitalGlobe, NextView License | Analysis AAAS.*

\(^{19}\) See note 6.
Figure 11: Buildup of troops and equipment near Novocherkassk

In July 2012 (top), the fields outside Novocherkassk show no activity. On 30 March 2014 (bottom) hundreds of combat vehicles, tents, and support facilities are present. Coordinates: 47.52 N, 40.22 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.
In July 2012 (left), trees at this tank depot near Novocherkassk are in full leaf. In the image showing a buildup of tanks at the base (right) the trees are bare, suggesting that the image was indeed taken on 27 March 2014, and not the previous summer. Coordinates: 47.52 N, 40.16 E. Images ©2014, DigitalGlobe, NextView License | Analysis AAAS.

**Kuzminka**

The third of the sites published by NATO that AAAS examined was located near the town of Kuzminka, some 36 kilometers west of Rostov (Figure 1). In its release, NATO compared imagery of the site taken on 25 October 2013 and 27 March 2014, and concluded that tanks and infantry fighting vehicles associated with a motorized rifle regiment had occupied the area, along with their support and supply facilities. To verify these conclusions, AAAS acquired imagery of the area covering both those dates, as well as 23 March 2014, 30 March 2014, and 5 April 2014. Once again, analysis of the imagery lends credibility to NATO’s conclusions. On 25 October 2013, the area appears as a patchwork of agricultural fields delineated by rows of trees. By 23 March the same fields are crisscrossed by a dense web of heavy vehicle tracks, and a large encampment of tents, trucks, and armored vehicles has appeared in its southwestern corner (Figure 13). The force remains in place through 27 March, 30 March, and 5 April, with no apparent draw-down in its level of readiness; throughout that period, elements of the formation can be seen maneuvering, presumably in exercises.

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20 See note 6.
Figure 13: Activity of combat and logistics vehicles near Kuzminka

Conclusions

Analysis of the port city of Sevastopol, which houses the Russian Black Sea Fleet, has revealed a number of observations that can be considered warning signs of a potential armed conflict. These include the movement of combat and logistics vehicles, the construction of roadblocks, and the establishment of a maritime blockade of strategic ports and harbors. Particularly in the case of maritime actions, these observations suggested a level of coordination and organization consistent with the interpretation that the armed groups which seized control of Crimea in February-March 2014 were not solely “spontaneous self-defense militias”. The apparent use of Russian naval vessels to blockade the port of Sevastopol strongly suggests that such actions are at the very least supported by the Russian military. While alternate interpretations of the imagery are possible, particularly with respect to the deployment and disposition of land-based forces. Nevertheless, when viewed in light of reports alleging the presence of Russian troops on the ground alongside irregular units, this analysis lends credibility to the involvement of Russian military forces in the takeover of Sevastopol – involvement which Russia later admitted.

Analysis also reveals patterns consistent with the involvement of Russian airborne units in the Crimean crisis. This is suggested by the substantial increase in the number of helicopters present at Kacha airbase, along with the clear signs that Ukrainian personnel at the neighboring Belbek airbase were sufficiently concerned about the prospect of an airborne assault to block the runway using their own aircraft. This anxiety may have been justified; observers have noted that Belbek’s runway would be ideal for landing heavy troop transports. Likewise, the barricades surrounding the base’s entrances appear to have been a well-advised – though ultimately unsuccessful – defensive measure; Belbek airbase was taken over in a Russian ground assault on 22 March. This outcome demonstrates that both of the features observed at Belbek were unambiguous warning signs of future conflict.

Analysis of Russian forces inside Russia reveals that the country’s armed forces are engaged in large-scale military exercises at multiple locations in close proximity to the Ukrainian border. Multi-temporal observations of their encampments reveal units departing their staging areas, engaging in maneuvers, and returning to their encampments. These results substantiate NATO’s assertions of a troop buildup in the border regions. Indeed, in Belgorod, it was possible to watch additional reinforcements arrive over the course of four days from 22 to 26 March. During this same period, Russian state media ran headlines repeating Moscow’s declaration that there was “No troop build-up or undeclared military activity near Ukraine borders.”


22 See note 12.


While the Russian government’s acknowledgement of the existence of ongoing military exercises\textsuperscript{25} may render the statement technically accurate with regard to \textit{undeclared} military activity, the claim that no build-up is taking place is inconsistent with the observations of this investigation. Finally, biological evidence in the form of seasonal foliage is entirely consistent with the acquisition dates reported by NATO via DigitalGlobe, and the images examined by AAAS and those released by NATO are consistent with one-another in their depiction of the landscape. In light of these observations, the claim that the imagery depicts exercises that took place in the summer of 2013\textsuperscript{26} lacks credibility.


\textsuperscript{26} See note 7.