North Korea: GIS Study of the Slowed Migration of North Korean Refugees

Brandi Hunnicutt

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Abstract
Since 2009, human rights organizations have noted an almost fifty-percent decrease of North Korean refugees reaching freedom in South Korea, when for so many years there was a steady increase. This capstone paper evaluated the decline by taking two perspectives of research, one perspective being physical terrain changes or modifications prohibiting the flow of refugees and a second approach of examining the lifestyle demographics of the refugees who have successfully crossed the North Korean border. Geographic Information System (GIS) tools were utilized to determine that in both research approaches there is data indicating purposes for the decrease -- proving that not only is the North Korean government to blame for this reaction, but policy in asylum and non-asylum countries were also a contributing factor.

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North Korea: GIS Study of the Slowed Migration of North Korean Refugees

Brandi Hunnicutt

University of Denver Department of Geography

Capstone Project

for

Master of Science in Geographic Information Science

November 20, 2015
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**Introduction:**

In 2015, those tuned into media would have witnessed the mass-migration of refugees originating from war-torn countries such as Iraq and Syria that have become an operating ground for different terrorist factions committing abuses against the people. As a result, people are fleeing at a rate that watch organizations have a hard time accounting for and they are flowing out of these countries freely. What about the refugees we aren’t seeing flowing out of nations that have deplorable health and welfare situations such as starvation, malnourishment, and access to health care -- places like North Korea? In a way, many comparisons can be made between the refugee situations unfolding in the Middle East with the situation that faces the North Korean people. The North Korean government participates in propaganda, brain washing, intense fear campaigns, imprisonment, and executions of its people, all in an effort to maintain regime stability. This is much like what journalists have been reporting on the refugee situation in the Middle East; people are fleeing with their families by the thousands to escape something similar being propagated by ISIS who wants the people of these regions to participate in a form of strict Islam. (Kingsley 2014) In a sense, the North Korean regime is like its own religion with the leader of the Democratic Republic of Korea (DPRK) being a god-like figure, and if a citizen challenges this order, their fate could be imprisonment for the person who committed the crime and three generations of their family as well. (Chang 2012)
Setting these comparisons aside, one major difference exists between these two regions, and that is freedom of travel out of the countries they are fleeing. One main difference between North Korea and Iraq or Syria is the strict travel policy in which it places on all of its citizens. Freedom of travel within North Korea and outside of North Korea is prohibited for the average North Korean. The privilege of leaving the country is one granted to only the most trusted of government officials that have proven their loyalty to the regime probably over many generations. (Liberty in North Korea 2015)

Leaving the country without the permission of the government can be punishable by imprisonment, labor camps, or even death. According to a human rights organization called Liberty in North Korea, It is illegal for the North Korean people to leave their country without the regime’s permission, and the regime attempts to restrict the people’s movement even inside their own country. If a North Korean wishes to travel to another part of the country, they are supposed to have a specific purpose and obtain permission from their work unit. If they do not live in Pyongyang, the showcase capital where most resources are concentrated, they will likely be denied access. The regime has also forcibly relocated hundreds of thousands of North Koreans to less favorable parts of the country as a form of punishment and political persecution. (Liberty in North Korea 2015) The prohibitions exist in an environment where the people outside of Pyongyang are helpless and
sometimes incapable of finding food, water, health care, or funds to acquire other items needed for survival. (Cunningham 2007)

Since the late 90's, many North Koreans disregarded this policy over the search for food or a better way of life. Steady increases of refugees were noted each year reaching asylum in South Korea; however, since 2009, the number of refugees arriving to countries of asylum have dropped significantly. (Ministry of Unification 2013) There is little access to North Korea to be able to speculate as to why there is such a drastic change, but what is being reported through media outlets is that the drop is probably related to tighter border security, China's intense campaign of repatriation of refugees, a North Korean fear campaign through executions, and a lower expectation from North Koreans. (Lankov, The Guardian 2015) (Sky News 2015) The purpose of this capstone project is to try and prove two of these theories using GIS. Through the use of GIS tools and analysis, this project will reveal that North Korea has increased security along the border and along pathways of travel that act as barriers preventing refugees from passing as easy as they did in the late 90's and early 2000's. In addition, an evaluation of lifestyle statistics of North Korean refugees will also reveal that there exists a low expectation of life beyond the border.

The benefit of answering these questions is to provide geospatial proof of increased security for the purpose of stopping refugee movement that could be used as supporting documentation when approaching North Korea on
human rights abuses. In addition, data studied on refugee life once they have left North Korea can also be used to help change policy in places like China or South Korea.

**Literature Review:**

Developing enough substantial evidence to support a need for this research required an in-depth analysis of literature published on North Korean migration patterns over time, lifestyle within North Korea between the height of cross-border migration and during the decline, publications on changes to refugee policy as it relates to the penal system in North Korea, and finally, a review of what life is like as a refugee that successfully escaped. The need to understand these four main areas is to evaluate number fluctuations and assess if the experts in the field of North Korea agree that there has been a decline in refugee movement out of North Korea as well as to assess if there has been any change in North Korea since the height of migration in the 90’s. The research behind all of these topics helps formulate the basis for this research and the need for the investigation. Although there is quite a bit of information available on North Korean migration and life in North Korea, much of what has been released is speculative at times because no one has full access to North Korea or all of the refugees. The vast majority of publications on North Korea is heavily reliant on many of the human rights organizations data and research that is based from refugee interviews.
Since the 17th century, mass migrations of Korean people have crossed the border between Korea into China due to war, famine, economic and political instability. Experts indicate that these migrations have resulted in as many as 1 million ethnic Korean people remaining in China and forming a fairly large population in Northeast China. This very large group of Korean people who have integrated with Chinese and serve, in some cases, as a life-support system once North Korean refugees cross the border. (Kirkpatrick 2014) There was accelerated migration under Japanese occupation of the Korean peninsula in 1910, but that number drastically declined at the end of World War II when Japan was removed from the region. (Nautilus Institute 2015) At the end of World War II, as China became a communist country and the Korean peninsula became divided, the North was supported by the Soviet Union and the South supported by the United States. Support in the form of military and food from the Soviet Union created a somewhat stable environment resulting in minimal migration across the border. Additionally, cross-border migration was not an issue during this time because the rewards, at that time, were not worth the risk. China and South Korea were not the economic powerhouses they have become today – both countries were in economic disrepair and had many years of recovery ahead of them. (Kirkpatrick 2014) However, between the 1990’s and 2009, a steady and
increasing flow of North Korean refugees existed, mostly as a result of one of the largest reported famines of the 20th century. (Ministry of Unification 2013) (Noland 2011) According to studies conducted by human rights organizations, famine has "stalked" North Korea for more than 20 years, but really peaked in the 1990's. (Committee for Human Rights in North Korea 2009) Some report estimates indicate that between 600,000 to 1 million North Koreans died as a result of this famine. (Kirkpatrick 2014) (Noland 2011) The provinces hit hardest are the provinces adjacent to the Northeast China border and as a result of proximity and less-secure border acted as a transit point for hundreds of thousands of refugees seeking food. Interview statistics show that North Hamgyong and South Hamgyong, the two provinces closest to the Northeast China border, account for 76% of the refugee population. See Refugee Population by Province Map. (Committee for Human Rights in North Korea 2006)

There are various publicized numbers from different organizations on the exact number of North Korean refugees that crossed into China during this time and could remain in the country. Most press reporting indicates that there could be 100,000 - 300,000, the State Department suggests that the number is much lower around 30,000 - 50,000, and South Korean reporting indicates that the number could be approximately 100,000. (Nautilus Institute 2015) (Noland 2011) The discrepancy in reporting is based in the reality that no one really knows the population statistics as North Korean
refugees live illegally in China. China has an agreement with North Korea to return refugees to North Korea upon being discovered; therefore, making China a very difficult and unsafe place to stay. The refugees have to live in hiding and if they can find work, do so illegally, based off of multiple reports and publications. (Committee for Human Rights in North Korea 2009) (Committee for Human Rights in North Korea 2006) There is some evidence that indicates that the number of refugees in China has declined drastically since the late-1990’s when reporting suggested the number was in the hundreds of thousands. (Nautilus Institute 2015) Results from a study analyzing population numbers of the three Northeast provinces of China show that population estimates from 1998 to 2009 dropped from around 33,700 North Korean refugees and migrants in 1998 to perhaps 5,700 in 2009. (Nautilus Institute 2015) Due to the fact that China is not a country of asylum for North Korean refugees, it is most certainly not where the refugees want to permanently stay. A review of interview surveys showed that the majority of North Korean refugees would prefer to live in South Korea or the United States over China. (Committee for Human Rights in North Korea 2006) The majority of North Korean refugees flee in hopes of reaching South Korea or other asylum countries.

Northeast China is a part of what many report as a new “underground railroad” for North Korean refugees. (Kirkpatrick 2014) China, for so many, is meant to be a transit hub for reaching freedom in South Korea, the United
States, or Europe; however, the sharp decline in numbers in China cannot be an indication of populations reaching their end destinations in South Korea, United States, and Europe since those numbers have also drastically dropped or have not seen an increase to a degree that would reflect the drop. (UNHCR 2015)

It is recognized that there is an inability to properly track the rise and fall of numbers in China; however, there are many organizations that track the flow of North Korean refugees in South Korea, where the majority of North Koreans arrive outside of the Northeastern China population. The statistics show that refugees arriving to South Korea started to decline in 2009, after steady increases between 1998 – 2008. (Nautilus Institute 2015) (Lankov, Behind the decline in North Korean defections 2015) A dramatic and significant decrease was noted in 2012 and 2013 when roughly 1500 refugees arrived in each of those years. (Ministry of Unification 2013)

Further reporting indicates that in 2014, that number dropped even lower to just over 1300 refugees. (Lankov, Behind the decline in North Korean defections 2015) The numbers of refugees granted asylum in the United States and Europe during this time are too low to account for this great decline. Based on these studies it is apparent that North Korean refugees have stopped crossing the border.

These patterns are troubling to many human rights organizations since the community knows that life in North Korea has not been altered for the
better. The countless stories from North Korean refugees describing life in insecurity makes anyone ponder the sharp decline.

Secret police, starvation, malnutrition, lack of medicine, executions, labor camps, travel restrictions internal and external, environmental insecurity, and economic uncertainty have existed under the regimes of the past and present. (Tudors and Pearson 2015) (Hassig 2015) The prevalence of all of these topics act as both a deterrent to leave North Korea, but also play a heavy role in why people would want to flee. North Korea’s entire system is based on maintaining the structure of the Kim dynasty, and all of the aforementioned challenges of the people, are a result of the Kim dynasty ideology of military-first politics and a belief that only the elite matter. (Vorontsov 2006) The elite class of North Korea is centered in Pyongyang, North Korea’s capital, and they constitute about 1% of the population. These people historically have been considered to be the most important to the survival of the Kim regime and have reaped the rewards while the 99% of the population has to search for food. (Wee 2013) This system has left North Korea so far behind the rest of the world. While North Korea’s Asian neighbors to the South in South Korea and to the West in China have experienced economic booms and significant changes since World War II, the North remains isolated and deteriorating from within. (Hassig 2015) The deterioration began with the end to the Cold War era. North Korea, for decades, had received aid from both China and the Soviet Union; Aid that
was the only means of feeding the people of North Korea. The public distribution system (PDS) was a food distribution system and all North Koreans were dependent on this system to receive controlled food rations. Upon the fall of the Soviet Union coupled with poor economic choices in the 1990’s and a series of back-to-back floods that destroyed food crops, the PDS failed miserably. This failure resulted in the mass starvation of almost a million people, according to some expert numbers. (Hassig 2015) (Tudors and Pearson 2015) However, what this failure also created was a shift in the thinking of many North Korean’s --- shifting from a loyalty to a socialist structure to becoming free-market participants now loyal to themselves and their family. (Tudors and Pearson 2015) The Kim regime had failed these people, forcing them to fend for themselves by any means necessary. The official salary of a civil servant is under $1 a month. A factory worker makes even less. (Tudors and Pearson 2015) With the government incapable of taking care of the people, these people have moved into a double-life economy to survive. The secondary ways of earning capital are numerous and can include growing crops to sell at market, renting out rooms by the hour to courting couples, and trading goods from China. The government is well aware of the free-market practices and does what it can to try and regulate, but in reality, the market has become rampant across the country and the government has lost the ability to truly manage and control the system. (Tudors and Pearson 2015)
The free-market has become the main source of income for the people of North Korea, and what you can earn in these markets is far better than any other means of income that the government can provide. It is being reported that this new way of earning and living is one of the reasons we are seeing a decline of refugees as North Korean way-of-life is becoming better. (Lankov, The Guardian 2015)

What the markets are also providing is access to information from the outside world at a rate never seen before in North Korea. North Korea’s closed borders and tight restrictions on information have precluded the population from knowing anything about the outside world from another source other than the government of North Korea. However, this has changed and people are now able to purchase and share DVD’s of South Korean dramas or other media, all of which is against the law, but the people are still participating in this illegal activity, according to reporting. This change is significant and profound. It is creating a lifestyle in North Korea that brings happiness to the people. Although this market activity has made life more tolerable in North Korea as a means to buy food, medicine, clothing, and entertainment goods, the goals of the regime get in the way of this tolerance. There is always a looming threat around the corner that creates dissent of the people and a need to try and leave the country. (Tudors and Pearson 2015)

One of the methods created to deter individuals from defecting or rejecting the goals of the regime is the prison camp system. The prison camp system
is known by all North Koreans and they do fear them. (Tudors and Pearson 2015) According to publications on this topic, the DPRK operates prison camps that rival in cruelty to anything in the 20th century. The prison camp system holds conventional criminals, convicted for crimes such as theft or murder, but also holds a significant number of political prisoners. The number estimates for how many people these camps hold varies in reporting, but most recent estimates indicate that the population could be as many as 120,000. (Tudors and Pearson 2015) (Hawk 2013) The number of people who are political prisoners is reportedly much larger than those in conventional prisons for non-political crimes. A political crime could be anything from making a statement against the government, insulting the Kim family, or distributing leaflets criticizing the government. (Tudors and Pearson 2015) All of these could put someone in a prison camp with no hope of ever being released. It has been reported that within these camps there is forced back-breaking labor, below subsistence rations, torture, and beatings. We also know that under a three-generation rule, political prisoners will likely be joined by family members as a result of their crime as well as children. (Tudors and Pearson 2015) In an effort to discourage prison escape, public executions of those trying to escape are commonplace and seen as an effective measure for stopping those from trying. Research indicates that over time there were as many as ten of these political prisons operating in North Korea; however, the data now reveals that there are four
that probably remain active. Experts cannot state that the drop in political prison camps means that the government doesn’t use them any less as a means to deter the people from renouncing the government or defecting since there is some belief that starvation of so many of these people has resulted in less of need for so many of the camps. (Tudors and Pearson 2015) We also can’t relate the drop in prison camps to the drop in refugees as the government still enforces tactics of cold and brutal measures such as exile. Research indicates that the prison camps are expensive to maintain, and the government has moved to using exile more and more as a means of getting rid of the unwanted. This involves removing the political criminal from society and placing them in the most remote areas of North Korea with nothing. It is thought that the majority of the people will die as a result. The most remote areas of North Korea, North Korea’s Siberia if you will, is along the border regions in the Northeast. (Tudors and Pearson 2015) If exile is on the rise to these areas, then perhaps refugee organizations should have noted an increase in these types of refugees fleeing; however, there has been no reporting indicating this. This could potentially be that the people placed in exile were in such a bad physical state that making the difficult journey was not possible. It is unknown if this method truly deters defection from North Korea, but the atrocities committed in these places must create a push-pull effect on the people – either pushing those to defect to avoid it or pulling those to stay because they are so scared of getting caught.
If the harsh penal system in North Korea should be a reason for trying to abandon North Korea for a better life elsewhere, despite the consequences for leaving, the environment should be an even bigger concern as it is on the verge of collapse, according to scientists. When discussing the environment, it has to be considered that the people are already struggling to find food, and if the environment continues on this track of failure, the implications of food and water shortages would be historic. According to scientific reports, North Korea’s fresh water supply is polluted and bacteria-infested; there is deforestation and soil erosion on a massive scale. (Villarreal 2012) Forests provide natural environments for creating water and air purification, food provision, ground water recharging, and buffering against natural disasters such as flooding, according to scientific reporting. It has been reported that North Korea has experienced severe losses and damages from flooding, probably as a result of massive deforestation, since the 1980’s. In fact there has been a steady increase of death due to flooding since the 1980’s. (Myeong 2014) This type of environmental failure creates a serious struggle for people to grow food or find water – two major issues that should create a massive surge of fleeing refugees, but experts are not seeing this in the last few years.

With the sharp decline of refugee’s reaching South Korea, an examination of old and new policies is in order to determine if there has been a change that would cause this. Reporting suggests that it is a well-known issue that
previous defectors from North Korea have revealed the countless crimes against humanity that is currently ongoing. Pyongyang has a long history of denying all of its atrocities, and to avoid having to face the music on refugee accusations against the government, they are doing what they can to try and stop the flow, according to press reports. (Human Rights Watch 2014)

However, press reports also indicate that the policy of the new leader, Kim Jong Un, outside of tighter border security, is just a continuation of old policies instilled by his father and grandfather. (Human Rights Watch 2014)

However, other reporting indicates that Kim Jong Un has taken a new and progressive approach beyond just tighter borders. Where there is reportedly an increase in fencing along the border, Kim’s policy also includes stationing more military in the area and rotating those military personnel more frequently to avoid in relationships to form with the population. Relationships between border guards and villagers can weaken the system and open up bribery more easily. In addition, Kim has made the progressive move to allow for labor migration. There is also a growing propaganda campaign highlighting double-defectors who fled to the South then wanted to return to the North. These people are given money and goods to return home to North Korea and tell their story to the public --- mostly to insult the South and its treatment of North Koreans. (Lankov, The Guardian 2015)
Design & Implementation

There are two approaches that were used to try and determine the reason behind the drop in refugee numbers. The first approach is a search for any physical changes along the terrain of North Korea to try and discover additional security barriers preventing North Korean’s from being able to cross the border. GIS tools that included the viewshed analysis and least cost analysis tools were used to designate areas for review using satellite imagery. The second approach is an evaluation of the statistics on the lifestyle of a refugee. A review of refugee economics and placement around the globe was reviewed to determine if the lifestyle post-departure from North Korea can be measured as being worse or on the same scale as living in North Korea. These two approaches were combined to try and add some insight as to why there is a decline in refugee numbers.

Viewshed Analysis:

A review of interviews conducted by human rights organizations indicate that the overwhelming majority of North Korean refugees cross one very important terrain feature to exit the country. That feature is the Tumen River spanning 324 miles along the Korea-China border and emptying into the Sea of Japan. (Encyclopaedia Britannica 2015) (Committee for Human Rights in North Korea 2009) The refugees who successfully have crossed this river without being detected are usually being assisted by paid guides who have made this journey countless times. There is no avoiding crossing this
river; however, even though this river is the third largest in Korea, it is very narrow and shallow, making for a relatively easy crossing as long as there is no threat from border guards on the North Korea or China side. A review of satellite imagery between 2013 and 2015 of the Tumen River showed many places that become frozen in the winter months as well. These areas would also make for an easy crossing, and we know from interview accounts, that many refugees have crossed the frozen sections of the Tumen. (Committee for Human Rights in North Korea 2009) The majority of refugees know to cross with the intention of reaching the Chinese border town of Tumen, a town that has a very large ethnic Korean population who can speak Korean. Through word-of-mouth or the paid guide, the refugee knows that their chances are better of reaching South Korea if they make it to this town first where a church or human rights organization might be able to assist.

Although, reaching Tumen by way of the river requires luck or money. According to Melanie Kirkpatrick, an investigative journalist, a refugee needs luck to evade border guards who think nothing of shooting a fleeing man in the back. Luck will also help him stay clear of the primitive but effective man-traps that are dug into the riverbanks for the purpose of snaring North Koreans who are about to cross the river to China. (Kirkpatrick 2014) The money is needed to bribe guards, if one is so bold and trusting.
The terrain prior to arriving to the river is mountainous and forest-covered. The main mountain range that stands between the refugees and China is the Hamgyong Mountains, also called the Korean Alps. See Map Graphic 1.

Accounts taken from interviews of refugees indicate that many have to cross this range in order to reach China. One woman states, "Three of us walked all night through the mountains." (Committee for Human Rights in North Korea 2009) A second woman says that they climbed the mountains all night before reaching China. (Committee for Human Rights in North Korea 2009) These people travel up and down extreme slopes and dangerous terrain to reach the The Tumen River, the main crossing point, according to interview testimony. One woman discusses her journey, "We crossed the Tumen River after walking all night." (Committee for Human Rights in North Korea 2009). Crossing such terrain is a difficult undertaking as the trek is hard and under the cover of darkness in most cases, but at least during this portion of the journey the refugee is under protection of forest cover. Once they reach the river there are a number of observation points where a refugee can be spotted. Knowing how vulnerable these people are at the river, the first step at trying to find any sort of modification to security in place was to conduct a viewshed analysis in ArcGIS.

Esri, the corporation that created the GIS software and services known as ArcGIS, defines a viewshed in the following way:
A viewshed identifies the cells in an input raster that can be seen from one or more observation locations. Each cell in the output raster receives a value that indicates how many observer points can be seen from each location. If you have only one observer point, each cell that can see that observer point is given a value of 1. All cells that cannot see the observer point are given a value of 0. The observer points feature class can contain points or lines. The nodes and vertices of lines will be used as observation points. (Esri 2012)

In a simplified way of explaining this, the viewshed tool is used to find where the best view of a point will be. In order to run a viewshed analysis, the ArcGIS software requires a digital elevation model (DEM) as an input to account for the many variables of the terrain and visibility factors and then a point file (the area that needs to be visible). For this specific viewshed, a 108-mile x 74-mile DEM of the North Korea-China border was downloaded from the United States Geological Survey database called earth explorer. (USGS 2015) To acquire points needed to run the viewshed I selected twenty-eight points along the river – these points were chosen as they are in the narrowest section of the river and also in close proximity to the town of Tumen.
Map Graphic 1: Mountainous Terrain at Border Crossing

Mountainous Terrain at Border Crossing

Tumen

China

North Korea

North Korea-China border

Tumen (Destination)
Tumen River
Contour in meters

Author: Brandi Hunnicutt
Date: 24 October 2015
Source: USGS
Geographic Coordinate System: WGS 1984
As stated above, the town of Tumen is the first destination for many refugees trying to make their way across the border and to a third country—in most cases that is hoped to be South Korea; however, in many cases these refugees don’t make it out of China or are caught by Chinese law enforcement and returned to North Korea. In addition, these points also reflect the areas of the river that were observed frozen in the winter time making it possible to just walk across the river to potential freedom. It is assessed that by finding the best observation points there is a high likelihood that there should be some sort of security observation point in these locations and if there are not it represents a hole in the security of guarding the border. See Map Graphic 2.

The viewshed was then conducted of all twenty-eight points along a 28-mile area of the Tumen River. The ArcGIS function displays the result in a visible or not visible output. Map Graphic 3.

Once the viewshed was completed it created a raster file that shows the visible and not visible areas. In order to use this data for identification of security posts within these identified areas the raster needed to be converted to a file that could overlay on satellite imagery in Google Earth. The next step in this process was to convert raster to polygon and then polygon to a .km1 file so that the output could be seen atop satellite imagery. This process made it easier to scan the areas of where the visible view of the river would be. See Image Graphic 1.
Map Graphic 2: River Crossing Points

River Crossing Points

North Korea-China border

North Korea

China

Tumen

Map credits:
Author: Brandi Hunnicutt
Data source: USGS
Date: 24 Oct 2015
Projection: Lambert Conformal Conic
Map Graphic 3: Viewshed of River Crossing Points
Once overlaid atop the satellite imagery a thorough scan of the imagery was conducted. The imagery reviewed was both historical and recent, but the historical imagery was not consistent throughout the area researched. In some areas, historical imagery was only available back to 2010; however, in many of the locations there was imagery available dating back to 2002 or 2003 resulting in a more accurate assessment of modifications made in the area. The criteria used for the search was trying to identify structures that appeared to be modified or new between 2002 and 2015 on both the North Korea and China areas. Focusing on China was part of this research as China is a major partner with North Korea on preventing the refugees from successfully reaching a third country like South Korea. (Cohen 2014) It has
been reported in the media and by government organizations that both China and North Korea have increased border security to prevent additional refugees from crossing the border. (Congressional Executive Commission on China 2014) The data that is represented in recent publications indicates that the drop in refugees began just after 2009. (Human Rights Watch 2014) If new structures or modifications could be confirmed between 2009 and 2015, then it could be assessed with moderate confidence that the increased presence along the border has had an impact on the flow of refugees.

**Viewshed Results:**

The viewshed output as seen in the viewshed of river crossing map was overlaid into Google Earth and reviewed in its entirety. The viewshed output covered an area of approximately 22-miles by 11-miles. Historical imagery was compared with recent imagery to determine if there had been any modifications to structures or landscape that could indicate an increase in security posture. This review resulted in identifying eight new structures that were constructed between 2003 and 2010. These structures also all fall within the visible points of the viewshed – possibly further indicating that the structures were placed in these locations to have a good look upon the Tumen River. It is also worth noting that 66% of the new structures were placed in the southern portion of the viewshed search area. See Map Graphic 4.
Map Graphic 4: Identification of New Structures Using Viewshed

Identification of New Structures Using Viewshed Analysis

North Korea-China border

Author: Brandi Hunnicutt
Data source: USGS & Google
Date: 24 Oct 2015
Projection: Lambert Conformal Conic
New structure 1 is assessed to be a probable guard tower. The structure is approximately 10-feet by 10-feet and casts a fairly large shadow - probably indicating that the structure has some height. The height of the structure is indicative of this probably being a guard tower. There is also a clear walking path leading to the structure that was not observed on the historical imagery coverage in 2011. The structure was probably constructed between 2011
and 2013 and sits very close to the bank of the Tumen River, making for an excellent guard tower location.

**Image Graphic 3:**

**New Structure 2, Coordinates: 42.978661 129.916839**

New Structure 2 is assessed to be a probable guard shack. The structure was built between 2011 and 2015 and is 15-feet by 20-feet. This structure also has a clear walking path that formed post-2011 when the structure was built. This structure's position along the bank of the Tumen and good
observation of the river suggests that this is probably a guard shack that was built in the last four years.

**Image Graphic 4:**

*New Structure 3, 42.924681 129.867640*

*New Structure 3* is another structure that sits along the bank of the Tumen River. The location is very near to a tunnel exit/entrance. The structure is approximately 10-feet by 15-feet. This structure is also assessed to be some sort of security structure due to location and visible view of the river.
New Structure 4, 42.830865 129.813492

This new structure is much larger than the previously noted guard shacks or guard towers. The structure is a new building that measures approximately 40-foot by 15-foot and there are two paths, likely for vehicles, that have access points to this building. The vehicle path is unique and interesting in that it forms a perimeter around the area and appears to maybe be for the purpose of performing vehicle perimeter checks. This entire structure and vehicle pathway did not exist prior to 2013. This building resides in an area that used to be part of the river itself; however, since 2013, the area was modified with the existing vehicle path. This area appears to be extremely marsh-like and would serve no other purpose other than being some sort of security point as this area likely is wet most of the year. *Image Graphic 5:*

**North Korea: New Structure 4**
Geographic Coordinates: 42.830865 129.813492

- Date of image: 25 Dec 2008
- Image source: Digital Globe

- Date of image: 09 Oct 2013
- Image source: CNES/Astrium
New Structure 5 measures approximately 10-feet by 12-feet and is probably a guard shack. The shack was built between 2002 and 2008 and is just south of Structure 4, but is not connected by vehicle path. The shack can be reached by a walking trail that connects to the vehicle path that services Structure 4. This structure also sits near the bank and has a visible view of the Tumen River.
Image Graphic 7:

New Structure 6, 42.820056 129.806340

New Structure 6 is assessed to be a probable guard shack and appears to have been some sort of observation point prior to the structure being constructed after 2008. A walking path is present between 2002 to 2015 – indicating that this area has probably been used since at least 2002 as a probable observation point; however, no structure was present until the 2013 imagery. It is possible that this area was modified to become more of a permanent border security location.
Image Graphic 8:

New Structure 7, 42.805251 129.809373

New Structure 7 measures approximately 15-feet by 13-feet and was constructed between 2002 and 2013. The structure is assessed to be a guard shack. This shack also sits near the bank with a visible view of the Tumen River.

New Structure 8, 42.836680 129.817903

New structure 8 measures approximately 30-feet by 10-feet and is 600-feet from the bank of the Tumen River. There appears to be one small access trail to this structure. This structure is further away from the bank of the Tumen than the other previously identified structures. It is possible that this
structure’s position is set further back to gain a wider view of this area. This portion of the river is one of the shallowest and narrow areas of the river, probably making this a preferable crossing point. The area that one could cross without having to touch water is very large at this location.

**Image Graphic 9:**

![Image of North Korea: New Structure](image.png)

**Least Cost Path Analysis**

The **Least Cost Path Analysis** is the second approach used in trying to identify any physical modifications or changes to structures along the path of where refugees have successfully travelled for so many years. A Least cost path analysis is a distance analysis tool within GIS that uses the least cost path or the path between two locations that costs the least to those travelling along it to determine the most cost-effective route between a
source and destination. Cost can be a function of time, distance or other criteria that is defined by the user. (Briney 2014) The thinking behind using this as a strategy for finding potential security modifications was that the tool could be weighted to account for the best route for someone needing to travel under the cover of forests. In many cases this tool is used in the GIS service world to find paths that avoid intervention such as forests; however, in the case of a refugee, a thick forests would be the best way to travel to avoid being detected.

The data files required to conduct this analysis included land cover, the same DEM file used in the viewshed, origin point shapefiles, and destination point shapefiles. According to reporting from the Commission for Human Rights in North Korea, the majority of refugees originate in the Northern most province of North Hamgyong – well over half of all refugees are probably from this province. (Committee for Human Rights in North Korea 2009) Since this area represents the largest population of refugees, I selected three of the major cities in the North as the origin points which include Kyongwon, Chongsong, and Onsong. The destination point is Tumen, China as it is the main hub for the refugees as stated above. The land cover data was downloaded from DIVA-GIS and represents the type of land use across North Korea. The land use data acquired includes forests, shrubs, cultivated areas, and water. The DEM file is used to account for slope as the steeper the slope the more difficult to move through. The least cost analysis tool
combines all of this data and formulates the best route, and in this particular instance, I speculated that the output would be the most likely route of a North Korean refugee trying to travel undetected.

Conducting the Least Cost Path analysis consisted of building a model in model builder that ran a series of tools from the arc toolbox. The tools used included finding slope, reclassify, weighted overlay, cost distance, and cost path. The following steps to create the model included:

Create Toolbox and new model:

- Add a toolbox to arc toolbox: A toolbox was created called "least cost path".
- New model was created within least cost path toolbox
- Model properties were modified for Environment so that workspace, process extent, and raster analysis were all selected.

Build the model:

- Calculate slope by dragging slope tool from Spatial Analyst tools to the model space
- Input the DEM raster within the slope tool leaving Z factor at the default of "1"
- Run the slope tool within the model so that there is data for the reclassifying portion of the model
- Drag reclassify tool from arc toolbox to the model space

- Input the slope output that was previously calculated as the input raster and review the values associated with the slope. For this model the lower values should reflect lower slope degree and the higher values should reflect the higher slope degrees.

- Drag weighted overlay to the model space so that values can be assigned to the land use raster. Lower values are assigned to thick forests as they act as cover for the refugee. Higher values were assigned to cultivated areas and open areas containing shrubs as these areas would be more of a threat to being seen. A weight percentage has to be added to the weighted overlay so that the model knows which to weigh heavier in the output - the slope or the land use. Since travelling under the cover of forests is probably more important to avoid detection than travelling across steep slopes, I assigned the land use a higher percentage than slope. Land use was assigned 60% and slope was assigned 40%. A costs output is added to the model to reflect this weight.

- The next step is to add the cost distance tool to the model space. There are two inputs that need to be added to this tool, the costs output just achieved from the weighted overlay and the destination point.
- The final tool to be added to the model is cost path so that we can now add our origin point that will be connecting to the destination. The cost path tool is added to the model space and the origin point of 1 of the 2 cities of Chongsong or Onsong is added as the input. As stated earlier, these two cities were selected since they are in the Northern Province where the majority of refugees originate.

- Run model for each of the origin points.

- Add least cost path output to display in map.

**Figure 1: Least Cost Path Model**
The result of the output is added to the map display and shows three paths from Kyongwon, Onsong, and Chongsong to Tumen. See Least Cost Output Map below. The output appears to have been successful as the cultivated areas are avoided and the heavy forests areas are predicted to be the best path. As stated above, when reclassifying the land use layer, forests were given a value of 1 – 2 and the cultivated/agricultural areas were given a much higher value of 9 – 10. This data is then overlaid in google earth so that an imagery analysis can be conducted of these paths in search of finding any new or modified structures that could be acting as security watch points -- preventing the refugees from making this journey. See Map Graphic 5.

Least Cost Path Results:

Upon review of the imagery of the paths that ArcGIS determined to be the best path based on the assigned values, there were three new structures discovered along each of the named paths originating from Chongsong, Onsong, and Kyongwon.
Map Graphic 5: Least Cost Path Output
New Structure along Chongsong Path, \(42.955743, 129.966727\)

The Chongsong least cost path is the second to longest of the paths and follows along the Tumen River through the mountainous terrain. It is worth pointing out that there are two other smaller cities along this path that could be considered as being origin points as well. The new structure observed on this route was constructed between 2010 and 2015 and sits along a road that runs through a thick forested area. The structure does have the appearance of being a guard tower, but image quality precluded being able to confirm.

Image Graphic 9:
New Structure along Kyongwon Path, 42.878574 130.171987

The Kyongwon Path is the longest of the three. An analysis of this path showed no new structures less than .75 miles from the path; however, one new structure was observed .75 mile from the path point. A new building had been constructed between 2014 and 2015 and measured approximately 30-feet by 20-feet. There are no other structures in the immediate area and this building sits at an elevation of almost 1,000 feet. A walking trail was also observed leading to the structure. If the trail leads to the entrance, it would indicate that the front of the building faces the Kyongwon least cost path and could be an observation point for looking upon that route.

Image Graphic 10:
New Structure along Onsong Path, 42.955743 129.966727

The Onsong path is the shortest of the three. A new building was constructed between 2010 and 2011 and measures approximately 50-feet by 25-feet. It is possible this building is related to agriculture in the area. The building sits very near to small fields that appear to be used for some type of farming, possibly small-scale farming. There are also no other structures in the area and no major roads. There is one small trail leading to the structure, much like what has been seen in the other structures identified. It is also possible that the farming areas are for sustenance farming – providing food to the isolated building. Many experts have indicated that many North Koreans have to grow their own food to survive. If this is some sort of observation post or remote station, it is possible that some small scale farming could be being conducted to provide food to those who are stationed here.
Image Graphic 11:

Demographic Analysis:

The final method used is an evaluation of the statistics associated with life outside of North Korea. Where the viewshed and least cost analysis coupled with imagery analysis was used to try and find physical security that has been put in place to stop the flow of refugees, an evaluation of lifestyle and hardship was conducted to try and prove that refugee numbers have probably dropped due to low expectations. Choropleth and informational maps were used as the canvas to represent life outside of the DPK with a focus on economics and lifestyle. As stated throughout this paper, there are heavy risks involved in attempting to leave the country. If a refugee choses
to leave alone, they risk exposing their family that stays behind to brutality of imprisonment or labor camps. If a refugee is caught along the way, their fate could be imprisonment or death. A series of unfortunate circumstances could arise as a result of trying to cross the border, and therefore, there is reason to speculate that North Korea’s drop in refugee numbers could be that the risk is just not worth the reward. Getting captured in China is one of many risks. A review of many accounts of refugees indicates that the hard road extends beyond China as China is hopefully just a transfer hub to trying to reach a country of asylum. There are only a few options for a refugee to reach freedom. They have to reach a South Korean consular or reach another country of asylum in South Asia, such as Thailand. Experts have conducted thousands of interviews of North Korean refugees and the data gathered from those encounters sheds a disturbing light on what a refugee has to endure, even once they have reached South Korea.

Demographic Results:

When a group of 1,248 North Korean refugees were polled on what destination they would prefer to live, the results indicate that overwhelmingly the refugees would prefer to live in South Korea or the United States of America; however, the actual refugee numbers do not reflect the preference. (Committee for Human Rights in North Korea 2006)
The overwhelming majority of North Korean refugees have remained in China. As seen above, the reality of where a North Korean wishes to live and where they actually reside are complete opposite. According to multiple sources on refugee numbers, it is assessed that China holds the largest amount of North Korean refugees. The estimates range from 28,000 to 400,000. The huge range exists because refugees reside in China illegally and there is no way of really knowing how many live in hiding. (Nautilus Institute 2015) (Kirkpatrick 2014) (Committee for Human Rights in North Korea 2009)
The following map graphic depicts estimates of the North Korean refugee population around the globe. The data is taken from multiple sources as no database was complete. Many western nations have policies on accepting the refugees as seen below; however, the overwhelming majority remain in China. See Map Graphic 6.

**Map Graphic 6: North Korean Refugee Population by Country**

Even if the number estimates differ, experts do believe that China does hold the largest North Korean refugee population outside of North Korea. There are a few different reasons for this, and the reasons are not because lifestyle is better. China has become somewhat of a trap for so many helpless refugees and the majority of those refugees are women. (Kirkpatrick 2014)
A refugee has a few options on making safe passage out of China; however, these options are not easy and require a network of people willing to help (i.e. aid organizations or Christian missionaries) or money to pay guides. If a refugee can make it to Mongolia or Thailand, the chances are good that they will be able to receive assistance to be sent to South Korea for settlement. China is a very big country and making either of these journeys without being caught by police or suffering at the hand of the natural environments of the Gobi desert or the Southeast Asian jungles requires a lot of luck, skill, and a will to survive. Where there are many refugees that have successfully made this journey, experts don’t know for sure how many have died trying to traverse the unforgiving terrain. Melanie Kirkpatrick states in her book, "Somewhere in the Gobi Desert stands a cross in the sand. It marks the grave of Yoo Chul-min, a ten-year-old North Korean boy who died while walking across the Chinese border to Mongolia." (Kirkpatrick 2014) See Map Graphic 7:

Although, so many do not make this journey not for a lack of trying, but as a result of China’s policy of repatriation to North Korea or exploitation of human traffickers. As previously mentioned, China and North Korea have a refugee agreement policy. Human Rights organizations state that, the Chinese policy of complicity with North Korea puts North Koreans in a permanent state of fear once in China. Their exploitation in China is almost
guaranteed by this practice; they are pushed into low-wage “dirty, difficult, and dangerous” work. (Committee for Human Rights in North Korea 2009)

Map Graphic 7: Journey from China to Mongolia

Other areas in which they are forced is marriage. Women are lured even from within North Korea to China for the purpose of becoming brides to the many unmarried Chinese men living in rural Northeast China. According to North Korea Now, a human rights organization for North Korean refugees, of the tens of thousands of North Korean refugees hiding in China, in 2008, it
was estimated that a disproportionate number, nearly two-thirds of the refugee population, were women. Of these women, 70 to 80 percent of North Korean refugee women are trafficked into forced marriages, commercial sex exploitation, and exploitative labor. (North Korea Now 2015)

There are four main provinces in Northeast China where the majority of North Korean refugees settle; three provinces along the border with North Korea and Shandong Province where there is a very large South Korean population. The three provinces along the border are Heilongjiang, Jilin, and Liaoning and consists of rural farmland and is considered to be relatively poor and underdeveloped. (North Korea Now 2015)

The ratio of marriageable age male to female in these regions is 14:1 in some parts. This imbalance can be attributed to China's one-child policy and the Chinese preference of having a male child over a female child. This selective method of choosing to have males predominantly over females has created the significant imbalance between men and women. Unfortunately, the imbalance has also created the need to import brides made up of unknowing participants who are either intercepted once they cross the border or are lured from North Korea with lies of having a better life once in China. (North Korea Now 2015) (Committee for Human Rights in North Korea 2009) The tales that these trafficked women provide are both sad and disturbing, and sets up the question of whether staying in North Korea would
have been the better choice than a life that is forced upon them. These vulnerable women went from one forced life to another.

The accounts of three North Korean women refugees below paint a picture of the inhumane treatment of these people who were just trying to leave one bad situation for a better life.

“Only when we arrived in a village in Heilongjiang did I hear that I was going to get married. I didn’t have a choice because I didn’t even know where I was.” (Kirkpatrick 2014)

“We met with one ethnic Korean man by chance, and he said we should get married to a Chinese citizen to be safe. While I was not sure whether I should follow him or not, he took me to Mishan in Heilongjiang and sold me to a Han Chinese man.” (Kirkpatrick 2014)

“I crossed the Tumen River with three other people, and we all went to the house of ethnic Koreans nearby. This household had an orchard. They let us work there for a while, giving us food and shelter. Once day, three men, including one dressed in a soldier’s uniform, came in a taxi and took me to Longjing, where I was sold to an ethnic Korean man.” (Kirkpatrick 2014)
Some of these women are able to run away from these lives of forced marriage, but unfortunately, they run to the sex trade business in Shandong province. Shandong province is home to an estimated 300,000 ethnic Korean’s and there is reportedly 80,000 South Koreans living in Shandong due to the import of South Korean companies to the area. The presence of so many ethnic Korean’s makes it appealing for North Korean refugees because the presence of so many of a similar culture and language could offer up an opportunity to be able to work and save money to go to South Korea. A booming sex trade business has made it so a refugee can earn ten times as much in a month than working as a waitress in a Korean restaurant. (Committee for Human Rights in North Korea 2009) Many of these women do try and save money to get to South Korea, but also many send money back to their families in North Korea. It is hard to make a determination on which life is worse, a life in North Korea, a life as a forced bride, or a life in the sex trade business. It is all an unfortunate circumstance. See Map Graphic 8.

If the ultimate goal and preference of a refugee is to reach South Korea then it must be the best of all options. Of the major refugee population centers that include the four provinces in China, North Korea, and South Korea, South Korea does offer the best economic situation.
South Korea isn’t only the best choice because the economic situation is better, but it makes more sense culturally. Many North Korean’s have extended family in South Korea, language similarity, and they remain close to North Korea where they can potentially make connections to the family that remain in North Korea. However, as it has seemed throughout this paper, the lives of the refugees are a story of continual hardship. Their search for freedom is an endless battle against abuse, discrimination and loneliness. (Shako Liu 2012) Where the statistics show that the average salary of a refugee is $16000 per year, a few thousand less than a sex trade worker in Shandong province, the type of work that is offered to the refugees are the worst of jobs that the average South Korean does not want to do. In South Korea the jobs are called 3D – dirty, dangerous, and difficult. (Pohl 2015) Much like the lives of many refugees around the world, the North Korean refugees suffer the same economic fate due to a lack of training, relatable education, and skills. The Asian Institute for Policy Studies reports that, 40% of of the North Korean refugees living in South Korea are children and young adults aged 10 to 29. Among the many challenges faced by these young North Korean refugees are different from adults’, such as gaps in physical health and socio-economic status, psychological health issues such as post-traumatic stress disorder (PTSD), and bias towards the North Korean refugees that are widely prevalent in schools and workplaces.
These obstacles prevent these youth from successfully integrating and having an opportunity at a life like their South Korean-born peers are able to achieve. Reporting from 2014 suggests that, new refugee arrivals suffer from six times the unemployment rate of the regular population and this can clearly be attributed to the cultural gap in terms of education, work ethic, and financial goals. The defector’s transitions could not be more extreme. (Ghandi 2014) See Map Graphic 9.

**Areas for Further Research:**
Between the imagery findings of increased security and a review of the results of income disparity and difficult hardships experienced by the refugees, the results indicate that there are two barriers preventing them from successfully reaching freedom. The barrier of observed physical modifications to the security along the border and a depressing outlook of life beyond the border. If a refugee can successfully cross the border exiting North Korea, the number of other hardships facing them is probably a major factor as to why there has been such a drop in the number of refugees.

It has been reported by a number of sources that the North Korean people are becoming more connected to the outside world through illegal cell phones smuggled into the country.
Map Graphic 9: Economics of a North Korean Refugee

Economics of a North Korea Refugee by Major Population Center

These three Northeast provinces represent the largest population centers of refugees. This is also the poorest of areas and hardest for finding work. The majority of those who live here are women who were forced into marriage.

Shandong Province, China holds one of the largest population centers of North Korean refugees. The variance in salary is dependent on if the refugee is in the sex trade (higher salary) or customer service trade such as waitress (lower salary).

Refugee Salary by Major Population Center
- $0 - $1250 per year
- $360 - $480 per year
- $780 - $19000 per year
- $9400 per year

Where salary is higher in South Korea, a North Korean refugee salary is 40% lower than the South Korean population.

Author: Bindi Hunnicutt
Projection: Asian South Lambert Conformal Conic
Source: Multiple Sources
This provides a communications network to family members or friends that have escaped. It is possible that their tales of trafficking, income inequality, and discrimination is deterring the North Korean people from trying to endure the long journey ahead that potentially could take years to come to fruition.

The United States does not have good diplomatic relations with North Korea and therefore exposing North Korea for stepping up border security for the purpose of preventing their people from leaving probably would not change policy. We do know from media reporting that the DRPK has worked very hard at trying to prevent the exit of the refugees because they expose the regime and the country. (Kim 2013) (Mandel 2014) It is possible the imagery findings of North Korean border security could be used to embarrass the regime and discount their constant propaganda that the people aren’t leaving North Korea because they prefer to stay, but rather North Korea has taken efforts to force the stoppage. Another usage of the findings is to provide some exposure to China as well. Sitting between the refugees and their freedom is China. The continued research into the population centers of China and the existence of such a horrific human trafficking trade could expose China in a light that they would prefer to keep quiet. This is also an area that South Korea could potentially address since the ethnic Koreans that live in Shandong province are such a huge factor in the sex trade practices. (Committee for Human Rights in North Korea 2009)
This project attempted to identify factors stopping the flow of North Korean refugees, but really only scratched the surface. Areas for further research could be to continue the search for the modification of security but with the use of higher quality imagery. The imagery used in this study was what was available on Google Earth. If high quality imagery consisting of more frequent collection could be purchased from a commercial imaging company the results could be more extensive. In addition, since China could potentially be pressured on this topic, a continued look at China’s security increases along their border could also be researched more intensely. China belongs to the United Nations Refugee Convention. China acceded to the Convention in 1982, which is the core international doctrine pertaining to rights of refugees, and its disregard for protection of North Korean defectors and asylum-seekers is perceived as noncompliance to its obligations, according to Eunbee Chung of Yonsei University. (Chung 2012) Estimating where China has contributed to physical barriers of these refugees is something worth exploring since the United States and South Korea have diplomatic room to possibly make headway.
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