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TEARLINE

PROJECT

2024 YEARBOOK

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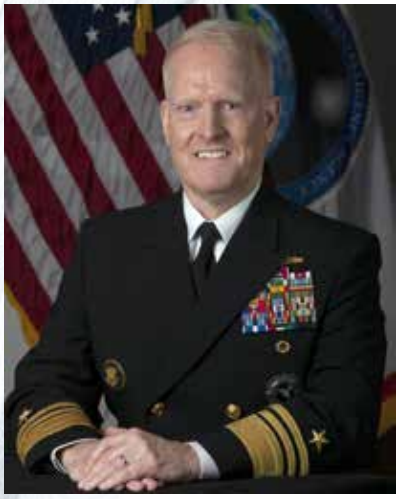
FOREWORD



Welcome to the National Geospatial-Intelligence Agency's second annual Tearline yearbook.

NGA delivers geospatial intelligence (GEOINT) from seabed to space at the speed and scale required to provide decisive advantage to military commanders and national policy makers. We leverage an expert workforce and innovative technologies to address the rising demand for GEOINT and the explosion of GEOINT data and associated information from both classified and unclassified sources.

To help meet the challenge of this deluge of data, NGA engages non-traditional collaborators to analyze commercial GEOINT data. The result, NGA's Tearline program, represents a coordination across academia, nonprofit organizations, and think tanks.

This publication highlights important work on hard national security problems, cumulating in the 14 enclosed Tearline articles published in 2024. Working with NGA, the contributors used computer vision, machine learning, artificial intelligence, and more traditional analytic methods.

Authors interrogated assumptions and conducted superb research, providing ground truth on topics like Russian oil and gas activities in North Africa, Chinese infrastructure investments in Namibia, and railroad construction in Kazakhstan.

You will also come across a compelling article that examines the operating status of a North Korean prison camp for political prisoners. Nearly 20 years ago, North Korea publicly announced the closure of this camp. However, the authors used current satellite imagery and interviews with former detainees to reveal the camp is still very active today.

NGA is proud to sponsor this program. Please be sure to visit the Tearline website at www.tearline.mil for the latest NGA Tearline reporting.

V/R, FDW
Frank D. Whitworth III, Vice Adm., USN
Director, NGA

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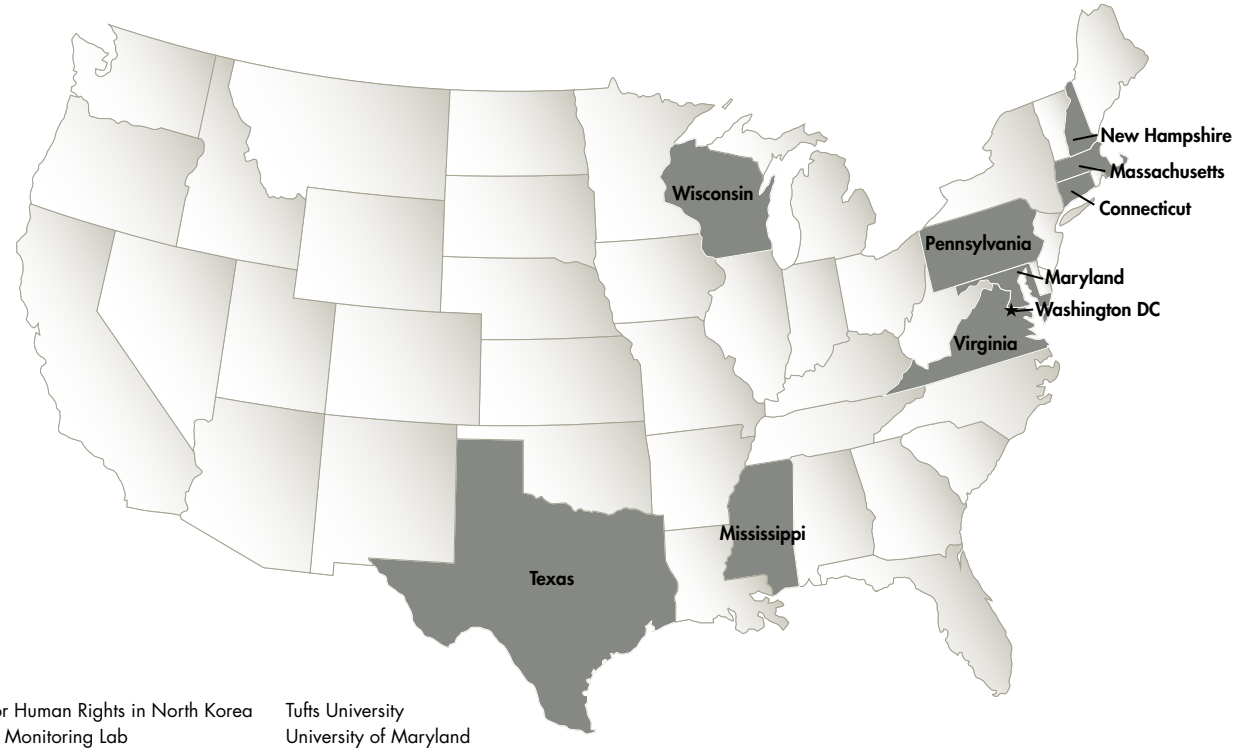

The Committee for Human Rights in North Korea
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Identification of Deliberate Building Targeting During Ukraine War: Evidence from Donetsk Oblast

Written by Jacob Aronson, Deniz Cil, Hayden Bassett, Katharyn Hanson, Corine Wegener and Brian Daniels from various organizations

Source: Base Map provided by NGA

OVERVIEW

We develop and apply a process for identifying the deliberate targeting of building types during ongoing armed conflict by conflict actors. Results indicate that cultural, and secondarily medical, buildings are likely to have been deliberately targeted by combatants. Targeting, however, occurred only in cities where direct fighting (territorial contestation) between Russia and Ukraine was ongoing.

The process combines remote collection of high-quality data through satellite imagery and automated AI-detection of building damage with statistical methods to rule out explanations other than deliberate targeting and provide insight on the reasons for deliberate targeting. We provide an explanation for deliberate targeting consistent with available evidence: combatants targeted buildings that supported the will and/or ability of their opponents to sustain combat operations.

ACTIVITY

Does Russia deliberately target some types of buildings–including civilian buildings--over other? What influences Russia's building targeting decisions. Based on statistical analysis of AI-developed data, we find that among Cultural, Educational, Medical, Religious, and Other building types, Russia targets Cultural and to a lesser extent Medical buildings at a higher rate than other building types. The higher rate of damage, which we refer to as "disproportionate damage," occurs even after we control for common explanations for why a building is damaged such as size, proximity to other damaged buildings, location in Ukraine, etc. As a result, disproportionate damage is likely the result of a deliberate attempt by combatants--primarily Russia–to damage a building or to use military activity that is known to cause damage to a building. Deliberate damage occurs only in areas and at times where active contestation between Russian and Ukrainian military units is occurring. This suggests that disproportionate damage occurs because Cultural and Medical buildings play a role in local fighting. Roles may include improved defensive positions, observation locations, or treatment of wounded soldiers.

INTRODUCTION

Just as surely as it leads to loss of life, war also destroys property. Many of the most harrowing images of war depict the loss of shelter, historical buildings, and critical services. While war destroys, it does not do so equally. Even within the same city or battlefield, some buildings experience damage while others do not. Which building types are more likely to suffer damage? Is targeting deliberate? Why does this damage occur? This paper proposes a process that combines AI-driven data collection and quantitative causal analysis to answer these questions.

Results provide an improved understanding of where, when, and, most importantly, why building types are deliberately targeted by combatants during ongoing armed conflict. The results provide insights about, but are not designed to identify, who caused damage. Findings contribute to our understanding of armed conflict, including a better understanding of local combatant goals and strategies and the civilian consequences of war. Findings also have policy implications such as an improved ability to forecast the consequences of fighting and identification of deliberate government policies by participating combatants that may constitute war crimes.

This process is applied to the case of Donetsk Oblast during the first year of conventional fighting following Russia's 2022 invasion of Ukraine (24 February 2022 to 23 February 2023). The requisite spatially and temporally disaggregated dataset is developed. Additional data on building type, building characteristics, and proximity to other relevant targets are included to allow the statistical methods to assess competing explanations for damage. Damage is also analyzed across contested and uncontested cities to provide insight on why damage occurred. Based on this data and analysis, we find that cultural buildings (heritage centers, libraries/archives, memorials, museums, and performance centers) are 68% more likely to suffer damage than other building types in Donetsk Oblast (including medical, educational, religious, and other buildings). The higher rate of damage to cultural buildings occurs only in locations that are actively contested by Russia's and Ukraine's armed forces as evidenced by either ongoing fighting or incomplete territorial control by a single combatant over a week. Medical buildings are also 13% more likely to suffer damage than other building types in contested locations.

Based on the evidence, we argue that cultural and medical buildings were likely targeted by combatants because of their perceived role in helping an opposing force sustain military operations in a specific location. This tactical explanation emphasizes the use of coercion to influence local decisions by an opponent to continue or abandon a specific fight as opposed to decision-making over the type of strategy used in the war itself.[1]

We reach this conclusion about the causes of deliberate targeting based on the type of buildings observed to be damaged, our ability to rule out many alternative explanations for targeting, and the conditions under which targeting occurred.

Cultural buildings are more likely to have stone or reinforced concrete construction that makes them more suitable as fighting positions, command posts, or civilian shelters. Medical buildings provide critical care that helps trapped civilians and military forces alike. The specific rationale for targeting these building types differ by perpetrator. Both Russia and Ukraine benefit from targeting buildings that their opponent uses to sustain military operations, such as reinforced buildings and medical facilities. Russia additionally benefits militarily from targeting buildings that support civilians. Ukraine's will to fight in a location may partially depend on the protection of remaining civilians. By destroying key buildings that serve civilian needs, civilians are forced to exit, which undermines a key rationale for continued Ukrainian defense. Our data and analysis do not allow us to identify the perpetrator of building damage. During the period of study, however, more battles involved Russia's forces trying to defeat well-entrenched Ukrainian forces in slow, grinding battles where Ukrainian civilians were present. As a result, observed deliberate targeting is more likely to have been perpetrated by Russian as opposed to Ukrainian forces.

The process proposed and the results developed using this process advance existing work—especially work that does not account for alternative explanations or only examines a subset of building types—in several important ways.[2]

First, building damage is identified systematically and comprehensively using satellite imagery and machine learning. This allows near real-time identification of damage and provides information on all buildings (of a certain minimum size) that are damaged. A comprehensive and representative sample is critical for conducting scientific research across difficult-to-access environs such as conflict-affected countries and areas affected by natural disasters. Second, the process uses statistical methods to test and compare numerous existing explanations for the occurrence of targeting. This makes it possible to rule out explanations for the occurrence of damage other than deliberate targeting. Ruling out many alternative explanations for the occurrence of damage is required to identify deliberate targeting. Third, the process exploits spatial heterogeneity—including variation in the intensity of fighting and in which combatant has control over an area—to provide evidence of why damage was caused (the statistical methods additionally help to answer these questions).

The paper unfolds as follows. We first describe the process and the methodology. The application of this process to Donetsk Oblast is discussed next, including the data that is generated, the variables assembled, and the statistical analysis employed. Examples of satellite data are shown to illustrate the types of buildings we observe to be damaged. The results of our methodology are then presented and discussed. We identify which type of building our process finds to be deliberately targeted and why this targeting may have occurred. This section also addresses potential limitations of our method, which result primarily from the use of a data sample for a single oblast and the use of satellite imagery to detect damage, as well as scoping conditions. This discussion provides guidance on when it is appropriate to draw conclusions based on this analysis. The paper concludes with policy implications and next steps in the development of the methodology to identify and explain damage to civilian infrastructure.

PROCESS TO IDENTIFY DELIBERATE TARGETING OF BUILDING TYPES

The proposed process is as follows. First, given a case of interest, polygonal building footprints are identified. Second, change detection based on satellite imagery is used to determine if the pixels in a building footprint have changed, which may indicate damage. Third, an AI model is built, trained, and validated to accurately identify when detected change corresponds to damage to a building structure. Fourth, variables that can be systematically collected on building characteristics—including type— are collected for each building in the sample. Fifth, variables that account for various spatial characteristics that might affect the occurrence of damage, such as building density and proximity to other damaged buildings, are constructed. Sixth, advanced statistical models that address temporal autocorrelation, the clustering of observed damage, and unobserved bias by time, city, and city time-trend are run. Seventh, results across areas on and behind the frontline and areas under the territorial control of each combatant are assessed to determine the conditions under which damage occurs and who the likely perpetrator of damage is. The goal of the process is to determine if some types of buildings are more or less likely to be targeted deliberately by combatants during an armed conflict and to help explain why targeting occurs. We use large-N data and statistical methods to accomplish this goal for several reasons. Statistical analysis makes it possible to separate systematic explanations (e.g., proximity to main roads) from non-systematic or "idiosyncratic" explanations (e.g., targeting error by a pilot). A combatant policy of deliberate targeting is a systematic explanation for damage, but it is only one of several systematic reasons. Statistical analysis can further differentiate between competing systematic explanations for observed damage. For instance, it is possible to determine if a building is damaged due to its type or due to its proximity to main roads. Combatants often use main roads to travel or resupply their forces, which means that proximity can lead to collateral damage to buildings. With sufficient data, it is possible to reliably compare many explanations for the occurrence of damage. It is diffcult, if not impossible, to assess competing systematic explanations using non-quantitative methods or very small sample sizes.

Measuring intentional combatant policy directly is diffcult. For this reason, we utilize a systematic variable "building type." This variable is a proxy for variation in building characteristics that may influence deliberate targeting such as building purpose, prominence, or construction materials. Buildings, on average, differ in these characteristics across each type. This makes it possible to use "type" to infer the local or strategic value of a building. Combined with statistical methods, it is possible to infer combatant policy from the observation that certain building types are damaged at a higher rate than others. To do this, it is necessary to collect data on all buildings (or at least a representative sample of buildings) to compare damage rates among building types.

The main impediment to understanding if buildings are targeted deliberately when using building "type" as the main variable is that

there are many reasons why we might observe disproportionate damage to a building type unrelated to deliberate targeting. In other words, there are other variables correlated with both building type and building damage that explain the observed occurrence of damage. This is referred to as a "confounding variable." For instance, cultural heritage buildings, which are one of the building types we examine, may be more likely to be located near to the center of a city. More intense fighting may also consistently occur near to a city's center because combatants see value in controlling the center or the center is a contested "no man's land" that sees continual bombardment. To continue the example above, proximity to a city's center would explain why a certain type of building is more likely to be damaged, and this explanation would be unrelated to deliberate targeting. To give "building type" its intended causal interpretation of deliberate targeting it is necessary to account for all important confounding variables.[3]

We take two steps to address the presence of confounding factors that may impede our ability to understand the relationship between building type and observed damage as deliberate targeting by a combatant. First, we utilize a statistical model that incorporates two-way fixed effects by location and time (by city and week in our application). Location fixed effects account for the impact of unobserved factors unique to the place where a building is located that do not vary over time, such as more intense fighting, strategic importance, or proximity to borders. Time fixed effects account for the impact of unobserved factors unique to a temporal period that do not vary by location, such as changes in military strategy or changes in support for a combatant. To further improve the robustness of the analysis, we also include location-specific linear time trends. These trends adjust for confounding factors unique to a location that have a directional change such as increasing or decreasing discrimination in the use of munitions in a location.

Second, we collect data on, and control for, several time-varying and building-specific explanations for damage other than building type. We do this because fixed effects do not account for alternative explanations that may vary by location and time. These variables include: (a) the size of the building footprint, (b) the distance of the building to the city centroid, (c) the distance of the building to the nearest primary road, (d) the distance of the building to the nearest secondary road, (d) the number of other buildings within 500 meters, (e) the lagged number of buildings of a different type damaged within 500 m, and (f) the lagged number of buildings of the same type damaged within 500 meters.[4]

Each of these variables represents a reason why we may observe building damage during a war other than deliberate targeting by a combatant. Specifically, they capture an elevated chance of unintended "collateral damage." Collateral damage may still result from combatant behavior. The intentional use of heavy weapons, for example, makes collateral damage far more likely, but its occurrence is different from intentional targeting.

APPLICATION TO DONETSK OBLAST IN UKRAINE

To show its utility, this process is applied to the case of Donetsk Oblast in Ukraine between 24 February 2022 and 23 February 2023. Donetsk Oblast, located in eastern Ukraine, has seen continuous fighting since Russia's full-scale invasion of Ukraine began on 24 February 2022. Mariupol was one of the first cities to suffer large-scale damage with nearly half of its buildings suffering damage after it was sieged by Russia's armed forces and then eventually captured on 20 May 2022. Fighting continued throughout the period of study, with Lyman, Soledar, Vuhledar, and Bakhmut seeing particularly intense combat.[5]

Dontesk Oblast is an appropriate test case for several reasons. High-quality satellite imagery and substantial data to account for alternative explanations are available, which allows implementation of all steps of the process described in Section 2, improving internal validity of the results. In addition, there is substantial variation in the intensity of fighting, the amount of attacks initiated by both sides, combatant territorial control, and the extent of building damage making it possible to understand the context under which building destruction occurred. Finally, fighting involved the use of weapons and techniques—small arms, artillery, missile strikes, and attrition warfare—common in other conflict settings. For this reason, results from this case are likely to be relevant for future, similar conflict situations, which improves the external validity of the results.

Statistical Method

Our unit of analysis is a building-week, which means that we provide an estimate of the probability that a type of building is damaged in a week. The data contains 61,543 buildings in 140 cities over the course of 51 weeks. Buildings are dropped from the sample once they are observed to be damaged. After taking these steps, the total number of observations is 2,964,234. Once fixed effects and lagged variables are included, the number of observations drops to 1,898,667. The dependent variable is a binary indicator of whether a building was observed to be damaged in a week. The independent variable is the type of building (cultural, educational, medical, religious, and other). Based on the unit of analysis and the independent variable, significant results indicate that a higher portion of one type of building is damaged compared to another type. See section 3.2 for a more detailed discussion of the data.

Quasibinomial statistical models are used because the dependent variable is binary (damage either does or does not occur to a building in a week). The advantage of the "quasi" version of a binomial model like a logit is that the standard errors account for possible overdispersion in the dependent variable that may occur if, for instance, there are many zeros. The analysis produces confidence intervals, which makes it possible to quantify confidence in relationships identified. Specifically, the confidence interval provides the range of values we might observe for the proportion of buildings of a particular type that are damaged 95% of the time if we were to repeatedly sample and analyze the data. Greater statistical significance (lower p-values) indicates greater confidence that the effect is consistent across samples and that a specific building type, after accounting for alternative explanations, suffers damage at a rate disproportionate to other building types.

DATA

The dataset used in our analysis is derived from several data sources.

Building destruction: We use new data that records damage to all buildings in Donetsk Oblast that are greater than 370 square meters (4,000 square feet) and are within a city with a pre-invasion population greater than 2,000. This includes a total of 140 different cities. Damage is recorded daily. The determination of if a building is intact or significantly damaged leverages daily Planetscope (Planet 2022) imagery from a constellation of SmallSats.[6]

The imagery has a 3.125 meter spatial resolution. As a result, only large-scale damage or destruction is detectable. A total of 5,088 buildings (8.3%) were observed to be damaged. This data is also used to record the number of buildings and the number of damaged buildings of the same and different type within varying proximities for each building in the dataset. Proximities include 150 meters, 250 meters, and 500 meters.

Building type: In total, 61,543 buildings are identified. To assess whether protected civilian buildings were damaged disproportionately, we identified whether a building was one of four classes: Cultural, Religious, Educational, or Medical. Open Street Maps was used to identify Educational and Medical Buildings. Data curated by the Virginia Museum of Natural History was used to identify Cultural and Religious buildings.[7]

Our sample includes 102 Cultural, 78 Religious, 193 Educational, and 729 Medical buildings. The remaining 60,441 buildings, which includes residential, commercial, and industrial buildings, are classified as "other." **Table 1** provides a summary of the building types and damage observed in this study.

Building footprint, city center, and proximity to roads: Data on the size of a building's footprint was obtained from multiple sources, including AI-derived footprints from high-resolution imagery (OpenStreetMap, Microsoft Bing Maps Machine Learning, Geofabrik) and manual delineation by analysts. Buildings with larger footprints may have an increased likelihood of experiencing collateral damage. For instance, errant fire is more likely to hit a larger building than a smaller building. City centers are identified based on the centroid of each ADM4 polygon derived from OpenStreetMap. Data on proximity to roads was derived from OpenStreetMap. The distance between a building and the closest primary (e.g., highways of all types) and secondary (e.g., main roads in a city) road is calculated. Proximity to roads may explain damage. Combatants, for example, may utilize larger roads such as highways, to move their forces, which increases the likelihood that a nearby building is damaged.

Armed conflict: Data on armed conflict events is obtained from the Armed Conflict Location and Event Data (ACLED) project.[8]

The precision of the conflict events in ACLED is limited to the city and, in some cases, the neighborhood. Because of uncertainty in the exact location of a conflict event, which makes it impossible to determine the proximity of conflict to a specific building, we aggregate event counts to the city-week. Each city-week is divided into one of four categories based on who initiated attacks: none (no conflict was recorded), Ukraine-initiated, Russia-initiated, and both-initiated. Areas with just Ukraine-initiated attacks are likely to be in Russian territory and represent the use of Ukrainian indirect strikes. Similarly, areas with just Russia-initiated attacks are likely to be in Ukrainian territory and represent the use of Russian indirect strikes. Areas where both sides are initiating attacks represent locations on the front line where combatants are using direct-fire weapons to fight each other and contest territory within visual range.

Territorial control: To identify territorial control, we draw on the Violent Incident Information from News Articles dataset.[10]

This data is available by tessellated polygon in Ukraine, which roughly conforms to an ADM4.[11] Because tessellation occurs around a city center point, a city may have multiple polygons when several ADM4s are near to each other. The variable records the portion of territorial control in a city-week that Russia has (the inverse indicates the portion of control that Ukraine has). Locations without any Russian control are identified as Ukrainian-held. Cities without any Ukrainian control are identified as Russian-held. We further divide Russian control into areas that Russia held prior to the start of the full-scale invasion and areas that Russia captured after the full-scale invasion. The conflict dynamics in areas captured by the so-called People's Republics of Donetsk and Luhansk might be different than in areas captured by Russian forces. All other locations (locations with partial control by both combatants) are identified as contested.

Table 1: Building Type and Damage

	Intact	Damaged
Cultural		
Heritage Building	3	13
Library/Archive	29	8
Memorial/Monument	7	2
Museum	20	17
Performance Center	1	2
Religious		
Place of Worship/Burial	64	14
Educational		
All education types	162	31
Medical		
All medical types	616	113
Total	**902**	**200**

Table 1: Building Type and Damage

EXAMPLES OF OBSERVED BUILDING DAMAGE

To show the types of buildings examined and the types of damage observed using satellite imagery, we focus on three illustrative examples in Ukraine: (1) the Martynov Palace of Culture in Bakhmut, (2) the Mariupol Drama Theatre in Mariupol, and (3) the Shakhtar Cinema in Horlivka. The first example of the type of damage that our data records is the destruction inflicted on the Marynov Palace of Culture in Bakhmut. Substantial damage can be seen on satellite imagery by 6 March 2023, which occurred as the result of shelling by Russia's forces (see **Figure 1**).[12]

The Palace of Culture, named after Yevgeniy Martynov (1948–1990), a Soviet pop singer and composer, is a nearly century-old building covered in brick and reinforced concrete that includes a theater hall in

central Bakhmut.[13] This building is representative of the type of building that we argue has been damaged disproportionately in Ukraine: locally prominent, made of durable materials, possibly occupied by emergency services (or military forces), and in an area over which combatants seek to establish territorial control.[14]

Figure 1: Satellite images of Martynov Palace of Culture, Bakhmut, Ukraine. Left: WV03_VNIR, Acquisition date: 2022-05-08, Resolution: 40 cm, Copyright: ©2022 Maxar Right: WV03_VNIR, Acquisition date: 2023-03-06, Resolution: 36 cm, Copyright: ©2023 Maxar

The second example of the type of damage that our data records is the Mariupol Drama Theatre (see **Figure 2**). The Mariupol Drama Theater, also known as the Donetsk Academic Regional Drama Theatre, was built in 1878 in central Mariupol. The current building, a large stone building with a red roof, white pillars, and classical frieze, was constructed in 1959 and was granted the status of Donetsk State Theater. This building, infamously, was destroyed by missile strikes conducted by Russia's armed forces.[15]

Figure 2: Satellite images of Mariupol Drama Theater, Mariupol, Ukraine. Left: GE01, Acquisition date: 2022-03-14, Resolution: 48 cm, Copyright: ©2022 Maxar Right: WV03_VNIR, Acquisition date: 2022-03-29, Resolution: 38 cm, Copyright: ©2022 Maxar

The building is also prominent, largely stands alone, and likely had substantial traffic in and around the building. The building additionally served as a humanitarian hub that may have been viewed by Russia's forces as helping to sustain the defenders' local will to fight by providing support to trapped civilians and/or military forces.[16] Targeting may have occurred because the building was seen as providing defensive utility, civilian traffic was confused for military activity, or destruction was intended to create refugee flows that pose logistic difficulties for the defenders. As such, the destruction of this building is also consistent with the reasoning advanced in this paper.

The third example of the type of damage that our data records is the Shakhtar Cinema in Horlivka.The Shakhtar Cinema is a venue for cultural events in Horlivka. Originally built in 1951 as a movie theater, it includes a large hall with Stalin-era decoration.[17]

Like the theater in Mariupol, the Shakhtar Cinema is a locally prominent building that is both taller and more likely to be more robustly constructed than neighboring buildings. The location is also centrally positioned in Horlivka. These characteristics may have made the location appealing to attacking and defending military forces, exposing the building to a heightened risk of damage. The characteristics of this building are also consistent with the patterns of building damage uncovered in our statistical analysis.

RESULTS FOR DONETSK OBLAST

Three model specifications are utilized to identify where and why damage to a building type occurs. The main model, shown in **Figure 3**, shows the effect of building type on the occurrence of damage using the full sample of Donetsk Oblast. This allows us to assess whether a building type experiences disproportionate damage on average across all cities in Donetsk Oblast. We run two additional models that interact the main variable with a measure of conflict, **Figure 4**, and a measure of Russia's territorial control, **Figure 5**. These two measures capture a similar idea: identifying which areas Russia and Ukraine are attacking or contesting directly and which areas may instead see indirect strikes by just one combatant. All models are robust to the inclusion or exclusion of various area weighting schemes including inverse area weights, dropping linear time trends, dropping all control variables, and using different distance measures for nearby damaged buildings. Note also that our results are robust to the use of a simple two-way fixed effects model without any control variables. All robustness test results are available upon request. Full statistical results for the models used to create **Figures 3–5** can be found in Appendix Table A1.

DELIBERATE TARGETING

Based on quantitative analysis of damage to buildings in Donetsk Oblast that occurred between 24 February 2022 and 24 February 2023, cultural buildings have a greater probability of experiencing damage than do religious, educational, or medical buildings (see **Figure 3**). Cultural buildings include heritage buildings, libraries, archives, memorials/monuments, museums, and performance centers. The X-axis indicates the building type. The Y-axis shows the probability that a building type is damaged in a week. The label shows the point estimate while the vertical bars show the 95% confidence interval (CI) for the difference in the probability that a building type will be damaged compared to the "baseline" probability (a "first difference"). The horizontal dashed gray line shows the baseline probability that a building type other than the four listed above is damaged. If the CI does not cross the dashed gray line, the effect is

statistically significant. Only cultural buildings, which have a 0.44% chance of experiencing damage in a week, are statistically different from other building types. By comparison, the probability of damage to another building type is 0.27%. More directly, this means that cultural buildings are the only building type that is observed to be deliberately targeted. While this probability appears small, it accumulates over time. Within the first year of war, for instance, each of the 102 cultural buildings in our sample had a 20.4% chance of experiencing damage compared to a 13.0–14.1% chance for a building of another type. An example helps to demonstrate the magnitude of damage. In a city with 10 cultural buildings, we would expect that two of these buildings would be damaged in the first year of conflict.

Our analysis accounts for other common explanations for the occurrence of damage, such as the size of the building's footprint. If cultural buildings are larger on average, they might also be damaged at a higher rate due to armed activity. Because we control for this variable, we know that cultural buildings are damaged at a higher rate regardless of their size. Similarly, presence in a location within a city that is more likely to experience fighting and collateral damage due to proximity to other targets, such as roads, does not explain why cultural buildings exhibit disproportionate damage. It is important to note that we examine large-scale damage observable by satellite, such as damage to the roof. Therefore, when we use the word "damage," we mean large-scale damage that might result from artillery, missile strike, or tank fire. Smaller-scale damage, such as broken windows or bullet holes, is not included. It is possible that other building types also experience small-scale damage at a higher rate.

To better understand why buildings of a specific type are more likely to be damaged, we analyze building destruction in areas that differ in important conflict dynamics. Specifically, we look at areas that differ in terms of who initiated conflict events (Russia, Ukraine, or both), who had territorial control (Russia, Ukraine, or contested by both), and whether this territory was (re)captured or controlled since the start of the war. These additional analyses produce consistent findings for both armed conflict and territorial control.[18]

Cultural buildings are more likely to experience damage during weeks when there is active armed contestation in the city where a building is located. Areas under armed contestation are defined as areas where both sides initiate conflict events **or** areas where neither side can establish territorial control. **Figures 4** and **5** visualize these results for locations with ongoing armed conflict between Russia and Ukraine (see **Figure 4**)[19] and for locations with varying territorial control (see **Figure 5**).

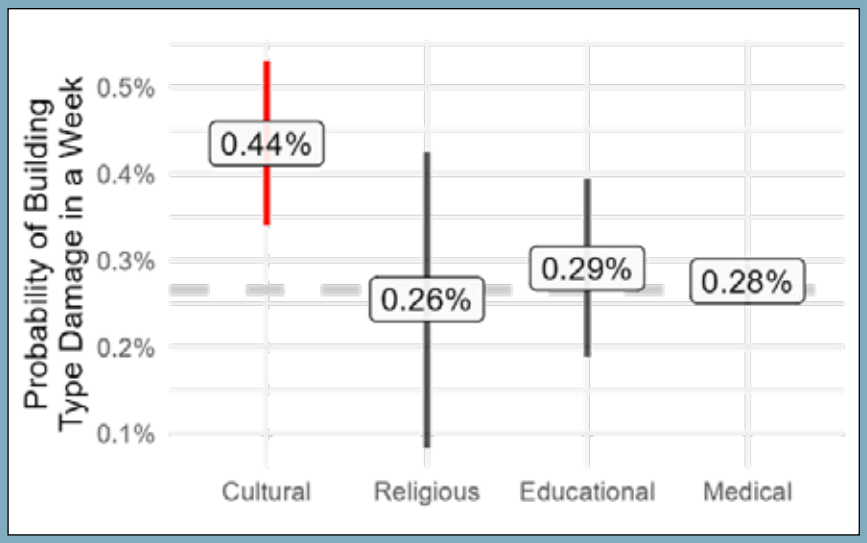


Figure 3: Building Damage in Donetsk Oblast

The effect for cultural buildings in frontline locations is above the gray dashed line. In a week, there is a 0.45% chance that a cultural building is damaged. Over a year, more than one in five cultural buildings (21.1%) in frontline locations are likely to be damaged compared to 12.6% for other building types. No building type suffers damage at a disproportionate rate in other locations: where no fighting is occurring, where fighting is initiated only by one side but not both, and where one side has complete control. This indicates that there is a "heterogenous treatment effect." While analysis of the full sample identifies a higher rate of damage to cultural buildings in all cities, subsequent analysis shows that the effect only occurs in locations with ongoing, direct fighting between Russia and Ukraine. This finding should be interpreted as the main result of the paper.

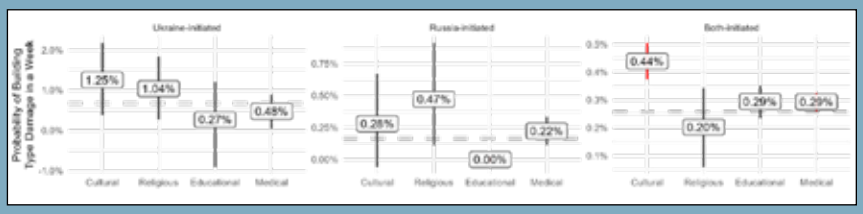


Figure 4: Damage in Locations with Ongoing Armed Conflict

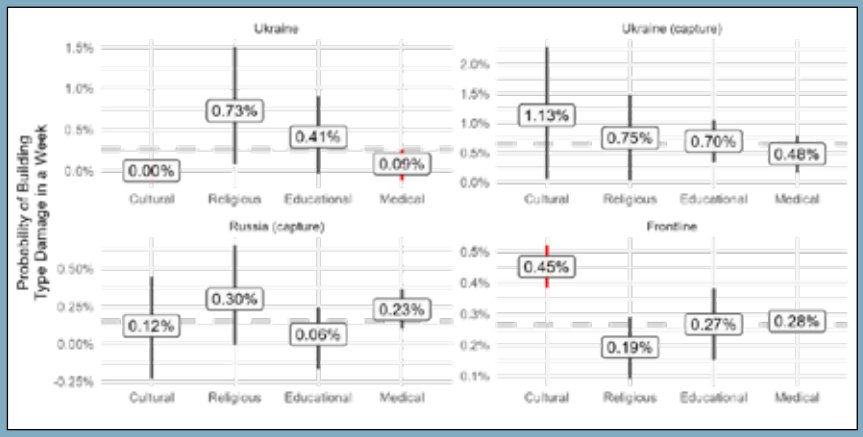


Figure 5: Damage in Frontline Locations (Incomplete Territorial Control) Note: In locations with back-and-forth fighting between Russia and Ukraine ("Both-initiated" and "Frontline") Cultural and Medical buildings are more likely than other building types to be damaged. In areas where Ukraine has territorial control, Medical buildings are less likely than other building types to be damaged.

The results shown in **Figures 4** and **Figure 5** also provide evidence that medical buildings are more likely to experience damage in actively contested areas. (The effect is positive but not significant in locations of incomplete territorial control. In a week, each medical building has a 0.29% chance of being damaged. Over a year, this equates to damage to one in six medical buildings (14.2%) in contested areas. Despite the smaller effect compared to cultural buildings, this is still an important finding—medical buildings, which are crucial for civilians and combatants, are disproportionately damaged and destroyed during ongoing fighting.

We also find two negative and significant effects in areas held by Ukraine since the start of the war. Cultural and Medical buildings are both less likely than other building types to be damaged. When attacks do occur, they occur because Russia has used indirect-fire weapons such as long-range artillery, suicide drones, or missiles. This finding suggests that Russia may be trying to avoid deliberately striking targets such as cultural sites and medical facilities that lack any local military utility and are likely to lead to more international condemnation if damaged. This is consistent with Russia's use of indirect weapons to prioritize targeting of strategic economic or military assets such as energy or transportation infrastructure.[20]

An important caveat is that these patterns may differ if locations such as Kyiv or cities further west were included in the sample. As a result, this finding should be interpreted with caution.

EXPLANATION FOR DELIBERATE TARGETING

Our results are consistent with a main explanation for why damage occurs: Cultural buildings (and to a lesser extent medical buildings) suffer damage at a higher rate than expected due to the role that they likely play in active military contestation.

There are several characteristics of cultural buildings that may influence their role in local combat. Cultural buildings, for example, may be constructed of sturdier material such as stone, or may be taller than other nearby buildings. When fighting in a city, combatants are advantaged by emplacing themselves in positions that are protected from enemy fire and that provide an advantage for spotting opposing forces. These characteristics that increase a combatant's desire to occupy or fight in a specific type of building also make it more likely that the same type of building will be targeted by enemy attack.[21]

Medical buildings are not as likely to provide commanding terrain but do directly support a combatant's ability to fight in a city by providing treatment to wounded personnel, which helps to sustain a combatant's willingness to keep fighting.[22] Anecdotally, several of the cultural buildings that were damaged also had humanitarian infrastructure co-located.[23] This humanitarian infrastructure may have also helped to sustain the willingness of Ukrainian forces, who have demonstrated greater concern for civilian wellbeing, to continue to defend a location. The targeting of civilians with coercion to undermine an opponent's will or ability to fight has long been used as a military strategy to varying effect.[24]

We reach this conclusion about the reason cultural (and secondarily medical) buildings are damaged at a rate disproportional to the damage experienced by other building types based on several findings. First, damage occurs at a disproportionate rate only in cities and weeks where conflict initiated by both Ukraine and Russia is ongoing. Damage does not occur at a disproportionate rate in cities where only one combatant initiates attacks (e.g., long-range artillery or missile strikes) or in cities where a single combatant has dominant control (e.g., Mariupol was under Russia's complete control from June 2022 onward). In other words, these building types are damaged due to characteristics that matter during direct and ongoing armed conflict.[25]

Any explanation of disproportionate damage needs to identify why a building type is targeted during but not outside of a battle. This helps to exclude other possible explanations for observed damage based on ideological reasons, such as targeting Ukrainian identity. Instead, these results suggest that the reason of disproportionate damage to cultural and medical buildings is to undermine Ukrainian will and/or ability to fight in a specific ongoing battle.

Second, the analysis accounts for key reasons why buildings might suffer unintentional damage, including centrality in a city, proximity to major roads that combatants might use to move forces and supplies, the density of other nearby buildings, and the number of other nearby same-and different-type buildings that were damaged in the prior week. Because we account for all these reasons, it is unlikely that cultural (and medical) buildings are damaged at a higher rate in contested locations due to collateral damage. In other words, the damage we identify does not occur because cultural and medical buildings happen to be in locations within a city where fighting naturally occurs or locations near to other buildings (e.g., train stations) that are more likely to be a military target. Excluding explanations for collateral damage does not guarantee that targeting was deliberate, but it does make it much more likely.

Third, the analysis accounts for the size of buildings based on the area of their footprint. If military activity such as artillery fire were randomly distributed throughout a city, larger buildings would naturally be damaged at a higher rate than smaller buildings. More area, in other words, means more exposure to explosions and errant strikes. Our findings hold after controlling for building area, suggesting that area does not explain disproportionate damage.This helps to exclude the explanation that cultural and medical buildings are damaged at a higher rate because they happen to be larger buildings on average. (It shouldalso be noted that our analysis examines the rate of damage, so the number ofbuildings of a particular type also does not bias the findings.)

Fourth, the disproportionate damage that occurs to cultural but not religious buildings provides evidence that buildings are not being targeted because of the religious identity or ideology that they represent.[26]

If, for example, Russia was seeking to destroy buildings for ideological reasons, they would also target religious buildings[27]—like the Islamic State's targeting of non-Sunni sites in Iraq and Syria.[28] This is further supported by the decreased damage to cultural and medical buildings observed in territory held by Ukraine since the start

of the war. In addition, damage also occurs at a disproportionate rate for medical buildings, which is another building type most likely to have local military value in ongoing armed conflict (as noted above, some cultural buildings also contained medical/humanitarian support). Together, this suggests that building types are not systematically targeted for ideological reasons, which helps to exclude ideology-based explanations for the occurrence of damage.

Several examples illustrate our theorized mechanisms and provide support for our empirical analysis. In the battle for Sviatohirsk in northern Donetsk province in June 2022, Ukrainian forces fought on or around the grounds of the Sviatohirsk Cave Monastery. The Monastery provided shelter to civilians, but, more importantly, was a tall and sturdy building that provided overwatch of the only bridge into the town and served as a critical defense position for Ukrainian forces. As the battle unfolded Russian fire damaged the building. Ukrainian artillery also likely damaged the structure when Russian forces operating in the vicinity of the Monastery were bombarded. As the military administrator of the town notes, damage occurred because both sides fought for control of the building: "the enemy was held off here, when the Ukrainians kept the Russians from fording the river."[29]

Russian forces also attacked hospitals due to their perceived role in sustaining Ukrainian resistance. In Kharkiv, for instance, Ukrainian forces at the Military Medical Center were attacked just a week into the invasion.[30] Correctly or incorrectly, the Russians believed that Ukrainian troops were fighting in or being supported by the medical facility. In Mykolaiv, a hospital was struck by missile fire for the same reason. This justification was laid out by a pro-Russian Telegram source: "The civilian hospital was converted into a military hospital, where they tried to get the wounded evacuated from the front back on their feet."[31] These justifications for striking Cultural and Medical buildings does not necessarily mean that they are legitimate targets according to international law.

In sum, our process allows us to say with some confidence that cultural, and to a lesser extent medical, buildings were deliberately targeted by combatants in cities in Donetsk Oblast where both Russia and Ukraine have been actively engaged in direct military contestation. The statistical analysis can rule out several common alternative explanations for disproportionate damage. For example, the analysis suggests that disproportionate damage did NOT occur because these building types are present in cities that experienced more widespread or intense fighting, or because these building types are bigger on average. The analysis can also rule out several explanations related to where in a city a building is located. Disproportionate damage did NOT occur because these building types are in areas within a city where fighting is more likely to occur, where both sides used heavier ordnance, or are near to other buildings that are more likely to be damaged (collateral).

LIMITATIONS OF METHODOLOGICAL APPROACH

There are several limitations of the process and results presented. Use of statistical analysis allows us to identify patterns of damage, which we link to deliberate combatant policies. This approach, however, is not appropriate for determining if a combatant targeted any single building. In addition, our analysis examines only a single oblast. Results may change if we examine all buildings in Ukraine or include cities, such as Kyiv, where Russia has targeted civilian infrastructure outside of actively contested areas. This difference in results would be due to variation in combatant goals and strategies across Ukraine. However, the scale and scope of conflict in Donetsk is comparable to other heavily contested oblasts such as Kherson and Kharkiv. Consequently, we expect that the findings in this paper are likely to apply to other areas that experienced similar large-scale attritional warfare. Lastly, the estimand in our study is the rate of damage by building type. We do not seek to, nor does our estimator produce results for, the count of damaged buildings of a specific type, although it would be possible to use the estimated rate to predict the number of buildings of a type that are damaged.

There are also a few limitations associated with the data generation process. As we have noted, our data records only damage that can be identified through satellite imagery. Small-scale damage such as bullet holes or damage that occurs inside a building are not detectable by satellite. Satellite-observable damage is more likely to occur when high-explosive weapons such as artillery or missiles are used and when these weapon systems are directed at the building. This is unlikely to bias our results, as we seek to exclude accidental damage and damage that does not result from military actions initiated by the armed forces of Russia or Ukraine. Finally, the minimum buildings size included in our data is 370 square meters (~4,000 square feet), which means our results only apply for buildings of this size or larger. Despite this, it is likely that our findings would apply to smaller buildings. The main reason why our findings would not apply is if smaller buildings had systematic differences along critical dimensions from large buildings (aside, of course, from size, which is controlled for). For instance, if small cultural buildings were not as robustly constructed as large cultural buildings on average, our findings would not apply.

CONCLUSION

This paper proposes a new process for identifying the deliberate targeting of buildings during armed conflict. This process involves the use of AI to identify building damage in satellite imagery combined with quantitative causal methods focused on the use of statistical analysis to eliminate observed and unobserved explanations for the correlation of building type and the occurrence of damage other than deliberate targeting. This method is applied to the case of Donetsk Oblast in the first year of the Russian invasion of Ukraine, February 2022 – February 2023. Results demonstrate that of the building types examined—cultural, religious, educational, medical, and other—only cultural and, secondarily, medical buildings are deliberately targeted and that targeting occurs only in locations and periods where both Russia and Ukraine have armed forces engaged in direct battle with each other. Building types are not damaged at a higher rate in other locations. The evidence assembled is consistent with deliberate targeting by combatants due to the perception that cultural and medical buildings affect the local ability or will of opponents to keep fighting. These buildings, in other words, affect the dynamics of local conflict and are targeted for this reason. This evidence is based on the type of building damaged, where and when damage was

observed, and the use of statistical analysis to eliminate alternative explanations.

Below, we discuss the policy implications of these findings and next steps in this research agenda.

POLICY IMPLICATIONS

Our main finding is that building types are deliberately targeted at a different rate because of the role that they play in local as opposed to national conflict dynamics. When seeking to justify damage to domestic or international audiences, this military reasoning is likely to be front and center. Unless there is a real threat of reciprocation, international law is unlikely to have much impact on this type of behavior because combatants view it as important to wartime outcomes.[32]

For instance, Russia's behavior may change if Ukraine can credibly threaten to destroy important buildings in Russia in response to Russia's deliberate targeting of buildings in Ukraine. A second implication is that the characteristics of a building that make it useful for military occupation and the presence of support institutions (especially "dual-use" services/institutions such as hospitals that can provide medical care to civilians and soldiers) increase the chance that a building will be deliberately targeted. Civilians seeking shelter from violence should take this into account. Humanitarian institutions should also be aware of how combatants perceive their role in conflict. While we do not test this directly, this type of targeting is likely to be especially problematic in long, grinding battles where one side has become militarily frustrated and is seeking alternative means to coerce an opponent.[33]

The data developed and the results of the quantitative analysis can also be used to improve decision-making and forecasting in the following ways:

1. The identification of the extent of destruction in a location based on the portion of buildings damaged can improve planning for post-conflict reconstruction.
2. The examination of the likely impact of conflict (or a natural disaster) on buildings can help provide interested third parties with information about civilian access to an adequate standard of living in a location. Understanding which types of buildings are destroyed and the extent of this damage provides policymakers with information that improves their ability to allocate humanitarian resources or effort.
3. The determination of the type and extent of buildings damaged can enable broad determinations about whether combatants are pursuing maneuver or attrition strategies, which provides information about how a combatant operates and what it is seeking to achieve. In addition, the types of deliberately targeted buildings provide information about combatant strategy, including how combatants view the link between the use of coercive activity and the accomplishment of local goals. For instance, whether a combatant uses a strategy of denial or punishment can be identified.[34]

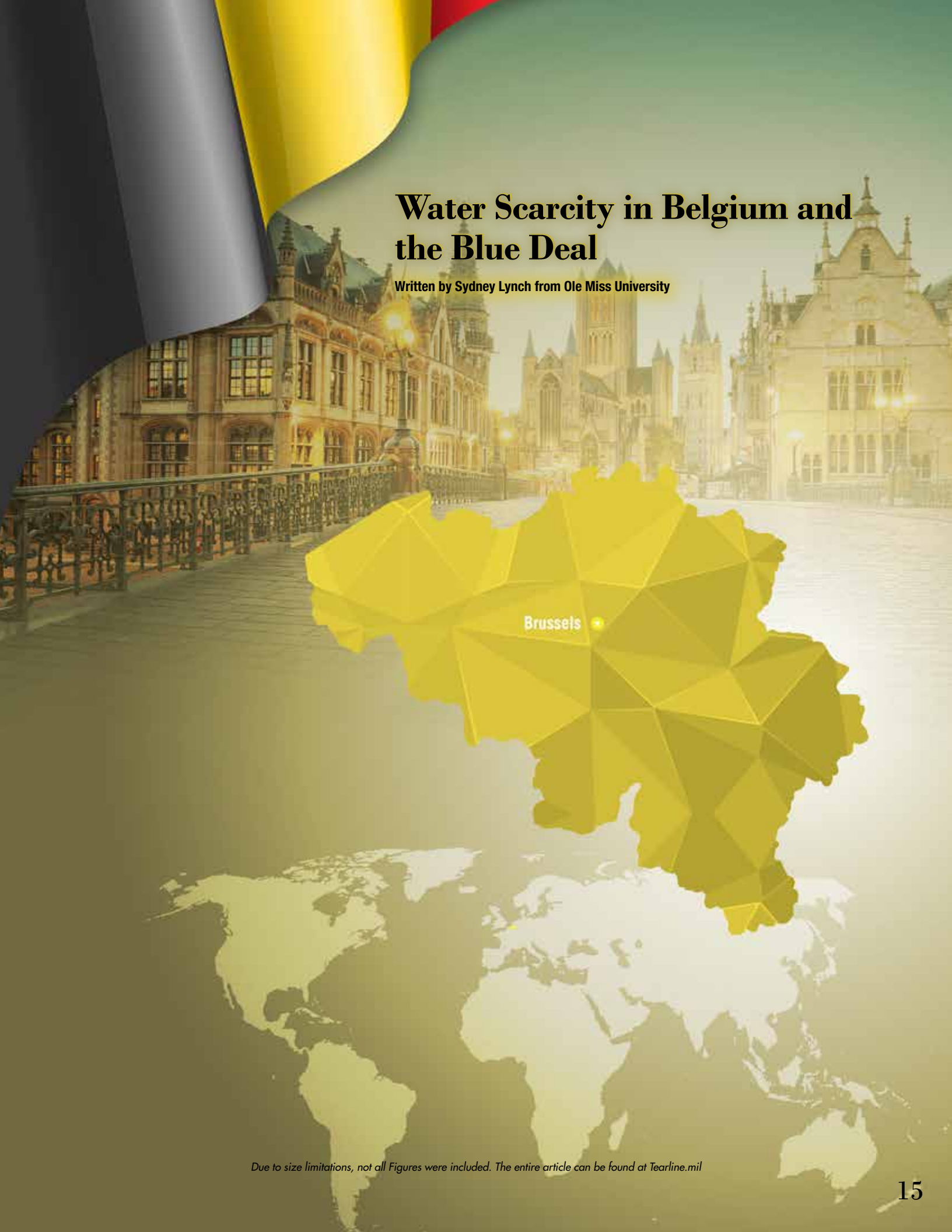
A better understanding of an opponent's local strategy can lead to a better military response.

LOOK AHEAD

There are two next steps for future research. First, we intend to apply our process and statistical methodology to more oblasts in Ukraine and to other cases. Analyzing additional data will provide further insight on the perpetrator of deliberate targeting and the reason why deliberate targeting occurred. Second, we plan to incorporate additional data on industrial buildings, powerplants, and energy and transportation infrastructure. These additional building types are currently included in the "other" building category. Power and transportation infrastructure are known strategic and tactical targets for Russia's armed forces. Additional analysis of expanded data may identify deliberate targeting of energy and transportation buildings, which would provide additional insight into who targeted distinct types of buildings in Ukraine, why deliberate targeting occurred, and the strategy Russia intends to use to try to bring Ukraine to the bargaining table.

Water Scarcity in Belgium and the Blue Deal

Written by Sydney Lynch from Ole Miss University



Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

Source: Base Map provided by NGA

Figure 1. Complete watercourse path
Source: Google Earth, 07/2023.

Figure 2. Location of the water treatment facility.
Port of Antwerp Bruges, 19/1/2024,
https://www.portofantwerpbruges.com/en/our-port/port-map

OVERVIEW

The 2020 Belgian Blue Deal is the nation's ambitious solution to the growing issue of water scarcity. Since its inception, a pattern has emerged, indicating that the government has mostly been able to complete low-cost and moderate-impact projects with either private companies or local municipalities. Therefore, the long-term efficacy of the Belgian Blue Deal cannot be assessed at this time but the start-up phase has been fairly successful.

Our work is primarily a survey of the Blue New Deal to date, not a comprehensive imagery analysis of 200-plus projects.

ACTIVITY

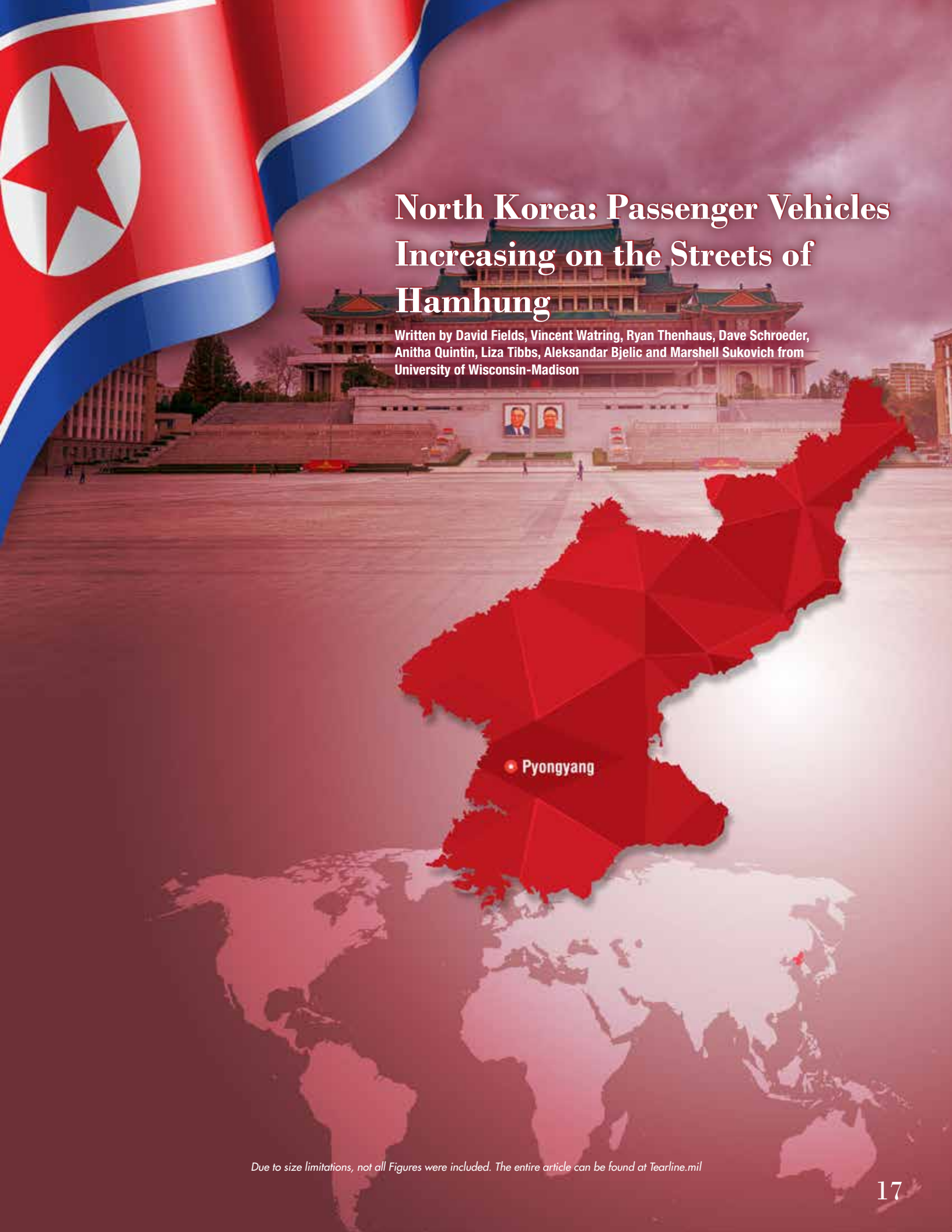
The Belgian Blue Deal is an ambitious program that aims to tackle water scarcity and drought through a multifaceted approach. The Blue Deal evolved from Belgium experiencing rainfall in more sporadic and often intense bouts that were not properly absorbed into the ground from 2000 onward, leading to water shortages in some areas and intense localized flooding in other parts of the nation. The program focuses on developing solutions by partnering with commercial, civic, and government organizations to conserve water and limit usage. The projects encompassed by the Blue Deal include research and development, educational awareness, regulations, and structural investments.

LOOK AHEAD

More time will be needed to determine if the government and partnered industries will be able to meet the estimated timelines for the larger projects as well as the many and varied smaller-scale projects.

North Korea: Passenger Vehicles Increasing on the Streets of Hamhung

Written by David Fields, Vincent Watring, Ryan Thenhaus, Dave Schroeder, Anitha Quintin, Liza Tibbs, Aleksandar Bjelic and Marshell Sukovich from University of Wisconsin-Madison



Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

Source: Base Map provided by NGA

OVERVIEW

Open GEOINT shows that the number of smaller-than-city-bus passenger vehicles (SPVs) on the streets of Hamhung, North Korea has increased modestly over the past 15 years and has been accompanied by modest improvements in vehicle infrastructure in the city. Our analysis also makes possible an estimate of vehicles per capita in Hamhung and possibly North Korea.

ACTIVITY

Our analysis has led to three key findings: (1) the number of SPVs in Hamhung appears to be increasing slightly but steadily, (2) this increase has been accompanied by modest infrastructure upgrades in the city, and (3) the widely cited figure of 30,000 total vehicles for all of North Korea is probably an underestimate. Our data, extrapolated with caveats, would suggest the presence of between 20,400 and 34,000 SPVs alone in North Korea.

BACKGROUND

Under Kim Jong-un, North Korea's political leadership has pledged to place more emphasis on the development of its civilian economy. Known as byungjin (dual development [of the economy and military]) this policy was seen as a subtle shift away from the sungun (military first) policy of Kim's father, Kim Jong-il.

Kim Jong-un has frequently demonstrated his commitment to byungjin by visiting non-military production facilities, promoting new development projects, and creating a "short course" for local officials on how to "struggle for local development."

Whether byungjin has brought meaningful development to North Korea is an open question. The paucity of data makes traditional means of analysis difficult. For decades researchers on the North Korean economy have turned to defector interviews and "mirror statistics" as a means of obtaining proxy economic data.[1]

More recently researchers have explored remote sensing data as a means of research.[2] Using satellite imagery, open data, and a defector interview, our team has surveyed SPVs numbers in the city of Hamhung since 2007. We assume a weak correlation between the number of SPVs on the road and economic activity in Hamhung. Furthermore, our research proposes an SPVs per capita figure for Hamhung and possibly all of North Korea based on survey data.

METHODOLOGY

Selection of Hamhung

Our team selected Hamhung for two main reasons. First, Hamhung was both large enough to contain a significant number of vehicles and yet small enough to make manual counting possible within our manpower resources. Historically, Hamhung has been the second largest city in North Korea, but current UN estimates suggest it is now the third largest city behind Pyongyang and Chongjin, with an estimated population of 544,000.[3]

Second, since Hamhung is neither the capital city (Pyongyang) nor located close to the Chinese border (like Chongjin), we believed that vehicle numbers in Hamhung might more accurately reflect urban North Korean cities as a whole, rather than being artificially inflated by a concentration of political elites or those involved in cross-border international trade.

Within the administrative area of Hamhung (see image below) we further narrowed our survey area to the approximate boundaries of the historic city of Hamhung, specifically the heavily urbanized area east of the Seongcheon River, west of the Holyeon Stream, and south of Mt. Dongheung.[4]

This area comprises approximately 22 km^2. This area does not include the port of Hungnam, but our surveys of the port area indicated few SPVs in that area.

Figure 1: Hamhung Count Area April 2023
Source: Google Earth

COUNTING METHODS

Our team was divided into two groups: the manual count group and the Computer Vision (CV) group.

Manual Counting

The manual count group manually counted all visible SPVs in satellite imagery of Hamhung on nine selected survey days (**Figure 1**) from 2007 to 2023. The selection of survey days was driven by the availability of suitable imagery,

approximately 50 cm resolution, cloud-free, and cover the entire 22 km^2 count area. Of the nine days selected, none were a Sunday and all the images were taken between 10:50 am and 11:59 am.[5]

Full coverage of central Hamhung proved to be considerably rare considering our standards, explaining our small sample size of nine suitable images. However, considering each counting day required counting and labeling hundreds of cars, these weather and resolution requirements were necessary for accuracy and confidence. Taking into account that our target was North Korea, we believe working off of this data was a foundational step on the issue.

In our sixteen-year date range from 2007 to 2023, there is a considerably large gap between counts from 2007 to 2015. In this eight-year gap, we chose to not count SPVs on many days due to cloud coverage and partial coverage of central Hamhung. Regarding cloud coverage, when clouds cover portions of the count area, we potentially lose out on tallying dozens or more SPVs. Resultantly, this could artificially lower our counts of SPVs, giving us a less precise idea of SPV growth or decline. Many of these days had full cloudless coverage of Hamhung, but they were made up of images taken from multiple satellite passes at different times of the day, making these days uncountable by our same-time standard. Having images at multiple time points introduces a variable that can affect the number of SPVs seen. For instance, a day with 9:00 am and 2:30 pm coverage may have differing densities of SPVs due to the time of day's influence on traffic. Nevertheless, our equations and calculations do take into account this time gap, and the graphical display of our data is to scale.

The difficulty of manual counting varied greatly based on the resolution of the imagery, the light, the presence of shadows, etc. In ideal conditions, distinguishing between an SPV and a small truck, such as a Hyundai Porter-style vehicle was easy. In less-than-ideal conditions, it required considerable judgment and interpretation. We generally considered vehicles SPVs if they were less than 20 ft in length and lacked a visible bed for cargo. Our team regularly checked questionable vehicles with other team members and undertook calibration activities to ensure that our counting procedures were uniform.

Originally, we hoped that our manual counting would merely serve to create a benchmark for the testing of our CV model (see below) however, it became clear that a scarcity of ultra high-resolution images (30cm for our CV model) for Hamhung necessitated that the bulk of our data for analysis be gathered from manual counts. Our team was capable of getting an accurate manual count from 40cm resolution, or even 50cm resolution in ideal conditions, whereas the CV struggled with imagery of lesser resolution than 30 cm. One persistent challenge for our manual count team was the presence of vehicles in interior courtyards. Vehicles on roadways are easily visible at better resolutions. Vehicles in courtyards are much more difficult to distinguish. Since a major portion of the vehicles we counted were in such interior courtyards, we did not attempt manual counts with images of lesser resolution than 50cm.

CV Counting

Our team spent significant time training and evaluating a computer vision model to attempt to automate counting and increase speed and accuracy. As mentioned above, the results were promising on satellite imagery at or near a resolution of 30 cm per pixel. While a lack of high resolution imagery of our target meant the model would be unfeasible for a large-scale survey of Hamhung over the years, future analysis of higher value targets such as Pyongyang is likely.

We trained Ultralytics' open source "You Only Look Once" (YOLO) version 8 classifier model on a subset of the DOTAv2 dataset in order to detect cars from overhead imagery. (https://captain-whu.github.io/DOTA/index.html) To train the model we utilized the University of Wisconsin - Madison's Center for High Throughput Computing. Accuracy of the model at this time is around 70% accuracy on target imagery of approximately 30 cm per pixel with few false positives. Accuracy here is defined as the percentage of cars the model successfully identifies out of the total number of cars in a given image. An example of the model classification is shown below. It is important to note our model specifically targeted small vehicles and did not attempt to identify trucks, buses, or other special vehicles.

Figure 2: AI Model Classification Example, 04/25/2023
Source: Google Earth

CV Training Metrics

We trained our model for 30 epochs over just one class from DOTA's dataset - the "small vehicle" class. DOTA provides tight bounding boxes for all object classification which allowed us to train the model on SPVs parked on angles that are not strictly orthogonal, something that all other datasets we surveyed could not provide. Below are various model metrics, including classification loss for both training and validation as well as precision and recall scores over the 30 training epochs:

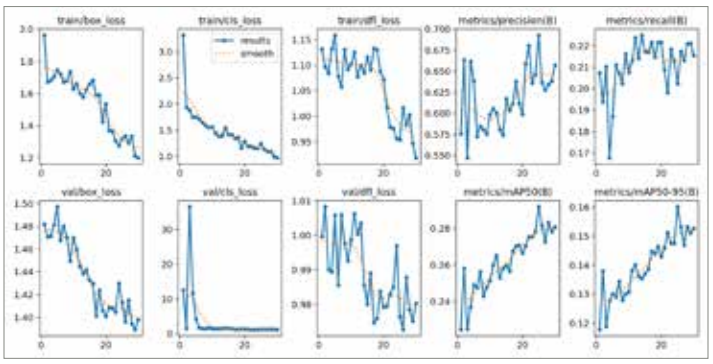


Figure 3: YOLOv8 training metrics

We hope to further utilize and improve this model in the future to automate vehicle identification and counting on an even larger scale, as collecting such data on vehicle counts across time in locations such as Pyongyang could provide even more insight into North Korea's economic situation.

RESULTS

Number of SPVs in Hamhung is Increasing

After finalizing and peer reviewing our survey days, we proceeded to record our results in a table to visualize any trends in the growth of total SPVs in Hamhung. Along with plotting the date, we decided to convert this to a total "Day Number." This way, we could later determine the growth of SPVs per day as a metric for growth over time (see **Figure 4**).

Date	Day Number	Total SPV Count
3/8/2007	1	261
7/13/2015	3049	192
12/9/2016	3564	185
6/1/2017	3738	460
11/3/2017	3893	257
2/11/2019	4358	483
3/30/2021	5136	636
8/21/2021	5280	647
4/25/2023	5892	723

Figure 4: This 3-column table displays the total SPV count over 9 separate counting days. The dates in the left most column were converted to set the first counting day as day 1. This conversion helps us to visualize the time between each of the counting days to more accurately visualize, to scale, the change in SPV numbers over 16 years.

After organizing our Hamhung count data, we began linear regression and t-test analyses on the total SPV counts. Deciding our null hypothesis to be an absence of total automobile growth in Hamhung, we found a significant growth in the total number of SPVs over 16 years (see **Figure 5**).

Figure 5: The above plot displays the growth in total counts of SPVs over 16 years in Hamhung where dates are defined as day numbers. Using Google Earth Pro software, tallies of SPV counts in the defined border of central Hamhung were generated and plotted. Then, performing a simple linear regression in Microsoft Excel, we determined the equation for our line of best fit and its R^2 value.

Our linear regression was performed using the Pearson correlation coefficient to generate an R value and a simple line of best-fit equation to visualize our correlation. We calculated the R value to be 0.725764883, and since R values range from +1 to -1, our 0.73 value indicates a strong association with our calculated equation y=0.0888x+82.727. This equation describes a growth rate of 0.0888 SPVs per day in Hamhung over these 16 years. To confirm our result further, we generated a p-value to determine whether we rejected or failed to reject our null hypothesis of a lack of growth in SPVs over time in Hamhung. By setting our acceptable threshold of a p-value of <0.05, we were stating we required greater than 95% confidence to reject our null hypothesis. In **Figure 6**, we calculated our p-value of 0.0268, meaning we reject the null hypothesis of a lack of automobile growth in Hamhung with 97.32% confidence (see **Figure 6**).

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7258264
R Square	0.526824
Adjusted R S	0.4592274
Standard Er	154.72708
Observation	9

ANOVA

	df	SS	MS	F	Significance F
Regression	1	186583.61	186583.61	7.7936493	0.0268422
Residual	7	167583.28	23940.468		
Total	8	354166.89			

	Coefficients	tandard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	82.726912	133.70726	0.6187167	0.5556937	-233.4405	398.89434	-233.4405	398.89434
Day	0.0887817	0.0318019	2.7917108	0.0268422	0.0135822	0.1639812	0.0135822	0.1639812

Figure 6: Using the Pearson Correlation Coefficient equation, we determined an R value used to generate a p-value to determine the significance of our correlation of days and SPV growth. Highlighted in yellow, our p-value indicates we are over 97% confident that our correlation is not due to random chance.

Using this equation to predict SPV growth by 2050, we could expect a tally of SPVs in the city of Hamhung to reach nearly 1,500.

This observed increase in SPVs has been corroborated by defector testimony. Our team was able to interview a resident of Hamhung who lived in the city in the previous five years. In discussion of the taxi services in Hamhung, they indicated that the number of taxis rose dramatically after 2018 and that most taxis in Hamhung were white. This information corresponds with our data, and many of the SPVs (perhaps a majority) counted after 2018 were white.

The interviewee used taxis frequently and reported paying around $4 USD per ride, nearly an average day's official salary in North Korea. Considering this high price, and considering the increase in SPVs, this would indicate some level of economic growth in Hamhung.[6]

MODEST UPGRADES TO TRANSPORTATION INFRASTRUCTURE

Accompanying the increase in SPVs, our team has noted some modest improvements in Hamhung's transportation infrastructure over the period. Hamhung appears to have added at least four gas

Figure 7: Exemplar: Service Station 1 under construction, 2016 and completed, 2017
Source: Google Earth

stations since 2007 for a total of five in the city.[7] Three of these have been added since 2016 (see exemplar **Figure 7**), and one older station was significantly expanded in 2019.[8]

According to 38 North.org, Hamhung received its first traffic light in 2019 at the intersection of Asian Highway 6 and the road leading south to Hamhung Station.[9]

Our analysis indicates that a second traffic light was added on Asian Highway 6 one kilometer further to the northwest by mid-2020. However, painted traffic circles—which are occasionally manned—in the middle of both intersections may indicate that these traffic lights are routinely out of operation. These traffic light intersections may be seen below.

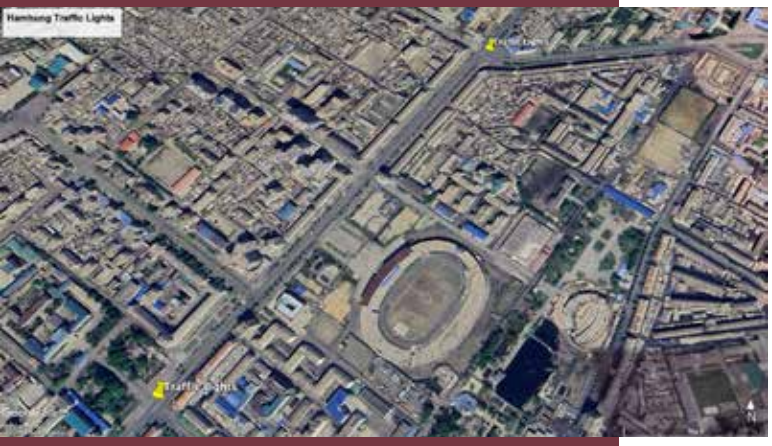


Figure 8: Hamhung Traffic Lights April 2023
Source: Google Earth

Despite a modest increase in SPVs, the parking infrastructure of Hamhung appeared unchanged and was characterized by an almost complete lack of lined parking lots. Except for the parking lot outside of the Shinhungsan Hotel, there does not appear to be another lined parking lot in the entire city.[10]

While SPVs are regularly parked in the lot northeast of the Hamhung Stadium and in the lot northeast of Hamhung Station, neither of these lots are lined. These lines are shown below in the parking lot region nearest to the road.

Hamhung's single lined parking lot compares unfavorably with the city of Rason, which has four small lined parking lots, despite having half the population of Hamhung, though cursory searches of North Korean cities indicate that lined parking lots

Figure 9: The only lined parking lot in Hamhung
Source: Google Earth

are rare outside of Pyongyang and the Kaesong Industrial Complex. The Shinhungsan Hotel, which is open to foreign tourists, may have lined its parking lot in order to generate revenue by charging for parking, as other North Korean entities have done. Though the hotel lot is lined to accommodate 28 vehicles, our team never observed more than five vehicles parked in the lot. Although it was outside of our focus on SPVs, our team did notice significant development related to trucking within our area of interest. Since 2017, four locations within the city center have been converted from vacant lots or agricultural land into walled compounds featuring large warehouses and yards presumably used for loading and unloading large trucks. The series of before and after images below visualizes this development.

Figure 10: Trucking location 1, June 2020 and April 2023
Source: Google Earth

Figure 11: rucking Locations 2 & 3, December 2016 and rucking Locations 2 & 3, December 2016
Source: Google Earth

While it is uncertain just what sort of activity these four locations are engaged in, it would appear their development has added to the trucking capacity within Hamhung.

WIDELY CITED FIGURE OF TOTAL NUMBERS OF VEHICLES IN NORTH KOREA IS LIKELY AN UNDERESTIMATE

Discussions of the car industry in North Korea frequently include an estimate of 30,000 total vehicles of all types.[11]

Although the exact source of this number is unclear—mentions of it never include citations—it may originate from a 2007 interview with North Korea expert Andrei Lankov in which he offered an estimate of 20,000 to 25,000 total "passenger cars" in the entire country. This estimate of 30,000 could also be a misreporting of the total production output capacity of the North Korean automotive industry, which has long been estimated at 30–35,000 vehicles per year, though nearly all observers believe the industry has only operated at a fraction of this capacity.[12] Except in the case of Lankov above, it is also unclear whether this figure of 30,000 is just an estimate of cars, or all motor vehicles.

While this figure of 30,000 is widely reported, other estimates are available. Nicholas Eberstadt reported an unnamed US government official as estimating 260,000 vehicles of all types (including military vehicles) in North Korea in 1990.[13]

Statistics Korea—a South Korean government Agency—has reported on average 270,000 vehicle registrations (자동차 등록) per year since 2013, though it is unclear what the source of this data is.[14]

Analysis done by our team makes it possible to offer an estimate of SPVs per capita in North Korea based on actual survey data, and this methodology could be expanded to estimate other vehicle types per capita. However, our estimate comes with three important caveats.

First, any population statistics for North Korea are just estimates themselves since North Korea has conducted very few censuses throughout its history, and many of them have not been up to international standards.[15]

Second, all of the data our team has generated is almost certainly an undercount since we only counted visible SPVs in Hamhung. Even working with ideal imagery, shadows, foliage, and cloud cover obscured many vehicles.

Third, surveys only included SPVs. Large buses, trucks, and cargo vehicles of all kinds were not included in our counts, and many estimates may be including these other vehicle types.

SPVs Per Capita in Hamhung and North Korea

Using the United Nations estimate of 544,000 for the population of Hamhung in 2024 and an average of the SPVs counted over our nine survey days (427), we estimate there is 1 SPV for every 1,274 residents. Assuming that Hamhung represents non-rural areas of North Korea with cars and that North Korea has a population of 26 million people, we would estimate the total number of SPVs to be 20,408, or 0.784 per 1,000 people. We understand that most rural areas of North Korea lack SPVs, so Hamhung, wealthier than most North Korean cities, should represent a middle ground between completely rural areas and the city of Pyongyang (another assumption) where SPVs are likely overrepresented. We understand this is a seemingly wide assumption, but given scant internal economic data and primary sourced data from imagery on North Korean topics, we wanted to socialize a new figure that can be refined over time. Since we believe our data represents an undercount, we ran the same calculation again only instead of using the average of all survey days, we used the survey day with the highest number of SPVs counted (4/25/2023, 723 SPVs). This calculation would indicate the total number of SPVs in North Korea to be 34,555, or 1.329 per 1,000 people.

Our analysis indicates that the figure of 30,000 vehicles for all of North Korea is almost certainly an underestimate if it is meant to include all motor vehicles, but it may be approximately accurate if it is meant just to apply to SPVs.

CONCLUSION

We hope that our calculations of SPVs per capita will become a methodological base or partial base for how future estimates of various types of motor vehicles in North Korea are calculated.

Such data is not just valuable as proxy data on the North Korean economy, but over time could be used to corroborate other sorts of analysis of the North Korean regime. For example, our analysis seems to corroborate reports that car "ownership" (access to vehicles) has been on the rise in North Korea in recent years. A steady increase in vehicles per capita in North Korea in the future could indicate an inability of the regime to police vehicle usage or, more hopefully, a relaxation of the restrictions that makes vehicle usage LESS onerous and expensive. In either case, such information would be helpful in gauging the intentions and health of the regime. As one of our team members has written elsewhere, internal restrictions on mobility and the decrepit state of North Korea's transportation infrastructure are as much, if not more, of a constraint on North Korea's economic growth than international sanctions. Monitoring North Korea's transportation infrastructure would be a way of knowing if such constraints are being addressed.

LOOK AHEAD

In the future, our team plans to conduct a similar survey of vehicles in Pyongyang and other North Korean cities to continue to refine our understanding of North Korean motor vehicle numbers. We acknowledge this initial case study was based on exquisite commercial imagery and conditions. In the future, we aim to apply our CV and manual methods against less exquisite commercial imagery standards and conditions that will increase the sample size.

Kaesong Industrial Complex: A Tortured History and Uncertain Future

Written by Peter Makowsky, Jenny Town and Iliana Ragnone from Stimson/38 North

Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

Source: Base Map provided by NGA

Figure 1: Overview of Kaesong Industrial Complex associated facilities.
Source: Pleiades NEO © Airbus DS 2024.

Figure 2: Destroyed Inter-Korean Liaison Office
Source: © Maxar, September 26, 2021

OVERVIEW

The Kaesong Industrial Complex (KIC), a joint venture between North Korea and South Korea that hosted South Korean manufacturers inside North Korea and employed North Korea labor, shut down in 2016 amid deteriorating relations. Recent commercial imagery analysis shows a moderate uptick in activity—especially since 2023.

This renewed activity could signal that North Korea is preparing to re-start some industrial activity at the KIC with internal resources or is refurbishing the complex to attract allies more aligned with North Korea.

ACTIVITY

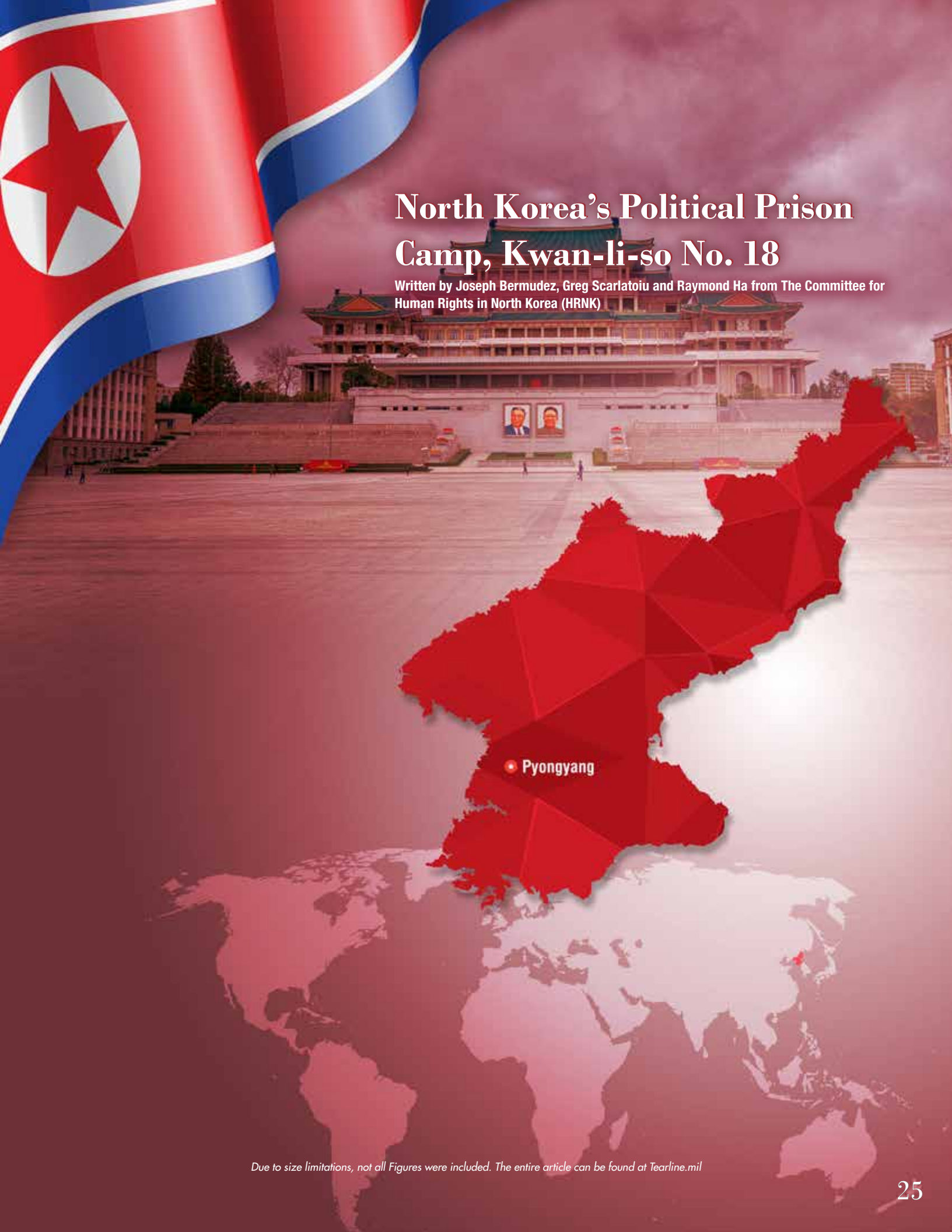
The Kaesong Industrial Complex (KIC) was opened in December 2004 as a symbol of efforts to create peace and stability on the Peninsula. The KIC operated for more than a decade despite ebbs and flows in the inter-Korean relationship. Kaesong appeared to withstand administration changes in South Korea and provocations from either side of the border until 2016. Even once it closed, there was still hope in Seoul and Pyongyang to restart operations, as most recently evidenced by its inclusion in the Panmunjom Declaration in 2018. South Korea has disbanded the Kaesong Industrial Foundation, which managed operations at the KIC, and unconfirmed reports suggest North Korea has eyes on using KIC to build its own industrial base. Commercial satellite imagery suggests that there has, indeed, been a resurgence of activity at the KIC in recent months that would indicate plans to use the facility are moving forward, without South Korean partnership.

LOOK AHEAD

The indicators are more apparent in April 2023 when activity began to increase in each of the industrial sectors when buses, trucks, and scores of people were readily observed. In some sectors, materials and equipment were removed from factories, either for transport elsewhere or consolidation within other factories. The questions remaining are how many of the factories will be used, whether North Korea might maintain control over the complex as a basis for building its own industrial base, or if it might try to shop out the complex to another partner – one whose political relations are more stable than the rocky North-South relations.

North Korea's Political Prison Camp, Kwan-li-so No. 18

Written by Joseph Bermudez, Greg Scarlatoiu and Raymond Ha from The Committee for Human Rights in North Korea (HRNK)



Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

Source: Base Map provided by NGA

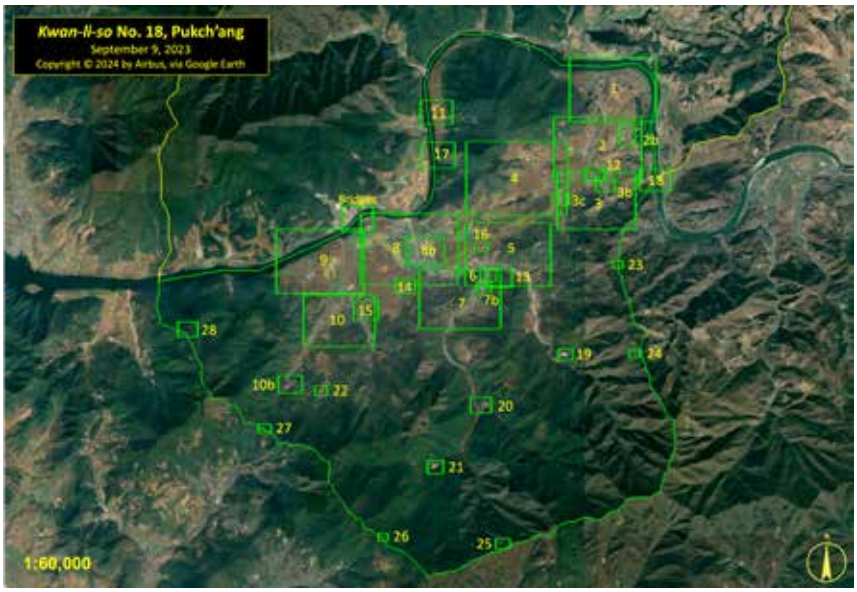


Figure 1: Overview of Kwan-li-so No. 18, September 9, 2023
Source: Copyright © 2024 by Airbus, via Google Earth

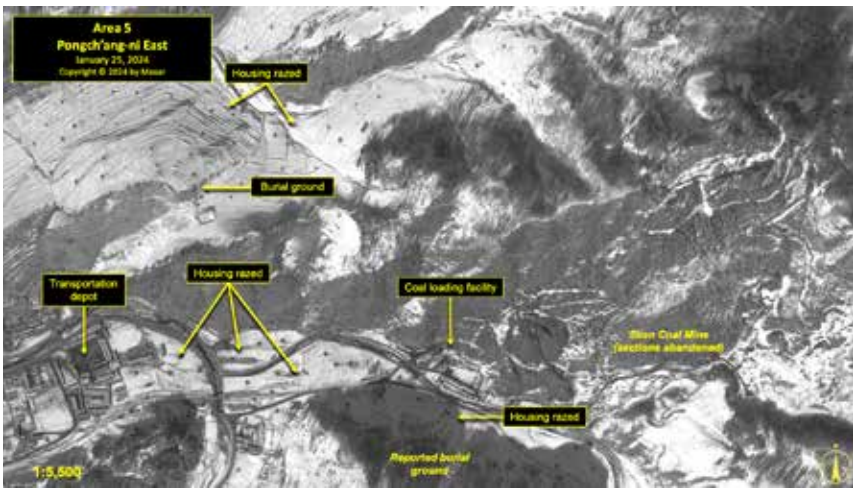


Figure 2: Tongch'ang-ni East. This is the same "Farming Unit No. 9" that is referenced in Area 3. According to a former detainee, structures associated with Farming Unit No. 9 are located at both ends of a broad and fertile farming area that stretches between Areas 3 and 5. The structures associated with Farming Unit No. 9 in Area 5 are in the top-left corner of the image, under the title box.
Source: Copyright © 2024 by Maxar

OVERVIEW

Although North Korea officially announced the closure of Kwan-li-so No. 18 in 2006, commercial satellite imagery analysis indicates that the camp has not been completely razed. Imagery analysis further indicates that the remaining facility, whether officially designated as such or not, is a large and active detention facility.

The Kwan-li-so No. 18 area remains active and is well-maintained, as indicated by numerous agricultural, light industrial, and mining activities.

ACTIVITY

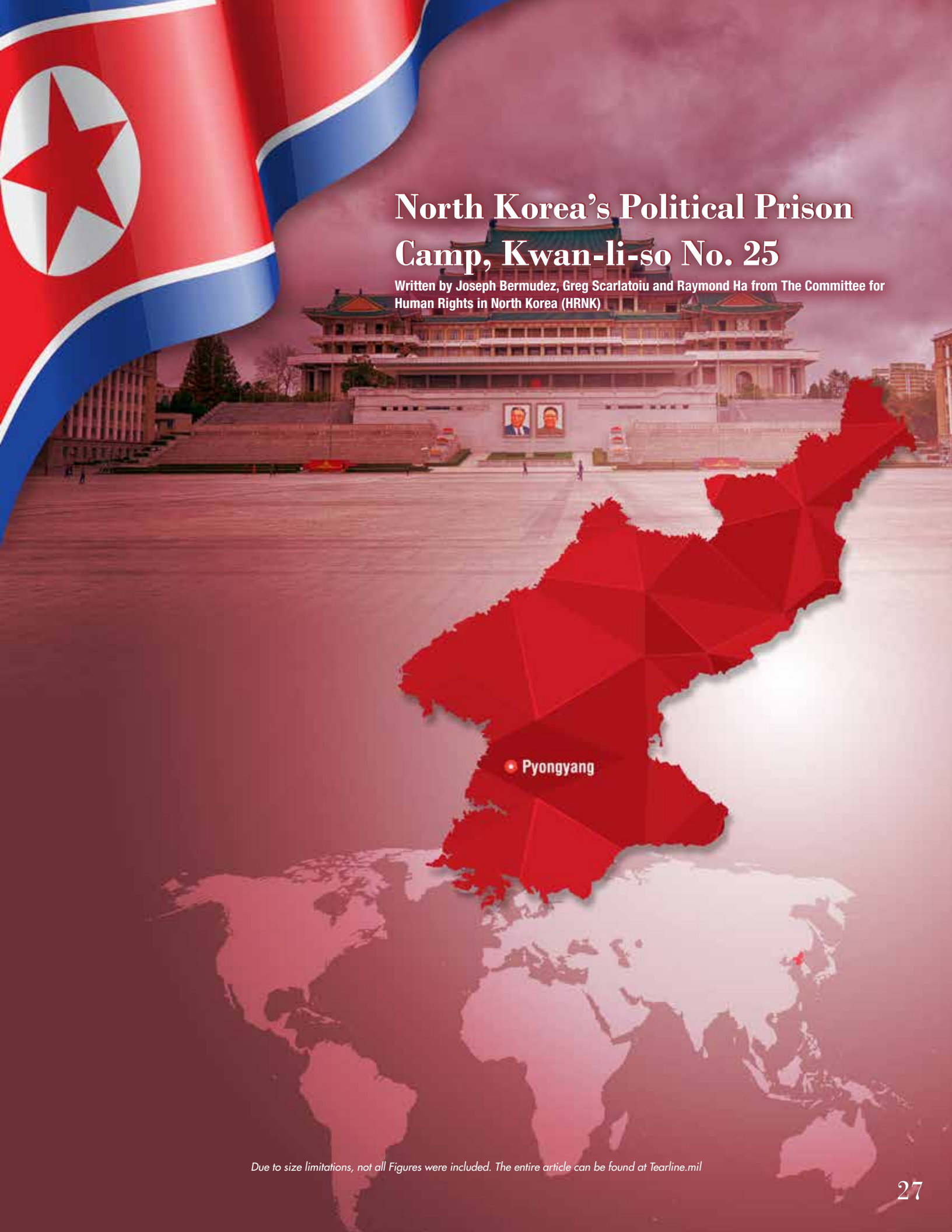
This report is part of a comprehensive long-term project undertaken by the Committee for Human Rights in North Korea (HRNK) to use satellite imagery and former detainee interviews to shed light on human suffering in the Democratic People's Republic of Korea (DPRK, more commonly known as North Korea) by monitoring activity at political prison facilities throughout the nation.

LOOK AHEAD

HRNK will continue to use satellite imagery to assess the operational status of North Korea's political prison camps (kwan-li-so). This analysis will be augmented with escapee testimony and open-source information whenever possible, and it will also seek to identify major changes at these facilities. North Korea's intensified crackdown on attempted escapes and the consumption and distribution of foreign information may have been accompanied by the reorganization or expansion of key detention facilities. In addition, HRNK will seek to develop a more complete picture of North Korea's network of detention facilities by looking beyond the kwan-li-so and the kyo-hwa-so to examine other types of facilities through satellite imagery.

North Korea's Political Prison Camp, Kwan-li-so No. 25

Written by Joseph Bermudez, Greg Scarlatoiu and Raymond Ha from The Committee for Human Rights in North Korea (HRNK)



Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

OVERVIEW

Based on an analysis of key physical features, political prison camp (kwan-li-so) no. 25, established around 1968, remains an operational prison. The prison camp is well maintained by North Korean standards. The estimated population, based on imagery analysis of the compound, is between 2,500 and 5,000 prisoners.

The prison camp's forced labor activity consists of a combination of agricultural production and light industrial manufacturing, such as bicycles and wood products.

ACTIVITY

This report is part of a comprehensive long-term project undertaken by the Committee for Human Rights in North Korea (HRNK) to use in the Democratic People's Republic of Korea (DPRK, more commonly known as North Korea) by monitoring activity at political prison facilities throughout the nation. Satellite imagery and former detainee interviews to shed light on human suffering in the Democratic People's Republic of Korea (DPRK, more commonly known as North Korea) by monitoring activity at political prison facilities throughout the nation.

Facility Analysis

Location: Susŏng-dong, Ch'ŏngjin-si, Hamgyŏng-bukto (Susŏng neighborhood, Ch'ŏngjin City, North Hamgyŏng Province)
CenterPoint Coordinates: 41.834384°N, 129.725280°E
Date of Imagery Used: November 22, 2023 (Maxar)
Size of Facility: 0.98 km² (0.38 mi²); 1,810 m by 1,240 m (1,979 yd by1,356 yd)

Executive Summary

This report is part of a comprehensive long-term project undertaken by HRNK to use satellite imagery and former detainee interviews to shed light on human suffering in the Democratic People's Republic of Korea (DPRK, more commonly known as North Korea)by monitoring activity at political prison facilities throughout the nation.[1]

This report provides an abbreviated update to our previous reports on a long-term political prison commonly identified by former detainees and researchers as Kwan-li-so no. 25[2] by providing details of significant activity observed between 2021 and 2023.[3]

Figure 1: Overview of Kwan-li-so no. 25, November 22, 2023
Source: Copyright © 2024 by Maxar

For this report, HRNK analyzed commercial pan-sharpened multispectral satellite images of Kwan-li-so no. 25 and its immediate environment taken in November 2023, focusing on the following physical features.[4].

- Security perimeters (internal and external), 8 entrances (internal and external), and approximately 45 guard positions[5]

Source: Base Map provided by NGA

- Main prison
- Headquarters, administration, barracks, and support facilities
- Activity in the immediate environment of the facility
- Walled compounds

Based on an analysis of these physical features, political prison camp (kwan-li-so) no. 25, established around 1968, remains an operational prison. Ongoing activity and good maintenance within and in areas immediately surrounding the prison indicate that Kwan-li-so no. 25 is a mature and well-maintained facility by North Korean standards.

Satellite imagery coverage of the facility and previous interviewee testimony continue to indicate that the prison's economic activity consists of a combination of agricultural production and light industrial manufacturing (i.e., bicycles, wood products, and other products) using forced labor.[6]

Despite analysis of extensive satellite imagery of prison during the past 11 years, HRNK is presently unable to confirm or deny escapee and open-source reports that the prison has a prisoner population of approximately 5,000 people. Our analysis of the composition and physical size of the prison suggests that it could accommodate between 2,500 and 5,000 prisoners. However, the population estimate could trend toward the higher end of the range as our composition analysis is anchored to bed count. Overcrowding from a lack of accommodation standards and human concerns can stretch the population estimate toward the high end of facility composition and dimension analysis. At any rate, reports dating from 2021 stating that the prison has a population of 41,000 appear to be exaggerated.[7]

As with our analytical caution presented in previous HRNK reports (such as *North Korea's Chŭngsan No. 11 Detention Facility*),[8] it is important to reiterate that North Korean officials, especially those associated with the Korean People's Army, Ministry of Social Security, and various internal security organizations,

Figure 2: Close-up view of the main section and headquarters and administration area of Kwan-li-so No. 25, November 22, 2023
Source: Copyright © 2024 by Maxar

clearly understand the importance of implementing camouflage, concealment, and deception (CCD) procedures to mask their operations and intentions.

Location and Subordination

Kwan-li-so no. 25 (41.834384°N, 129.725280°E) is located outside the town of Susŏng-dong (수성동 41.827222°N, 129.736111°E), Ch'ŏngjin-si (청진, Ch'ŏngjin City, 41.887222°N, 129.831944°E), Hamgyŏng-bukto (함경북도, North Hamgyŏng Province)—approximately 7.5 km northwest of Ch'ŏngjin and 458 km northeast of the capital city of P'yŏngyang. Specifically, it is located on the south bank of the Solgol-ch'ŏn (i.e., Solgol stream) across from sections of the village of Susŏng-dong, to which one foot and two road bridges connect it. The prison consists of a moderate-sized walled compound, and headquarters, support, and guard housing areas.

It should be noted that although escapee descriptions of this facility's function and operations match that of other kwan-li-so, the physical characteristics observed in satellite imagery are more representative of the country's kyo-hwa-so (long-term prison labor facilities).[9]

Escapee testimony about Kwan-li-so no. 25 indicates that it "houses political prisoners only, while those who committed economic crimes are not allowed into the facility."[10] This kwan-li-so is reported to be subordinate to the Ministry of State Security's (MSS) Prisons Bureau.[11]

It is likely under the control of the ministry's North Hamgyĕng Bureau, but it may be subordinate to the ministry's Ch'ĕngjin-si Bureau. The MSS reports to the State Affairs Commission, which is chaired by Kim Jong-un, the General Secretary of the ruling Korean Workers' Party (KWP).[12]

It was reported in June 2022 that Ri Chang-dae was appointed as the Minister of State Security, replacing Jong Gyong-taek.[13] Jong was sanctioned by the U.S. Department of the Treasury in December 2018[14] and the European Union in March 2021[15] for his role in perpetrating human rights abuses as the Minister of State Security.

Organization

The organizational structure of Kwan-li-so no. 25 is likely similar to that of North Korea's other detention facilities, including its kyo-hwa-so prison labor camps. A provisional organizational structure, based on publicly available information about how North Korea operates its detention facilities, is shown below. There is likely some level of coordination between Kwan-li-so no. 25 and the Ministry of Light Industry, but the camp's relationship with other organizations is unclear.

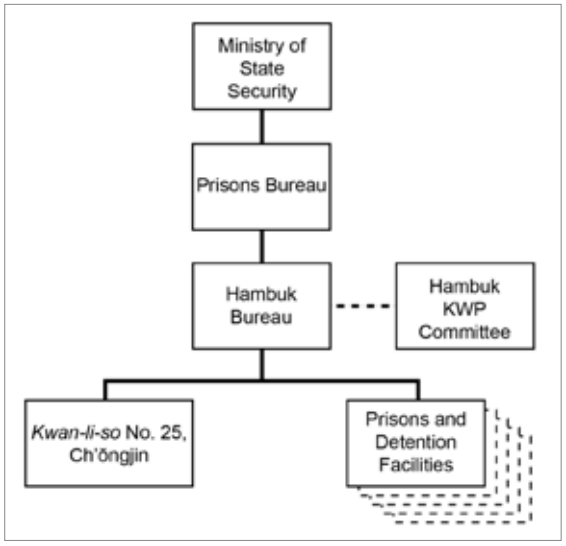


Figure 3: Ministry of State Security's North Hamgyong (Hambuk) Bureau
Source: (Chart: Original Work HRNK)

There is limited information about the forced labor activities imposed on the prisoners at Kwan-li-so no. 25. Interviews with escapees indicate that prisoners at this facility have been engaged in agricultural production, furniture manufacturing, bicycle manufacturing, and other activities. While unconfirmed, prisoners may also be used as forced labor outside the physical confines of the camp. It is also unknown whether there is any economic relationship between Kwan-li-so no. 25 and the light industrial facility (workshop) located immediately outside the northwest corner of the camp.

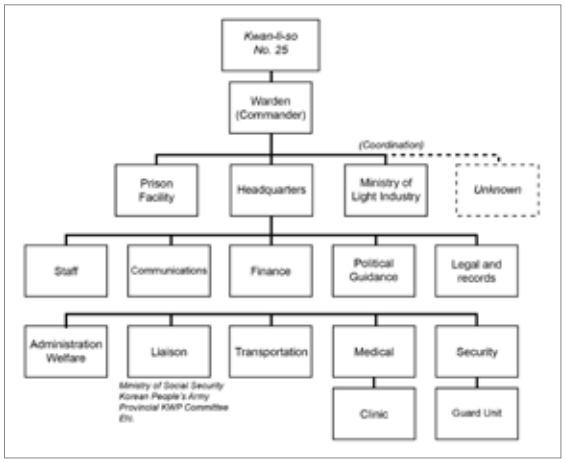


Figure 4: Organizational Structure of Kwan-li-so no. 25 - Provisional
Source: (Chart: Original Work HRNK)

There are at least 3 military garrisons (likely for both active and paramilitary reserve forces) and 11 air defense artillery sites observed within 5 kilometers of the prison. These air defense sites are well positioned to provide protection to Kwan-li-so no. 25. However, they should be understood as components of the integrated air defense of Ch' ngjin-si.[16]

The closest air facility to Kwan-li-so no. 25 is the

Korean People's Air Force's Sŭngam-ni Airbase, located approximately 18 kilometers to the south-southwest and a small partially complete air club/UAV airfield approximately 1 kilometer northwest. Sŭngam-ni is a training base. Due to its mission, organization, and location, it almost certainly provides no support to Kwan-li-so no. 25. Likewise, the incomplete air club/UAV airstrip provides no support to Kwan-li-so no. 25.

While the prison is likely connected to the regional telephone network, it is likely via buried service, as no evidence of overhead service was identified in satellite imagery. The prison is connected to the regional electric power grid via overhead high voltage power transmission cables that run from the prison to a substation approximately 1 kilometer to the southeast. The nearest rail facility is the rail station at Sus0ng-dong, 800 meters to the east of the prison.

Minor Construction Activity

Readers are encouraged to review the development of Kwan-li-so no. 25 between 2003 and 2021, as analyzed in our previous four reports on this facility.[17]

This report only addresses major changes between 2021 and 2023. Our analysis shows that the prison and associated agricultural and light industries were active from 2021 to 2023. This is indicated by ongoing maintenance of agricultural fields and orchards, the planting and harvesting of different crops over the years, movement of vehicles and supplies at the camp's light industry facilities, and people observed throughout the facility. Most changes observed to the physical infrastructure of Kwan-li-so no. 25 were minor in nature and typical of what had previously been observed at the prison. These changes include rearrangement, razing or construction of small structures, and minor adjustments of roads and trails.

Located in the southeastern corner of Kwan-li-so no. 25 is a small 690 m (823 yd^2) compound with a high security wall. Inside the compound is a 160 m^2 (190 yd^2) single-story building. Approximately 100 meters to the east is a 115 m^2 (138 yd^2) single-story building. Both structures were constructed during 2010 and remain today.

This walled compound is relatively isolated within the prison, and it is overlooked by 12 guard positions. Moreover, its size and construction are not consistent with North korean practices for the storage of heavy equipment or munitions. Therefore, the most reasonable explanation for the walled compound is that it is a high-security prison compound for prisoners of significant importance. The adjacent single-story building is likely for guard or support personnel, as it is not enclosed by a high-security wall. These buildings have not changed noticeably since their construction and remain active.

Sometime between February and August 2018, a second walled compound was constructed 50 meters to the

Figure 5: Incomplete air club/UAV airfield north of Kwan-li-so No. 25, November 22, 2023
Source: Copyright © 2024 by Maxar

Figure 6: A view of the cultivated fields on the north side of the main prison being worked by prisoners, November 22, 2023
Source: Copyright © 2024 by Maxar

Figure 7: Secure compound in southeastern corner of Kwan-li-so no. 25, November 22, 2023
Source: Copyright © 2024 by Maxar

east of the high-security compound. This approximately 198 m^2 (237 yd^2) compound is surrounded by a security wall and contains an approximately 48 m^2 (57yd^2) building. The presence of an opening in the security wall suggests that it is not a high-security compound. Although the purpose of this compound is unknown, its proximity to the existing high-security compound indicates a close association

Overall Assessment

Taken in context with previous high-resolution satellite imagery analysis, analysis of recent high-resolution satellite imagery of Kwan-li-so no. 25 and its environment indicates the following.

- Kwan-li-so no. 25 remains an operational prison facility that has witnessed minor changes between 2021 and 2023. These changes appear to be typical of those observed at other North Korean detention facilities. It remains a mature and well-maintained prison facility by North Korean standards.
- The current prisoner population is employed to both maintain the agricultural fields, orchards, and livestock and to work in the prison's wood products and light industrial factories.
- Perimeter walls, fences, and gates are well maintained and in good repair.
- Guard positions are well positioned to provide overlapping fields-of-view of the prison and are well maintained and in good repair.
- Administrative buildings, barracks, housing, cultural buildings, support buildings, and grounds are well maintained and in good repair.
- The grounds and buildings (i.e., wood products factory, light industrial facility, and prisoner housing) of the central compound appear to be moderately well maintained and in a moderate state of repair.
- The wood products and light industrial factories appear to be operating, as suggested by the presence of various numbers of vehicles, supplies, and the changing size and shape of the associated wood chip/sawdust piles.
- All agricultural fields are well-defined, maintained, and irrigated. The fields to the north of the prison have crops under cultivation through almost all four seasons of the year.
- The livestock structures are well maintained and in use.
- There is likely both an important economic and social relationship between Kwan-li-so no. 25 and the adjacent villages of Susŏng-dong and Songgong-ni.
- It is unknown if there is any economic relationship between Kwan-li-so no. 25 and the light industrial facility (workshop) immediately outside the northwest corner of the prison.

Background for Context

The United Nations Commission of Inquiry on Human Rights in North Korea (UN COI) determined that "crimes against humanity have been committed in North Korea, pursuant to policies established at the highest level of the State."[18]

Many of these crimes against humanity take place against persons detained in political and other prisons—persons who the Commission determined are among the "primary targets of a systematic and widespread attack" by the North Korean regime,[19] including murder, enslavement, torture, imprisonment, rape, forced abortions and other sexual violence, persecution on political grounds, and the enforced disappearance of persons. According to the UN COI, "The unspeakable atrocities that are being committed against inmates of the kwan-li-so political prison camps resemble the horrors of camps that totalitarian States established during the twentieth century."[20]

Based on research conducted by HRNK, seven trends have defined the human rights situation under the Kim Jong-un regime:

1. an intensive crackdown on attempted defections;
2. a restructuring of the political prison camp system, with some facilities closer to the border with China being shut down, while inland facilities have been expanded, and construction of internal high-security compounds within the prisons;
3. the sustained, if not increased, economic importance of the political prison camps;
4. the disproportionate oppression of women by North Korean officials. Women have assumed primary responsibility for the survival of their families and thus represent the majority of those arrested for perceived wrongdoing at the jangmadang markets, or for "illegally" crossing the border;
5. an aggressive purge of senior officials, aimed at consolidating the leader's grip on power;
6. targeting of North Korean escapees; and
7. increased focus on eliminating "anti-reactionary" thoughts.

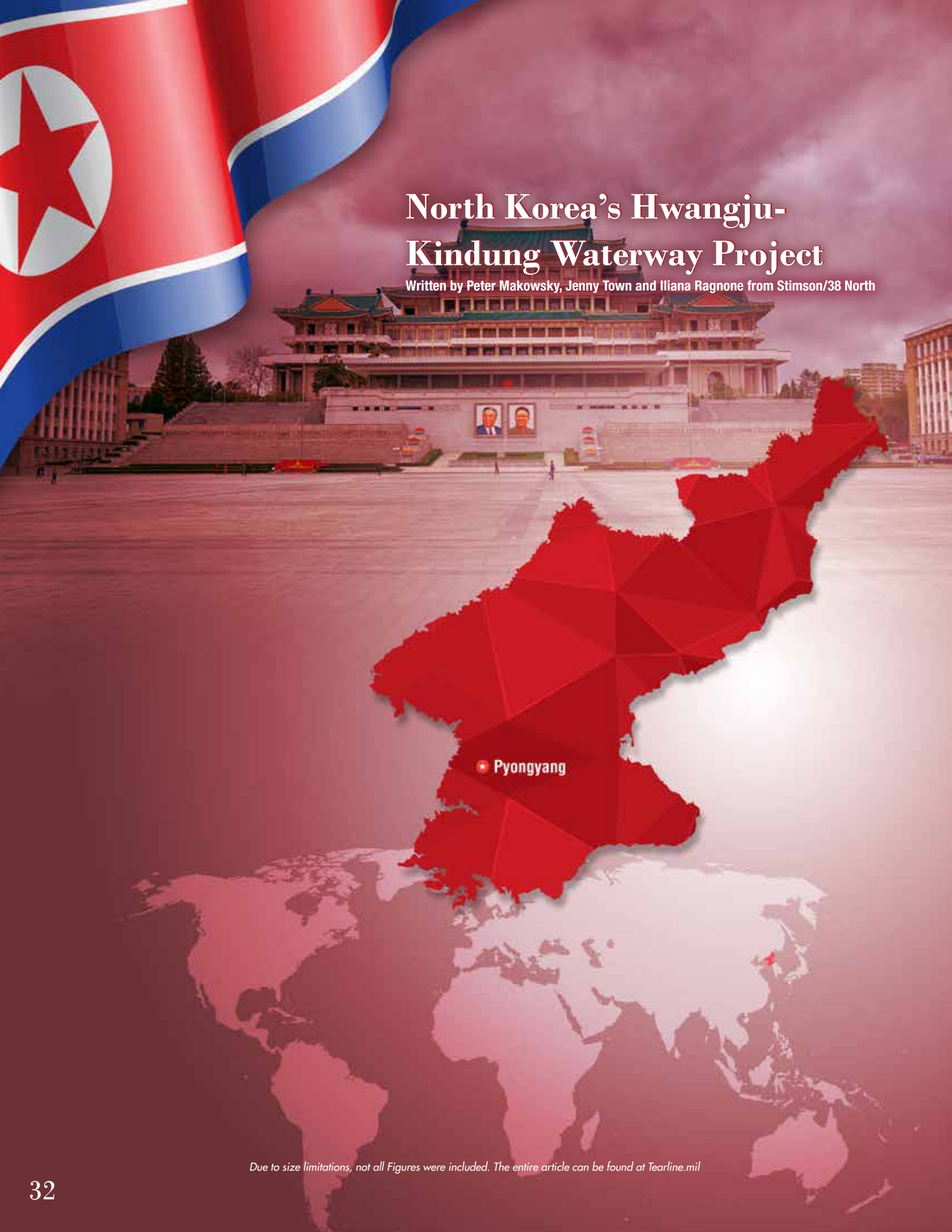
While commercially available satellite imagery allows the outside world to see guard positions and often people, for example in political prison camps, the full extent of Kim Jong-un's human rights violations in the camps remains hidden. Nevertheless, the continued monitoring of such camps provides a way to shed some light on the abuses endured by North Korea's most vulnerable—its political prisoners, who are oppressed through unlawful arrest, detention, torture, inhospitable prison conditions, sexual violence, and public and private executions.

LOOK AHEAD

HRNK will continue to use satellite imagery to assess the operational status of North Korea's political prison camps (kwan-li-so), including kwan-li-so no. 14, 15, 16, and 18. This analysis will be augmented with escapee testimony and open-source information whenever possible, and it will also seek to identify major changes at these facilities. North Korea's intensified crackdown on attempted escapes and the consumption and distribution of foreign information may have been accompanied by the reorganization or expansion of key detention facilities. In addition, HRNK will seek to develop a more complete picture of North Korea's network of detention facilities by looking beyond the kwan-li-so and the kyo-hwa-so to examine other types of facilities through satellite imagery.

North Korea's Hwangju-Kindung Waterway Project

Written by Peter Makowsky, Jenny Town and Iliana Ragnone from Stimson/38 North



Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

OVERVIEW

The Hwangju-Kindung Waterway was officially declared operational in December 2023. This new gravity-fed waterway system aims to provide a constant, uninterrupted water supply to the Hwangju-Kindung Plain for crop irrigation. It will reduce the region's dependence on electrical pump stations that require constant electricity supply.

Completion of the Hwangju-Kindung Waterway was also noted as fulfilling North Korea's rural development and irrigation construction goals set at the Eighth Party Congress. Whether the new waterway will work as designed remains to be seen, as the system has yet to be tested during the extremes of the country's wet and dry seasons.

ACTIVITY

GEOINT analysis shows the completion of the Hwangju-Kindung Waterway.

LOOK AHEAD

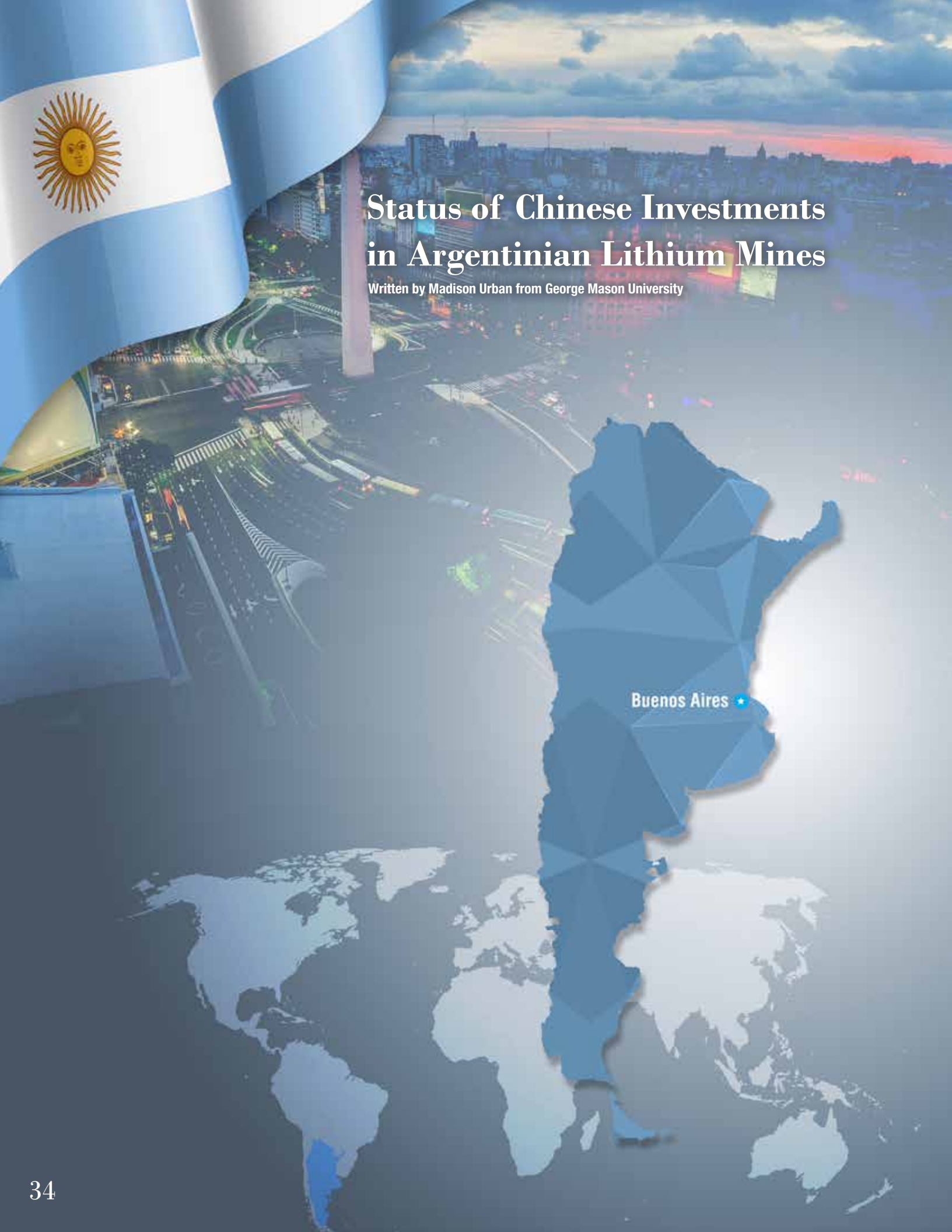
Now completed, much reliance will be placed on the success of this unique and innovative means to supply water for irrigation to a region whose agricultural output is important to a nation striving to increase its food stores and become self-reliant from import markets. Whether this gravity-fed system will be successful and whether other such projects will commence merits watching, and includes the following:

- Evidence of continuously filled irrigation canals.
- The addition of new canals and evidence of failed irrigation pathways.
- Lush fields showing healthy crops.
- Low reservoir water levels.
- The construction of new gravity-fed waterways being built in similar, high-elevation agricultural farmlands.
- New ways that North Korea will try to reduce its reliance on a consistent electricity supply while continuing development in key sectors.

Source: Base Map provided by NGA

Figure 1: Overview of Hwangju-Kindung Waterway.
Source: Google Earth

Figure 2: Tunneling spoil piles visible along water tunnel path on imagery from May 8, 2023
Source: Copyright © 2023 by Maxar



Status of Chinese Investments in Argentinian Lithium Mines

Written by Madison Urban from George Mason University

OVERVIEW

Chinese companies own or otherwise have significantly invested in six of 16 active lithium mining projects in Argentina, including four of the six most developed projects. Investment in these mines helps to further cement the People's Republic of China's dominance and control over the lithium industry, a mineral critical for the green-energy transition, particularly in the construction of lithium-ion batteries.

Seventy-five percent of the world's lithium is contained in the desert salt flats (salars) at the crossroads of Argentina, Bolivia, and Chile, which is known as the lithium triangle.

ACTIVITY

This report provides a detailed disposition of ownership and status of Chinese-backed lithium projects in Argentina. GEOINT analysis shows that most declarations from company sources are on-time and progressing often rapidly with a few projects behind scheduled projections.

Source: Base Map provided by NGA

BACKGROUND

Lithium has been deemed by the U.S. Department of Energy (DOE) as both a critical material and a critical mineral for having "a high risk of supply chain disruption and serv[ing] an essential function in one or more energy technologies, including technologies that produce, transmit, store, and conserve energy." DOE also conducts risk assessments, looking at a mineral's value and anticipated access. In the short term (2020–2025), it is a near-critical material given its high value for energy and moderate supply chain risks, but in the long term (2025–2035) it moves to critical as the risks to the supply chain increase. Lithium is in high demand and will only likely increase as it is a key component in lithium-ion batteries, necessary for green energy transitions.

Seventy-five percent of the world's lithium is contained in the desert salt flats (salars) at the crossroads of Argentina, Bolivia, and Chile, which is known as the lithium triangle. While the People's Republic of China (PRC) controls over 50% of the world's lithium refinement capability, it is seeking to secure greater access to raw lithium, currently controlling about 25% of global mining capacity. To do so, it is increasingly using state-owned enterprises and encouraging private enterprises to invest in the lithium triangle, including in northern Argentina.

Scope of Investment by PRC Companies

According to Argentina's Ministry of the Economy, as of February 2023, there are 16 lithium projects beyond advanced exploration in either the construction, feasibility, pre-feasibility, or preliminary economic assessment stages. Six of the projects are owned in full or in part by a Chinese company, including four of the six most developed projects (see **Figures 1a-1b**). Ganfeng Lithium operates three projects while Zijin Mining Group, Tsingshan Holding Group, and Sino Lithium Materials are each involved with one project. According to the estimates published by Argentina's Ministry of the Economy, once each site is producing, the total estimated average annual production of these six sites is 119,000 t/LCE, enough to cover 88.8% of the estimated 2022 global consumption of lithium.

Ganfeng Lithium and Tibet Summit Resources also have announced investment into two other projects each that are in earlier stages of development.

This report will analyze six Chinese-backed projects using commercial imagery and open press and business reporting.

In northern Argentina, by virtue of its elevation, sunshine, and lack of precipitation, lithium is mined through evaporation in 15 of the 16 projects. The process begins with wells that pump lithium-rich brine

Figure 1a: Map of Lithium Projects
Source: 2024 Mapbox © OpenStreetMap

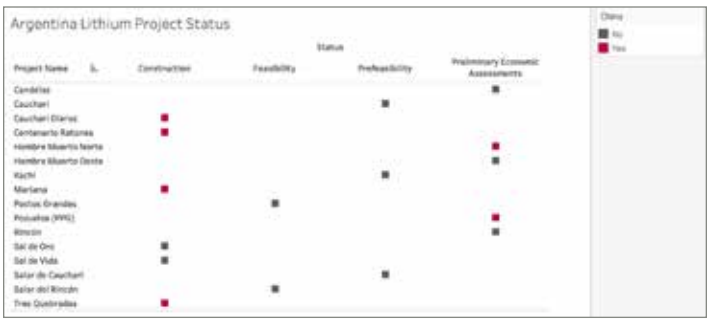


Figure1b: Status of the Lithium Projects.
Source: Ministerio de Economía Argentina

into shallow ponds on the surface where the mixture sits. Over time as the water evaporates, it leaves lithium behind that is chemically processed and refined. While evaporation is the most common method of mining lithium, it is highly inefficient, time consuming, and water-intensive. Local indigenous communities are protesting the development of lithium mines as it drains critical water resources and disrupts their primary forms of income: tourism and salt mining. In 2010, a group of indigenous peoples in Jujuy and Salta provinces began a legal battle with provinces over the right to consent to mining. Constitutional reform efforts during the summer of 2023 decreased the protections on protest and paved the way for greater access to land at the expense of indigenous communities. The passage of the reforms in under three weeks led to protests that were repressed in an internationally denounced crackdown on speech and protest.

The other project, Centenario Ratones, mines lithium through a similar process of brine pumping but then is processed through chemical absorption, decreasing the amount of brine needed and allowing water to be recycled. This process is touted by Eramet, the company that developed it, as able to produce lithium in 24 hours, as opposed to the sometimes 18-month evaporation process.

Ganfeng Lithium

Ganfeng Lithium was founded in 2000 and is now listed on the Shenzhen Stock Exchange and the Hong Kong Stock Exchange with 16 active lithium projects in six countries on six continents. In Argentina, they have five projects underway, three of which go beyond advanced exploration. Ganfeng Lithium's partner, Lithium Argentina, announced in June 2023 that its Caucharí-Olaroz project is producing lithium, while the Mariana Salt Lake project at Salar de Llullaillaco and the Pozuelos-Pastos Grandes project are under construction. The Mariana project held its groundbreaking ceremony on May 30, 2022 and Ganfeng Lithium's work on the Pozuelos-Pastos Grandes project began when it was purchased in October 2022. Furthermore, Ganfeng Lithium is conducting exploratory drilling at Salar de Incahuasi and another project at Salar de Pastos Grande.

Caucharí-Olaroz Project

The Caucharí-Olaroz project is a joint venture between Lithium Argentina (44.8%), Ganfeng Lithium (46.7%), and Jujuy Energía y Minería Sociedad del Estado (JEMSE) (8.5%) that is operated through a local holding company, Minera Exar. While Lithium Argentina is a separate company, on February 26, 2024, it announced that it had appointed a new president and CEO, Sam Pigott, who is "a member of the senior leadership team of Ganfeng Lithium." Ultimately, Ganfeng Lithium anticipates investing $641 million in the project which it

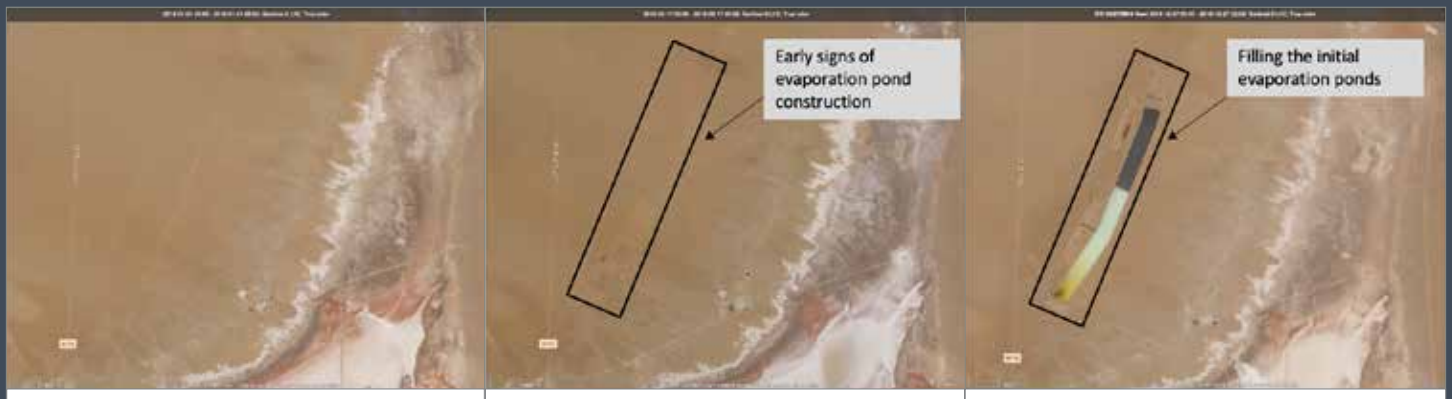


Figure 2: Initial signs of construction on evaporation ponds at the Caucharí-Olaroz mine. Source: Sentinel

projects will produce 40,000 tons per year of lithium carbon. Lithium America's (Lithium Argentina's precursor company) announced on the company's website the plant was producing on June 12, 2023.

In 2019, Ganfeng Lithium announced $160 million investment in the Caucharí-Olaroz project. According to Lithium America's September 2023 corporate presentation, it began exploration of the site in 2009 and the feasibility study and environmental permits for the site were approved in 2012. Imagery analysis reveals that construction and filling the brine ponds began in 2018 as shown in **Figure 2** above.

In 2020, Lithium America announced that Ganfeng Lithium expanded its investment, and imagery analysis reveals further work was done building the evaporation ponds, lime plant, refining capabilities, and tailing ponds (**Figure 3-4**). In July 2022, Ganfeng Lithium stated that it anticipated the operation of the Caucharí-Olaroz plant to begin by the end of the year, however, it did not begin until June 2023, a delay of approximately six months.

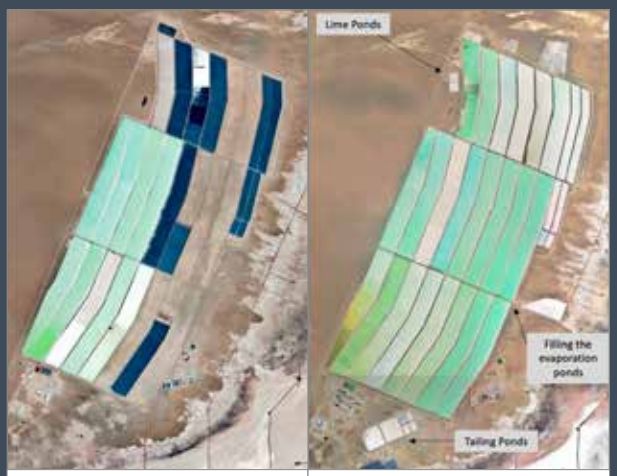
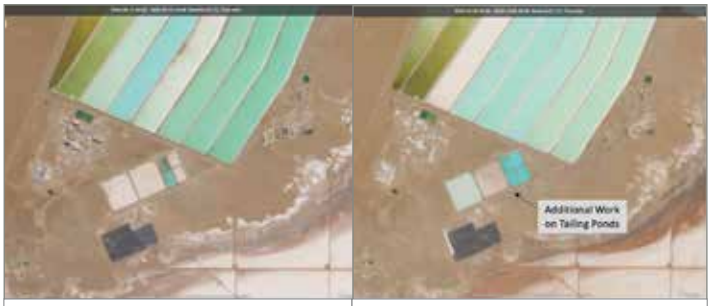


Figure 3: Development of the evaporation ponds and site at large. Source: Google Earth

November 14, 2020 | May 8, 2023

Figure 4: Development of the refinement capabilities.
Source: Google Earth

During the public announcement of initial production, Lithium America stated that "[a]dditional purification processing equipment necessary to achieve battery-quality lithium carbonate is expected to be completed in the second half of 2023, as planned." Since then, according to imagery analysis, additional work has been done on tailing and mother liquor ponds (see **Figure 5**). When Lithium Argentina announced the 2023 production results for Caucharí-Olaroz in January 2024, it stated the lithium carbonate plant is running at 50% capacity and will ramp up production to capacity throughout 2024.



June 14, 2023 | December 6, 2023

Figure 5: Progress on tailing and mother liquor ponds.
Source: Sentinel

Mariana Project

The Ganfeng Lithium project at Salar de Llullaillaco (the Mariana Project) is operated through a local subsidiary, Litio Minera Argentina S.A. with Ganfeng holding a 100% equity share. In June 2021, the environmental impact study was approved proceeded by the groundbreaking ceremony on May 30, 2022 (left image, **Figure 6**). The ceremony was attended by local officials and the PRC ambassador to Argentina, Zou Xiaol, participated virtually. Since then imagery analysis reveals that work has continued on the evaporation ponds (**Figure 6**) as has construction on the camp and lithium processing facilities (**Figure 7**). In their 2022 Annual Report, Ganfeng Lithium announced that the project is expected to begin production in 2024. However, the most recent imagery shows that the evaporation ponds are not yet completed (**Figure 6**). The ponds are located approximately 1000 meters southwest of the base or camp.

Pozuelos-Pastos Grandes

The Pozuelos-Pastos Grandes (PPG) is operated through a local subsidiary, Lithea Inc, which Ganfeng Lithium acquired in late 2022. Ganfeng Lithium announced that construction had begun on PPG at

May 28, 2022 | December 9, 2023

Figure 6: Site Development, Groundbreaking to Most Recent.
Source: Sentinel

October 16, 2022 | August 31, 2023

Figure 7: Camp Development.
Source: Maxar

an end-of-year presentation to its shareholders according to reports by Shanghai Metals Market (which provides information on metal markets) and MooMoo (a trading platform). Ganfeng Lithium also announced on its PRC-based website that the pilot project produced lithium by the end of 2023 and that "salt field construction scheduled to commence at the end of 2023 and production expected to start in 2026." With that announcement, the pilot plant is outpacing its initial production targets, as the target production date on Ganfeng Lithium's Latin America website is 2024. The project covers two salars, Salar Pastos Grandes in the north and Salar Pozuelos in the south (**Figure 8**). According to the original feasibility study completed by Lithia and submitted in January 2019, the salars will be connected by a brine concentration pipeline with the processing plants and brine ponds to be constructed in and around Salar Pozuelos.

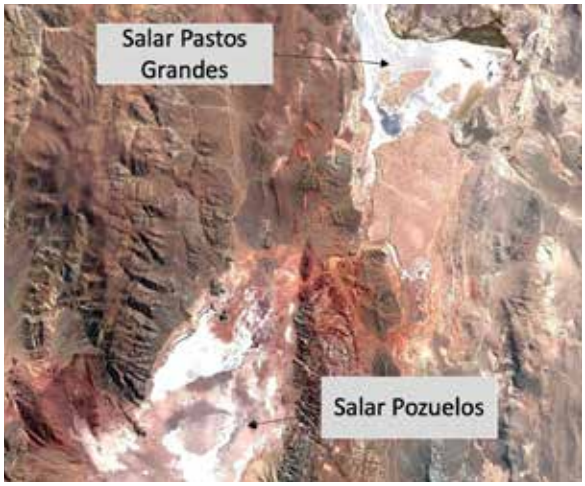


Figure 8: Map of the Salar Pastor Grandes and Salar Pozuelos.
Source: Google Earth, 2023

From August 2022 to December 2023, imagery reveals there has been some minor construction on the processing facilities and camp on the north side of Salar Pozuelos (**Figure 9**).

As stated above, Ganfeng Lithium had announced construction on the salt flat would commence by the end of 2023. Beyond the initial test pond that has been filled since at least January 2021, imagery analysis does not reveal evidence of additional construction on evaporation ponds (**Figure 10**). However, it does show construction of additional wells and installation of pipes since 2021 (**Figure 10**). Furthermore, imagery analysis reveals that the site continues to be under construction with additional well and pipeline infrastructure observed in the January 2024 (**Figure11**).

Tsingshan Holding Group

Centenario Ratones

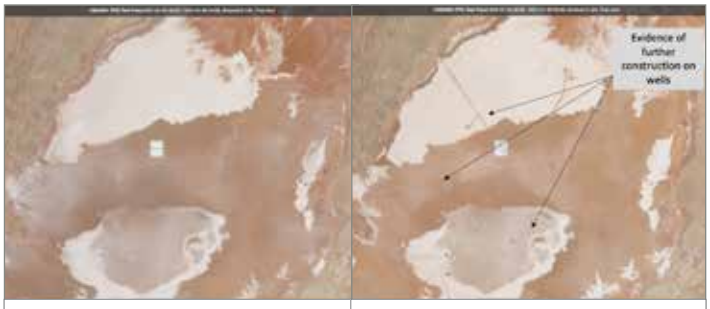
Tsingshan Holding Group acquired 49.9% ownership in the Centenario Ratones owned by a French company, Eramet. The cash injection kickstarted the project again after it had been shuttered in 2020 due to the effects of COVID-19. The project serves as the pilot project for Eramet's innovative chemical mining process.

Construction on the chemical processing plant began in May 2022 with Eramet setting its target production date of early 2024. In March 2023, Eramet announced on its website that it anticipates commissioning the first plant in November 2023, processing the first ton of lithium in 2024, and reaching full capacity by 2025. After the Tsingshan investment, construction on the facilities increased rapidly, according to imagery analysis (**Figures 12-13**).

Figure 9: Construction at Processing Facilities and Camp. Source: Maxar (left), Google Earth (right)

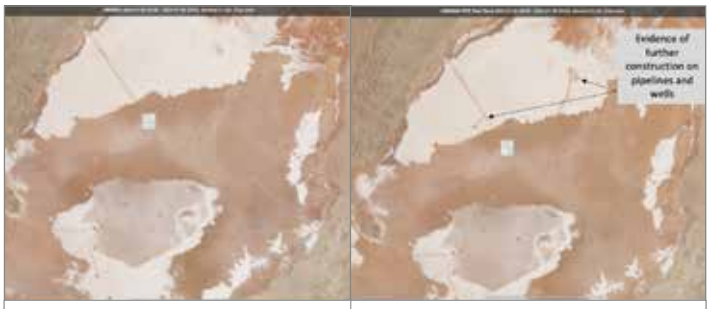
August 22, 2022 | December 2, 2023

Figure 10: Well and Pipe Construction. Source: Sentinel



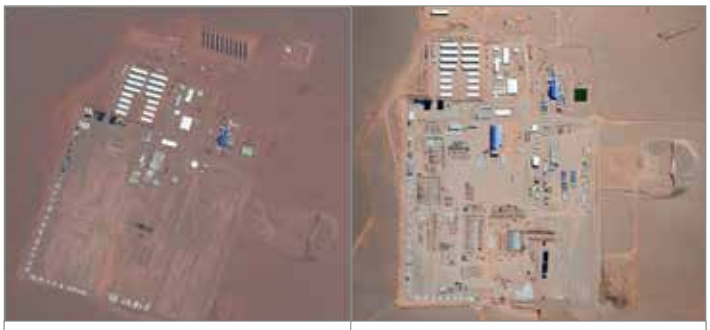
January 30, 2021 | January 20, 2024

Figure 11: Construction in early 2024. Source: Sentinel



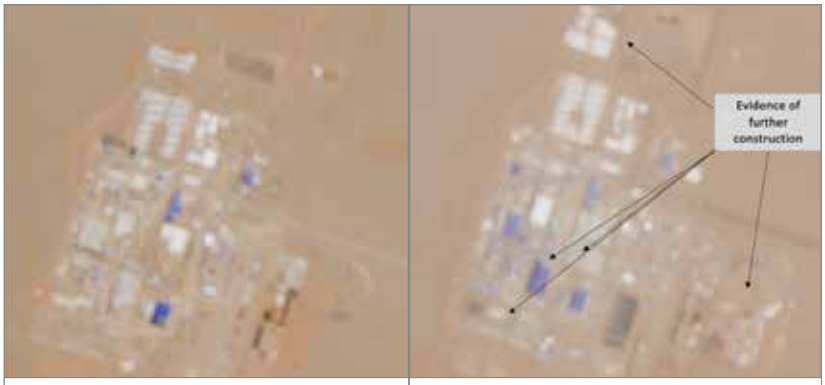
January 5, 2024 | January 20, 2024

Figure 12: Centenario Ratones plant construction. Source: Maxar, Google Earth



November 7, 2021 | October 7, 2022

Figure 13: Centenario Ratones plant in November 2022 and March 2023. Source: Eramet



March 31, 2023 | December 31, 2023

Figure 14: Centenario Ratones Construction in 2023.
Source: Sentinel

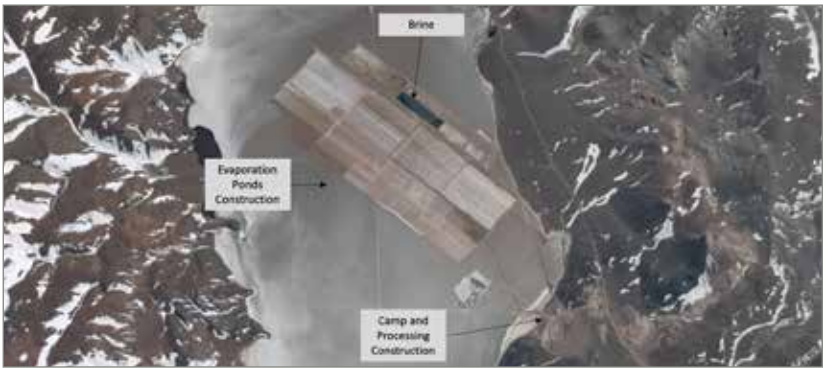


Figure 15: Development of the salar site.
Source: Maxar

April 8, 2023

Figure 16: Additional Construction.
Source: Maxar

January 5, 2024

Figure 17: Fiambalá Production Site.
Source: Maxar

Eramet did not announce that it had met its previously stated goal of commissioning the plant in November 2023 and it is unclear if it will be able to receive and process lithium on schedule in early 2024. However, the latest satellite imagery available from December 2023 shows further construction of the processing plant (**Figure 14**).

Zijin Mining Group

Tres Quebradas Salar

Zijin Mining Group obtained the rights to Tres Quebradas Salar in 2022 through the acquisition of the local subsidiary, Liex. Zijin Mining stated that it expected that production was anticipated by the end of 2023 with a scheduled second phase of construction to increase capacity after. The project has two main sites, a mining and early processing facility at the salar itself and the lithium processing facility just outside the city of Fiambalá.

According to imagery analysis, by August 31, 2022 development of the evaporation ponds, processing facility, and workers camp increased rapidly at the salar (**Figure 15**).

By mid-2023, the evaporation ponds were at least partially dug and the first pools filled and progress was made on the construction of a solar power grid, according to imagery analysis from August 2022 to April 2023 (**Figure 16**).

However, based on imagery analysis from December 2023 the construction and filling of the evaporation ponds had not been completed by the end of 2023, when the Zijin had initially announced the site would be producing.

At the same time, production continued at a dedicated lithium production plant just outside the nearby city of Fiambalá. The Fiambalá site houses the Lithium Carbonate Plant, the discard ponds, and other supporting installations (**Figure 17**).

Sino Lithium Materials and Chengdu Chemphys Chemical Industry Co., Ltd.

Hombre Muerto Norte

In 2017, Lithium South precursor company, NRG Metals, entered into a conditional off-take agreement with Chengdu Chemphys Chemical Industry Co., Ltd. ("Chemphys"), an agreement that gave them the right "for the sale of any lithium produced at HMNLP, as well as a first right of refusal and first right of offer for the sale of lithium produced at any other projects that NRG moves forward, board representation and certain anti-dilution provisions and a use of proceeds agreement." In April 2020, NRG announced that Sino Lithium Materials and Chemphys developed a "proprietary lithium extraction process" which "has the potential to significantly increase lithium recovery and reduce the production lead time compared the conventional processes" and that would be tested at Hombre Muerto Norte. Since the announcement of the proprietary lithium extraction process, imagery analysis does not reveal any construction on the site's evaporation ponds (**Figure 18**).

Figure 18: Construction at Hombre Muerto Norte.
Source: Maxar

According to Lithium South's September 2023 corporate presentation, two of the Lithium South directors are Chemphy's employees and Chemphy's has "an 11-member technical team working full time on development of the Direct Lithium Extraction Technology" for Lithium South, a new form of lithium extraction. Lithium South filed its technical report in November 2023 and in January 2024, it announced it was nearing the end of its preliminary economic assessment.

LOOK AHEAD

There are at least three other announced projects by Chinese companies, including an additional investment by Ganfeng Lithium at Salar de Incahuasi and two by Tibet Summit Holding, at Salar Arizano and Salar de Diablillos. However, these projects were not included in any detail in the 2023 list of lithium mines from the Argentinian Ministry of Economics due to being in the very earliest stages of exploration.

Russian Activity in North Africa's Oil and Gas Industry

Written by Emmanuelle Brindamour from Yale University

Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

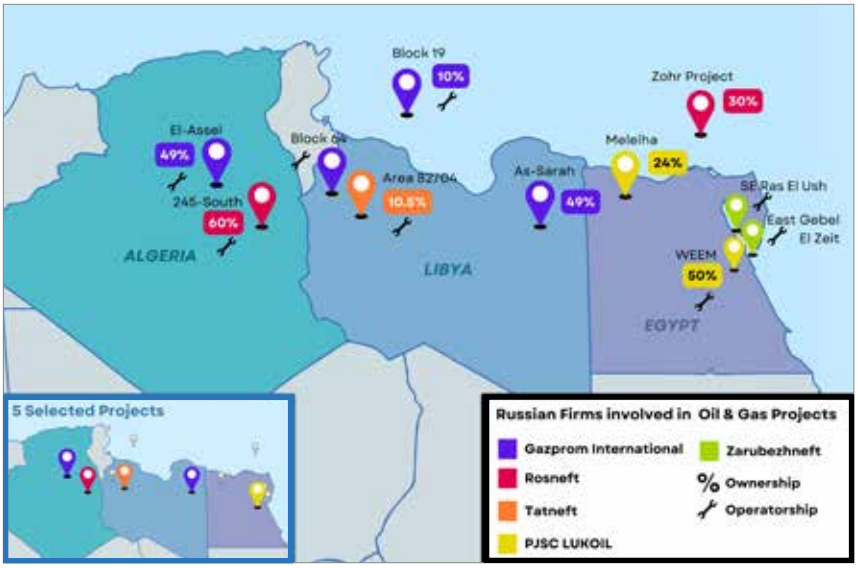


Figure 1: All active Russian-backed oil and gas projects in Algeria, Libya, and Egypt as of 2024.
Source: Original work by author.

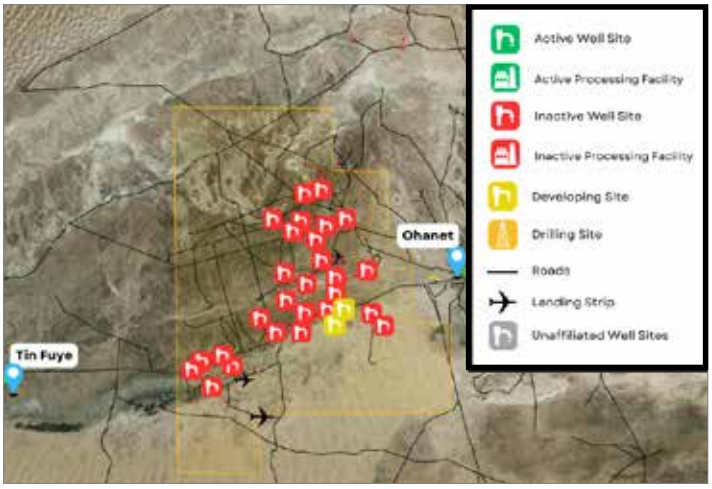


Figure 2: Overview of well site activity levels as of February 2024 in the Block 245-South contract area.
Source: Base map: Landsat-8, April 2024.

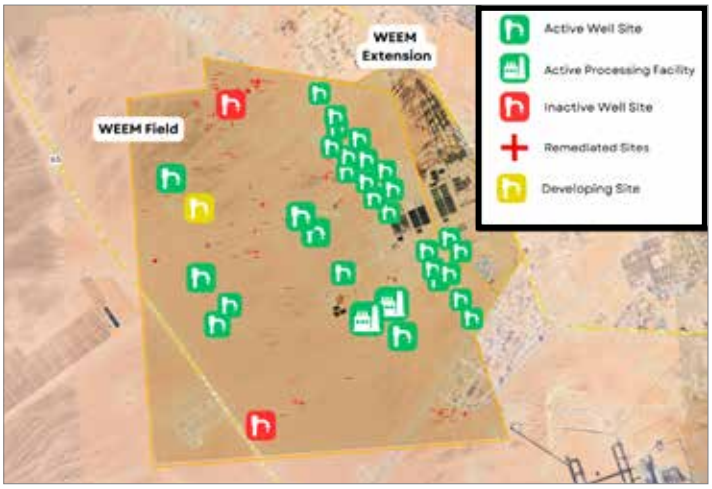


Figure 3: Overview of well and processing facility activity levels at WEEM as of February 2024. Remediated sites are sites previously active, but unidentifiable due to full covering of the area.
Source: Base map: Google Earth, January 2024.

OVERVIEW

In light of the European energy security crisis prompted by the War in Ukraine, this report provides an in-depth analysis of Russian involvement in North African oil and gas industries, focusing on five ongoing upstream projects across Algeria, Libya, and Egypt.

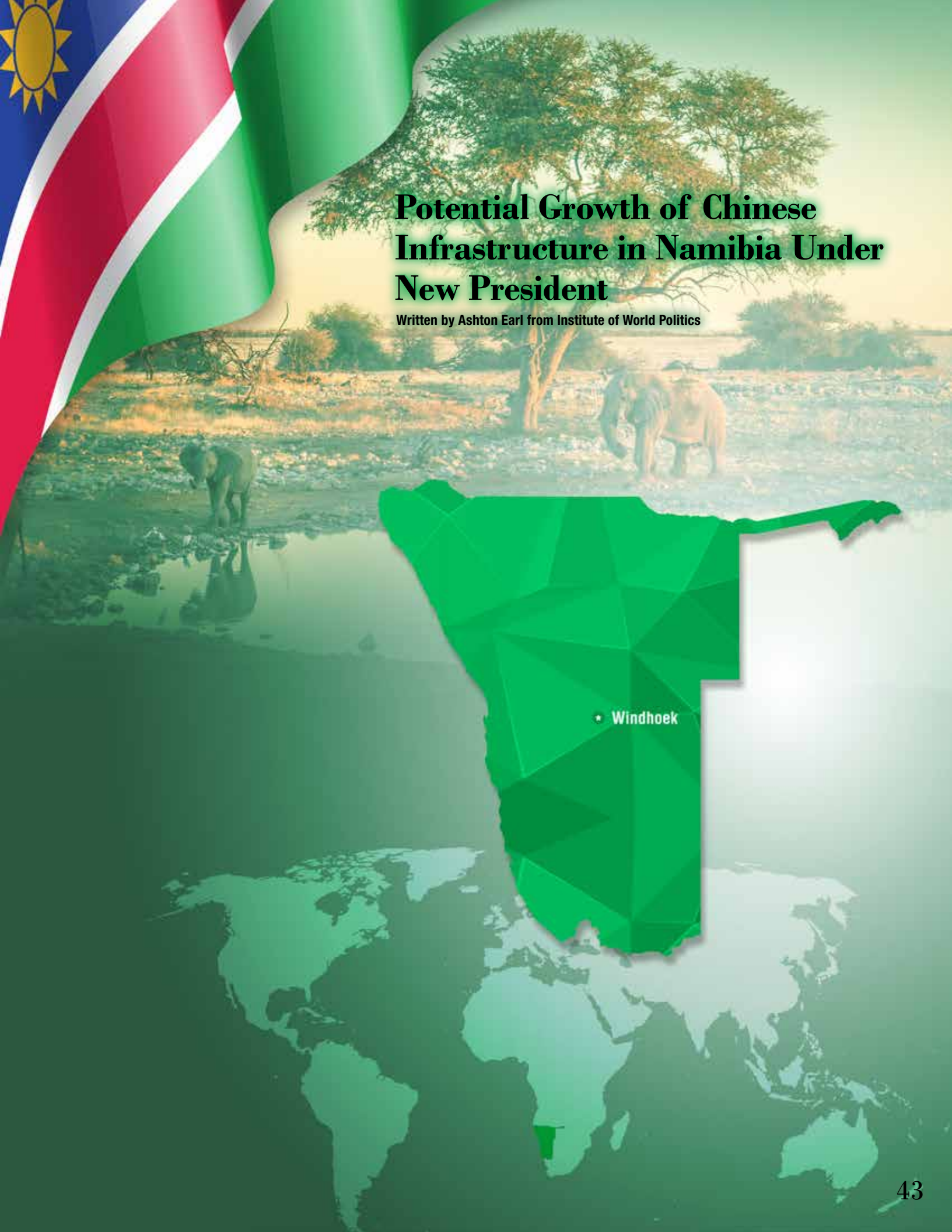
Imagery analysis reveals modest discrepancies between company reports and observed activities in 2 out of 5 ongoing projects. In Libya, the Area 82-4 and As-Sarah projects are on schedule. In Egypt, the West Esh El-Mallaha Project is on schedule. By contrast, in Algeria, the El-Assel Project is behind schedule and the Block 245-South Project is decommissioned.

ACTIVITY

This report analyzes commercial imagery, ground photography, social media, open press reports, and corporate documents to assess the progress of Russian-backed oil and gas projects in three North African countries: Algeria, Egypt, and Libya.

LOOK AHEAD

Overall, Russia's continued involvement in North Africa's energy sector is a strategic move to secure influence amidst the shifting geopolitical landscape and European efforts to reduce dependency on Russian energy. While these five projects do not exhibit a direct correlation with Russian re-positioning in the wake of Ukraine, the renewal of these cooperative ventures as well as new agreements of this type should be monitored in context. Future energy cooperation between North African nations and Russian companies will likely partially shape regional energy dynamics and thus impact global energy markets and geopolitical alignments.



Potential Growth of Chinese Infrastructure in Namibia Under New President

Written by Ashton Earl from Institute of World Politics

OVERVIEW

Chinese development in Namibia will likely continue to grow under the projected Netumbo Nandi-Ndaitwah administration.

Satellite imagery analysis shows reported increases in Chinese-funded/constructed infrastructure in Namibia throughout Ndaitwah's administration as Foreign Minister. Further development will enhance Chinese influence over the southern African maritime thoroughfare, increasing the likelihood of restricted access to Western vessels should Sino-American relations continue to deteriorate.

ACTIVITY

Namibia's upcoming presidential election in November will set the tone for its foreign policy for the next five years. The candidate projected to win is the current Vice-President of Namibia and the South West Africa People's Organization (SWAPO) presidential nominee, Netumbo Nandi-Ndaitwah. Ndaitwah served as Namibia's Foreign Minister for over a decade. Satellite imagery analysis indicates that, under Ndaitwah's watch, a significant number of Chinese-funded infrastructural developments were completed and are currently operational. This report posits that this growth is likely to continue under a prospective Ndaitwah Administration, which, coupled with Chinese influence in South Africa, Mozambique, Madagascar, and Comoros, would provide the Chinese Communist Party (CCP) outsized influence over nations lining the Cape of Good Hope sea line of communication (SLOC).

BACKGROUND

Namibia is currently in the middle of its presidential election, preparing for the selection of the late President Hage Geingob's successor. The two leading candidates are Netumbo Nandi-Ndaitwah, who currently serves as the Vice-President of Namibia and was chosen as SWAPO's presidential nominee last year, and Panduleni Itula, a former SWAPO member who was ousted from the party when he led the minority opposition against President Geingob in the 2019 presidential election. Although SWAPO popular support has seen significant deterioration from its original, near-unanimous control in the '90s, Itula was only able to secure around 30% of the 2019 popular vote. Most election analysts project a continuation of SWAPO rule under Ndaitwah, despite a slight projected decrease in SWAPO support. Namibia currently suffers from one of the world's largest unemployment rates at around 20% and has had recent struggles with corruption. Many Namibians associate these issues with SWAPO rule, but alternative candidates still struggle to propose acceptable alternative policies or unite against the current majority party.

Since her assumption of the Ministerialship of International Relations and Cooperation, Ndaitwah has shown preferential treatment towards the Chinese over the United States and other Western entities, thus setting the tone for increased bilateral business and investment. This includes annual visits to Beijing, frequent encouragement of Chinese aid in her speeches, and a mass influx of Chinese development aid both before and after Namibia's joining of the Belt and Road Initiative (BRI) in 2018. While discussions regarding Sino-Namibian bilateral economic aid predate Ndaitwah's rise to the Ministerialship, the increased frequency of such meetings correlates directly with Ndaitwah's ascension in 2012. These began

Source: Base Map provided by NGA

with Ndaitwah's first meeting with Chinese Foreign Minister Wang Yi in September 2013, where Chinese advancement of infrastructural development in Namibia was addressed.[1]

The meeting drew from Namibian calls for an economic "Second Revolution," culminating in what eventually became Yi's rallying cry for Namibian investment.[2] Ndaitwah recognized that "China and Namibia enjoy a profound traditional friendship," a theme she frequently cites, referring back to Chinese aid rendered to the Namibian independence movement. The 2013 discussion paved the way for Xi Jinping's first in-person meeting with then-Prime Minister Geingob eight months later in Beijing where development of Chinese mining and infrastructure was discussed.[3] A day later, Prime Minister Geingob met with other Chinese officials to discuss Namibian legislation to protect increases in Chinese investment in Namibia.[4] The following year, the Chinese sent a special envoy to Geingob's inauguration as President, and helped the Geingob-Ndaitwah partnership with the CCP expand further.[5] In 2016, Wang Yi visited President Geingob, and agreed to Namibia's proposed bilateral development of Xi Jinping's Ten Cooperation Plans proposed to the Forum on China-Africa Cooperation (FOCAC), including "port-neighboring industrial parks" and mining infrastructure.[6] The same day, February 5th, 2016, Wang Yi met with Ndaitwah to address the initiation of those plans and catalyze the "Second Revolution" of Namibian economic independence aided by China.[7] In the meeting, Ndaitwah referred to China as "a true, trusted and reliable friend of the people of Namibia", again referencing China's support for the SWAPO-ruled Namibia since its inception.[8] In 2017, Ndaitwah visited Beijing for the first time as Foreign Minister.[9] During this visit, Ndaitwah and Yi reaffirmed commitment to goals set the previous year.[10] Ndaitwah praised the Chinese as "true friend[s] of developing countries." The same occurred between the two at the United Nations summit in New York in September of that year.[11] Just six months later, Ndaitwah made a second visit to Beijing to meet with Yi and facilitated a new visit by President Geingob, as well as discussed the further development of Sino-Namibian ties.[12] The next day, under Ndaitwah's supervision, the China-Namibia Comprehensive Strategic Cooperative

Partnership was agreed to by Presidents Geingob and Xi Jinping in Beijing, officially entering Namibia into the BRI.[13] Since that point, Ndaitwah has overseen the fulfillment of these bilateral agreements in the form of rapid industrial development in Namibia. The most recent is the inauguration of Sino-funded community farms in May 2024, known as the Harambee O-yetu Project.[14] Ndaitwah's participation in the event is just the latest as she operates in her new role as head of the party and incoming President. These developments continue today.

GEOINT Survey of Sites

The following imagery depicts Chinese construction projects across Namibia developed under Ndaitwah's supervision as Foreign Minister from 2012 to January 2024. Many of these construction projects continue today, and will likely continue and expand under her anticipated administration. Major, multi-million dollar projects predominantly fall under the following categories; roadwork, ports, mines, military infrastructure, and government buildings. This section will provide a case example for each category and a list of other related projects for further research.

Figure 1: TR9/1 - Windhoek to Hosea Kutako International Airport
Source: Copernicus July 5, 2024

ROADWORK

Trunk Road (TR) 9/1 or Highway from Windhoek to Hosea Kutako International Airport

In December 2015, China Railway Engineering Seventh Bureau and a Namibian company, Onamagongwa Trading Enterprises (OTE), won a joint contract from the Namibian government to pave a new 45km route between Windhoek and the Hosea Kutako International Airport.[15]

On December 16th, 2015, ground was broken for the first 8.4 kilometer phase of the project. Friction between the partnering enterprises delayed the project, but in 2017 the Namibians and Chinese signed an Economic and Technical Cooperation Agreement (ETCA) granting a seed fund of RMB 200 million (NAD 400 million).[16] Phase 2A of the highway has been funded by a grant from African Development Bank Group, and Phase 2B, the final phase, is funded by a grant from the China Eximbank.[17] Currently, the Chinese, through Zhongmei Engineering Group Ltd., alongside SMEC (formerly VKE Namibia), an Aussie-Namibian consulting group, are finishing the paving of Phase 2B of the highway, anticipated to be completed next year.[18] Phase 2A is also nearing parallel completion.[19]

Figure 2: Space between Windhoek and Hosea Kutako International Airport October 2016 vs July 2024
Source: Copernicus

Figure 3: TR9/1 Phase 1 - October 2016 vs July 2024
Source: Copernicus

OTHER CHINESE-AIDED ROADS

ROUTE	CONSTRUCTION START	COMPLETION
Omakange - Ruacana (Namibia Northern Highway Upgrading Project Sec 1)	2013	No reported completion
Omafo-Ongenga-Okalongo-Outapi (Namibia Northern Highway Upgrading Project Sec 2)	2013	2016
Swakopmund-Walvis Bay	2013	Ongoing

Table 1. Roads developed with Chinese assistance during Ndaitwah's tenure. Source: AidData's Global Chinese Development Finance Dataset, Version 3.0

Roads developed with Chinese assistance during Ndaitwah's tenure.

Figure 5: Port Walvis Bay - July 2024
Source: Google Earth, July 5, 2024

Figure 6: Port Walvis Bay - March 2014 vs July 2024
Sources: Copernicus March 2014, Google Earth, July 5, 2024

PORTS

Walvis Bay

In Although fewer examples exist of Sino-developed portage in Namibia, the development of Walvis Bay is asymmetrically significant. Following back and forth deliberation from 2007 onward regarding funding for the expansion of Walvis Bay's container terminal, the Namibians opted for an African Development Bank loan of $300 million over an offer of $100 million in preferential buyers credit from China Eximbank.[20]

However, China Harbor Engineering Co (CHEC) was selected as contractor, with construction commencing in 2014. The expansion was completed August 2019, increasing Walvis Bay's container handling capacity from 350,000 containers to 750,000 per year.[21] Increased Chinese presence at the port coincided with a leaked letter to the Namibians regarding intentions to develop a Chinese naval base at Walvis Bay.[22] This initiative has not materialized, but exposes intention and potential capacity for a physical Chinese military presence at the western gateway to the Cape of Good Hope SLOC. The port is also just under 40 km south of the 2001-built China Telemetry, Tracking and Command Station just northeast of Swakopmund. This site allows the Chinese enhanced tracking capabilities of spacecraft in the southern hemisphere, and is ideally positioned to track their reentry.[23] Consolidation of the two strategic sites makes Walvis Bay an attractive hub for Chinese investment.

Figure 7: Port Walvis Bay - New Container Terminal -June 2024
Source: Google Earth

Figure 7.1: Port Walvis Bay - Dry Docks - June 2024
Source: Google Earth

Figure 7.2: Port Walvis Bay - Fuel Terminal - June 2024
Source: Google Earth

MINES

Husab Uranium Mine

Namibia hosts rich critical mineral deposits. Of these, the Chinese have invested heavily in Namibian uranium. The largest of these investments is the Husab (Hushan) Uranium Mine Development Project. In 2006, Australian company Extract Resources developed Swakop Uranium to explore and develop uranium acquisition prospects at Husab, located northeast of Swakopmund and 45km from Walvis Bay. Five years later, Swakop Uranium was granted license by the Namibians to develop the mine. In January 2012 China General Nuclear Power Corporation Uranium Resources Company (CGNPC-URC)/China-Africa Development Fund (CADFund) joint-subsidiary Taurus Mineral was provided a $2.115 billion USD loan from the China Development Bank (CDB) (which owns CADFund) to purchase Extract Resources, thus procuring Swakop Uranium and rights to the Husab Uranium Mine. This successful proposal came directly after a failed acquisition attempt by Rio Tinto in 2011. Following the acquisition, China loaned Namibian state-owned company Epangelo Mining Company $258,920,326 USD to acquire a 10% stake in Husab in November 2012. Construction began in 2014 and was completed in 2016.[24]

Husab is the world's third largest uranium mine, and, combined with output from Namibia's three other major uranium mines, of which China owns shares in two (Rössing and Langer Heinrich), produces the third-most uranium by nation globally. The majority of Husab's uranium is exported to China with 20% marketed globally through China Guangdong Nuclear (CGN) Global Uranium, incorporated in the UK in 2014 with the express purpose to sell Husab uranium internationally.[25]

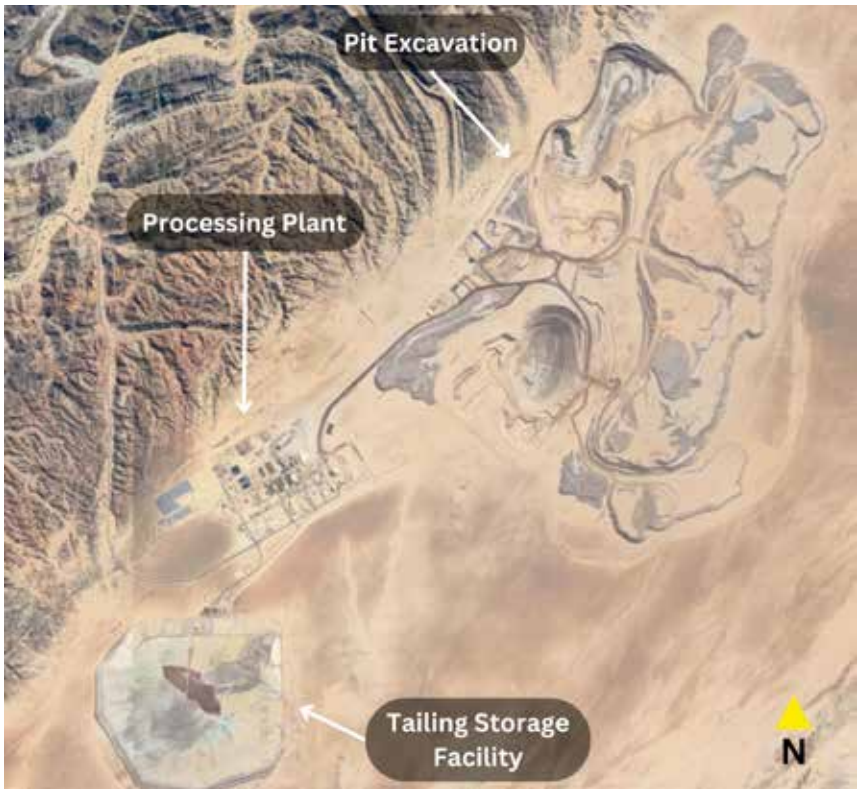


Figure 8: Husab Uranium Mine - July 2024
Source: Google Earth, July 3, 2024

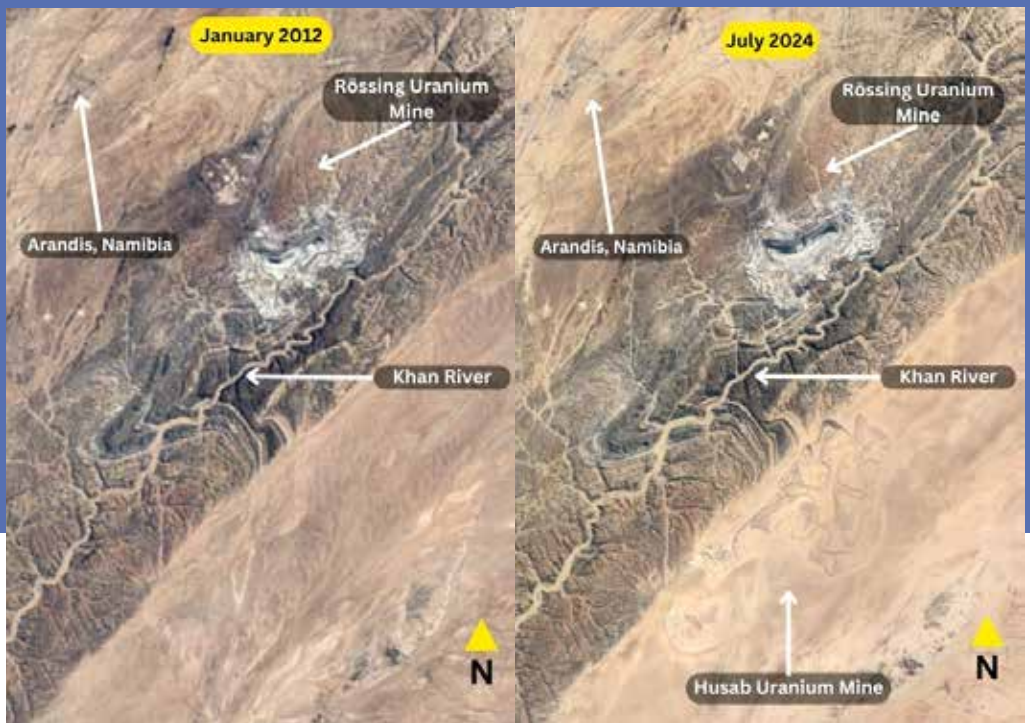


Figure 9: Husab Uranium Mine - January 2012 vs July 2024
Sources: Google Earth 2012, Google Earth, July 3, 2024

MILITARY INFRASTRUCTURE

Namibia Command and Staff College

On March 16th, 2008 the PRC signed an Economic and Technical Cooperation Agreement (ETCA) with Namibia to fund the creation of the Namibia Command and Staff College.[26]

Construction began in 2011 and, after delayed construction due to reports of unsustainable working conditions and resulting worker strikes, the facility was handed over to the Namibian government in October 2019. The purpose of the institution is "to provide full knowledge of tactical and operational warfare both at command and staff level and comprehensive understanding of the military's role within a democratic society" and that "China will work with Namibia to further deepen [their] cooperation and exchanges in the national defense area to cope with the global safety and security challenges shoulder to shoulder" according to the Chinese Ambassador to Namibia at the time, Zhang Yiming.[27] Despite local law requiring design and construction of public buildings be performed by Namibian entities, complete control of the project was handed over to the Chinese.[28]

The facility was designed by the Institute of Architectural Design in Gansu. The Chinese Ministry of Commerce awarded the construction of the project to the Zhengtai Group from Taishou City and Shenyang Engineering Supervision Consulting from Shenyang City.[29] The facility bears strong resemblance to domestic Chinese professional military education (PME) facilities with an ornate gateway, clustered barracks, perimeter fencing, and space for future designated drill/physical activity space. Similarities could be coincidental due to heavy Chinese involvement in planning and development. However, they could also point to Chinese PME in Namibia, which would lead to bilateral interoperability for future military operations.

Figure 10: Namibia Command and Staff College - 2024
Source: Google Earth, November 2023

Figure 11: Namibia Command and Staff College Gate
Source: Google Street View 2023

Figure 12: Okahandja - July 2014 vs July 2024
Sources: ArcGIS, July 2014, Google Earth, July 15, 2024

GOVERNMENT BUILDINGS

SWAPO Party Headquarters

In May, 2019, the Namibian government awarded a N$730 million (over $40 million USD) contract to Chinese-owned Unik Construction to build the SWAPO party headquarters in Windhoek.[30]

Unik has been used multiple times by the Namibians, including for constructing the connecting highway between Walvis Bay and Swakopmund. Construction commenced on the SWAPO HQ immediately, with ground breaking in June.[31] Some observers, including former secretary general Pendukeni Ivula-Iithana, have expressed concern that Chinese construction of party headquarters and other government offices may "compromise party leaders." Others, including Joshua Meservey of D.C.-based thinktank, the Hudson Institute, suggest that disproportionate use of Chinese contractors and telecommunications specialists for these facilities, coupled with Chinese propensity for economic espionage, risks the disruption and exposure of sensitive discussions posed to take place within their walls.[32] Many of these concerns stem from an incident in 2018 when China was found to be siphoning data from the Sino-funded and constructed African Union (AU) headquarters in Addis Ababa, along with the discovery of "microphones and listening devices...in the walls and desks of the building, following a sweep for bugs."[33] Two years later, Japan's Cyber Emergency Response Team (CERT) alerted the AU to a series of servers inside their headquarters which were feeding internal video surveillance to a Chinese hacking group called "Bronze President".[34] These events directly followed the establishment of the PRC's National Intelligence Law in 2017, which the United States, Australia, and other Western countries have interpreted as requiring Chinese private entities to report sensitive information back to the party on demand.[35] These events have led to greater suspicion by African political officials, including Ivula-Iithana. Nonetheless, under Ndaitwah's leadership, SWAPO has continued the use of Chinese funds and contracting for the development of government buildings. Construction of SWAPO HQ was stopped in March 2024 due to Namibian failure to procure funding, falling short by nearly N$100 million.[36] Future development is anticipated to progress alongside access to capital.

Figure 13: SWAPO Party HQ - Windhoek - July 2024 and (Close-up)
Source: Google Earth, July 5, 2024

Figure14: SWAPO Party HQ - The Namibian: March 31, 2024 and SWAPO Party HQ
Source: Google Street View 2024

CONCLUSIONS

Satellite imagery analysis helped survey Chinese development projects and assistance to Namibia during Ndaitwah's tenure as Foreign Minister from 2012 to January 2024. Not only were these project completed, but they were done so consistently and with increased volume following Ndaitwah's oversight of Namibian admission to BRI (see chart for additional context).

Ndaitwah's rhetoric surrounding formal bilateral agreements with China suggest further collaboration in years to come, especially with her likely to take the presidential helm. Whether Ndaitwah intends to favor China over Western support remains to be seen. However, with growing support for Chinese involvement relative to that of the United States by Namibian citizens, the incentive structure seems indicative of that trend.[37]

Regardless, it is almost certain that Ndaitwah will leave the door as open as possible to Chinese development in Namibia should she succeed this November. As stated above, both her rhetorical tone and her actions to initiate and escort the BRI agreement to completion are indicative of such. Furthermore, Ndaitwah's hands-on execution of the terms of the agreement, from her immediate follow-up visit to Beijing a year following its signage to her inauguration of Sino-funded community farms this last May, indicate her continued commitment to follow through on its implementation.

Outside of complaints from CCP party officials, and Xi Jinping himself, regarding return on investment for global BRI projects, there is no evidence suggesting the Chinese will halt further BRI work in Namibia.[38]

Potential BRI developments will likely take the form of higher emphases on digital infrastructure and tighter risk controls.[39] If any holds are to be placed by the Chinese, it will likely serve only to consolidate investment in the strategic areas highlighted above, as they pursue their global ambitions.

LOOK AHEAD

President Geingob's advancement of Ndaitwah to the position of Minister of International Relations and Cooperation correlates directly with a sharp increase in both Sino-Namibian relations and Chinese-funded, constructed, and/or operated infrastructural developments. These developments occur throughout a variety of industrial sectors including transit, ports, mining, and military infrastructure. Chinese investment and political partnership is intended, according to Ndaitwah, to usher in a "Second Revolution" in Namibia.

OTHER CHINESE-AIDED GOVERNMENT BUILDINGS

NAME	LOCATION	CONSTRUCTION START	COMPLETION
Anti-Corruption Commission Head Office	Windhoek	Not Listed	Not Listed
Auditor General Head Office	Windhoek	2023	Ongoing
Council of Traditional Leaders Head Office	Windhoek	2023	Ongoing
Directorate of Civil Aviation	Windhoek	Not Listed	Not Listed
Government Hangar Complex	Windhoek	Not Listed	Not Listed
Ministry of Lands and Resettlement Office	Windhoek	Not Listed	Not Listed
Omuthiya Police Station	Omuthiya	Not Listed	2018
Oshikoto Police Regional HQ	Omuthiya	Not Listed	2018
Otjomuise Police Station	Otjomuise	Not Listed	2017
Presidential Office	Windhoek	Not Listed	2017
Zambezi Regional Council Building	Zambezi	Not Listed	2019

Government buildings developed with Chinese assistance during Ndaitwah's tenure

Table 2. Government buildings developed with Chinese assistance during Ndaitwah's tenure
Source: Joshua Meservey - Government Buildings in Africa Are a Likely Vector for Chinese Spying Heritage Foundation

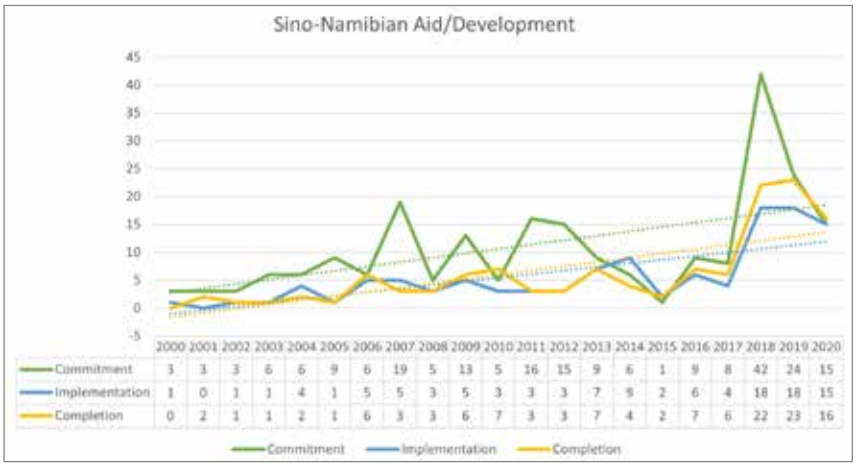


Table 3. Chinese Aid to Namibia 2000-2020
Source: Author generated graphic, Data sourced from William and Mary University's AidData

With these highlights of Ndaitwah's Foreign Ministerialship, and political promises to uphold the legacy of the late President Geingob, it is likely that, unabated, the Sino-Namibian relationship will expand during Ndaitwah's prospective five-year first term as President. This expansion will heavily supplement Chinese advances along the Cape of Good Hope, and help secure the SLOC under Chinese political control.

Climate Change Impacts on Water Availability in Namibia

Written by Mara McCollor and Emily Monroe from Cook Engineering Design Center and Dartmouth College Department of Geography

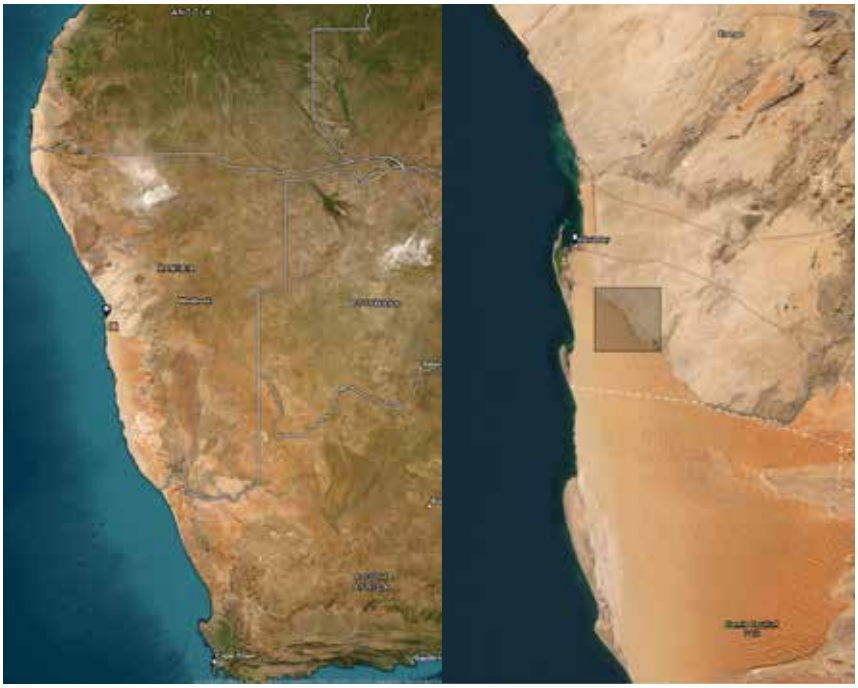


Figure 1: Map showing area of interest within Namibia
Source: ArcGIS by Esri, original source Maxar, September 2022, https://livingatlas.arcgis.com/wayback/

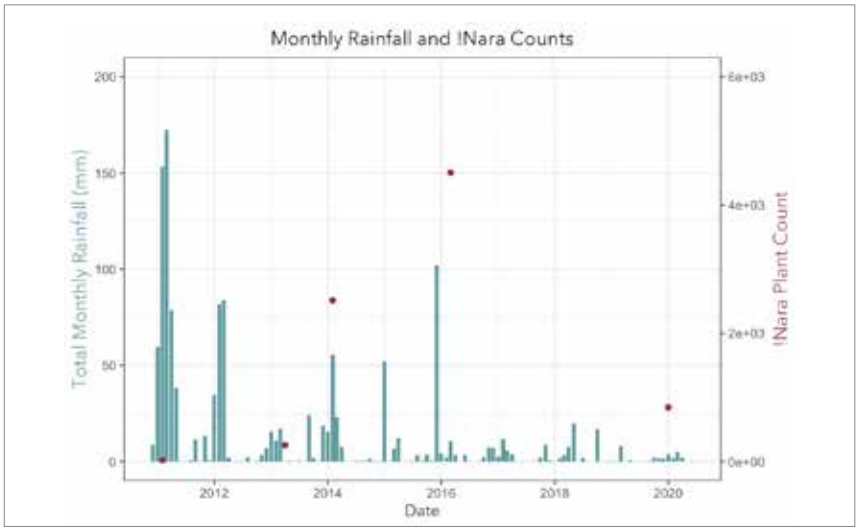


Figure 2: Number of !nara plants identified plotted on top of total monthly rainfall.

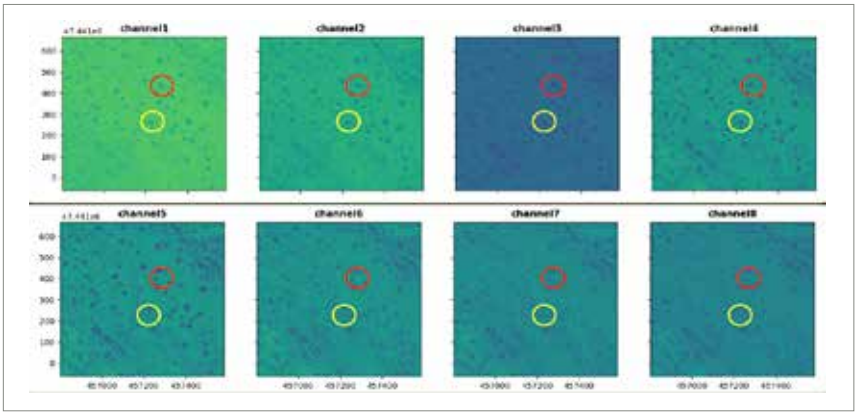


Figure 3: Bands 1 - 8 differed significantly between !nara and trees while Band 4 differed significantly between !nara and the overall background.

OVERVIEW

Imagery analysis suggests a native melon species in the Namib Desert may be a quantifiable proxy for the intensity of rain events due to climate change. This intensity in turn may be a leading indicator of economic and political unrest in the Namib Desert region because the melon is a primary source of food for the Topnaar people.

The !nara plant (scientific name: Acanthosicyos horridus) is a deep-rooted melon native to the Namib Desert. The plant, often found in ephemeral river channels, is susceptible to damage during major flooding events. Such events are increasingly common despite an overall decrease in smaller, more regular precipitation events. This study shows that !nara melon count is linked to the increased intensity of rain events likely driven by climate change.

ACTIVITY

This study developed and deployed an algorithm to detect the presence of !nara in the Namib region, which is linked to the volatility of rain in the region due to climate change in addition to being a food source for the Topnaar people, providing a tangible link between climate change and a people group in Namibia. The effects of a changing climate, including increased aridity and less frequent but more substantial flooding events, introduce strain on hydrologic conditions and subsequently plants, such as !nara, and the ecosystems that support their existence. Given the plant's direct reliance on water availability, it can be used as a proxy for identifying the impacts of changing climatic and hydrologic conditions in the Namib Desert.

LOOK AHEAD

Future work in the area of study should focus on the expansion of using satellite imagery to identify !nara on a broader temporal and spatial scale, potentially with the development of a record to track distributions over time for future analysis.

China's Interests in Myanmar: Analyzing the Status of Projects

Written by Carlos Alatorre from Institute of World Politics

OVERVIEW

The Kyaukphyu Special Economic Zone (KPSEZ) is a primary area of focus for China in Burma (Myanmar). The KPSEZ, under theumbrella of the Belt and Road Initiative (BRI), is one of three special economic zones funded by foreign-direct investment andsupported by the Myanmar government for economic development.

The KPSEZ was planned to have a deep-sea port, a tanker port to receive oil and gas, a power plant, a gas-fi red power station, an industrial park, and high-end housing spanning 2400 acres. Since 2013, development has been inconsistent, with a disproportionate focus on the energy infrastructure and tanker port. As of April 2024, GEOINT analysis shows limited development in the industrial park, deep-sea port, and housing projects.

ACTIVITY

The China-Myanmar Economic Corridor (CMEC) is a series of BRI infrastructure projects formally announced by China's foreign minister Wang Yi in 2017. The CMEC is intended to provide China easier access to the Bay of Bengal by connecting Kunming in Yunnan province to Kyaukphyu in Rakhine state, to bypass the Malacca Strait and promote greater economic cooperation between China and Myanmar. However, under China's BRI there has been a disproportionate focus on energyinfrastructure and limited development on the industrial park, deep-seaport, and housing. A survey of the KPSEZ projects will show the status of each as of April 2024. These projects will be compared, when appropriate, as a benchmark of progress or lack thereof, to the Malaysia-China Kuantan Industrial Park (MCKIP), a comparable SEZ in southeast Asia.

BACKGROUND

Purpose of CMEC

According to the Center for Strategic and International Studies (CSIS), the purpose of the CMEC is to provide China direct access to the Indian Ocean, starting from Kunming in Yunnan province, and ending in Kyaukphyu, a small port town in Rakhine state. This would bypass the Strait of Malacca, a perceived vulnerability acknowledged by China's former president, Hu Jintao, in 2003. According to China Aid, a Chinese foreign aid and international development agency, a Memoranda of Understanding (MoU) was signed between Myanmar's Minister of Planning and Finance U Soe Win and China's National Development and Reform Commission Deputy Director He Lifeng in 2017 to establish the CMEC as the collective name of the BRI projects in Myanmar, folding all existing Myanmar projects into it. The CMEC intends to provide a Y-shaped link covering both the western coast and the capital city, Yangon (**Figure 1**).

According to Transnational Institute, an international non-profit researchand democratic advocacy think-tank, only 9 of the 40 CMEC proposed projects were agreed to by Myanmar

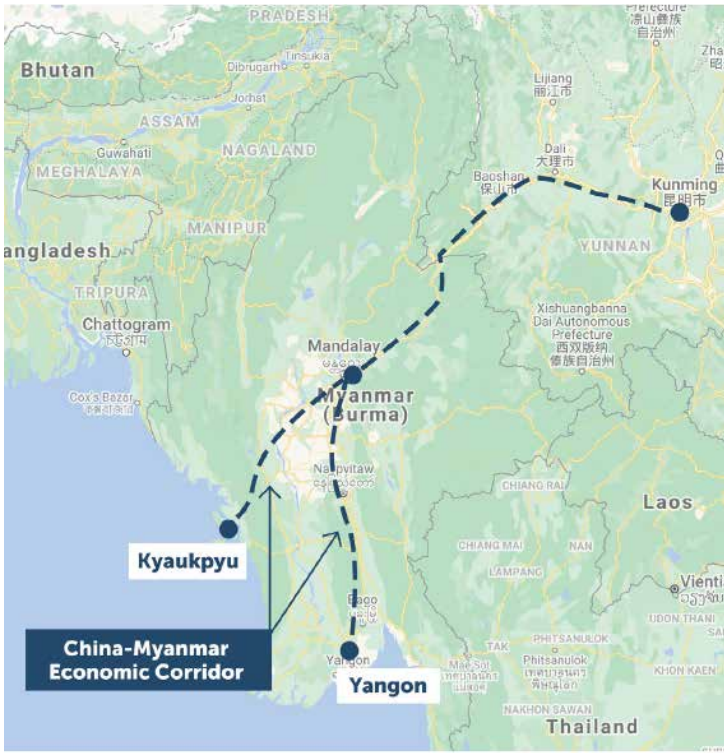


Figure 1: China-Myanmar Economic Corridor
Source: BRI Monitor, CIPE

in 2019. These projects include the development of three border trade zones, a special economic zone located near the anticipated Kyaukphyu deep-sea port, the gateway to the Indian Ocean, and the Muse-Mandalay Railway project to connect all three. China International Trust and Investment Corporation (CITIC) Group,a Chinese state-owned investment company, is leading a consortium of companies to complete the development of the KPSEZ deep-sea port and the industrial park in phases. According to CITIC Group's KPSEZ introduction press release, the economic zone plans to have an industrial park, a deep-sea port on both Yabe and Made Island's with a connecting bridge, and a highway system going from ports to industrial park (**Figure 2**) stating "Kyaukphyu will be the Pearl City of the Bay of Bengal." However, the press release does not give a date when the project should begin.

Despite the declarations above, a gap exists between the publicdeclarations of KPSEZ progress and the GEOINT evidence of markers thatdemonstrate construction progress. This report will provide GEOINT andother open-source information evidence that suggests energy projectswith a bent towards benefi ts to China were prioritized for completion overindustrial and housing projects in parts of Rakhine State in Myanmar. Thereport will demonstrate this by conducting a survey of the proposedprojects in the KPSEZ and assess the status of completion.

Financial Investment

According to CITIC Group's website, in 2015 CITIC won the bid to complete the KPSEZ project and formed CITIC Myanmar, a consortium of Chinese and Burmese companies, which includes China Merchants Holdings, TEDA Investment Holdings, China Harbour Engineering Company Ltd., and Yunnan ConstructionEngineering Group, to construct a $7.3 billion deep-water port and $2.7 billion industrial

park as part of the special economic zone. The industrial park was set to be built in three phases, the first phase began in 2015 with an investment of $1.3 billion by 2020, according to the Sandhi Governance Institute. China National Petroleum Corporation's (CNPC) gas and oil pipelines cost $2.54 billion build and were completed in 2013 and 2014, respectively. According to BRI Monitor, a series of reports from the Sandhi Governance Institute, Chinese state-run media outlet Xinhua called both pipeline pioneer projects of the BRI and CMEC even though they were completed before the formal announcement. The Myanmar national news outlet, The Irrawaddy, reported that CITIC Myanmar holds a 70% stake and 50-year lease over the KPSEZ after the Myanmar government renegotiated a new framework through the KPSEZ Management Committee.

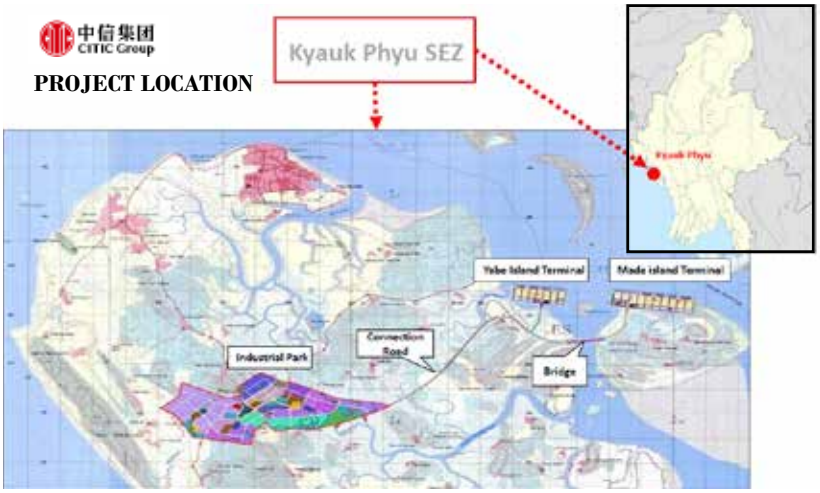


Figure 2: CITIC Group's planned sites for KPSEZ development
Source: CITIC Group website, November 9, 2018

METHODOLOGY

This report utilizes open-source information and satellite imagery to analyze the status of KPSEZ infrastructure projects. The KPSEZ was chosen because Kyaukphyu is the only BRI-led SEZ in Rakhine state, a state that has the longest coastal area in Myanmar. Kyaukphyu is of strategic interest to China because of its access to the Bay of Bengal and its proximity to the Shwe gas fields. Open-source information was supported by relevant documents such as MoU's and company press releases, as well as news reports that confirm bilateral agreements and project construction timelines. The imagery was sourced from Maxar and public layers in Google Earth. The projects are grouped under two categories:

- Delayed KPSEZ Projects
- Completed KPSEZ Projects

The status of KPSEZ will be contrasted, where appropriately comparable, with the Malaysia-China Kuantan Industrial Park, another special economic zone under the BRI in southeast Asia with comparable infrastructure projects to Myanmar.

Figure 3: Proposed deep-water berth on Yabe Island
Source: CITIC Group website, November 9, 2018

Figure 4: Proposed deep-water berths on Yabe and Made Island
Source: CITIC Group website, November 9, 2018

DELAYED KPSEZ PROJECTS

Deep-Water Port and Connecting Highways

The deep-water port, according to CITIC Group's press release, is intended to "generate sustainable economic growth and prosperity for KPSEZ…[through] port services." The current Myanmar-built port in Kyaukphyu is localized to fishing boats and occasional visits from the Myanmar military. It is located east of Kyaukphyu township on the northeastern point of Ramree Island. The separate tanker port on Made Island was built to accommodate tankers for oil transport and provide Rakhine state an oil terminal for the previously built pipeline. However, according to a CITIC rendering made in November 2018, the deep-sea port will be split into two deep-water berths on Yabe and Made Island (**Figure 3-4**).

Figure 5: North side of Made and Yabe Islands, Airbus, Source: Google Earth, March 15, 2024

Figure 6: North side of Yabe Island, Airbus, Source: Google Earth, March 15, 2024

Imagery analysis of Made and Yabe islands from November 2018 to March 2024, shows no newly cleared farmland, paved roads, construction materials, or survey sites developed in either region (**Figure 5**).

Imagery analysis from November 2018 to March 2024 shows a lack of construction or development (**Figure 6**). As of March 2024, no construction development of roads or bridges connecting Yabe to Made or Ramree islands was observed.

Industrial Park and Housing

According to the KPSEZ informational presentation on CITIC Group's website, the KPSEZ Industrial Park will span 2400 acres and include textiles, construction materials, food processing, pharmaceutical, and electronics industries. A small section of the industrial park will include an integrated residential area with high-end housing. An image from CITIC Group's November 2018 press release shows a rendering of the residential area in the proposed industrial park (**Figure 7**).

Figure 7: Proposed industrial park and high-end housing on Ramree Island, Source: CITIC Group website, November 9, 2018

Imagery analysis of the proposed site on Ramree Island in March 2024 (**Figure 8**) suggests no newly cleared farmland, paved roads, construction materials, or survey sites have been developed in the region.

Figure 8: Proposed industrial park and high-endhousing site on Ramree Island, Airbus, Source: Google Earth, March 15,2024

COMPARISON TO MALAYSIA-CHINA KUANTAN INDUSTRIAL PARK (MCKIP)

This section will describe the Malaysia-China Kuantan Industrial Park (MCKIP), a progress marker to compare the KPSEZ industrial park and housing section with the development of a similar BRI-led special economic zone in southeast Asia. The MCKIP is a Chinese-Malaysian joint industrial park and deep-sea port project totaling

Figure 9: MCKIP proposed industrial park and port overlay in Kuantan.
Source: Retrieved from https://www.mckip.com.my

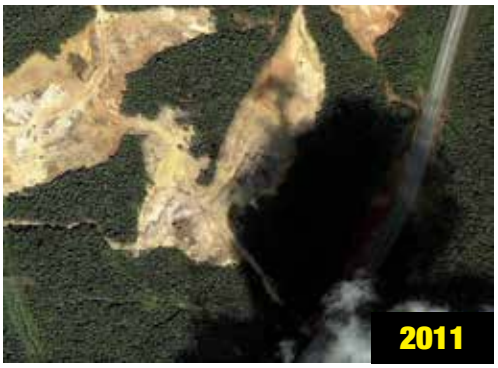


Figure 10: MCKIP industrial park and residential housing construction site, Wayback Imagery
Source: GeoEye (Ikonos), January 18, 2011

Figure 11: MCKIP industrial park and residential housing construction site with cleared vegetation and new roads, Wayback Imagery
Source: Digital Globe, August 18, 2015

Figure 12: MCKIP industrial park and residential housing construction site with paved roads and newly built apartment complexes, Wayback Imagery
Source: Digital Globe, June 17,2017

Figure 13: MCKIP industrial park and residential housing construction site with completed industrial park facilities for manufacturing and apartment complexes, Wayback Imagery
Source: Digital Globe, August 2, 2022

over 3500 acres and located in Kuantan on the east coast of Pahang state, Malaysia (**Figure 9**).

Like Myanmar's KPSEZ, Malaysia's MCKIP began construction prior to a formal BRI agreement. According to the offcial MCKIP website, MCKIP construction began in February 2013. It was placed under the umbrella of the BRI after China and Malaysia signed an MOU in May 2017 aiming to "promote joint economic development in the Silk Road and the 21st Century Maritime Silk Road," according to a report from the Malaysian Investment Development Authority. China and Malaysia offcially announced the MCKIP project in 2019. Unlike the Myanmar's industrial park and high-end housing, Malaysia's MCKIP has experienced consistent development since 2013. A comparison of satellite imagery from February 2011 to August 2022, shows steady development of the high-end housing section of the MCKIP 1 industrial park. The 2014 image shows survey sites and cleared land for construction vehicle access. The 2017 image shows all the vegetation cleared in preparation to pave roads, and foundations for a water tank. The 2018 image shows a significant jump in development with construction of small-scale apartment complexes and a parking lot for the residents. The 2023 image shows near-completion of the apartment block and the south end of manufacturing facilities identified by green roofing (**Figure 10-13**).

Figure 14: MCKIP residential section of industrial park, YouTube, October 26, 2020, Source: Retrieved from https://youtu.be/19x5MpylfGQ?si=IWt4np1Gz5REuwHx

Aerial drone footage of MCKIP from 2020 made by Southern Corridor Malaysia, a Malaysian marketing company, shows the completed apartment block of the residential section of MCKIP 1 (**Figure 14**). Malaysia is a more stable investment environment than Mynamar in general as active conflict is not present in Malaysia as it is in parts of Myanmar. However, contrasting Mynamar projects with comparable Malaysian projects creates a framework to view priorities and resource allocation.

COMPLETED KPSEZ PROJECTS

Oil and Natural Gas Pipeline Projects

The location of the industrial zone lies between the end terminals of an oil and natural gas pipeline running from Kunming, Yunnan to Kyaukphyu, Rakhine (**Figure 15**).

Project Scope and Structure

According to BRI Monitor, China and Myanmar agreed on the pipelines in 2007, with construction of the gas and oil pipelines starting in 2010. The pipelines were jointly managed and

Route of the Myanmar-China Oil and Gas Pipeline Project (Myanmar Section)

Figure 15: Myanmar-China oil and gas pipeline, Kyaukphyu to Yunnan border Source: BRI Monitor

constructed by China National Petroleum Corporation (CNPC) and Myanma Oil and Gas Enterprise (MOGE), both state-owned enterprises (SOE) of their respective countries. According to the BRI Monitor, the oil pipeline moves imported oil transported by tanker from Middle Eastern suppliers, while the natural gas pipeline moves gas extracted from the Shwe fields off the coast of Rakhine. Despite pipeline construction starting before the BRI's inception, MOGE received over $1.6 billion in loans in November 2010 from the China Development Bank (CDB), an SOE finance institution that currently provides long-term lending to support the BRI.

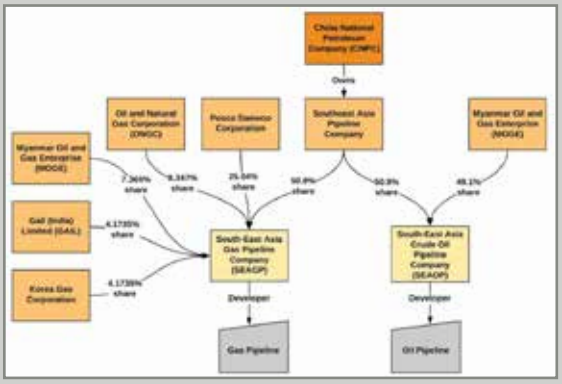


Figure 16: CNPC owns Southeast Asia Pipeline Company, which has a majority share of ownership in the oil and gas pipeline, Pei Hua Yu, The People's Map of Global China, March 31, 2021

After both pipelines began operations in 2017, state-run media outlet Xinhua retroactively called both pipelines a "pioneer project of the Belt and Road Initiative." According to the BRI Monitor, the BRI-led energy projects included in the KPSEZ oil and gas pipelines include an oil terminal, tanker port with storage facilities, offshore natural gas rigs, a natural gas terminal, and a gas-fired combined cycle power station. The oil pipeline begins at the Made Island oil terminal and tanker port, whereas the natural gas pipeline begins at the MOGE natural gas terminal and is fed from the offshore rig. The gas-fired combined cycle power station receives gas from a separate gas line and was built to satisfy the needs of Kyaukphyu as per the cooperation agreement. According to Pei Hua Yu and People's Map of Global China, an independent publication that tracks China's international activities, the CNPC owns Southeast Asia Pipeline Company (SAPC) which joined two consortiums, South-East Asia Gas Pipeline Company (SEAGP) and South-East Asia Crude Oil Pipeline Company (SEAOP), and has 50.9% ownership of both pipelines (**Figure 16**).

Figure 17: Oil pipeline terminal and tanker port with storage facility, Wayback Imagery; Source: Maxar, April 13, 2023

1. Oil Terminal and Tanker Port

The oil pipeline is capable of transporting 22 million barrels of oil annually, accounting for 5% of China's daily import demand, with CNPC-SAPC holding a 51% share in ownership. MOGE holds a 49% share. The pipeline terminates at the tanker port and oil storage facility on Made Island. Imagery shows the oil pipeline terminal connected to a berth for tankers to unload oil imports for storage or delivery (**Figure 17**).

Imagery analysis from 2010 to 2014 (left to right) shows cleared land for construction, administrative buildings and concrete roads, and the addition of 12 crude oil storage tanks to accommodate increased supply (**Figure 18-19**).

Figure 18: Cleared land and beginning of construction for expanded tanker port, Wayback Imagery
Source: Digital Globe, February 20, 2010.

Figure 19: Completed construction of 12 storage tanks, administrative buildings, and oil terminal, Wayback Imagery
Source: Digital Globe, October 25, 2014

Figure 20: CNPC offshore natural gas rig in the Bay of Bengal; Source: CNPC Myanmar website

Figure 21: Timeline of combined cycle power station construction from 2018-2023, Wayback Imagery Source: Maxar, November 18, 2018

2. Offshore Natural Gas Rig and Gas-Fired Combined Cycle Power Station

According to the China state-run news outlet Global Times, over 52 billion cubic meters of natural gas have been shipped by the natural gas pipeline since July 2013. A cooperation agreement between China and Myanmar states "10 billion cubic meters of natural gas will be supplied to the PRC per year for 30 years," whereas Myanmar is allowed no more than 2 billion cubic meters per year which cannot affect China's overall volume. From ownership percentage perspective, CNPC-SAPC through SEAGP owns 50.9% of the gas pipeline, while MOGE owns 7%. In addition, according to the CNPC website, China controls the operation of three offshore blocks for natural gas in the Shwe fields and moves it to an onshore gas terminal near the west coast of Ramree Island (**Figure 20**).

The gas-fired combined cycle power station was built by Kyaukphyu Electric Power Co. Ltd., a joint venture between SOEs Power China Resources and Myanmar's Supreme Group. According to The Irrawaddy, the station is a 135-megawatt power plant that uses Myanmar's share of natural gas to power the Kyaukphyu region. A press release from Power China Resources noted the power station began operation in October 2022, stating that Power China has "fulfilled its social responsibilities" and intends to "strengthen cooperation under the [BRI] and the [CMEC]." Imagery analysis from 2018 to 2023 showed consistent annual development of the gas-fired power station. In 2018, only the administrative buildings and dirt roads for transport were constructed (**Figure 21**). In 2021, farmland was cleared for development of the combined cycle turbine to power the station with a completed substation southwest of that (**Figure 22**). Imagery also showed development of roads for construction vehicles. In 2022, the construction site was widened considerably for the foundation of pipes that would run natural gas to the turbine (**Figure 23**). Imagery showed the excavation for a man-made cooling lake. In 2023, the power station was completed with the addition of water in the cooling lake (**Figure 24**).

As an added note, according to The Irrawaddy, there were initially four Chinese-backed natural gas power plants under development, with only the combined cycle power station currently in operation. The other three projects, operated by Hong Kong power company VPower, have been shuttered due to a "limited supply of natural gas" according to former Kyaukphyu lawmaker U Poe San. He went on to say, "[now] we only have four to five hours of electricity a day."

Figure 22: Timeline of combined cycle power station construction from 2018-2023, Wayback Imagery Source: Maxar, March 26, 2021

Figure 23: Timeline of combined cycle power station construction from 2018-2023, Wayback Imagery Source: Maxar, February 2, 2022

Figure 24: Timeline of combined cycle power station construction from 2018-2023, Wayback Imagery Source: Maxar, February 4, 2023

LOOK AHEAD

After the completion of energy infrastructure projects in the KPSEZ, BRI-led economic development projects for Kyaukphyu have ceased or been shuttered. With the increase in fighting between Myanmar's military junta and rebel groups in the region, it's likely that Chinese companies will cancel projects or delay them until the fighting is resolved. The rebels have threatened Chinese companies to discontinue supporting the military junta of they may damage the oil and gas pipelines that connect Kyaukphyu to Yunnan.

Geospatial Evaluation of Kazakhstan's Dostyk-Moyinty Railroad Progress: Spring 2024

Written by Wescott Yeaw, Natasha Wood, Laura Stahl, Niki Mandel, Belmin Avdic and Mahmoud Nofal from Tufts University

Source: Base Map provided by NGA

OVERVIEW

The Dostyk-Moyinty railway (DMR) is a rail line in eastern Kazakhstan connecting the Kazakh-China border crossing at Dostyk with the interior of Kazakhstan. It is a critical component of the larger Middle Corridor (MC) trade route linking Central Asia, China, Europe, and Russia. Kazakhstan is currently adding a second rail line to the DMR, which is projected to increase transit volume five times along the route.

On-time completion of the DMR indicates Kazakhstan's commitment and ability to successfully execute MC infrastructure development and increase its role as a conduit for trade between the European Union (EU) and China. The DMR expansion will facilitate Chinese trade to Europe, Central Asia, and Russia, with policy implications for the United States by potentially complicating sanctions enforcement against Russia and aiding the expansion of Chinese influence in Central Asia and Europe.

ACTIVITY

Kazakhstan is currently undertaking a second line expansion of the DMR as part of its "Nurly Zhol" (Bright Path) infrastructure development project. Construction began on 17 November 2022, and is projected by the Kazakh government to end in the fourth quarter of 2025. Geospatial analysis confirms consistent, substantial progress on the rail line across several administrative districts despite minimal open press and business reporting. Construction is over halfway completed and is on pace to finish by Q4 2025.

BACKGROUND

The development of a second rail line along the Dostyk-Moyinty railway (DMR) in Kazakhstan forms a crucial component of a broader initiative to modernize the Dostyk-Aktogay-Moyinty-Zharik-Zhezkazgan-Saksaulskaya-Kandyagash-Aktobe-Iletsk railway corridor which runs through a significant portion of Kazakhstan and links China to Russia. Figure 1 below shows the layout of the Kazakh rail network, with the DMR highlighted in yellow and terminating in the east at the Chinese border.

Figure 1: KTZ rail network map with the Dostyk-Moyinty Rail Line and Dostyk-Iletsk Corridor marked. Source: Maximilian Dörrbecker, Wikimedia Commons

The DMR rail addition is entirely financed by Kazakhstan's sovereign fund through the "Nurly Zhol" infrastructure development project, with construction undertaken by the national rail company Kazakhstan Temir Zholy (KTZ), according to the independent but government-linked Astana Times. The second rail—spanning 836 km and including 419 engineering structures such as bridges and overpasses—began construction in November 2022 with a projected end date of fourth quarter 2025. The project aims to increase Kazakhstan's trade capacity, as transit container export volumes have increased 2.2 times in the past five years and freight cargo between China and Kazakhstan was up 22% in January 2024 compared to January 2023. As previously noted, KTZ projects the second rail will increase DMR transit by a factor of five, from 12 to 60 freight train pairs a day.

By elevating train speeds and augmenting transport capacity, the second DMR line will better meet demand along the China-Europe transit route, which is central to global trade dynamics. Moreover, this modernization effort facilitates transnational commerce and advances regional economic integration, including regional trade with Russia. As such, the Dostyk-Moyinty railway development epitomizes Kazakhstan's commitment to fortifying its transport infrastructure within the context of broader geopolitical and economic imperatives.

METHODOLOGY

This report uses open-source imagery, reporting, and public statements to analyze the construction progress and geopolitical significance of the second track of the DMR. Imagery was sourced from Maxar and Google Earth, while progress reports and shipment impact projections were gathered from railway industry magazines and official Kazakh government statements.

Railway Construction Process and Identifiers

Agico Group, a railway supply company, notes that railway construction occurs in several phases: logistics, ground preparation, track laying, and ballasting. The first phase, logistics, requires gathering construction materials

and equipment in large quantities near the railway site. This includes sand and gravel to prepare the ground and act as ballast, preconstructed rail, additional rail sleepers and tracks, and construction machinery. The sites at Sarikum and Orta Deresin, announced by KTZ as logistics hubs, show clear signs of expansion for DMR construction. See **Figures 2a–b**, which show the Sarikum site, with expansions to the gravel and sand pits and new pre-constructed rail supply depots made between September 2021 and May 2023.

The Orta Deresin supply depot, about 84km east of Sarikum, serves as a major rail sleeper storage site. The concrete ties and premade rails are stacked in large lines along the railway, with transport cranes on temporary track to shift supplies onto the main rail line for laying. The premade rails and concrete ties are visible as large gray squares, with or without track attached, via satellite imagery; see **Figures 3a–3c**.

These features have been confirmed by comparing them to ground photography of DMR construction sites released by the official KTZ Telegram channel; see **Figures 3d–3e**.

Figure 2a: The Sarikum logistics site. Coordinates 46°59′12.28″N 74° 7′1.13″E
Source: Google Earth, September 23, 2021

Figure 2b: The Sarikum logistics site. Coordinates 46°59′12.28″N 74° 7′1.13″E
Source: Google Earth, May 2, 2023

Figure 3a: Orta Deresin supply depot. Notice the empty space south of the railway. Coordinates 46°49′29.94″N 75°13′28.10″E
Source: Google Earth, October 31, 2019.

Figure 3b: Orta Deresin supply depot site now features concrete rail ties, premade tracks, and construction machinery. Coordinates 46°49′29.94″N 75°13′28.10″E
Source: Google Earth, May 21, 2023

Figure 3c: Close up of the Orta Deresin supply depot site showing the concrete ties and construction machinery in more detail. Notice the large yellow and red cranes near the concrete tie stacks. Coordinates 46°49'29.94"N 75°13'28.10"E
Source: Google Earth.

Figure 3d: Ground imagery of a DMR construction site featuring the large red crane and stacks of concrete rail ties.
Source: KTZ official Telegram Channel.

Figure 3e: Ground imagery of a DMR construction site featuring the large yellow crane, stacks of concrete rail ties, and freshly laid track to facilitate supply transport.
Source: KTZ official Telegram Channel.

The second phase, ground preparation, involves laying and packing down a base layer of sand, which provides a stable and even base for the rail sleepers. **Figure 4a** shows ground preparation visible from Google Earth satellite imagery taken May 12, 2023. Notice the bright line of new sand north of the existing track, the roller vehicle used to compact and level the sand mounds, and the dump trucks on the access road north of the new rail ground carrying sand. **Figure 4b**, Google Earth imagery from May 18, 2023, shows a nearby sandlot and access road used by construction vehicles to gather and pour sand along the new railway.

Figure 4a: Imagery of the new sand base being laid and compacted north of the existing rail. Coordinates 46°55'27.46"N 74°17'15.81"E
Source: Google Earth, May 12, 2023

Figure 4b: Imagery of a forward sandlot along the construction site, dump truck and excavators, and the access road. Coordinates 46°55'27.46"N 74°17'15.81"E
Source: Google Earth, May 12, 2023,

Construction has continued despite winter snow. In **Figures 5a-b** below, which show a section of rail west of Sayak in January and April 2024, sand mounds and newly graded ground are visible. Trucks are pictured driving on the access roads. The image is not clear enough to determine whether a second track has now been laid, but there does not appear to be one. Given the absence of the sand piles and the continuing presence of mid-sized dump trucks, we can infer that this portion of the railway is still in the late stage of the initial ballast-laying process. We would expect to see sleepers and tracks being laid on this site shortly.

Figure 5a: Track construction in progress on 3 January 2024. Note the line of sand heaps to the north of the existing track, robust roadway above them, and regular access routes to the leveled ground above the track. Coordinates: 46.83483, 77.84664
Source: Copyright Maxar 2024.

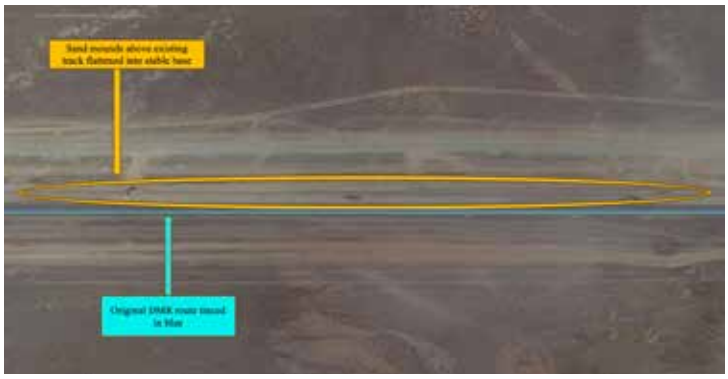


Figure 5b: Compare 5a image to this one. In the same location, the sand heaps are gone and the sand has been spread to the north of the existing track. Coordinates: 46.83483, 77.84664 Source: Copyright Maxar 2024, 25 April 2024

Figure 5c: Copyright Maxar 2024, January 17, 2024. Coordinates 46.8823, 77.4924

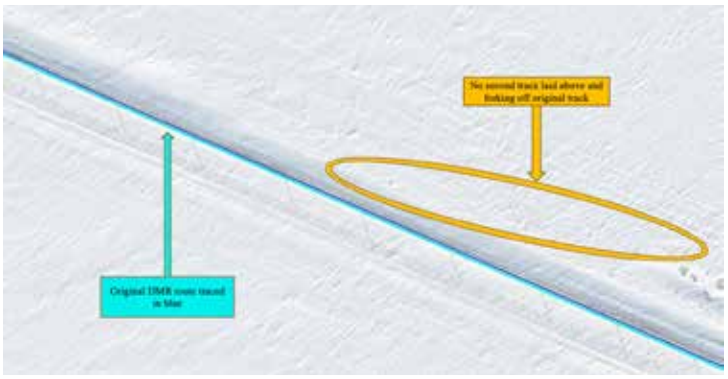


Figure 5d: Copyright Maxar 2024, January 11, 2023. Coordinates 46.8823, 77.4924

Figure 6: The end of the laid new track on January 17, 2024. Despite the snow, the truck paths to the north of the railway, the numerous access points, and the flatly graded rail bed are still visible. Copyright Maxar 2024. Coordinates 46.81846, 77.67652

The final stages involve laying track on the prepared ground and weighing it down with gravel. This is easiest to spot on overhead imagery, as there is a clear second rail line running parallel to the original track. **Figures 5c-d and 6** show areas near the towns of Sayak and Aktogay, between early January 2023 and late April 2024. These figures illustrate various steps of the track-building process, from grading to completion, and span multiple administrative districts. Common features of this imagery include heavy snow cover and low clouds, given the time of year in which they were captured, but tracks are still visible.

In **Figure 5c** left column, Maxar imagery from January 17, 2024 clearly shows a new track forking off above the old line east of Sayak and west of the Karaganda/Jetisu border. For comparison, Figure 5d, the exact same location one year prior, features only one track.

Imagery and Analysis

Our analysis, based on imagery from late 2023 until May 2024, suggests, approximately 17.3% of new track has been laid along the length of the new DMR. Specifically, the imagery indicates new track is actively being added, and 33.4% of the route is undergoing ground preparation. **Figure 6**, created by the authors using imagery analysis, shows the portions of the rail with the original track in blue, new track laid in yellow, and ground preparation completed in red (magenta). KTZ's official Telegram reports the track is being constructed at 14 different points simultaneously across the length of the route, to be connected at once, which is reflected in the imagery.

Figure 7: Map showing the DMR route, new track and sand laid, as well as regional borders. Original work compiled by the authors from imagery analysis, mapping base
Source: Google Earth.

Development along the railroad is further advanced on the eastern end of the route. The railroad crosses three regions of Kazakhstan: Karaganda in the west, Jetisu in the east, and a small section of Abai region. **Figure 7** shows the Karaganda portion of the railroad from Moyinty in the far west to Саяк (Sayak) has more sand preparation than track. Immediately east of the border between Karaganda and Jetisu imagery shows much more track has been laid.

The Kazakh Bureau of National Statistics indicates that the cost of all construction work carried out between January-April 2024 in Karaganda (86,758.9 million tenge) was more than twice that carried out in Jetisu during the same period (40,346.4 million tenge). However, Bureau of National Statistics data from Jetisu comparing year-over-year construction by volume in early 2024 was 226.4% of construction during the same period in 2023. Karaganda demonstrates a less significant (though still notable) year-over-year growth in construction of 149.1%.

These figures account for all construction, including railroad development. Karaganda has a more urban population than Jetisu (81.7% urban vs. 44.6% urban) and data reflecting higher construction costs in Karaganda may be due to higher numbers of other urban construction projects, in addition to the DMR. Ultimately, **Figure 7** confirms that rail development in the eastern region of Jetisu has progressed faster than in the western region of Karaganda.

The imagery suggests that the process of prepping the rail line and laying sand is more time consuming than laying the track itself. Therefore, while only 17.3% of the track has been laid, it is reasonable to assume that the 33.4% of the track with sand laid will have track laid shortly. This assessment is based on visible trends—portions of track prepared with sand consistently have large stretches of track added on top shortly thereafter. As of writing, 50.7% of the route has either completed ground preparation or has track laid. Imagery indicates that the bulk of the work on the railroad has been done since mid-2023. If the remaining 50% of the route takes another 12–18 months to complete, we estimate that the DMR railway is on track for completion by Q4 2025, which is the current projected completion date. Major

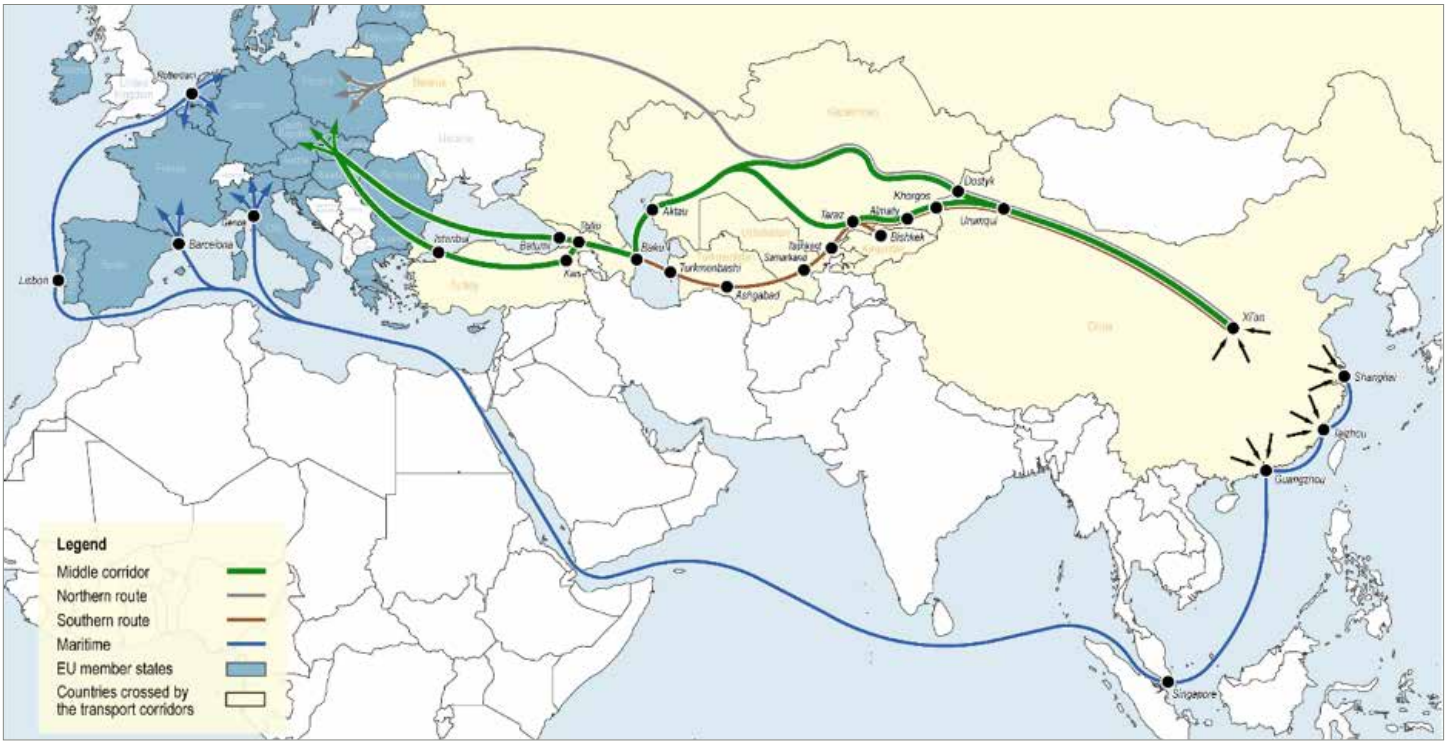


Figure 8: World Bank map depicting trade routes, including the DMR, from China to Europe and Russia.
Source: World Bank, Middle Trade and Transfer Corridor

hurdles that would delay completion beyond 2025 include limited funding, political turmoil, and inclement weather.

Strategic Importance

The map in Figure 8 clearly shows Kazakhstan's vital geo-strategic position in Central Asia between China, Europe, and Russia. Dostyk serves as a critical starting point for a vital trade corridor directly linking China, Kazakhstan, and Russia, and thus has major benefits for those countries.

Benefits to Kazakhstan

The DMR is key to Kazakhstan's goal to increase its domestic and regional trade and thus bolster its power in Central Asia. Developing DMR infrastructure provides domestic jobs constructing rail and operating trains and boosts trade and business through greater regional connectivity. The new line's anticipated 20 million ton capacity increase will be a significant boost to bilateral China-Kazakh trade. The faster, higher-capacity trade route also makes Kazakhstan a more attractive economic partner for both China and Russia, increasing its regional power in Central Asia while allowing Astana to balance between Beijing and Moscow. By reducing reliance on traditional trade routes through countries like Russia, Kazakhstan aims to leverage its strategic location and emerging transport infrastructure to become a central link between Europe and Asia.

Benefits to China

DMR expansion also benefits China. The new rail line enhances the Middle Corridor's viability as an alternate China-Europe trade route by increasing transport capacity to meet rising demand for Chinese goods. Better DMR infrastructure helps China secure stable overland trade routes that are less susceptible to geopolitical disruptions or U.S. pressure. Successful DMR completion helps provide a more reliable and efficient trade route to Europe and strengthens China's economic presence in Central Asia. DMR expansion also increases Chinese trade volume and provides access to emerging markets, expanding its economic and political influence, thus softening China's image among those worried about its rise.

Benefits to Russia

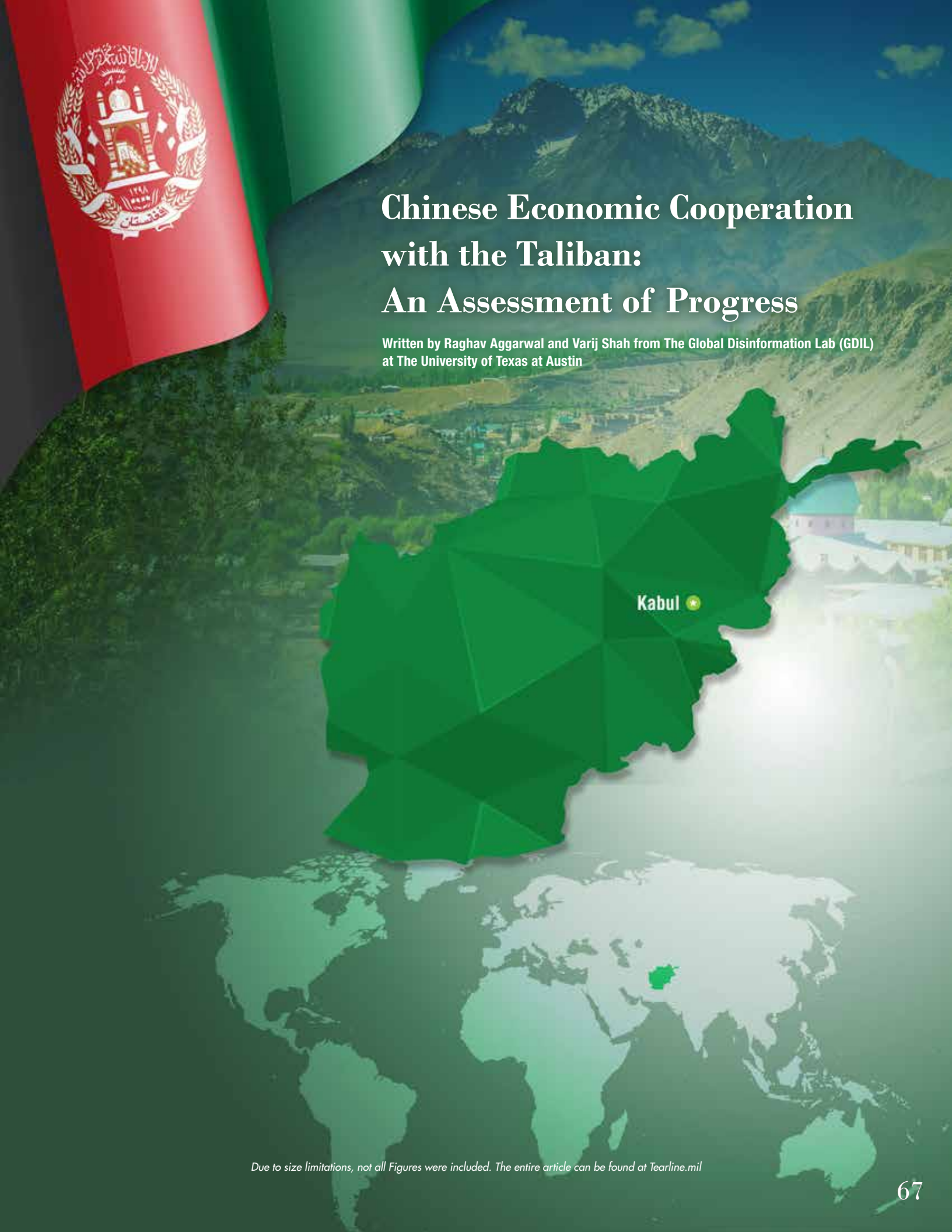
While the DMR expansion has potential to boost China-Europe trade in the mid to long-term, it also boosts China-Russia trade in the short to mid-term. The DMR line serves as the access point for the Northern trade route from western China into Russia. According to PTC Operator, the company running the Dostyk terminal, transshipment through Dostyk of Chinese goods to Russia (and Russian goods to China) has increased since Russia invaded Ukraine. Raising transit capacity along the line would allow for further increases in China-Russia and Kazakh-Russia trade. Russia would thus have greater access to Kazakh and Chinese raw materials, machinery, and electronics exports.

LOOK AHEAD

Based on the imagery collection outlined above, and on the projected completion date of Q4 2025 put forth by the Kazakh Ministry of Transportation and the involved officials, we are confident that the Dostyk-Moyinty railway extension will be completed within the government's target time frame. The successful completion of this railway project will bolster Kazakhstan's efforts to frame itself as a key transportation corridor between Europe, Russia, and China. It will also strengthen the trade relationship between China and Central Asia, allowing for significantly increased trade volume over this critical border crossing. In the current geopolitical moment, a Kazakhstan with stronger ties to China and the ability to frame itself—and function—as a strategic economic partner will give Almaty a more prominent role on the regional economic stage. If the Dostyk-Moyinty extension project carries through as we predict, Kazakhstan will be making good on its promise to solidify the infrastructure of the Middle Corridor.

Chinese Economic Cooperation with the Taliban: An Assessment of Progress

Written by Raghav Aggarwal and Varij Shah from The Global Disinformation Lab (GDIL) at The University of Texas at Austin



Due to size limitations, not all Figures were included. The entire article can be found at Tearline.mil

Source: Base Map provided by NGA

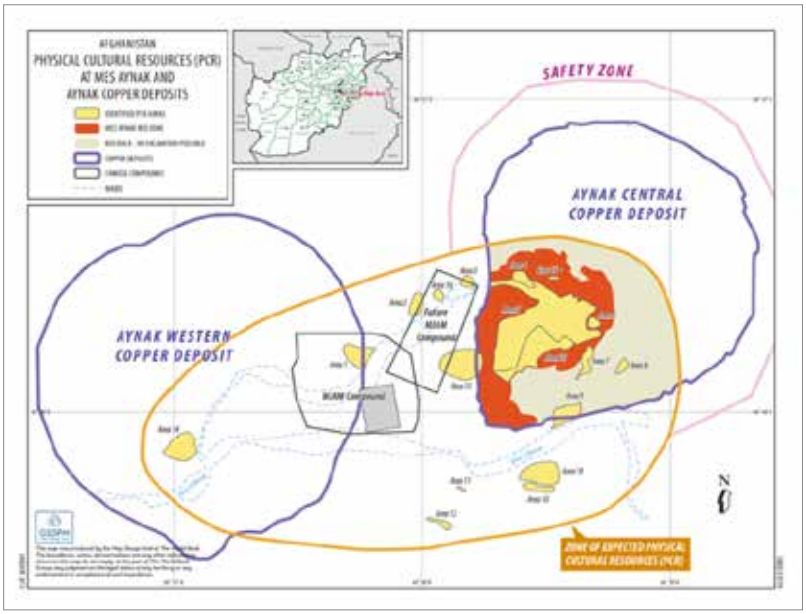


Figure 1: Map of the Mes Aynak area with identified mining areas. The map also notes "Physical Cultural Resources" strewn across the site, referring to Buddhist archaeological remains.
Source: World Bank

Figure 2: Additional facilities were constructed around the site in the next ten years. However, the presence of a Buddhist archaeological site in the surrounding hills prevented extraction from those areas.
Source: Copyright Google Earth 2019.

OVERVIEW

This report evaluates the progress of five commercial projects central to Sino-Taliban economic cooperation. GDIL finds modest progress in Chinese-backed mining and oil projects and limited progress in industrial and road projects.

The industrial and road projects have been accompanied by significant disconnects between publicized claims and on-the-ground progress.

ACTIVITY

The Global Disinformation Lab (GDIL) at the University of Texas at Austin analyzed commercial imagery, volunteer mapping services, ground photography, open press reports, and business literature to assess the progress or lack of progress of Chinese-backed projects in Afghanistan with an emphasis on the Taliban administration time period since 2021.

"Friendshoring" and securing access to critical minerals and industries are a defining point in U.S.-China competition. With the arrival of the Taliban in Kabul, there is much media speculation on the potential for the Taliban to go all-in on Chinese-funded extraction and connectivity projects that can provide a semblance of economic stability. Foreign Policy reported that, on paper, Afghanistan is one of the most mineral-rich countries in the world but historically has struggled to build its mining sector. China has funded at least 112 Belt and Road projects throughout Central Asian neighbors, underscoring the region's significance to China's Belt and Road Initiative (BRI).

LOOK AHEAD

Imagery analysts should continue examining the Mes Aynak Copper Mine and Amu Darya Basin for new extraction infrastructure. While progress on a Sino-Afghan road-link and an overseas Chinese industrial park is slow, policymakers should consider new momentum in these projects as a sign of China putting more economic weight into the Sino-Afghan relationship.

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